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Analysing Metropolitan Municipal Water Services Delivery Performance in South Africa: A Comparative Assessment of Household Access, Water Quality, and Households' Satisfaction

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Abstract—This paper investigates the water service delivery performance of metropolitan municipalities in South Africa between 2022 and 2024. This enables adequate understanding of the prevailing conditions of water service delivery in the metros and thus forms the basis for service enhancement intervention. Using a conceptual framework that combined principal-agent, equity, and public value theories, this study analyzes a combination of secondary quantitative data on water service delivery performance across metropolitan municipalities in South Africa. The data was sourced from various government databases to pursue the study objectives of exploring water access, water quality, and households' water service satisfaction. The findings revealed a significant disparity in the performance of the metros in water service delivery. While the City of Cape Town and Ekurhuleni demonstrated consistent water service excellence, Buffalo City, Nelson Mandela Bay, and Mangaung struggled with incessant water interruptions and declining water safety. Despite the robust water infrastructure status as reported in WIQI, systemic challenges, such as leaking water pipes and institutional inefficiency, undermine reliable water service delivery among metros in South Africa. This paper thus concludes that for South Africa to effectively address the persistent water service delivery challenges confronting it and efficiently achieve SDG 6 by 2030, there is the need for crucial investment in water management technology, establish water service delivery taskforce across metros, invest in wastewater treatment technologies, establish a national water management training institute to regular provide trainings to metro staff. Lastly, inter-metro best practices sharing must be entrenched, while a public database with updated water performance data must be made available to support water research. These recommendations emphasize inter-metro collaboration, technological integration, and policy reforms to address systemic gaps and enhance public satisfaction with water service delivery.

Keywords—Water Quality, Households' satisfaction, Metropolitan Municipalities, Water Service Delivery, Public Value

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1 Introduction

To ensure the health and well-being of people, access to safe and sufficient drinking water is crucial [1, 2]. However, the intensity of water scarcity across the world in the last three decades has been unprecedented [3, 4], with severe scarcity in arid and semi-arid countries [5], such as South Africa, where drought and ecological degradation have been prominent [6, 7]. To better sharpen this submission, [8] presented the following statistics: South African urban centres currently harbour over 64% of South Africans, with about 36% living in rural and informal settlements and without a matching water supply [9]. The statistics indicated the slow pace with which South Africa is moving towards achieving Sustainable Development Goal 6 (SDG 6) and SDG 6.3 [10]. Specifically, SDG 6, target 3, aimed at improving water quality, wastewater treatment, and safe water reuse [11, 12, 13], matching the elements fundamental to South Africa's water security and broader sustainable development agenda.

Therefore, achieving SDG 6 is strategic to South Africa and fundamental to achieving the constitutional mandate of ensuring access to safe water for all South Africans [14]. The leading government department responsible for providing water services is the Department of Water and Sanitation (DWS). This body coordinates water governance systems in the country, and it has recognised the critical interconnectedness of SDG 6.3 with the other seven (7) targets in SDG 6, in addition to numerous other SDG development priorities. The DWS is advocating for various government units to adopt a collaborative approach to address the water shortage problem in South Africa.

Despite the efforts of the national government to address the problem of water service delivery in the country, the expected improvement has yet to be recorded. According to the General Household Survey (GHS) conducted by Statistics South Africa (Stats SA) in 2023, for instance, between 2018 and 2023, 87-89% of households in the country still lacked access to piped or tap water in their dwellings [15]. In addition, there have been complaints about the quality of drinking water supplied to households in the country [16]. These highlight the inadequacy of the water supply, both in quantity and quality.

A unit of government strategic to water service delivery in South Africa is the Metropolitan Municipalities. These metros, as they are often referred to, coordinate water service delivery to households in the country [17]; however, they are confronted with many challenges in doing this [17, 18, 19, 20, 21], thereby creating widespread dissatisfaction among South Africans [22, 23]. This dissatisfaction is rooted in the inability of the Department of Water and Sanitation (DWS), the national body in charge of water governance, to ensure proper coordination of metropolitan municipalities for adequate water service delivery.

To enhance the water service delivery experience of households in South Africa, especially at the metropolitan municipality level, given its central role in water service provision, there is a need to understand the prevailing water access, quality, and households' satisfaction level. Until these are ascertained, suggesting policy actions towards addressing metropolitan municipalities' challenges in water supply, such as decaying water infrastructure [22, 24], financial mismanagement [25], inadequate skilled manpower [8, 18], and institutional inefficiency [18] might be temporary and less effective. This is given the need to appreciate the magnitude of the situation, in line with recent data, to better plan for effective and efficient intervening policy actions.

Sequel, this paper:

i. assess household water supply in each metropolitan municipality in South Africa between 2022 and 2024.
ii. investigate the quality of water supplied to each metropolitan municipality in South Africa between 2022 and 2024.
iii. identify the water service delivery satisfaction level of households in metropolitan municipalities in South Africa.
iv. recommends actionable policy initiatives to improve water service delivery among metropolitan municipalities in South Africa.

One basic factor motivated the scope of the study (2022 to 2024). Addressing issues with social service delivery, such as water supply, required the adoption of recent literature and reports to guarantee the recency of the problem being addressed. As supported by [26], focusing on a limited but recent timeframe enables the timely identification of findings that can inform effective recommendations.

While there are existing studies on metropolitan municipality water service delivery performance in South Africa, this study expands their scope by encompassing more areas and recent data. For instance, in the study by [27] that assesses water service delivery performance, the focus was on the cities of Tshwane, Cape Town, and

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eThekwini, leaving five other metropolitan municipalities unassessed. This study addressed this gap by covering all eight metropolitan municipalities in South Africa and reassessing the three cities' water service delivery status to establish possible improvements. Furthermore, this paper provided recent insight into the findings of [28] that, aside from actual water service delivery improvements, other factors such as psychological and behavioural influences affect households' water service delivery experience. While the study relied on the General Household Survey dataset from 2015 to 2017, this study uses the Water Services Barometer Survey of 2022, a more recent dataset, to ascertain the level of households' satisfaction with water service delivery using the indicators of drinking water safety and water quality index score.

The findings of this study would not only complement existing studies on the subject but would also inform policy and operational recommendations for improving water service delivery in each metropolitan municipality and South Africa, generally. Furthermore, it would directly support and contributes to the achievement of SDG 6 [29], South African National Development Plan (NDP) and the fulfilment of the mandate of the South African Constitution (1996) in section 27(1)(b) that "Everyone has the right to have access to sufficient food and water" [1].

