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Urban Water Supply System and Its Management in Ward-16 under Rajshahi City Corporation, Rajshahi

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Abstract

Water supply problems in urban areas vary greatly with poor settlement areas. While most cities have provisions for pipe-borne water supply, the challenge for poor settlements is the lack of provision for the supply of pipe-borne water. This study provides an understanding of the potential and challenges for sustainable water supply in urban poor settlements as the basis for intervention. Eleven settlements were identified, cutting across Ward 16 in Rajshahi City Corporation areas. A sample size of 571 households was drawn from 5011 households constituting questionnaires. Water samples were collected from different sources of water used by the communities in the poor settlement. A total of 29 water samples were collected for laboratory analysis, and a total of 8 types of water quality tests were performed. Results reveal poor access to pipe-borne water and over-dependence on boreholes; valuable time is lost to water fetching. Among the challenges to be surmounted to ensure sustainable water supply are poor physical conditions in poor settlements, poor management of metropolitan growth, and water supplier challenges. Among the samples, fecal coliform was found in 13.75%, turbidity was higher in 31%, and iron was higher in 38%, which is injurious to health. It is recommended that a comprehensive land use plan be prepared that covers the metropolis and poor settlements, legal recognition for the existing poor settlements, expansion of the capacity of the water treatment plants, and provision of public boreholes to meet water supply in the interim.

***Keywords**: Sustainable; Challenge; Water Supply; Poor Settlements; Water Quality.*

1. Introduction

Water is the primary need to sustain life; every citizen in the country has the right to have access to potable water. The provision of safe and adequate water supply services is a necessary component of sustainable development (Azad, & Fan, Q.2017). The provision of adequate supplies of potable water for use in urban areas in developing countries is crucial for the well-being of the people. The demand for such supplies in developing countries has been on the rise over time because of rising standards of living that occur with economic progress and population increases resulting from natural growth, rural-urban migration, and rising per capita income (Bodrud-Dozaa, et al., 2020). The estimated water supply service level in Bangladesh in terms of coverage, quantity, quality, and reliability is very low. A well-performing urban water supply system should provide water supply for human and livestock consumption, industrial, and other uses in terms of coverage, quantity, reliability, and acceptable quality, taking the existing and future realities of the city into consideration (Islam, et al., 2020). This research paper assessed and evaluated the performance of Ward 16 in the Rajshahi City Corporation water supply system in terms of main performance indicators such as water supply coverage, water quality, operation and maintenance, and customer satisfaction, and recommended solutions for improving the water supply service. Regarding coverage and water availability, the capacity of the water supply system, which encompasses sources, transmission, storage facilities, and distribution systems, should satisfy current and future demands (Mahmud, 2021). In the case of Ward 16, Rajshahi City Corporation, the sources do not satisfy the demand of the present and future population, and the distribution system does not cover the whole part of the selected area (RCC, 2023). There are poor settlements in the town that are out of the reach of distribution pipes but unavailable of water most of the time. In addition to insufficient water supply coverage, high water

loss, and water quality issues, these are the major challenges facing Ward 16 in the Rajshahi City Corporation water supply system. As the water lost is non-revenue water, it also has economic effects because the water utility is losing revenue. High leakage also contributes to water quality risks due to the infiltration of contaminants, especially in areas with poor sanitation.

2. Methodology

2.1 Study Area

Rajshahi is Bangladesh's largest metropolis and a major urban, commercial, and educational center. It is also the administrative center for the division and district of the same name. The city has a population of approximately 763,580 people and is located on the north bank of the Padma River, near the Bangladesh-India border. It is located in Bangladesh's central highlands at latitude 24°23'29.8" N and longitude 88°35'55.3" E. Rajshahi has a tropical wet and dry climate, according to the climatic classification. Ward 16 (Koyerdara area) can be noted as a possible area for major planning due to its reasonable distance from the city center and possibility for decentralization. To maintain Rajshahi's ecological balance, the overcrowded population of the city center can be relocated to Ward 16. This report highlights the current state of the poor settlement areas as well as the issues that residents there deal with on a daily basis.

