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The Performance of Small-Town Water Systems in the Upper West Region of Ghana

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Abstract

Small-town water systems are water supply systems built primarily for people living in rural or peri-urban areas in many developing countries. This study examined the performance of small-town water systems in the Upper West Region (UWR) of Ghana, focusing on functionality, management practices, and sustainability challenges. The study adopted an exploratory research design and applied both qualitative and quantitative methods, using surveys and interviews with water users, system operators, and officials from the Community Water and Sanitation Agency (CWSA). The findings revealed that while most assessed small-town water systems were functional, they operated below optimal levels, with overall coverage below 3% across all selected districts. Frequent pump failures (46%), pipe leakages (22%), and an unstable power supply (16%) were identified as the main technical problems. Over half of the system operators lacked adequate training, and community involvement in managing the water systems was rare, as management was overly centralised under the CWSA. The study recommends the adoption of solar-powered mechanised water systems to reduce power-related interruptions, and a holistic approach to the management of the water systems that integrates technical efficiency, financial accountability, strong institutional collaboration, and inclusive community ownership to ensure the sustainability and optimal performance of small-town water systems in the UWR and similar systems in other developing countries.

Keywords: Water Systems, Systems Performance, Water Supply, Pump Failure, Pipe Leakages, Systems Functionality

Introduction

Access to clean and reliable drinking water is a basic human right and an important part of making life better and more sustainable. Sadly, more than two billion people around the world still struggle to get safe drinking water, especially in rural parts of sub-Saharan Africa (Matchawe *et al.*, 2022; Nyika and Dinka, 2023). According to the World Health Organisation (WHO)/United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) 2023 update, 27% of the global population (2.2 billion people) lacked "safely managed drinking water", 43% of the global population (3.5 billion people) lacked "safely managed sanitation", 25% of the global population (2.0 billion people) did not have access at home to a handwashing facility with soap and water (Homayoun Aria & Asadollahfardi, 2025).

Consequently, small town water systems, which are water supply setups built mainly for people living in rural areas or in small towns near cities (peri-urban areas), are used to supply water in many developing countries. Small towns are settlements that are sufficiently large and dense to benefit from the economies of scale offered by piped systems, but too small and dispersed to be efficiently managed by a conventional urban water utility (Yap et al., 2023). They require formal management arrangements, a legal basis for ownership and management, and the ability to expand to meet the growing water demand (Pointet, 2022). Accordingly, small towns usually have populations between 5,000 and 50,000, but can be larger or smaller (Vîlcea et al., 2024). Some common types of small water systems include hand-pumped boreholes, which allow people to manually fetch underground water, and rainwater harvesting systems that collect and store rainwater for later use. Others include small piped water networks that serve just one village or area, and solar-powered boreholes that use sunlight to pump water from underground. These systems are especially helpful because they are simple to use and work well even in remote areas with limited resources.

Measuring the performance of small water systems involves assessing both technical and non-technical aspects. Accordingly, one of the most important indicators is functionality, which refers to whether the water system is operational at the time of inspection (Zulkifli et al., 2022). A functional system ensures that pumps, taps, and other infrastructure are in working order and that water is flowing without prolonged interruptions. Another crucial measure of the performance of small water systems is the service level provided to users, which includes the quantity of water available per person each day, the distance to the water source, and the overall reliability of supply (Odjegba et al., 2023). A higher service level means people can access adequate amounts of water near their homes and rely on the system to work consistently, without frequent breakdowns.