2 Literature review

2.1 Structure of water service delivery in South Africa

Several policies and legislative frameworks guide water service delivery in South Africa. The essence of these is to ensure orderliness in the provision of water services among the constituent components of the country. Leading in these frameworks is the constitution of the country. For instance, in Act 108 of the 1996 constitution of the Republic of South Africa, Section 27(1)(b) established the inalienable rights of all South Africans to water in sufficient quantity [1]. In addition, Section 152 and Schedule 4B stressed that municipalities were assigned the core responsibility of providing water services to communities. However, only metropolitan municipalities are so mandated, with a few from municipalities in categories B and C.

Other legislations backing up the constitution in its recognition of the right of all South Africans to basic water supply are Water Services Act 108 of 1997 [1]; National Water Act 36 of 1998 that addresses the structure of water resource management; Municipal Structures Act 117 of 1998 that segregate power, functions and responsibilities among the various categories of municipalities. Buttressing this Act was the Municipal Systems Act 32 of 2000, which reassigned water service delivery, integrated development planning, performance management, and public participation to municipalities. In buttressing this, [1] noted that related Acts such as the Municipal Systems Act, the Municipal Structures Act, and the subsequent Amendment Act (Act No. 33 of 2000) divided the municipalities into categories A, B, and C, each having distinct responsibilities. Lastly, the Municipal Finance Management Act 56 of 2003 provided guidelines on the financial management framework for municipalities. This includes budget requirements, revenue, and supply chain management.

Aside from these acts, several policy initiatives such as the National Water Resource Strategy (NWRS-2), the Free Basic Water Policy of 2001, and the Strategic Framework for Water Services of 2003, also support the earlier-mentioned legislative frameworks. Within the purview of these policy strategies were mechanisms for water conservation, tariff structure, and minimum water standards. Adjoining regulatory agencies created to ensure efficient and effective water service delivery in South Africa are the Water Services Authority, the Department of Water and Sanitation, and the South African National Standards (SANS 241:2015), which determine water quality standards.

The constitution, regulations, and Acts position the Department of Water and Sanitation (DWS) as the major body for regulating water service delivery at the national level in the country. As captured in Figure 1, the DWS works in conjunction with several national departments, such as the National Treasury, the Corporate Governance and Traditional Affairs (COGTA), health, the Water Research Commission (WRC), etc. Below the DWS at the national level is the provincial level, which comprises provincial departments, water boards, and the provincial oversight bodies. Right after the province is the local government, which is structured into three categories of A (8 Metropolitan Municipalities), B (44 District Municipalities), and C (205 Local Municipalities).

While DWS coordinates water services delivery, the actual duty of providing water services to households is reserved for municipalities, spearheaded by Metropolitan Municipalities [1]. Despite the critical role of metros in

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water service delivery, adequate information on their performance is yet to be sufficiently studied, given that most water service reports are either based on national or provincial assessments. Given this gap, this paper assesses the performance of metropolitan municipalities in South Africa using water supply and quality metrics.

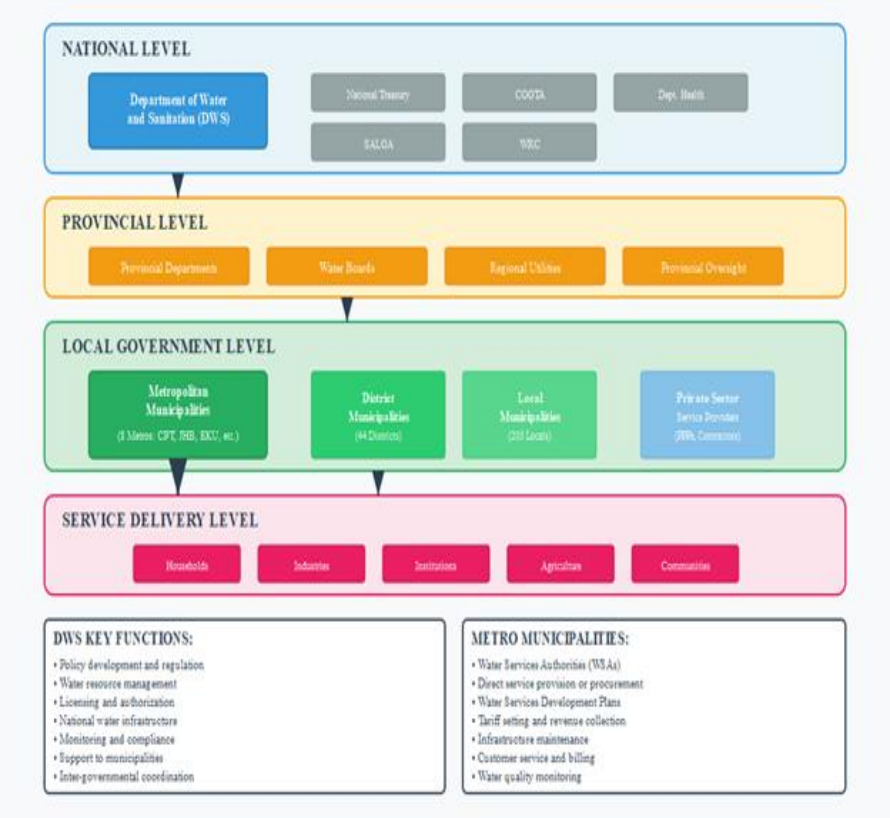

Figure 1: South African Water Services Delivery Governance Structure

2.2 Metropolitan Municipal Performance Measurement Framework

Two key metrics were used to measure the water service delivery performance of metropolitan municipalities in South Africa: water quantity and quality. Three basic indicators of equity, accountability, and satisfaction were adopted to ascertain the appropriateness of water supply in terms of quantity. However, a combination of the National Drinking Water Standard, SANS241:2015, and the Blue Drop Risk Rating (BDRR) is used for water quality assessment. While the former focuses on the constituting chemical components of drinking water, the latter measures the health risks associated with water.

2.3 Theoretical Framework

Public service is uniquely different from commercial services, where affordability or capacity to pay determines access. In accessing public services such as water, equity remains the watchword, often captured as fairness regardless of status or affiliation. Providing water in South Africa falls within the purview of metropolitan municipalities as enshrined in the constitution and several Acts. In discharging this sacred responsibility, equity must be observed. Explaining access to public services such as water can be done using several theories.

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Equity theory

This theory was proposed by Homans in 1958 [30] and later enhanced by Adams in 1965 [31]. Equity theory, as posited by [31, 32], examines the extent to which members of an entity perceive fairness and justice in how they are treated. In ascertaining fairness without bias, the theory compares what the first and second person receives. Based on the extent of difference in this, the feeling of equity or inequity is established [32]. The postulations of this theory fit the engagement between the government and the people when it comes to social service delivery issues, such as access to water [33]. Given the South African constitutional pronouncement that "Everyone has the right to have access to sufficient food and water", access to water must not be class or location-centric, such as focusing on urban areas to the neglect of the rural areas, as it is currently reported in the literature [7, 8, 18, 22, 26, 34].