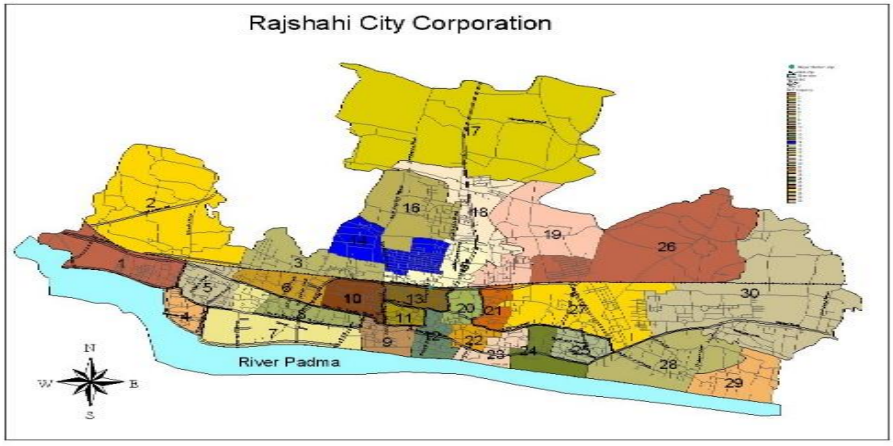

Figure 1: Existing Map of Rajshahi city Corporation

2.2 Data Collection

Data on the quality of two different types of water sources was gathered for the study. All of the primary data were gathered through field research, and secondary data came from a variety of sources. In order to determine whether it would be appropriate to provide a comprehensive plan for the site, the study area was visited and thoroughly examined as part of the reconnaissance survey. Planning a sustainable neighborhood area based on total population, total household, poor settlement, water consumption condition, and customer happiness after gathering all necessary data for the residents of the disadvantaged settlements, various surveys regarding the water supply facilities have been devised. To identify the water quality and water supply system, water quality has been verified throughout the year using Rajshahi WASA data and physical surveys. After compiling all the information, ward-16 in Rajshahi Municipal Corporation's water supply system, water quality, management system, and maintenance gap have been discovered.

The most important component of research activity is gathering data. Data on the required model simulation input parameters, water losses, and system leakage management trends were acquired in order to complete this task. The methods for gathering data were field visits and data collection in Ward -16 from about January 2022 to April 2023. Data on water production, water consumption, and water quality were obtained from the town water supply office, UNDP, various organizations, Design reports from the previous consulting offices were used as secondary data in this research.

2.3 Assessment of Customer Satisfaction

The primary assessment of customer satisfaction, especially for poor settlement, was done based on the water quality outputs and the operation and maintenance by comparing them with national and international standards. Random sampling is used to distribute the questionnaires, but the total sub-system area is considered.

2.4 Assessment of Water Quality

Water samples were taken from a number of the town's water sources that are used by the communities. For laboratory examination, a total of twenty-nine water samples were gathered, of which twenty-one samples came from inside of homes (tube wells), eight samples came from outside of homes (tube wells), and a total of twenty-nine samples were taken. Additionally, samples were taken from two upgraded water sources. Physiological, chemical, and biological parameters have been tested to ensure water quality. A total of eight tests were performed here. The tests are like PH, TDS, turbidity, arsenic, fecal coliform, iron, manganese, and chloride. Samples collected from house connections and public fountains were taken to the DPHE authority laboratory, and the physical, chemical, and biological characteristics of the ward-16 water have been analyzed.

3. Results and Discussion

3.1 Water Demand

The total water production by Rajshahi WASA is 95.00 ml (95000 cubic meters per day). 89.00 ml of water is extracted from underground water, and only 6.00 ml of water is from surface water. The total water supply through the pipeline network provided by Rajshahi WASA is 780.50km. The number of water supply subscribers is 46,851. The total water demand is 113.29 mld (113290 cubic meters/day), but 95.00 mld of water is supplied by Rajshahi WASA. However, to supply this water, Rajshahi WASA demands a charge from the households in Rajshahi City. The water average tariff (demand) by Rajshahi WASA is 4.18 taka per cubic meter. The annual maintenance cost for the water supply is 1500.00 lakh taka, and the annual water bill demand by Rajshahi WASA is 782.43 lakh taka. But the yearly income of Rajshahi WASA is only 507.42 lakh taka. So, the government gives a huge subsidy to the Rajshahi WASA for supplying water in RCC. On the other hand, within 2035, about 3 lakh people might be added as new citizens in the RCC. So present water demand (113290 cubic meters per day) will surely increase in the near future. To meet this water demand, Rajshahi WASA has undertaken some projects and proposed some important projects so that they can ensure customer satisfaction and adequate water supply for future generations. Recently, some activities have been taken to ensure and meet the present water demand by the concerned authority.