Water quality is also a critical performance indicator, focusing on whether the water supplied is safe for human consumption (Perveen & Amar-Ul-Haque, 2023). This is usually assessed through laboratory testing for microbiological contaminants, such as Escherichia coli, and chemical pollutants, including arsenic, fluoride, and nitrates, as maintaining good water quality is essential for protecting public health and preventing waterborne diseases. The sustainability of a small water system is another key consideration in performance measurement. Sustainability refers to the ability of the system to continue functioning effectively over time, taking into account financial, technical, and institutional dimensions (Farghali et al., 2023; Martínez-Peláez et al., 2023). Financial sustainability depends on the availability of adequate funds for maintenance and repairs, whereas technical sustainability relates to the availability of spare parts and skilled technicians, and institutional sustainability requires a competent management structure to oversee operations. In addition to these core indicators, other measures usually used to assess small water system performance include community satisfaction, the ability to recover operational costs through user fees, and the speed at which faults are repaired (Sukma & Leelasantitham, 2022; Zhang et al., 2024). These measures provide a broader picture of how well the system meets user needs and how efficiently it is managed.

Despite these established benchmarks, many small water systems fail to meet even basic performance standards. A study in Ghana found that numerous systems suffer from frequent technical breakdowns, delayed repairs, and inadequate maintenance regimes, which undermine both reliability and long-term sustainability (Mantey et al., 2024). These challenges highlight the need for stronger management practices, better funding mechanisms, and improved maintenance strategies to ensure consistent service delivery. Small-town water systems in Ghana, primarily managed by the Community Water and Sanitation Agency (CWSA), provide piped water to rural and peri-urban communities, with over 500 small town piped schemes in operation as of 2021. These systems often utilise groundwater, using borehole-powered, solar, or electric pumps, managed by local Water and Sanitation Management Teams (WSMTs). The Upper West Region (UWR) was the first region to commence the CWSA reform programme by incrementally participating in the management of Small

Towns Piped Water Supply Systems (STPWSSs). The Region piloted its reform programme on Lawra, Nandom, Tumu, Jirapa and Gwollu Water Systems in July 2017. Following the success of the pilot programme, the region scaled up its direct management to cover eleven (11) additional STPWSSs, namely, Kpongu, Busa, Manwe, Goripie, Wechiau, Kaleo, Nadowli, Daffiama, Lambussie, Hamile-Happa and Funsi Water Systems (Community Water and Sanitation Agency, 2023).

Therefore, this study examines the performance of small-town water systems in the Upper West Region (UWR) of Ghana. Aside from Wa, the regional capital of the UWR, small-town water systems such as boreholes with hand pumps, mechanised wells, and small piped networks are the main sources of water supply for the remaining towns and villages in the UWR. Whereas some of these systems operate reliably, many do not. Frequent breakdowns, seasonal water shortages, and poor maintenance often leave communities without safe water for long periods. This situation poses serious risks to public health and disrupts daily life, especially for women and children who are typically responsible for collecting water. Although many studies have examined the challenges faced by rural water systems in Ghana (Angmor et al., 2024; Boasinke & Braimah, 2022), most focus on the country as a whole or highlight broad national trends. As a result, there is limited research that examines the performance of small-town water systems in the UWR in detail, taking into account the region's unique social, economic, environmental, and institutional conditions. Without such a local perspective, it is difficult to fully understand the specific problems that affect small water systems in this part of the country. Therefore, the study addresses this gap and contributes to improving public health, enhancing water quality, and increasing the infrastructure sustainability of small-town water systems in Ghana and other developing countries, as the findings are expected to provide actionable insights to guide policy decisions, strengthen monitoring systems, and promote more sustainable management of small water systems.

Methods

The study Area

The study was conducted in the UWR of Ghana, where most people live in rural communities and rely primarily on small-town water systems for their water supply. The UWR of Ghana features 22 Small Town Piped Water Supply Systems (STPWSS) that rely on groundwater, serving communities typically with populations between 2,000 and 50,000. Managed primarily by the CWSA since 2017, these systems aim to provide sustainable, potable water, though they face challenges like poor maintenance, financial mismanagement, and climate-induced shortages. The STPWSS in the UWR are shown in Figure 1.

