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Evaluating Water Stations' Management Performance in Providing Safe Drinking Water: A Case Study of Tikrit's Water Stations

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Keywords:
Project management; SWOT; Water treatment; Water turbidity.

Highlights:

- *Tikrit water stations meet 100% of pH, TDS, and chlorine standards but fail turbidity tests (17.5% compliance).*
- *SWOT analysis reveals critical weaknesses: neglected maintenance and lack of specialized staff.*
- *Temperature rise correlates with increased turbidity (R = -0.345), impacting water quality.*
- *Study uses field inspections and lab tests to assess 10 stations, identifying key improvement areas.*

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Abstract: The quality of drinking water must adhere to the standards set by the World Health Organization, including limits on pollutants, sediments, dissolved minerals, chemical compounds, and the absence of harmful bacteria. Some developed countries have even stricter standards than those set by the World Health Organization; as a result, producing safe drinking water in these countries requires more complex and expensive treatment methods. The present study assesses the water stations performance to provide safe water for human use. The assessment focuses on the efficiency and effectiveness of the studied stations, including their ability to consistently meet required laboratory test results and infrastructure standards. The study also identifies any weaknesses in operating each station to improve them. The Strengths, Weaknesses, Opportunities, and Threats (SWOT) method is used to assess the current and future state of a particular work environment, to identify internal positive and negative factors, as well as external opportunities and threats. The water stations in Tikrit were chosen to assess the condition of their equipment, machinery, and pipelines. Monthly tests were conducted according to the Tikrit Water Department's guidelines, focusing on temperature, pH level, dissolved salts, and turbidity. Samples were gathered over four months. The results were analyzed and compared with standard specifications to identify the stations' strengths and weaknesses. Ten water treatment stations were chosen to participate in the study and gather the necessary data. The study showed that water stations in Tikrit met most water test specifications, scoring 100% in total dissolved solids, pH level, chlorine, and temperature tests. However, they lack specialized and regular personnel, as identified in inspections and examinations. The results of turbidity testing showed that the station met specifications only (17.5%) of the time and deviated from them by (82.5%). The station data showed a weak relationship between turbidity and the other tests, except for temperature, which had a simple relationship with turbidity with (-0.345) Correlation Coefficient. As temperature increased, evaporation and water consumption rose, leading to more sedimentation and increased turbidity to a certain extent.

تقييم أداء إدارة محطات المياه في توفير مياه شرب آمنة: دراسة حالة لمحطات المياه في تكريت

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الخلاصة

يجب أن تتوافق مياه الشرب بجودة تعادل المعايير التي وضعتها منظمة الصحة العالمية. وتشمل هذه المعايير حدودًا للملوثات، الرواسب، المعادن الذائبة، والمركبات الكيميائية، بالإضافة إلى تقليل البكتيريا الضارة. بعض الدول المتقدمة لديها معايير أكثر صرامة من المعايير التي وضعتها منظمة الصحة العالمية، مما يعني أن إنتاج مياه شرب صحية في هذه الدول يتطلب طرق معالجة أكثر تعقيدًا وأكثر تكلفة. تهدف هذه الدراسة إلى تقييم أداء وكفاءة محطات المياه في توفير مياه آمنة للاستخدام البشري. وتركز على كفاءة وفاعلية هذه المحطات، بما في ذلك قدرتها على الالتزام المستمر بنتائج الاختبارات المختبرية المطلوبة ومعايير بنيتها التحتية. كما ستحدد الدراسة أي نقاط ضعف في تشغيل كل محطة لمعالجتها وتحسينها. تم ادخال تقنية تقييم وادارة جديدة وهي تقنية نقاط القوى والضعف. يعدّ تحليل القوة والضعف والفرص والتهديدات (SWOT) وسيلة تُستخدم لتقييم الحالة الحالية والمستقبلية لبيئة العمل معينة، بهدف تحديد العوامل الداخلية الإيجابية والسلبية، بالإضافة إلى الفرص والتهديدات الخارجية. تم اختيار محطات المياه في تكريت لتقييم حالة معداتها وآلاتها وأنابيبها. تم إجراء اختبارات شهرية وفقًا لإرشادات دائرة مياه تكريت، مع التركيز على الفحوصات المهمة وهي درجة الحرارة، مستوى الحموضة، الأملاح الذائبة، والعكارة. تم جمع العينات على مدى فترة أربعة أشهر، وتم تحليل النتائج ومقارنتها بالمواصفات القياسية لتحديد نقاط القوة والضعف في المحطات. تم اختيار عشر محطات معالجة مياه للمشاركة في الدراسة وجمع البيانات اللازمة. تظهر الدراسة أن محطات المياه في تكريت تلبي معظم مواصفات اختبارات المياه، حيث حصلت المحطات على مطابقة تساوي ١٠٠٪ في اختبارات المواد الكلية الصلبة الذائبة والاس الهيدروجيني والكلور، ودرجة الحرارة من حيث مطابقتها للمواصفة القياسية.و تظهر نتائج اختبار العكارة أن المحطة تلبي المواصفات فقط بنسبة (١٧,٥٪) من الوقت، وتنحرف عنها بنسبة (٨٢,٥٪). تُظهر بيانات المحطة وجود علاقة ضعيفة بين العكارة والاختبارات الأخرى، باستثناء علاقتها مع درجة الحرارة التي لها علاقة بسيطة مع العكارة بمعامل ارتباط (-٠,٣٤٥), وهذا يرجع الى ان زيادة درجة الحرارة، تزداد عملية التبخر واستهلاك المياه، مما يؤدي إلى المزيد من الترسيب وزيادة العكارة إلى حد معين. كما ان اغلب المحطات تفتقر إلى تواجد الأفراد المتخصصين والموظفين الدائمين والذي يقع على عاتقهم تشغيل المحطة وادامتها.