3.2 Customer Satisfaction

As per the information obtained from senses-2022, a total of 19,042 people live in Ward 16, and there are a total of 5011 private houses and institutional, commercial, and industrial customers. The survey covers around 9% of the total population, around 571 HH. The customer's poor settlement response to water usage satisfaction is presented in Figure 2.

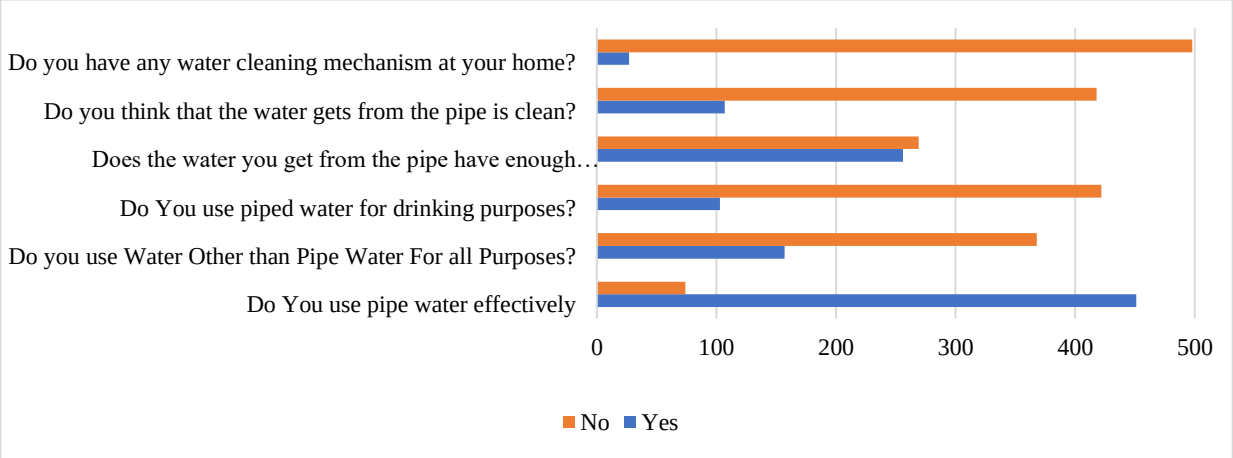

Figure 2: Customer response on water usage

3.3 Water Quality

The results of the water samples taken from all existing sources, selected households, and public fountains in comparison with the international (WHO) and national (Bangladeshi) standards are indicated in the table below. Water quality results for water samples were taken throughout the year. Sample (ward 16) taken from a selected household the results are shown in Table 1:

Table 1. Groundwater qualities in the study area

Sample SL	Depth (feet)	Arsenic (0.05)	Iron (0.3-1)	Manganese (0.1)	Chloride (150-600)	Fecal Coliform (0)	TDS (1000)	PH (6.5-8.5)	Turbidity (10)
Sample 1	140	0.001	0.4	1.9	150	0	1000	7	2.5
Sample 2	125	0.001	2.7	1.2	140	0	1022	7	9.6
Sample 3	120	0.001	0.3	1.8	85	0	1020	7	3.3
Sample 4	165	0.027	4	0.6	65	0	701	7.1	50.9
Sample 5	155	0.061	1.1	1.2	115	0	970	7.2	7.9
Sample 6	160	0.001	0.4	0.01	50	75	715	7.2	9.4
Sample 7	155	0.004	0.4	0.05	80	0	657	7	8.5
Sample 8	145	0.001	0.3	0.7	35	0	753	7.2	7.9
Sample 9	155	0.022	10.3	0.27	90	0	605	7	169
Sample 10	160	0.001	3.4	1.32	68	0	530	7.2	50
Sample 11	160	0.044	8.8	1.28	135	0	865	7.1	141
Sample 12	155	0.006	0.9	0.6	72	0	570	7.2	5.6
Sample 13	155	0.046	3.3	1.1	28	0	470	7.1	12.6
Sample 14	140	0.054	8.5	0.6	100	0	850	7.1	105
Sample 15	180	0.001	0.5	1.5	15	0	396	7.3	4.2
Sample 16	140	0.001	1.4	0.5	65	0	506	7.2	41.3
Sample 17	145	0.049	0.5	0.78	48	250	492	7	7.1
Sample 18	165	0.101	3.5	0.2	10	0	427	7	52
Sample 19	155	0.008	0.5	0.73	60	0	540	7.2	5.6
Sample 20	170	0.217	1.5	1.14	60	0	530	7.1	23
Sample 21	155	0.194	1.6	1	23	0	440	6.9	9.7
Sample 22	140	0.041	0.1	0.8	36	0	460	7.2	0.5
Sample 23	140	0.104	0.2	1.2	30	0	540	7.1	2
Sample 24	140	0.101	0.3	0.4	90	0	745	7.1	2.7
Sample 25	140	0.005	0.1	0.5	78	0	715	7.1	1.3
Sample 26	140	0.001	0.8	2.5	60	5	700	7.9	3.2
Sample 27	130	0.001	1	2	30	5	675	7.9	7.3
Sample 28	125	0.001	0.8	0.8	95	0	825	7.8	1.4
Sample 29	145	0.033	0.9	0.5	90	0	781	7.9	5.8