The theory explains all the possible forms of discrimination in water supply to households in South Africa. Without eliminating these discriminations, [30] furthered that it could lead to citizens' dissatisfaction [22, 23, 30, 31, 35] with the government and its agencies. Despite the relevance of the equity theory in explaining equity as an indispensable component of water service delivery, the theory fails to comment on other indicators for ascertaining social service performance, such as accountability and satisfaction. Given this gap, the paper explores other theories.

Principal-Agent Theory

The principal-agent theory was propounded by Holmstrom & Milgrom in 1991 [36] and it leverages on the understanding that government services are usually delivered indirectly through its agencies and intermediaries [37]. The theory assumes that principals, in their characteristic manner, lack operational competency and provide only a narrow mandate [38]; thus, the need for agents, who are strategically chosen experts [39], to pursue pre-set goals [37]. Just as observed in the provision of social service delivery, such as water, the national government of South Africa, as mandated by the constitution, is to provide citizens access to water of the right quality and quantity [40, 41]. However, this service is indirectly delivered through municipalities, which are more competent and closer to the people to do this efficiently and effectively.

In this mix, the principal-agent theory, as buttressed by [37], allows a kind of information asymmetry that eliminates accountability. This asymmetry enables the agent to prey on the process [36, 42, 43] and thus culminate in service inefficiency. From this information gap, challenges hindering effective water service delivery by metropolitan municipalities, such as financial mismanagement [25] and institutional inefficiency [18], manifest. Even though in this case, the principal through DWS regulates and monitors the activities of metropolitan municipalities [1], the service inefficiency persists [42].

From this theory, this paper extracts the indicator of accountability in the relationship between the government and its agents managing water service delivery in South Africa. To what extent does the government hold the metropolitan municipalities accountable for water service delivery to households? The extent to which this is done is significant in measuring the performance of these metros in water service delivery.

Public Value Theory

To complete the circle, there is a need for service feedback from households. Given this need, the third theory-public value theory, was adopted. This theory, proposed by Moore in 1995 [44], examines public service delivery from the people's value perspective [45]. It seeks to direct government efforts towards value creation [45, 46, 47, 48], thereby enhancing the government's effectiveness [47]. In essence, it proposes the involvement of people in the choice of government actions and inactions [44]. In the delivery of water service, this theory suggests that there is a need for the integration of communities in the process. Aside from creating a sense of importance in the minds of the people, it could also facilitate the development of responsible water use and water infrastructure protection. The core values that are of importance in the delivery of social services, such as water, as proposed by this theory, are effectiveness in service delivery, trust in government and its agencies, transparency [47], and public participation in the service delivery process [46]. This theory, therefore, offers the theoretical platform for evaluating water service delivery performance [49] in the South African municipalities to understand the extent to which the service incorporates public values through public satisfaction.

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2.4 Integrated theoretical model

Individually, none of the theories had the combined indicators adopted in this paper; each complements the others. To better explain how the theories integrate to explain metropolitan water service delivery, Figure 2 was prepared using draw.io, an illustration design programme.

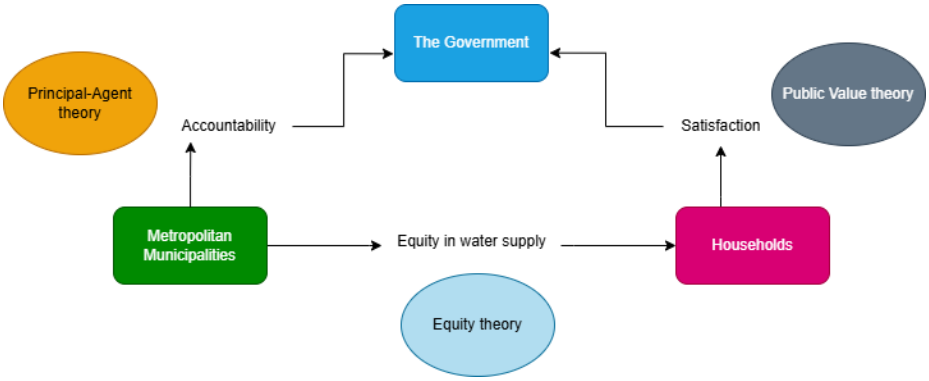

Figure 2: Integrated Measurement Indicator for Water Service Delivery Performance.

In the delivery of public services, three distinct parties are involved - the government, its delivery agency, and the people. Different mechanisms guide the interaction among these entities. As depicted in Figure 2, principal-agent theory explains the interaction between the government and its agencies, where the agency is accountable to the government, its principal. Also, a reasonable level of service equity is expected between the agency and the people (households). It is here that the equity theory assumed relevance, while between the households and the government, the public value theory emphasizes the importance of service feedback, with which satisfaction or dissatisfaction could be expressed.

Simply put, metropolitan municipalities in South Africa are responsible for supplying water to residents in the appropriate quantity and quality. In explaining this mandate, three relevant theories have been discussed, with each contributing one indicator to explaining the water delivery performance of metropolitan municipalities. Given each limitation, as individual frameworks, and the strengths in combining the three, the integrated model presented in Figure 2 was adopted.

3 Research methodology

3.1 Data Sources and Analysis

In pursuit of the objectives of this paper, existing quantitative secondary data were adopted from a public database. Aside from saving time and eliminating the administrative hurdle associated with primary data collection from government agencies and households, the adopted data repositories maintained by municipalities, provinces, and the national government offer data in an organized and condensed format, making it easy for extraction. Thus, data for this paper were sourced from:

i. Stats SA (Department: Statistics South Africa). Accessed on 4th July 2025; 11:42 am. https://www.statssa.gov.za/?page_id=1854&PPN=Report-03-01-83. Report-03-01-83 - The state of basic service delivery in South Africa: Analysis of Census 2022 data, 2022. Publication date & time: 31 October 2024 @ 14:30.
ii. Stats SA (Department: Statistics South Africa). Accessed on 5th July 2025 @ 11:52 am. https://www.statssa.gov.za/?page_id=1854&PPN=P0302. P0302 - Mid-year population estimates, 2024. Publication date & time: 30 July 2024 @ 11:00.
iii. Blue Drop Progress Report (2023). Department of Water & Sanitation, South Africa. Accessed on 4th July 2025 @ 11:54 am https://ws.dws.gov.za/IRIS/latestresults.aspx.