الكلمات الدالة: إدارة المشاريع، تقنية نقاط القوى والضعف، معالجة المياه، عكورة المياه.

1.INTRODUCTION

Water quality is determined by its physical, chemical, and biological properties, with impurities that can be suspended or dissolved. These impurities are often reduced or removed to make water suitable for drinking. The permissible level of impurities varies depending on the intended use of the water [1]. Drinking water should be clear, free from impurities, safe for consumption, and have a pleasant taste and odor. Any change in color, taste, or odor indicates water pollution [2]. Water is typically pure at its source but becomes polluted as it flows through rivers and encounters pollutants. The purification process includes sedimentation, filtration (using sand filters in Iraq), and chlorination to remove impurities and microorganisms. Intermediate steps are crucial for further purification, as water can spread diseases and parasites. The aquatic environment also plays a role in the life cycle of pathogens, with reports confirming that 80% of infections in developing countries are linked to water pollution [3]. Water purification and treatment should be prioritized, not just for domestic use, but also to prevent the discharge of toxic chemicals into rivers that can cause diseases. The effectiveness of treatment plants relies on the processes used for purification and disinfection, as well as the performance of the personnel [3, 4]. Many studies have focused on analyzing and studying the characteristics of water used for human consumption, whether from rivers, pumping stations, or the tap. Typically, various physical and chemical properties are examined, including turbidity, pH level, total dissolved solids (TDS), electrical conductivity, total hardness (TH), chloride, fluoride, and sulfates. These values are then compared to the standard specifications determined by the World Health Organization or the concerned country [4]. One of these studies focuses on removing turbidity through Water Treatment Plants (WTPs) designed to meet Iraqi specifications. Of the samples collected, 13% exceeded specified limits, with the highest levels at the Aldanadan and Alsaheroon plants. The Duncan test showed significant differences in turbidity levels among the WTPs. Alsaheroon, Alghzlani, and Aldanadan showed the highest residual turbidity, calling for urgent improvements in the turbidity removal processes at the WTPs [5]. The World Health Organization's statistics show that over five million people die each year from water-related diseases caused by water contamination. Furthermore, 50% of the population in developing countries suffer from illnesses linked to water pollution, with 80% directly tied to water contamination. As a result, waterborne diseases lead to the death of one-fourth of children in these countries before they reach the age of five [6]; therefore, it is important to consistently monitor and follow up on water quality to ensure the ongoing availability of safe drinking water and for various other uses. Effective mechanisms should be in place to promptly and efficiently identify and treat pollutants to safeguard public health and the environment from the adverse effects of water pollution. Multiple tests have shown water pollution, with turbidity considered a crucial indicator of water contamination. Water filtration and treatment plants prioritize removing turbidity because it provides a breeding ground for various disease-causing organisms, microorganisms, and bacteria [7]. The present study aims to identify the weaknesses and strengths in the management of water treatment plants. This aim will be accomplished through two main approaches: By performing essential tests on the water discharged from the plants and evaluating the performance of each plant through field visits to assess the condition of pumps, water filters, sedimentation basins, treatment facilities, and the effectiveness of the operating staff. This study is unique because it evaluates performance and utilizes the strengths, weaknesses, opportunities, and threats (SWOT) technique to present the results.

2.RESEARCH SIGNIFICANT

Drinking water should follow the World Health Organization's standards by having pollutants, chemical minerals and harmful bacteria within acceptable limits. The research focuses on the performance of Tikrit water stations to confirm that the water provided is hazard-free. Its importance comes from multiple areas:

1- Achieving Health Standards: The research makes sure the water stations are applying required health standards, thus leading to safer drinking water for people.
2- Identifying Weaknesses: The investigations highlight mistakes in station operating which supports efforts to improve the performance and efficiency of water treatment processes.
3- Using SWOT Analysis: By using this research, officials can find out which internal and external factors impact the stations and plan better ways to boost services.
4- Impact of Environmental Changes: The research reveals how environmental factors such as temperature and turbidity, impact water quality.
5- Guiding Future Policies: Results from this research may guide the creation of better water policies in Tikrit so that the infrastructure responds to both present and future needs.

As a result, the research improves both public safety and water quality which is beneficial to the community's health.

3.RESEARCH OBJECTIVES

1- Evaluate the Performance of Water Stations: Examine whether water stations in Tikrit are able to give citizens water that is healthy and secure.
2- Define Quality Standards: Use different water tests to check the pH, salts and degree of cloudiness, in order to assess if it meets the regulations.
3- Data Analysis: Collect and analyze monthly data on the stations' performance to identify trends and patterns in water quality.
4- Identify Shortcomings: Investigate the causes that reduce the stations' effectiveness and plan improvements aimed at raising performance.
5- Develop Improvement Strategies: Suggest ways to use the study results to raise water stations' effectiveness by considering improved staff training and new equipment.
6- Utilize SWOT Analysis: Review the strengths, weaknesses, opportunities and threats of the stations using SWOT analysis to see what lies ahead for water treatment.