3.4 Customer Satisfaction

Consumer satisfaction in poor settlement areas is closely related to the acceptance and preferences of the customers. Satisfaction is the fulfillment of the desire for a stated good or service. The extent to which a consumer is satisfied with a good or service is therefore determined by the perceived performance of the utility, which is an evaluation of that good or service in light of the consumer's needs. If the utilities know what customers regard as important and if they can gauge to what extent their customers are satisfied, they can devise strategies aimed at improving the aspects of services vital to the customers. Out of 525 valid respondents to the question about the effective use of water, 86% responded yes to the effective use of pipe water, and 30% responded yes to alternative sources of water for daily purposes. On the other hand, only 20% use piped water for drinking water, and about 49% say they get enough pressure on the pipeline. About 20% say they get clean water from pipelines, and only 5% have water-cleaning mechanisms in their house. Here is another finding we get: due to frequent pipe water interruptions in the town, most industrial, commercial, and public institutions use their own sources for different purposes.

3.5 Water Quality

The PH value of all taken water samples is within the range of national and international standards. The TDS value for all samples is within national and international standards. However, this does not mean that the water utility is working well on the quality of the pipe water supply because the observed TDS value in three samples is high. The turbidity in the samples taken from nine sources is higher than both national and international standards. Turbidity is an important parameter for drinking water because it can affect the appearance, taste, and safety of the water. High turbidity can indicate the presence of suspended particles, such as sediments, clay, and organic matter, which can make water appear cloudy, discolored, and unappealing. The reason why turbidity is higher in Ward 16 is through broken water lines, rusted water pipes, mud, sand, and other waste materials that may be mixed with the waterline and create higher turbidity. Arsenic in the samples taken from six sources is higher than the limited value. There seems to be a higher chance of arsenic contamination in the human body. The total coliform for 4nos samples is far from both national and international standards. This shows that drinking water sources can be contaminated by stormwater run-off from roadways, farms, and livestock operations and discharges from sewage treatment or septic systems. The presence of coliform bacteria in water does not guarantee that drinking the water will cause an illness. Rather, their presence indicates that a contamination pathway exists between a source of bacteria (surface water, septic system, animal waste, etc.) and the water supply. Disease-causing bacteria may use this pathway to enter the water supply. system, and corrosion can result in the contamination of drinking water and adverse effects on its taste and appearance. The chlorine content in all samples taken is below both international and national standards, as shown in the table. The iron in the samples taken from 12nos sources is higher than both national and international standards. Manganese in the samples taken from 10nos sources is higher than both national and international standards. The samples water quality parameter comparison is shown in Figure 3.