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iv. Blue Drop Progress Report (2022). Department of Water & Sanitation, South Africa. Accessed on 4th July 2025 @ 11:54 am. https://ws.dws.gov.za/iris/releases/2021_BD_PAT_report_final-28Mar22_MN_web.pdf
v. No Drop Report (National), 2023. A document from the Department of Water and Sanitation. Accessed on 5th July 2025 @ 18:52. https://ws.dws.gov.za/IRIS/releases/ND_2023_Report.pdf
vi. The Water Service Barometer Study (2022). User perceptions of the current provision of water services in South Africa. A document of the Water Research Commission (WRC) research project. Accessed on 5th July 2025 @ 10:01 am. https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20909.pdf

Numerical survey data were extracted from the sources above, sorted based on structural similarity, merged, and descriptively analysed using frequency and percentages to gauge the extent of the prevalence of the adopted indicators.

3.2 Data coverage

The data used in this paper spanned the period from 2022 to 2024. The motivation for this is that addressing issues with social service delivery, such as water supply, requires the adoption of recent data and reports to guarantee the recency of the problem being addressed. As supported by [26], focusing on a limited but recent timeframe enables the timely identification of findings that can inform effective recommendations.

3.3 Study area

This study focused on the Category A municipalities, often referred to as Metropolitan Municipalities or simply Metros. This is due to their direct involvement in the provision of water services to households in their constituency [50]. Data on water supply in these metropolitan municipalities from 2022 to 2024 was extracted and analysed from the public reports by government departments and agencies in South Africa.

There are eight metropolitan municipalities in South Africa (see Figure 3), and all, as listed below, are covered in this paper.

i. Buffalo City
ii. City of Cape Town
iii. City of Ekurhuleni
iv. City of Johannesburg
v. City of Tshwane
vi. eThekwini
vii. Mangaung, and
vii. Nelson Mandela Bay.

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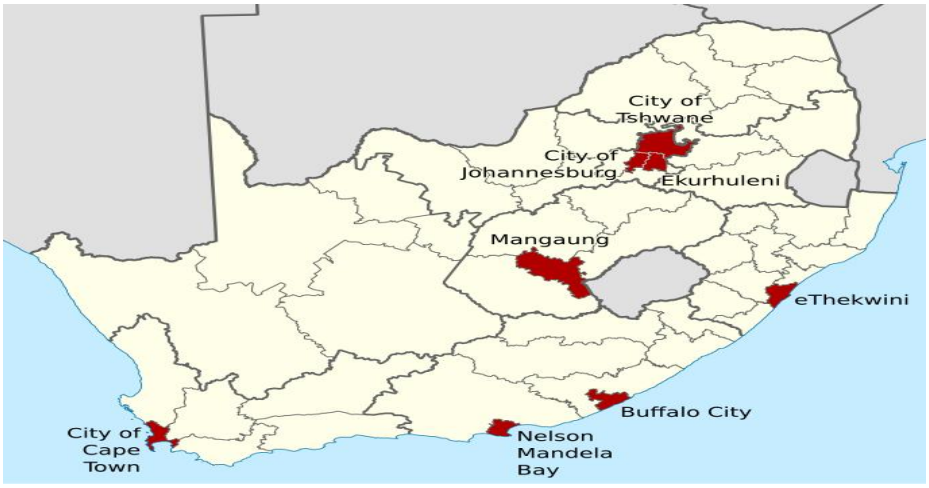

Figure 3: Map of South Africa showing the Eight Metropolitan Municipalities
Source: Google Image Search

3.4 Limitations in the adopted data

Despite that, the data adopted in this paper is robust and current; it is still prone to the following limitations:

i. Adequacy: This paper required data on water access, drinking water quality, and households' water service delivery satisfaction. Although complete data on each of these indicators were found for the years 2022, 2023, and 2024, water access and drinking water quality data were found for 2022 and 2023, while household satisfaction data were found for 2022.

ii. Data Bias: The data adopted in this paper were harvested from government agencies' databases, including the one on household satisfaction level. Criticism could arise on the need for a non-government-conducted survey to ascertain households' water service delivery satisfaction experience.

Even though the limitations above exist, they do not fundamentally compromise the validity of this study's contributions to understanding water service delivery dynamics in South Africa. Specifically, this paper focuses on relational analysis between service indicators rather than absolute measurements, making it robust to systematic biases. The findings of the paper provide invaluable insights into the nexus among water access, quality, and satisfaction that remain valid despite the temporal and data source limitations mentioned. Furthermore, the approach adopted in this paper aligns with established practices in development research where perfect data is scarcely available, especially when relying on secondary data, making researchers work with the best available evidence. The robustness of limitations combined with transparent acknowledgment ensures that conclusions drawn are scientifically sound and practically relevant for policy development.

3.5 Ethical considerations

In the use of public data such as those made available by Statistics South Africa and DWS, the ethical requirements are that:

a. The data should not be altered. Though researchers can decompose the data to extract what is needed in a study, data fabrication is unethical and rejected. Thus, this study adopted correct data without any kind of alteration.

b. Proper acknowledgement: In this study, all data sources are adequately acknowledged.

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4 Results and analysis

4.1 Performance metrics

An integrated model formed from Equity, Principal-Agent, and Public Value theories (see Figure 2) is adopted to ascertain the performance of metropolitan municipalities in water service delivery. The model adopted equity in access, accountability, and public satisfaction as performance metrics. These metrics have assumed prominence in ascertaining the performance of water service delivery [51, 52].

Access to Improved Water Sources by Households in Metropolitan Municipalities

Access refers to the extent to which people can get water when needed. According to [1], unrestricted access to water is a universal right, and the South African government is committed to ensuring it. To measure access in this study, data on water supply to households were extracted from [1, 2]. According to the 2022 census data in South Africa, households could be classified into four categories regarding how they access water. While 59.7% of households in the country access water inside their dwellings, 22.7% of households get water from within their yard, 8.9%, outside their yard, and 8.7% had no access to water. This country overview indicated that about 91.3% of households have access to water. However, for a more detailed assessment of water access, especially at the metropolitan municipality level, given their role in water service delivery in the country, Figure 4 was presented.