4.RESEARCH METHODOLOGY

This study aims to understand the strengths and weaknesses in water treatment plant management, a thorough approach is used with these main steps:

1- Conducting Essential Tests: The researchers will obtain samples of treated water from the treatment plants for detailed testing in the laboratory to check water quality. During these tests, professionals will look at pH, salt levels, clarity and measure pollutants that are chemical and biological in nature. The findings will be checked against the standards by the World Health Organization to check whether health criteria are being met.
2- Field Evaluation: During the research, experts will check the equipment and structures at all treatment plants by visiting them on-site. You will check pumps, water filters, sedimentation basins and treatment plants when making these visits. How well the operating staff can do their duties will be studied based on their training, years of experience and how they face daily problems.
3- Data Collection: All findings from work done outdoors and in labs will be well recorded. Comprehensive analysis of performance trends is possible because data is collected over a certain period of time.
4- SWOT Analysis: After collecting data, the team will conduct SWOT analysis of the water treatment plants to understand their present situation. By studying internal strengths, weaknesses, opportunities and threats, this analysis will show how to improve the plants' performance and make better use of resources.

5- Interpreting Results: All test and field data will go through statistical analysis to show possible connections between the variables. Findings will be discussed related to the purposes of the study and suggestions for enhancing the running of water treatment plants will be presented.
6- Formulating Recommendations: Using the results from the analysis, ways to enhance performance and maintain health standards will be suggested to supply safe water to the community.

Using this procedure, the researchers want to analyze the efficiency of water treatment plants which supports better water quality and better health protection for people.

5.WATER DESALINATION STATIONS

Desalination stations depend on new methods and machinery to take salts and pollutants out of water so it is suitable for humans and industry in water-scarce places [8]. In general, water desalination stations in Iraq consist, as shown in Fig. 1, of the following units:

1- A low-lift pumping station: It is a station for pumping water from a lower location to a higher location. They are found in most city and area water distribution networks that supply public water [9].
2- A water treatment plant: Can a facility process dirty or rough water so it's pure enough for drinking, industrial uses or to grow crops? Communities rely on water treatment plants and these plants employ several steps to remove impurities and polish the water quality [9]. A water treatment plant consists of [9]:
   - Mechanical Treatment Stage: At this point, major objects, floating trash and additional materials are taken out from the raw water. The purification steps are surface flow, screening, filtration, agitation and sedimentation.
   - Chemical Treatment Stage: Chemicals such as chlorine, coagulants, heavy metals and organic matter are specifically used to remove suspended substances.
   - Biological Treatment Stage: Bacteria and algae are employed to transform organic pollutants, so they become harmless. You accomplish this stage through biological screening, biological sedimentation and biological filtration.
   - Activated Carbon Treatment Stage: Activated carbon is used to adsorb organic and chemical substances from the water.
   - Disinfection Stage: Mostly, water is treated with chlorine to eliminate microbes and decrease the risk of puzzling infections caused by water.
   - Final Sedimentation and Filtration Stage: In this stage, the system is used to take out large items from the water during this phase before shipping to others.
3- These processes may be different in different water treatment plants because each plant serves a unique water source and meets different local regulations.
4- High lift pumping station: There are several pumps that feed water into the city's reservoirs from two separate pipelines.

6.TESTS

1- Turbidity means that a liquid looks cloudy or murky due to sediment, silt or particles of organic matter. This standard is used for water clarity, and, in the U.S., it is showed in NTU or FTU. If the water is turbid, it most likely contains contaminants or pollutants. Turbidity is monitored in water treatment, environmental work and research as it determines the water quality and how treatments and filters are working.
2- pH is checked to discover how each property affects other water properties and what chemical reactions take place. It allows for discovering the necessary supplements and choosing methods to boost water quality depending on the pH.
3- Each sample of water is measured for temperature, so the team can see the difference these changes make in water chemistry and know how they affect any chemical processes and interactions in the water.
4- Any miners, salts, metals, ions and other dissolved inorganic and organic materials in water are known as Total Dissolved Solids (TDS). TDS is most often shown in terms of parts per million (ppm) or milligrams per liter (mg/L). It indicates if the concentration of salt in water agrees with what is permitted.
5- When water is treated, chlorine is used to get rid of bacteria and viruses and stop diseases spread by water consumption. It is mixed with drinking water and wastewater so that the water remains safe and right for consumption [10-12].

7.SWOT TECHNOLOGY

In other words, SWOT is a term for assessing Strengths, Weaknesses, Opportunities and Threats. It helps view and compare the current and expected future state of an organization's workplace, along with both internal advantages and disadvantages and external possibilities and dangers. We use this analysis to see how a company or organization functions and what situations it encounters. [13]. Using the SWOT technique in studies helps develop competitive strategies and improve organizational performance. It identifies opportunities to be exploited, threats to be addressed, strengths to be leveraged, and weaknesses to be improved [13, 14]. Evaluating a company's strategy can be done with SWOT analysis. Since it is so flexible, the SWOT analysis is useful in different types of work. It helps in academic research by pointing out what can be gained and what dangers lie ahead. A SWOT analysis helps analyze both inside and outside factors affecting a company, allowing it to spot strengths and weaknesses. This method is commonly applied and has a history of more than 60 years. Leading companies listed on the Fortune 500 use it to help develop their goals. Fig. 1 represents a SWOT matrix [15, 16].