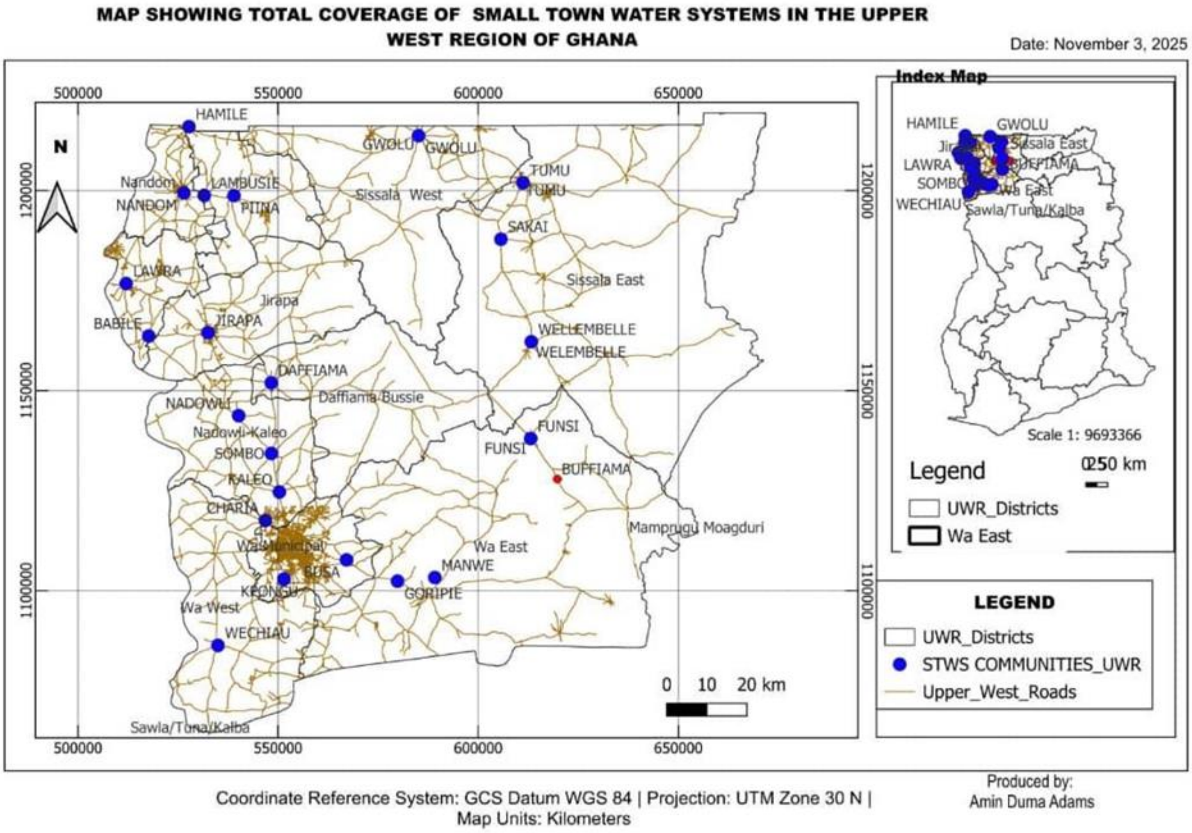

Figure 1: STPWSS in the UWR managed by the CWSA

Research Design, Data Collection, and Analysis

The study adopted an exploratory research design and applied both qualitative and quantitative research methods. In addition, the study applied stratified random sampling to select the water systems for the study. The water systems were first divided into different categories based on location, type of system, and whether they were working well, partly working, or not working at all. From each category, systems were then chosen randomly for study. Subsequently, six water systems, namely, the Nandom system in the Nandom Municipal Assembly, the Kaleo system in the Nadowli District, the Funsi system in the Wa East District, the Wellembele system in the Sissala East District, and the Gwollu system in the Sissala West District, were selected for the study. Within the communities of the selected water systems, households were randomly selected to be part of a questionnaire survey. In addition, focus group discussions and interviews were held with stakeholders such as members of the water user associations, system operators, members of the water and sanitation committee, district water officers, officials of CWSA, and non-governmental organisations (NGOs) operating in the water sector. The study population consisted of two hundred (200) water users and twenty-five (25) stakeholders, including system operators, members of water and sanitation committees, district water officers, officials from the CWSA, and NGOs. These groups were selected because they play key roles in the provision, operation, and management of small water systems, and their perspectives were critical for understanding both the technical and institutional factors influencing system performance.