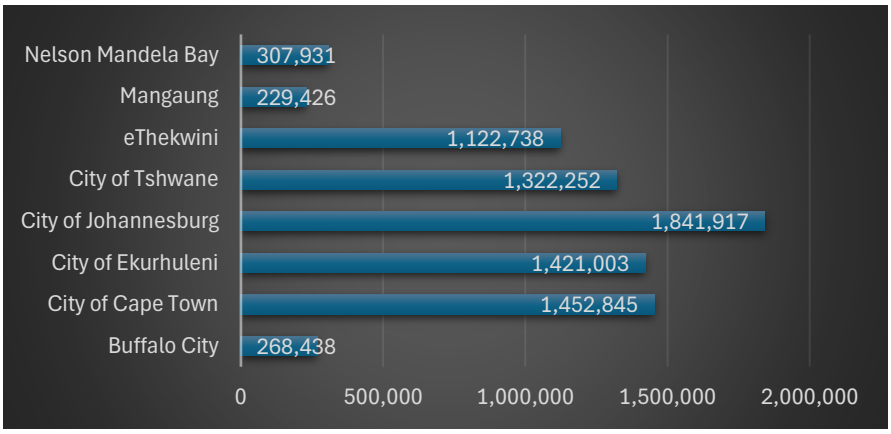

Figure 4: Number of Households in each Metropolitan Municipality in South Africa
Source: [51]

Table 1 presents further information to complement that in Figure 4. Table 1 presents information on the percentage of water distribution in the eight metropolitan municipalities in South Africa. Table 1 allows for water supply comparison over a period of three years. In 2022, the average percentage of water access by households was 96.2 out of the 7,966,550 households in the country [1], indicating a significant water supply to South Africans. An in-depth study of the data enables metro comparison. For instance, in the cities of Tshwane and Buffalo City, the lowest water supply percentages of 94.2 and 94.3 were recorded, indicating the need for improved water service delivery in the areas. By 2023, an improvement of 1.6% and 2.4% was recorded in the two cities, respectively. In 2024, however, while the City of Tshwane experienced a further boost in the percentage of households' access to water, a decline of 1.1% was recorded in Buffalo City, showing that the improvement observed in 2023 was not sustained in the following year.

In the City of Cape Town, even though access to water services by households was impressive, the city further enhanced its coverage to include an additional 2.2% in 2023, which was sustained in 2024. This emphasized the city's concerted effort in promoting the achievement of the South African constitution's mandate of ensuring unhindered access to safe drinking water. In line with this trend, a continuous increase in households' water access from 2022 through 2024 can be observed in the Cities of Ekurhuleni and Johannesburg. This underscores the investment effort in these metropolitan cities. However, in eThekwini, Mangaung, and Nelson Mandela Bay, there

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are fluctuations in the percentage of households' water access, showing the need for a proper study of these cases to understand the factors creating the instability in water service access.

Table 1: Percentage distribution of household water supply to Metropolitan Municipalities in South Africa.

Metropolitan Municipalities	2022	2023	2024
Buffalo City	94.3	96.7	95.6
City of Cape Town	97.6	99.8	99.8
City of Ekurhuleni	98.2	98.6	99.3
City of Johannesburg	97.6	98.9	99.6
City of Tshwane	94.2	95.8	96.5
eThekwini	95	95.3	94.9
Mangaung	95.4	91.7	96.2
Nelson Mandela Bay	97.5	87.6	98.2

Source: Curated from reports from [1, 2, 15].

Access to water is just a component of effective water service delivery. Equally important is the extent to which households experience water service interruption. To analyze this trend, Table 2 is presented to profile the percentage distribution of households that reported water service interruption, at least for two days, in the metropolitan municipalities.

Table 2: Percentage distribution of households that reported water interruption (at least two days) by Metropolitan Municipalities in South Africa.

Metropolitan Municipalities	2022	2023	2024
Buffalo City	34.8	66.7	27.5
City of Cape Town	5.8	28.8	6.9
City of Ekurhuleni	11.8	38.3	17.4
City of Johannesburg	18.3	37.7	25.3
City of Tshwane	17.1	47.3	23.2
eThekwini	61.2	53.3	28.6
Mangaung	37.9	44.6	21.8
Nelson Mandela Bay	46.0	43.8	40.3

Source: Curated from reports from [1, 2, 15].

In Table 2, indications of significant water interruption can be noticed in almost all focus areas. For example, between 2022 and 2024, it is only in eThekwini and Nelson Mandela Bay that a steady reduction in the percentage of water interruptions could be noticed. In every other metropolitan municipality, the rate has continued fluctuating, thereby discrediting the vague assumption that water service delivery in the focused areas is effective, given the data in Table 1. Exploring the factors responsible for the concerning water service delivery interruption rate would require comparing the adopted data in this study with contemporary literature on the subject.

Quality of Water Supplied to Households in Metropolitan Municipalities of South Africa

The overall well-being of an individual is dependent on the extent of hygiene observed in what is consumed. As water is an indispensable component of what people consume daily, ensuring its safety has remained an essential concern to governments. Accountability, as extracted from the principal-agent theory, is adopted to report the quality of water supplied by metropolitan municipalities in this study. This is to explore the extent to which metropolitan municipalities complied with the directives of their principal and the national government to provide safe drinking water to their constituencies. In ensuring water safety, the South African government adopted a

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National Drinking Water Standard, SANS 241:2015. This standard relies on a web-assessment tool, Blue Drop Risk Rating (BDRR), for assessing drinking water compliance with chemical and microbiological components.

In the BDRR assessment, five risk indicators of Design Capacity, Operational Capacity, Water Quality Compliance, Technical Skills, and Water Safety Plan were adopted to address drinking water's risk assessment requirements as contained in the SANS 241:2015 standards. The BDRR formular is: BDRR = (A x B) + C + D + E

Where the weighting factor is based on the following five risk indicators:

A - Design Capacity: Larger plants present a higher risk as they supply water to a larger population.

B - Operational Capacity: Plants operating above their installed capacity present a higher risk as their capability is compromised to deliver safe drinking water.

C - Water Quality Compliance: C1 Microbiological (70%) + C2 Chemical (30%).

D - Technical Skills: Poor technical, management, and maintenance skills base present a collective and individual high risk.

E - Water Safety Plan: The absence of a WaSP, risk-defined monitoring programme based on full SANS 241 assessment and implementation of actions to reduce risk, would represent a high risk due to non-compliance with SANS 241 requirements and lack of risk-management procedures.

The proportional risk allocation between the components is 35:35:20:10 for A/B: C: D: E.

Therefore, full BDRR formular = (35% (A*B)) + [35% C (70% C1 (Micro compliance X monitoring compliance) + 30% C2 (Chemical compliance x monitoring compliance)] + 20% D + 10% E.

A BDRR value is calculated for each water supply system in South Africa, as provided in Blue Drop Reports [16, 52]. A BDRR %deviation is used in this study and calculated using the following formular: BDRR% deviation = BDRR/BDRRmax x 100. Where BDRRmax = Maximum BDRR of the water supply system. The BDRR% deviation is a calculated unit of risk measurement that indicates the variance of a BDRR value before it reaches its maximum BDRR value. This unit of measurement allows the Department of Water and Sanitation to compare all sizes and types of water treatment plants equally. All water supply systems are categorised according to their risk rating, placing them in one of four categories as reflected in Table 3.

Table 3: BDRR Risk Rating Categorization.