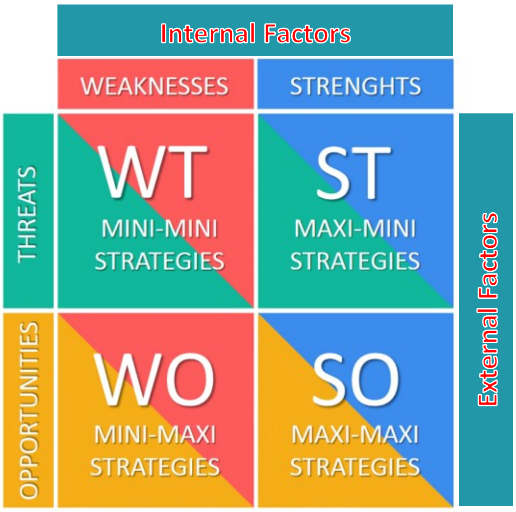

Fig. 1 A SWOT Matrix.

8.DATA ANALYSIS AND PRESENTATION OF RESULTS

Ten water treatment stations were chosen to participate in the study and gather the necessary data. Each station was assigned a specific code for this paper. The assigned codes are listed in Table 1.

Table 1 Code for Each Water Station Name.

Seq.	Water Treatment Plant Name	Code
1	Tikrit Unified Water Project (first phase)	A
2	Al-Awja Water Project	B
3	Al-Mahzam Water Project	C
4	Al-Qadisiyah Water Project	D
5	Hammad Shehab Project	E
6	Al-Suqur Water Project	F
7	Dium Water Project	G
8	Old Tikrit Water Project	H
9	Al-Fares Water Project	I
10	Tikrit Unified Water Project (second phase)	J

In addition to other data, the survey of water treatment stations focused on TDS, chlorine levels, turbidity, pH levels and temperature. Readings were done at different times, two weeks to a month away, so that changes in pollution levels during floods or dust storms could be seen, as occurred in the data. Table 2.

8.1.Analyzing Each Station in Detail and Presenting the Main Conclusions and Observations

8.1.1.Station (A)

8.1.1.1.The Inspection and Laboratory Tests

Analysis of the water looked at temperature, turbidity, pH level, chlorine level and total dissolved solids (TDS), uncovering the results below:

1- The turbidity column for this station showed that the turbidity level is above the allowed level set in the standard, as shown in Fig. 2, indicating a weakness in the station's turbidity treatment.

2- For pH level tests, the results from all the months matched the required standards., as shown in Fig. 3, indicating the station's strength in achieving the desired pH level.

3- Because the chlorine content was at a safe level, the results of the chlorine test were confirmed and matched the legal standards., as shown in Fig. 4, suggesting that the station has strength in achieving the desired chlorine levels.

4- The Results from total dissolved solids (TDS) TDS analysis and the actual obtained numbers are consistent with the set rules, as shown in Fig. 5, indicating the station's strength in maintaining the desired TDS levels.

The findings offer useful information on the station's strengths and weaknesses in terms of temperature, turbidity, pH level, chlorine and dissolved solids. As for the temperature test, it insignificantly impacted the station's performance. Temperature varied seasonally and even within a single day.

8.1.1.2.Evaluating the Performance of The Water Treatment Station and its Components

The performance of station A, including its strengths and weaknesses, can be assessed using the SWOT analysis framework. This analysis involves conducting laboratory tests and inspecting the station's components to evaluate their suitability for operation and the level of attention and maintenance they receive. Further details can be found in Table 3.

Table 2 Data Collection.

Code	Test / Read / Stander	TDS	Chlorine%	PH	Turb.	Temp.
	Stander	1000	5	7-9	25	Var.
A	R1	328	2	7.9	29.6	13
	R2	308	1.5	7.62	86	18
	R3	278	1	7.61	86.4	21
	R4	278	2.5	7.79	39.7	17.4
B	R1	308	2.5	7.78	102	18
	R2	282	4	7.92	74.9	21
	R3	260	2	7.78	22	30
	R4	276	1.5	7.61	50	17.4
C	R1	328	4	7.93	38.6	13
	R2	252	2.5	7.69	52	30
	R3	258	1.5	7.94	30	30
	R4	272	2	8.01	29	20
D	R1	306	2	7.98	87	11
	R2	278	1.5	7.4	42.6	16
	R3	254	2.5	7.84	46	32
	R4	272	1	8.01	29	20
E	R1	322	4	7.84	29.8	13
	R2	254	1.5	7.75	49	30
	R3	244	2.5	8.02	29	30
	R4	248	1	7.72	31.8	20
F	R1	324	4	7.61	36.9	13
	R2	254	1	7.71	54	30
	R3	262	2.5	7.83	24.6	30
	R4	276	2	7.82	35.8	20
G	R1	308	2.5	7.98	118	11
	R2	342	1.5	7.74	41.4	16
	R3	258	4	7.82	21.7	30
	R4	280	1	7.56	58.7	16
H	R1	312	1	7.94	107	18
	R2	270	2.5	7.83	87.5	21
	R3	242	1.5	7.62	23.5	30
	R4	276	2	7.82	42.4	17.4
I	R1	310	1.5	7.67	98	11
	R2	236	2	7.8	27.3	30
	R3	276	1	7.82	42.4	17.4
	R4	276	2.5	7.77	62.5	16
J	R1	340	2	7.87	1.98	13
	R2	282	1.5	7.75	3.4	21
	R3	246	1	8.09	2.2	30
	R4	286	2.5	8.04	1.67	17.4