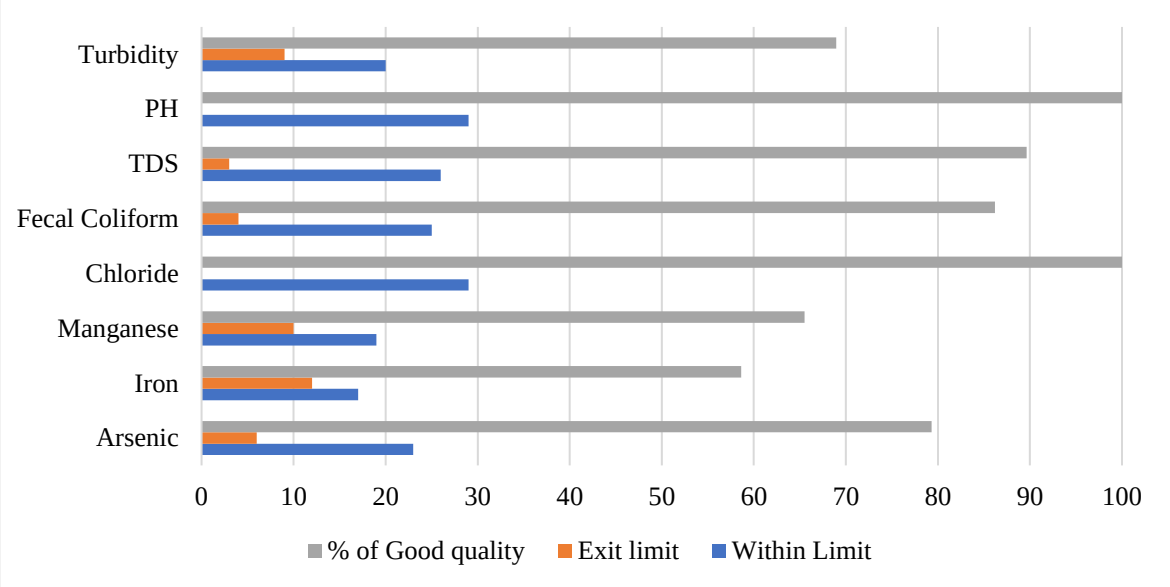

Figure 3: Water Test result findings

4. Conclusion

The existing water distribution system in Ward 16 of Rajshahi City Corporation was established for a small population but upgraded to a population of approximately 19,042. However, as per this research, the biggest challenges observed are that there is poor operation practice in the water utility and all the households are not yet connected to the water supply network. Most of the boreholes are currently not operational, and this makes the ward face a pipe water problem. Due to the lack of proper maintenance practices, there are also a lot of pipes and valves that are closed and not working at this time. Accordingly, the water distribution network faced frequent pipe bursts and failures during low-demand times and was exposed to large volumes of water loss, especially in high-pressure zone areas, while during high-demand times, mostly residences found in dense populations and higher levels of the town were not receiving and/or serving continuous water from the system. Due to a lack of operation and maintenance practices, the water loss in the town goes up, which makes the water demand and supply unbalanced. Water quality management is also not a guideline of national and

international standards, as some parameters depart from these guidelines. This also clearly shows that there is a lack of operation and management in the water supply line based on customer satisfaction. In general, the main problem in this ward can be generalized as the problem of operation and challenges to ensuring the quality of water supply in the poor settlement areas and also ensuring safe drinking water for the poor settlement people.

There should be structured operation and maintenance practices to improve the whole pipe water system in this ward. There should be planned and regular routine inspections for leakage from water supply system components such as transmission and distribution pipes, reservoirs, collection chambers, and pump houses. It is recommended that bacterial and chemical water quality tests be conducted periodically (at least two times a year). And as indicated in the WHO guideline for drinking water quality, the bacteriological test should be accompanied by turbidity, free residual chlorine, pH, and coliform, where chlorination is applied. The water utility should respond immediately to maintenance requests from customers to avoid water loss and complaints from customers, and it needs to have regular discussions with the customers. The water utility should also conduct a regular survey to know customers' satisfaction levels and make improvements to its service to increase customer satisfaction and ensure sustainable development in poor settlement areas.

6. References

Islam HMS, Jamal M, Ahsan MA, Ahmed S, Akter S, Sultana R, Nahar A, Uddin MR. (2020) Physicochemical and microbiological quality of potable water supplied by DWASA in dhaka city of Bangladesh. American Journal of Biological and Environmental Statistics. 2020;6(1):1-6. DOI: 10.11648/j.ajbes.20200601.11

Bodrud-Dozaa M, Islam SMDU, Rumed T, Quraishie SB, Rahmane MS, Bhuiyan MAH. (2020) Groundwater quality and human health risk assessment for safe and sustainable water supply of Dhaka city dwellers in Bangladesh. Groundwater for Sustainable Development, 2020;10:1-12. DOI: https://doi.org/10.1016/j.gsd.2020.100374

Azad, A. K. & Fan, Q. (2017, September 12). Towards a cleaner Bangladesh - safe water, sanitationand hygiene for all. The Financial Express. https://thefinancialexpress.com.bd/views/towards-a-cleaner-bangladesh-safe-water-sanitation-and-hygiene-for-all-1505225835 (Accessed on 12November, 2022)

Mahmud, R. (2021). Citizen satisfaction in the service delivery of city corporations inBangladesh. Scholars Journal of Research in Social Science, 1(2), 1-13. DOI: 10.5281/zenodo.5703382

RCC (2023). Information collected from conservancy department of Rajshahi City Corporation, Personal communication.