Low	Medium	High	Critical
<50%	50%<70%	70%<90%	90%<100%

In the rating, the lower the risk percentage, the better the water safety for household consumption. In this study, the BDRR rating data for 2022 and 2023 were found in the Stats SA database, with that of the year 2024 yet to be updated. Given this data limitation, the water quality status for only 2022 and 2023 was provided and discussed as captured in Table 4.

Table 4: Metropolitan Municipality BDRR rating for 2022 and 2023.

Metropolitan Municipalities	2022	2023	Status
Buffalo City	31.6%	41.7%	↓
City of Cape Town	25.7%	31.0%	↓
City of Ekurhuleni	33.3%	29.2%	↑
City of Johannesburg	34.7%	29.2%	↑
City of Tshwane	35.2%	33.1%	↑
eThekwini	32.6%	31.6%	↑
Mangaung	72.5%	36.2%	↑
Nelson Mandela Bay	31.9%	45.9%	↓

Source: Curated from reports from [1, 15].

In Table 4, the BDRR rating for metropolitan municipalities indicated mixed results. While improvements in the quality of water supplied were reported in the cities of Ekurhuleni, Johannesburg, Tshwane, eThekwini, and Mangaung, the opposite was recorded in Buffalo City, the city of Cape Town, and Nelson Mandela Bay, indicating the need for crucial effort in assessing the factors responsible for this water quality decline. When this BDRR rating overlaps with the water interruption data in these three metros in 2022 and 2023, a new perspective emerges.

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For instance, in 2022, the water interruption rate in Buffalo city was 34.8% with an increase of 31.9% in 2023. This increase in the rate of water interruption is further worsened by the declining water quality rating reported in Table 4, thereby indicating the need to examine the issues surrounding this emerging scenario.

Similarly, in the City of Cape Town, an increase of 23% in the percentage of water interruption (for at least two days) from 5.8% in 2022 to 28.8% in 2023 raises some concern. This was further complicated by the decline in the quality of water in the city from 25.7% to 31%. Even though the water risk rating is still in the low category, there is a need to watch this trend to avoid the rating from moving from the current low risk category to the medium category. Out of the three metropolitan municipalities with a declining water risk rating, only Nelson Mandela Bay recorded a reduction in water interruption between 2022 and 2023. Even though a sustained water interruption reduction is equally recorded in 2024 as indicated in Table 2, there is still some concern with the quality of water being supplied in the metro, especially given the closeness of the 2023 risk rating category.

In all other metropolitan municipalities, considerable improvements in the risk rating of water supplied were reported, with the best improvements noticed in Mangaung, where the risk rating declined from the High-risk category (72.5%) in 2022 to a Low-risk rating category (36.2%) in 2023. This showed the extent of effectiveness in the strategy deployed by the metro in addressing the challenges with the quality of their water supply to households. To explore the connection between the level of water interruption and the water risk rating on the quality of water service delivery infrastructure available in the metropolitan municipalities, the data on the Water Infrastructure Quality Index (WIQI) is provided in Figure 5.

According to [1], WIQI classifies engineering infrastructure based on the level of services that households have access to. There are five categories of infrastructure classification using WIQI (namely: no service (1), minimum (2), basic (3), intermediate (4), and full service (5)). This classification is calculated based on the water service delivery infrastructure condition in each metropolitan municipality [1]. In the South African water regulation, a WIQI of above 4.5 indicated best access to improved water services among metropolitan municipalities. The score of the various metropolitan municipalities in the country in 2022 is as depicted in Figure 5.

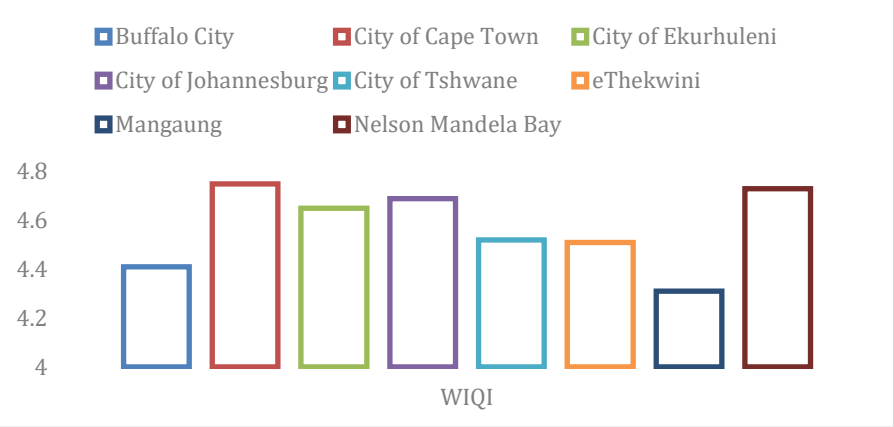

Figure 5: Water service infrastructure quality index by metro in 2022.

In all the metropolitan municipalities in South Africa, the minimum WIQI score was 4.31 (Mangaung), with others scoring as high as 4.75 (City of Cape Town), indicating good access to improved water service, thereby complementing the data in Table 1. However, the level of water interruption experienced by households in focus areas, despite the excellence of water infrastructure in the metros is concerning. Even though access to water services delivered by metropolitan municipalities was laudable in 2022, this study held that adequate attention is yet to be paid to other factors, aside from the quality of water infrastructure, that have a bearing on reducing cases of water interruption by metropolitan municipalities.

Even though this study could not access the BDRR rating for the years 2024 and that of WIQI for 2023 and 2024, insight from the available data provided a valid platform for exploring the water quality dimensions in South Africa. This limitation was further enhanced by the findings of contemporary literature on the subject.

Public Satisfaction with Household Water Supply in Metropolitan Municipalities

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In ascertaining public satisfaction with water supply by metropolitan municipalities in South Africa, there is a need for specialized data on the user perceptions of water provision services in the country. Given the extensive resources associated with getting this data from the primary source, this study adopted the Water Services Barometer Study 2022. This report emanated from the concerted efforts of the Water Research Commission (WRC) and the South African Local Government Association (SALGA) in exploring the perception of households on water provision services in the country. The survey was built on similar early initiatives of 2011 and 2015 to ascertain the present water service delivery satisfaction status of water service users in the country. Using a combination of close-ended questionnaires and structured interviews designed around 12 questions focusing on the perception of households on water delivery services, the survey reported a dual service experience of South Africans. In urban areas, 79% of the respondents indicated satisfaction with water quality, while in the rural areas, 64% laud the quality of water services, 12% stated that drinking water is sourced from rivers and wells, rather than from taps, so they do not know about tap water service quality. This further established the disparity in water service delivery between the urban and rural areas of South Africa [26].