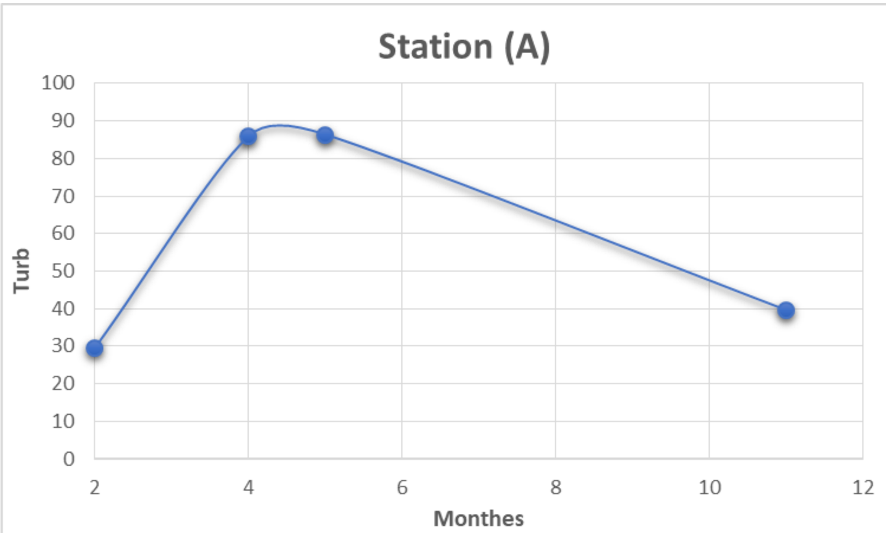

Fig. 2 Turbidity Test for Station (A).

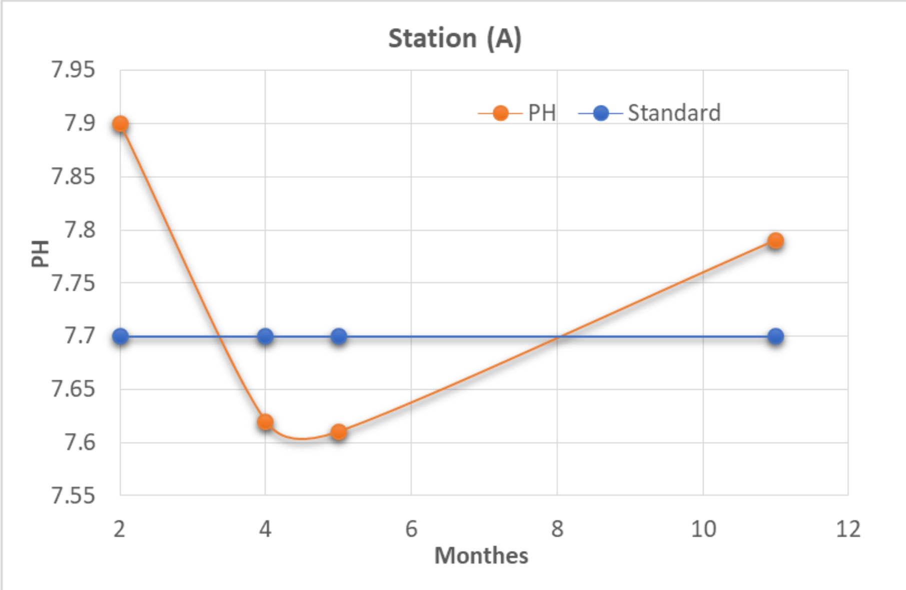

Fig. 3 pH Level Test for Station (A).

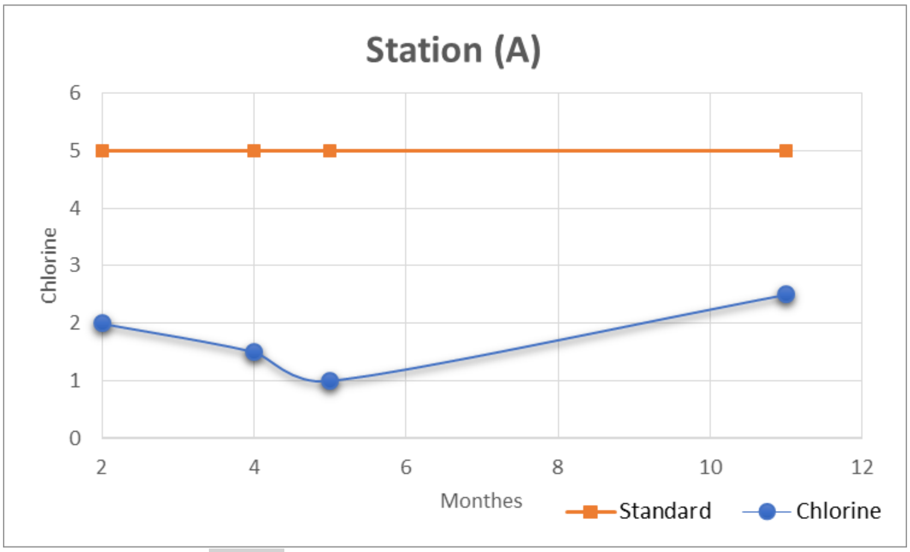

Fig. 4 Chlorine Level Test for Station (A).