The data for the study were collected using a questionnaire and interviews**.** The questions were focused on whether the water systems were working, how reliable they are, how much users trusted the water quality, how often breakdowns occurred, and the overall satisfaction of water users. To validate the research instrument, all questions with a scale were subjected to reliability tests using Cronbach's Alpha. A Cronbach's Alpha of at least 0.700 is acceptable, as it reflects the internal consistency of the research instrument in measuring the same constructs (Mazhar et al., 2021). In addition, focus group discussions were held with key stakeholders, such as systems operators and water vendors. Key informant interviews were also conducted with water committee members, CWSA officials, and NGOs. These interviews gave deeper insights into management practices, financial challenges, and institutional arrangements for the water systems. The quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) software package 24.0, and the results were presented using descriptive statistics, such as percentages and charts. Furthermore, ethical issues were carefully considered. Participation was voluntary, and the study participants were informed about the purpose of the study before they agreed to take part.

Results

This section highlights community perspectives on access, availability, safety, and the management of water systems, as well as officials' views on technical challenges, funding, and policy support. By comparing community responses with those of officials, this section provides a clear understanding of the strengths and weaknesses of the studied water systems and identifies areas that require improvement for sustainable management.

Preliminary Analysis

Cronbach's Alpha is a measure of internal consistency, indicating how closely related a set of items is as a group, with values ranging from 0 to

1. Higher values indicate greater reliability, with a commonly accepted threshold of 0.70 or higher considered acceptable. The construct "small town water systems performance in the UWR" has a Cronbach's Alpha of 0.82. This value was above the 0.70 threshold, indicating acceptable reliability. This indicates that the variables used to assess the performance of small-town water systems in the UWR were reasonably consistent, though there may be room for improvement in the scale's design or item selection.

Demographic Information of Respondents

The majority of respondents were female (80.5%), while males accounted for 19.5%. This was a significant finding because in many rural communities, women are the primary users and managers of household water. They are typically responsible for fetching, storing, and using water for domestic purposes such as cooking, washing, and sanitation. Therefore, their higher representation in this survey ensured that the findings captured the perspectives of those who were most directly involved in water-related activities. Regarding the age distribution of the respondents, the largest group fell within the 21–30 years range (36%), as shown in Figure 2. This age group is typically active in both household and community responsibilities, which means their perspectives provided valuable insights into the functioning and management of the water systems. On the other hand, only a small number of respondents (2%) were between 16 and 20 years of age, showing limited participation from younger people, possibly because they were still in school or less involved in household water responsibilities. Overall, the age distribution suggests that the study reflected the views of the most active working-age population, who are directly affected by water challenges and are likely to be involved in community water management activities.