To further explore the spread of users' experience on water service delivery in South Africa, Table 5 is presented. In the table were three indicators of drinking water safety, water service quality, and overall customer satisfaction. The first indicator was calculated using the percentage of responses on drinking water safety. In this regard, the higher the percentage, the higher the respondents' satisfaction with water safety in each metro. The service quality perception score calculated a composite score out of 10 for respondents' perceptions across 14 aspects of municipal water and sanitation services. The perceived Service Quality Index (SQI) scores were interpreted as: 9 or more out of 10 = outstanding; 7 or more, but less than 9 = very good; 6 or more but less than 7 = good; 5 or more but less than 6 = adequate; and less than 5 = disappointing/requires urgent improvement. Four aspects of water and sanitation services were explored to ascertain the extent of customers' satisfaction with the overall water services. These aspects were the level of metropolitan municipality's water services (water quality, water supply, maintenance of sewage pipes, meter readings), water tariffs, metro municipality's sanitation services (the toilets they supply, maintenance of sewage pipes, sewage treatment), and sanitation service charges. Thus, the formula adopted for calculating the customer satisfaction index was:

$$Index = \frac{Total\ score}{20-(sum\ of\ NAs\ x\ 5)} \times 10.$$

Table 5: Households' water services delivery satisfaction score

Metropolitan Municipalities	% of Drinking Water Safety	Service Quality Index Score	Customer Satisfaction Index Score
Buffalo City	57	6.33	6.97
City of Cape Town	73	7.00	7.30
City of Ekurhuleni	89	6.90	7.32
City of Johannesburg	89	6.16	6.86
City of Tshwane	100	6.64	6.69
eThekwini	85	6.45	6.91
Mangaung	76	6.12	6.82
Nelson Mandela Bay	53	6.09	6.84

Source: Extract from the Water Services Barometer Study (2022).

In Table 5, there were indications of water safety concerns in seven of the eight metropolitan municipalities in South Africa. This is given by the percentage of responses in favour of the subject. Aside from the City of Tshwane, the extent to which households are satisfied with the safety standards of drinking water is less than 100%, with the lowest water quality confidence in Nelson Mandela Bay and Buffalo City. Furthermore, the service quality index score was at its lowest in Nelson Mandela Bay, Mangaung, and the City of Johannesburg, showing the need for improved water service delivery in these areas. Overall, only the City of Cape Town had a "very good" score in service quality, with none reaching the outstanding service quality status.

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The customer satisfaction index score is adopted to ascertain South Africans' general satisfaction with water service delivery. As shown in Table 5, none of the metropolitan municipalities scored below the “adequate score” grade; however, the data showed the yearnings of the South African people for improved water service delivery. Aside from the Cities of Cape Town and Ekurhuleni, where the satisfaction index score was “very good”, other metros’ performance was just considered “good”. As there were no data on households’ water satisfaction level for 2023 and 2024, the conclusion of this paper shall be in line with that of 2022.

5 Discussions

This section is structured in line with the objectives of the paper.

5.1 Households’ water access in Metropolitan Municipalities in South Africa

Water is an indispensable component of people’s daily diet [1]. Even medically, people have been encouraged to take water in a reasonable quantity, especially in arid countries of Africa such as South Africa [6, 7]. In the country, and mostly in the metropolitan municipalities, supplying water to households has been challenging [17], given several impediments confronting the water sector. To streamline the policy approach to addressing this trend, this study examines the current water service delivery performance of each metropolitan municipality in the country. From the findings of the study, it was evidenced that in 2022, access to water service delivery was in four categories of access to water inside dwellings (59.7%), access to water with the yard (22.7%), access to water outside the yard (8.9%), and households without water supply access (8.7%). Overall, 91.3% of households had access to water in South Africa, indicating a significant water service coverage in the country in 2022. However, significant water service performance variation exists among metropolitan municipalities regarding water access. While impressive water supply records were evidenced in the Cities of Ekurhuleni, Cape Town, Johannesburg, and Nelson Mandela Bay, other metros, such as Mangaung, eThekwini, Buffalo City, and the City of Tshwane, trailed behind.

Also, in 2023 and 2024, this performance variation persists with sustained improvements in the Cities of Cape Town (an increase of 2.2% in 2023 and maintained in 2024), Ekurhuleni, and Johannesburg. This demonstrates consistency in the commitment of these metropolitan municipalities to water service delivery. However, metros with low water supply performance were the City of Tshwane (94.2%) and Buffalo City (94.3%), indicating the dire need for improved water service delivery in these metros. In addressing this trend in these metros, however, there is a need to factor in the inconsistency, notably visible in Buffalo City here in 2023, where water access improved by 2.4%, but declined by 1.1% in 2024. Unlike in Tshawe, where water access improvement was sustained in 2023 (1.6% increase) and 2024 (0.7% improvement). A similar performance fluctuation could be noticed in eThekwini, Mangaung, and Nelson Mandela Bay, indicating the need for a detailed analysis of the factors responsible for the performance instability. While commenting on water service inconsistency among metropolitan municipalities in South Africa, [8] emphasised this inconsistency in Nelson Mandela Bay.

Another important indicator for assessing households’ water service delivery performance is the frequency of water interruptions. This paper found that significant water interruptions occurred in all metropolitan municipalities, and these interruptions lasted for at least two days. Within the focused period (2022 and 2024), only eThekwini and Nelson Mandela Bay displayed steady improvement in reducing the occurrence of water interruptions, thereby demonstrating service reliability. However, trends could be observed in Buffalo City, Cities of Cape Town, Ekurhuleni, Johannesburg, Tshwane, and Mangaung, where surges in the frequency of water interruptions characterized the year 2023. This calls for a dedicated study of the factors responsible for this surge in these metros in 2023. While confirming the inconsistencies with water service delivery in Tshwane, Mangaung, and Nelson Mandela Bay, [50] added that similar service deficiencies are also true of the cities of Ekurhuleni, Johannesburg, eThekwini, and Buffalo City.

In comparing water supply access with the extent of water interruption, an insight emerged into the effect of water interruption on water service quality. This effect demonstrated that persistent water interruptions could indicate water supply quality issues beyond water access metrics. On water interruption among metropolitan municipalities, [55] buttressed that water service is inadequate, especially in Nelson Mandela Bay, where residents were averse to paying for water services. The literature offers insight in explaining the factors causing water interruptions among metropolitan municipalities in South Africa. Decaying water infrastructure [22, 24], financial

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mismanagement [25], inadequate skilled manpower [8, 18], and institutional inefficiency [18] are a few of the hindrances confronting metros in the delivery of water services to households.