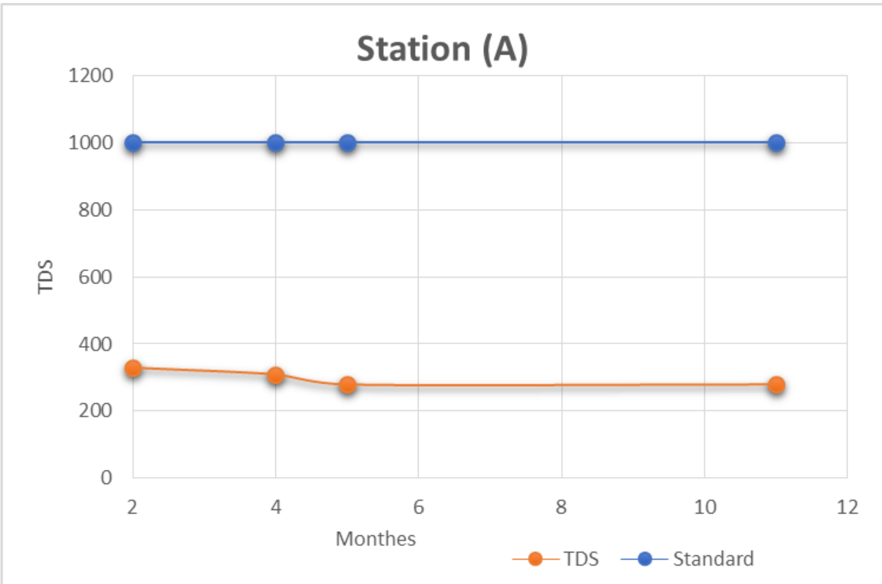

Fig. 5 Total Dissolved Solids (TDS) Test for Station (A).

Table 3 The Performance of Station (A) Using the SWOT Analysis Matrix.

Strong	Weakness
1. Achieve the desired temperature. 2. Meet the pH specifications. 3. Attain the required chlorine levels. 4. Achieve the desired level of dissolved salts. 5. Ensure the presence of both upper and lower pumping stations. 6. Confirm the existence of the primary, process, and final basins. 7. Ensure the availability of backup pumps. 8. Install pressure gauges.	1. Failure to achieve the permissible turbidity level. 2. Some components are deteriorated and neglected. 3. Lack of regular maintenance staff at the stations.4. Not all existing staff members are qualified in their respective fields.

8.1.2.Station (B)

8.1.2.1.The Inspection and Laboratory Tests

The analysis included temperature, turbidity, pH level, chlorine level, and total dissolved solids (TDS) in the water, revealed the following:

1- Upon observing the turbidity column for this station, it was found that turbidity exceeded the limits specified in the standard, as shown in Fig. 6, indicating a weakness in the station's turbidity treatment.

2- Regarding the pH level, it was observed that the tests conducted during the specified months met the standard requirements, as shown in Fig. 7, indicating the station's strength in achieving the desired pH level.

3- Based on the chlorine level, it was found that the chlorine test and its compliance with the standard indicated that the levels were within the permissible limits, as shown in Fig. 8, suggesting that the station has strength in achieving the desired chlorine levels.

4- The analysis of total dissolved solids (TDS) and the extracted values showed compliance with the standard specifications, as shown in Fig. 9, indicating the station's strength in maintaining the desired TDS levels.

The results explain the advantages and disadvantages of the water treatment station according to temperature, turbidity, pH level, chlorine and total dissolved solids. As for the temperature test, it insignificantly impacted the station's performance. Temperature varied seasonally and even within a single day.

8.1.2.2.Evaluating the Performance of the Water Treatment Station and its Components

The performance of station A, including its strengths and weaknesses, can be assessed using the SWOT analysis framework. This analysis involves conducting laboratory tests and inspecting the station's components to evaluate their suitability for operation and the level of attention and maintenance they receive. Further details can be found in Table 4.

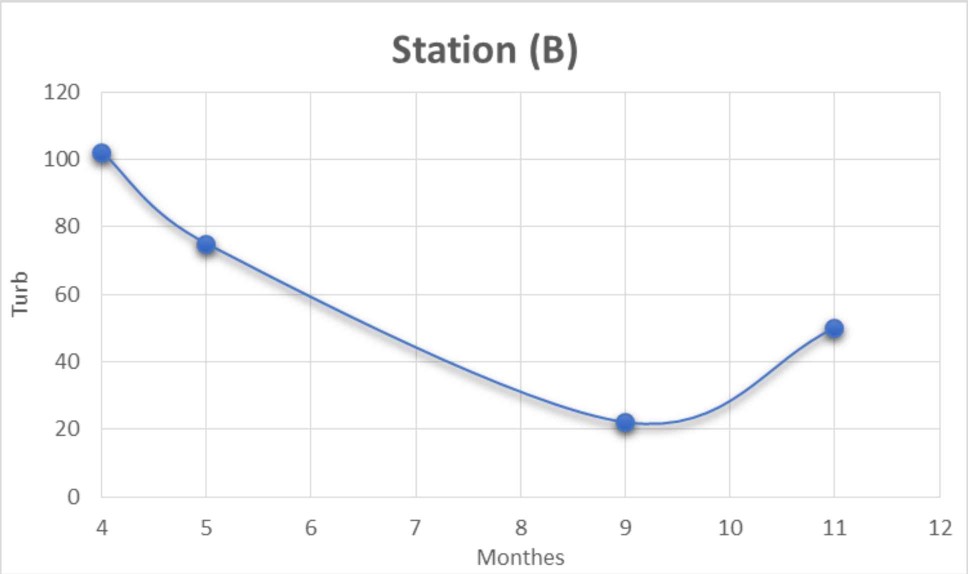

Fig. 6 Turbidity Test for Station (B).