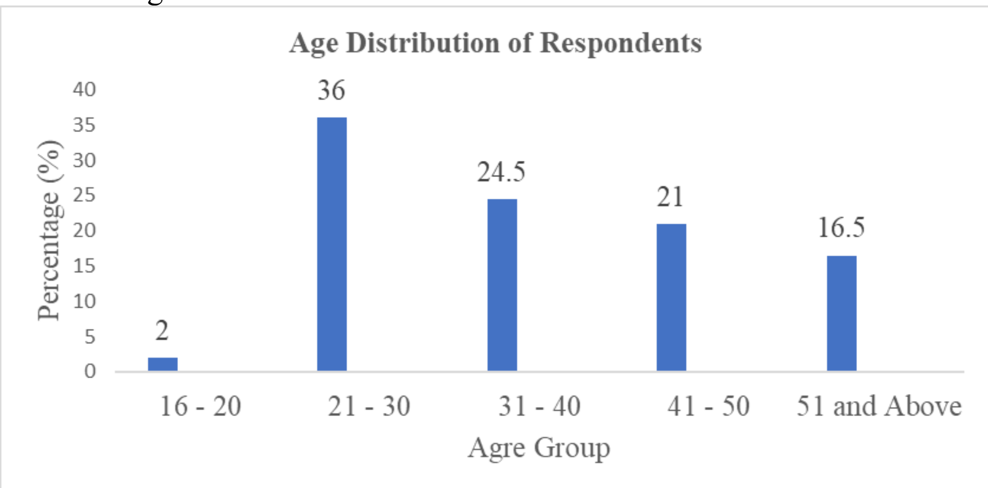

Figure 2: Age Distribution of the Respondents

The Performance of the Small-Town Water Systems in the UWR

Officials' Rating of the Functionality of the Water Systems

The responses from officials on the functionality of the assessed water systems indicated varying levels of performance, as shown in Figure 3. The majority of the respondents **(**48%) rated the functionality of the water systems as fair because the water systems experienced intermittent operation, frequent breakdowns, or inadequate water supply to meet the community's needs, whereas 20% of the respondents rated the functionality of the water systems as poor. Overall, the findings revealed that most small water systems in the Upper West Region were functional but not optimal. The dominance of "fair" ratings highlights the need for improved maintenance, better technical support, and strengthened management practices to enhance performance and ensure sustainable water service delivery. Accordingly, many small-town water systems face premature failure within a 10-year design period, requiring significant capital maintenance to fix, which can cost six times more than regular, ongoing maintenance (Palash Chandra, 2026).

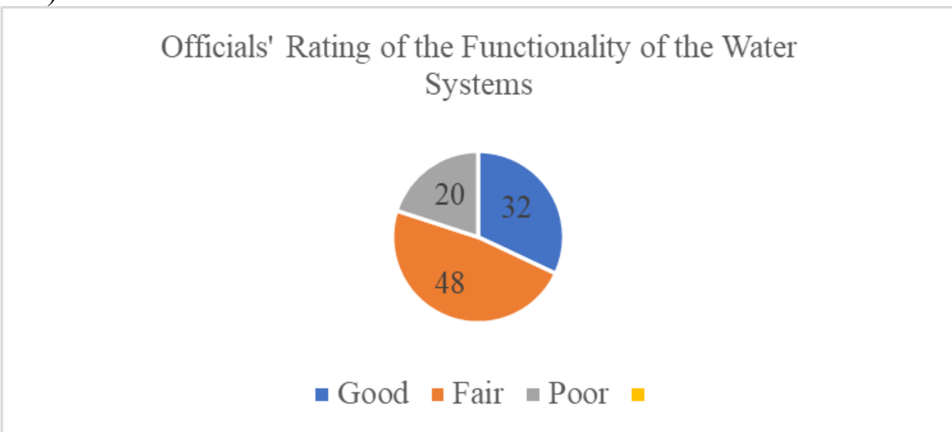

Figure 3: Rating of the Water Systems Functionality

Water Users' Satisfaction with the Water Systems

The assessment of the functionality of small-town water systems by water users provides valuable insights into user satisfaction. As shown in Figure 4, the majority of respondents **(**77.0%**)** indicated that they were dissatisfied with the performance of their water systems. Only 13.5% expressed satisfaction, with a very small proportion, 1.5%**,** reporting being very satisfied with the functioning of the water systems. The findings indicated that the water users' satisfaction with the water systems was generally low. The overwhelming dissatisfaction expressed by the water users could be attributed to persistent challenges such as irregular water supply, frequent breakdowns, poor water quality, and inadequate coverage**.**