5.2 Households' water service quality in Metropolitan Municipalities in South Africa

Given the extent of data available on drinking water quality among metropolitan municipalities (2022-2023), this study found that Ekurhuleni, Johannesburg, Tshwane, eThekwini, and Mangaung demonstrated improved water quality during the focused period. The most significant improvement is particularly in Mangaung, where the BDRR rating dropped from high (72.5%) to low (36.2%). Concerns could be observed in the trend in Buffalo City, City of Cape Town, and Nelson Mandela Bay, where the BDRR rating increases, thereby indicating a reduction in drinking water quality in these metros. More particularly, the trend in Buffalo City is most concerning, given that within 2022 and 2023, the city experienced a significant water interruption level from 34.8% in 2022 to 66.7% in 2023. In the same period, the water quality drops, showing a dual failure in water access reliability and safety, further validating the need for a detailed analysis of what is going on in the metropolitan municipality.

Equally, in the City of Cape Town, there was an indication of a rapid water service. For instance, the water interruption rate moved from 5.8% in 2022 to 28.8% in 2023, showing a 23% increase. Furthermore, the risk of drinking water quality moved from 25.7% to 31%, indicating a significant quality concern in the water service in the metro. In Nelson Mandela Bay, a mixed performance was recorded as the metro reported a decrease in the rate of water interruption, a positive score, but as regards water quality, it recorded a negative score, given the increased BDRR rating, pushing the metro towards the medium-risk category.

Furthermore, the WIQI assessment showed an excellent water infrastructure status across all metropolitan municipalities in South Africa. More closely, in this regard, the City of Cape Town had the highest WIQI score (4.75), indicating access to improved water services, while Mangaung recorded the lowest score (4.31), also indicating a commendable water service infrastructure. This infrastructure further complements the improved water supply recorded across the metropolitan municipalities within the study period. An emerging concern, however, is the level of water interruption recorded, despite the excellent status of water service infrastructure. There is a need to explore other factors that could explain the increasing water interruptions besides the infrastructure deficit.

5.3 Households' water service delivery satisfaction in Metropolitan Municipalities in South Africa

Relying on the Water Services Barometer Survey, this paper finds a moderate but concerning water service delivery satisfaction landscape across South African metropolitan municipalities. Even though none of the metros fall below the 'adequate' satisfaction level, systemic underperformance is evident, especially as none of the metros achieved the 'outstanding' service status. A deeper insight into the findings of this paper showed that seven out of the eight metros in the country indicated water safety satisfaction gaps, with Buffalo City and Nelson Mandela Bay showing the most significant concern, as noticed in the low drinking water safety score.

The findings further positioned the City of Cape Town and Ekurhuleni as the most satisfying metros in water service delivery, even though others had a slightly lower score. The absence of any metro within the 'outstanding' satisfaction metrics shows systemic performance improvement opportunities for all metros. This thus underscores the need for a sector-wide reform. Lastly, there is an established disparity in urban-rural water service delivery. Bridging this gap is important and urgent.

5.4 Recommendations on the factors hindering effective water service delivery in the South African Metropolitan Municipalities

Challenges confronting the water service delivery sector in South Africa are both general and peculiar. The general challenge found in this study was the need for a sector-wide service delivery reform to enable users' experience of water services to reach 'outstanding' status. Even though WIQI data showed the availability of excellent water infrastructure across metropolitan municipalities, the incidence of water leakage invalidates this claim, further necessitating investment in infrastructural maintenance. In the works of [22, 24], recent investment in the maintenance of water infrastructure has been low, which has occasioned continuous water loss due to leaking pipes. Other general challenges that might explain the fluctuating water service delivery performances as found in this paper were suggested in the literature, such as inadequate skilled manpower [8, 18].

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The city of Mangaung has a significant challenge in maintaining a steady water supply, given the high rate of water interruptions in the metro. In support of this finding were [56], who equally reported that Mangaung faces severe drought that has occasioned water shortage in the municipality. Although in a mild proportion, sharing in this challenge is eThekwini and Nelson Mandela Bay [8, 57].

Given the findings of this paper and the complementary information from supporting literature, this paper proposes the following actionable policy initiatives for water service delivery improvements among metropolitan municipalities in South Africa:

a. To address the issues with critical underperforming metropolitan municipalities, such as Nelson Mandela Bay, Buffalo City, Mangaung, and the City of Johannesburg, there is a need for:
   i. The establishment of a water service delivery task force in each of the metros with dedicated national oversight.
   ii. The metropolitan municipalities should foster best practices exchange between high-performing (City of Cape Town and Ekurhuleni) and low-performing ones.
b. To enhance water quality, there is a need for the deployment of real-time water quality monitoring platforms. This will enable a timely response to water safety cases among metros. The DWS should coordinate this to minimise procurement and management costs associated with the required technology.
c. To minimise the incidence of incessant water interruption, using Internet of Things (IoT) sensors and data analytics, the DWS should develop a predictive maintenance system that issues notifications of possible infrastructure damage.
d. To enhance the capacity of water management officials, there is a need for the establishment of a national water management training institute that focuses on training metro staff in the best practices in water management and water service delivery.
e. Specifically, this paper is faced with significant data absence in many of the adopted water service indicators in this study. It is arising from this that this paper recommends a regular and periodic data update on the public databases of public service bodies to support social-service-oriented studies and researchers.

6 Conclusion

This paper explored water service delivery performance across metropolitan municipalities in South Africa between 2022 and 2024. Specifically, the paper adopted three basic measurement indicators of water access, water quality, and household water services satisfaction. The findings revealed a significant disparity in the performance of the metros. While the City of Cape Town and Ekurhuleni demonstrated consistent water service excellence, Buffalo City, Nelson Mandela Bay, and Mangaung struggled with incessant water interruptions and declining water safety. Despite the robust water infrastructure status reported in WIQI, systemic challenges, such as leaking water pipes and institutional inefficiency, undermine reliable water service delivery among metros in South Africa.

This paper thus concludes that for South Africa to effectively address the persistent water service delivery challenges before it and efficiently achieve SDG 6 by 2030, there is the need for crucial investment in water management technology, establish water service delivery taskforce across metros, invest in wastewater treatment technologies, establish a national water management training institute to regular provide trainings to metro staff. Lastly, inter-metro best practices sharing must be entrenched, while a public database with updated water performance data must be made available to support water research.

There are two major limitations in this study. Firstly, the paper examined water service delivery performance in the eight metropolitan municipalities in South Africa, leaving close to fifty other municipalities in Categories B and C, unattended. Secondly, adequate data to enable objective period comparison was lacking. Subsequent studies could investigate water service delivery performance in the uncovered municipalities, focusing on the peculiar factors responsible for the observed performance trends. Furthermore, studies need to explore primary data sources, especially from households, to triangulate existing public survey reports.

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