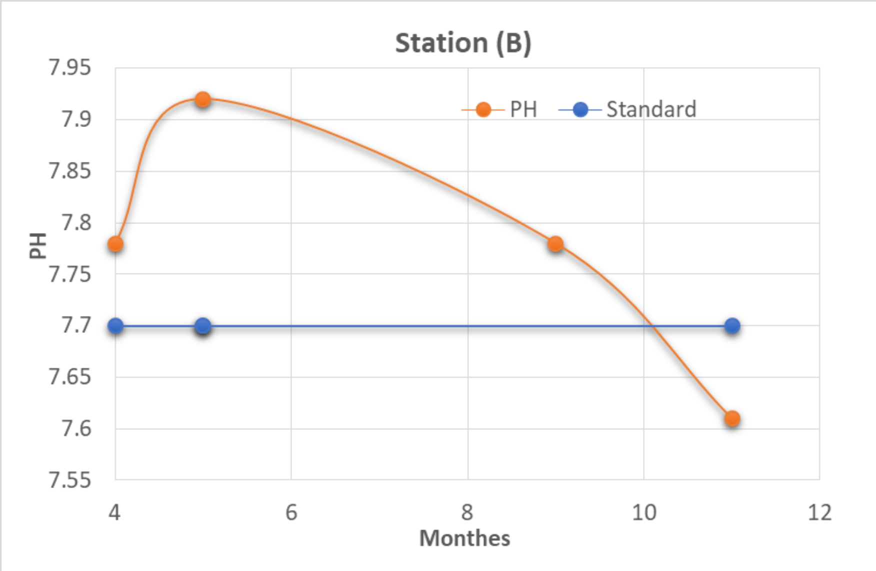

Fig. 7 pH Level Test for Station (B).

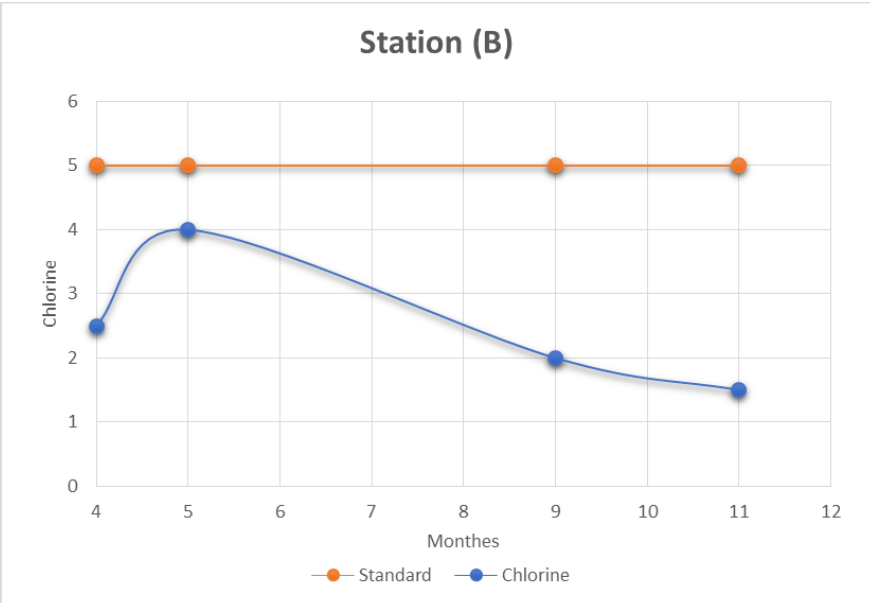

Fig. 8 Chlorine Level Test for Station (B).

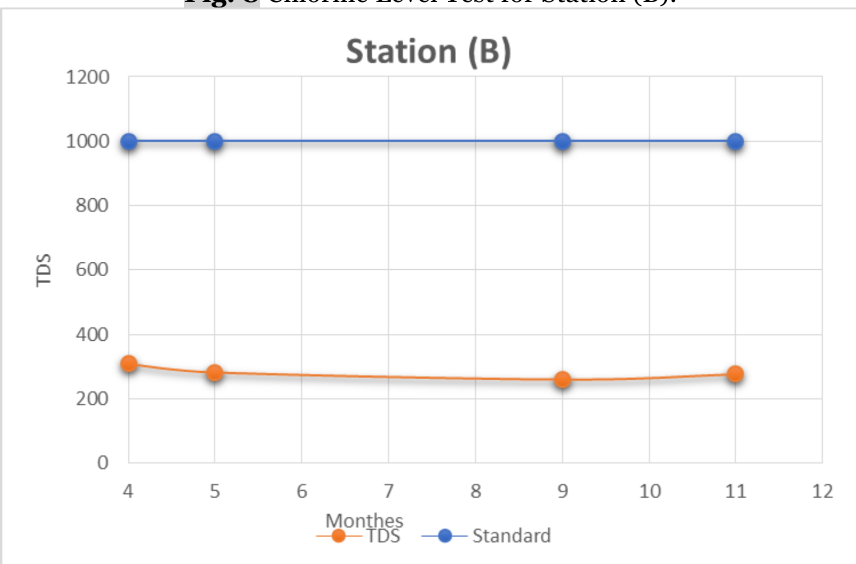

Fig. 9 Total Dissolved Solids (TDS) Test for Station (B).

Table 4 The Performance of Station (B) Using the SWOT Analysis Matrix.

Strong	Weakness
1. Achieve the desired temperature. 2. Meet the pH specifications. 3. Attain the required chlorine levels. 4. Achieve the desired level of dissolved salts. 5. Ensure the presence of both upper and lower pumping stations. 6. Confirm the existence of the primary, process, and final basins. 7. Ensure the availability of backup pumps. 8. Install pressure gauges.	1. Failure to achieve the permissible turbidity level. 2. Some components are deteriorated and neglected. 3. Lack of regular maintenance staff at the stations. 4. Not all existing staff members are qualified in their respective fields. 5. Some basins are left uncovered and are exposed to dust storms. 6. Some pipes have cracks and are partially buried in the soil.

Furthermore, the remaining stations from A to I met the required conditions and specifications, except for the turbidity test, which did not comply with the required specifications in most of them. Additionally, most stations had weaknesses, including negligence, lack of maintenance, and the absence of dedicated and consistent specialized staff in each station. To clarify the performance in terms of laboratory test achievement, the results were condensed and compared in Table 5. A checkmark (√)indicated compliance with the specifications, while an (X) mark indicated non-compliance.

Table 5 Results of Stations' Performance Comparison.

Code	Test / Read	TDS	Chlorine%	PH	Turb.	Temp.
	Stander	1000	5	7-9	25	Var.
A	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
B	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	√	√
	R4	√	√	√	X	√
C	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
D	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
E	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
F	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
G	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	√	√
	R4	√	√	√	X	√
H	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	√	√
	R4	√	√	√	X	√
I	R1	√	√	√	X	√
	R2	√	√	√	X	√
	R3	√	√	√	X	√
	R4	√	√	√	X	√
J	R1	√	√	√	√	√
	R2	√	√	√	√	√
	R3	√	√	√	√	√
	R4	√	√	√	√	√

Overall, the stations had a low compliance level (17.5%) with turbidity testing and a high failure rate (82.5%). However, all stations were 100% compliance with pH testing, TDS, and chlorine levels, meeting the required specifications.

8.2.Analyzing Aggregated Station Data to Identify the Relationships Between Them

The water's turbidity was the only test that did not meet the necessary specifications for station operation. As a result, a comprehensive data analysis was conducted to establish if there is a correlation between turbidity and the other required tests, such as total dissolved solids, pH level, chlorine content, and temperature. In this case, the Statistical Package for the Social Sciences (SPSS) can be used to input and analyze the data and determine the extent of the relationship. The relationship between the numerical variables in a linear way was measured using the Pearson correlation coefficient (R). The dependent variable in each sample was the turbidity level which was tested using the five measured independent variables: total dissolved solids, pH, chlorine content and temperature. This coefficient tells us how connected the variables [17, 18]. The correlation coefficient (R) can range from +1 to -1. When it gets closer to zero, it means that the relationship between the variables becomes very weak. On the other hand, as it approaches 1, the relationship becomes very strong. A positive sign indicates a direct relationship, while a negative sign indicates an inverse relationship between the variables [19, 20]. After analyzing the data, the results in Table 6 were found. Turbidity showed a weak positive relationship with total dissolved solids and weak negative relationships with pH level and chlorine content. The relationship with temperature was moderately negative, as shown in Table 6.

Table 6 Relationship Between Turbidity and Other Tests.

Dependent	Independent	(R) Person	Sig.
Turbidity	TDS	0.270	0.092
	PH	-0.161	0.321
	chlorine	-0.052	0.751
	Temperature	-0.345	0.029

9.CONCLUSION

This study showed that water stations in Tikrit meet most water test specifications, scoring 100% in total dissolved solids, pH level, chlorine, and temperature tests. However, they lack specialized and regular personnel, as identified in inspections and examinations. The results of turbidity testing showed that the station met specifications only 17.5% of the time and deviated from them by 82.5%.

These observations indicate that:

1- The station's performance in treating turbidity was weak.
2- On-site evaluations suggested that neglect and lack of cleaning and maintenance of sedimentation and treatment basins contributed to this issue.
3- Additionally, the increase in turbidity was affected by the country's climatic conditions and changing flood situations.
4- Failing to clean rivers and stabilize riverbanks also increased water turbidity.

The station data showed a weak relationship between turbidity and the other tests, except for temperature, which had a simple relationship with turbidity. As temperature increased, evaporation and water consumption increased, leading to more sedimentation and increased turbidity to a certain extent. The research team believes that the results are fairly realistic, as most of the stations encounter the issue of turbidity and its treatment, which explains why the results do not align with the specifications in this aspect. However, the remaining results comply with the specifications, which can be attributed to the availability of the necessary water treatment equipment in the majority of the stations included in the study.

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