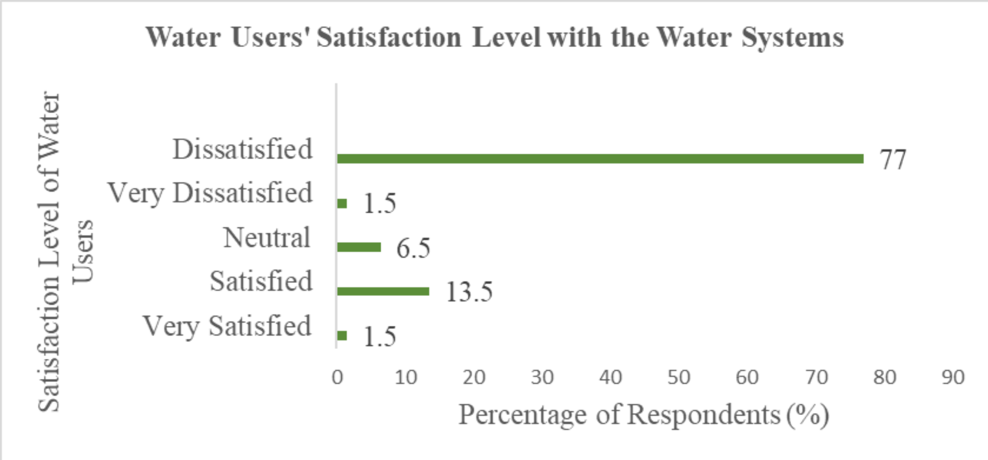

Figure 4: Water Users' Satisfaction Level with the Water Systems' Functionality

The low satisfaction with the functionality of the water systems is supported by other researchers who observed that water users' satisfaction with small-town water systems is generally mixed, often characterised by high appreciation for the improved convenience of having a local source, coupled with significant dissatisfaction regarding water quality, reliability, and maintenance (Kosoe et al., 2025; Osumanu et al., 2022). This calls for the need for improved maintenance, effective management, and regular monitoring to enhance service delivery and meet community water needs in the UWR.

Coverage of Water Supply from the Water Systems

The assessment of small-town water systems across the six selected districts in the UWR revealed that coverage levels are generally low, with significant disparities in functionality among the districts. Overall, the findings indicated that the coverage of the water distribution from small-town water systems across the districts was extremely low, below 3% in each of the study districts**.** Furthermore, the rate of non-functionality among existing systems remains a significant barrier to achieving equitable water access. However, an official of the CWSA, through an informal interview, revealed that "the coverage of water in the districts has increased significantly in recent times due to donor-supported projects installing piped systems, leading to over 27 small-town systems in the UWR". Notwithstanding this, there is a need for strategic interventions, including the rehabilitation of non-functional systems, the expansion of water infrastructure to underserved communities, and the strengthening of management and maintenance mechanisms to enhance the long-term sustainability of the water systems in the UWR.

The Major Operational Challenges of the Small-Town Water Systems

Technical Challenges

Officials and staff of NGOs were presented with five technical challenges of the water systems (pump failure, pipe leakages, electricity/power problems, inadequate storage reservoirs, and water quality concerns) to determine which of them were more pronounced. The most prevalent technical challenge facing small-town water systems was pump failure, as 48% of the respondents reported this as the major challenge facing water systems in the UWR, as indicated in Figure 5. This suggests frequent breakdowns of pumping equipment, which often lead to service interruptions and increased maintenance costs. The second most common issue was pipe leakage, with 32% of the respondents claiming this was a challenge facing the water systems, indicating that ageing infrastructure and poor maintenance practices could be contributing to significant water losses. Water quality concerns were the least identified technical challenge of the water systems, probably because borehole water is generally of good quality unless polluted by anthropogenic activities.

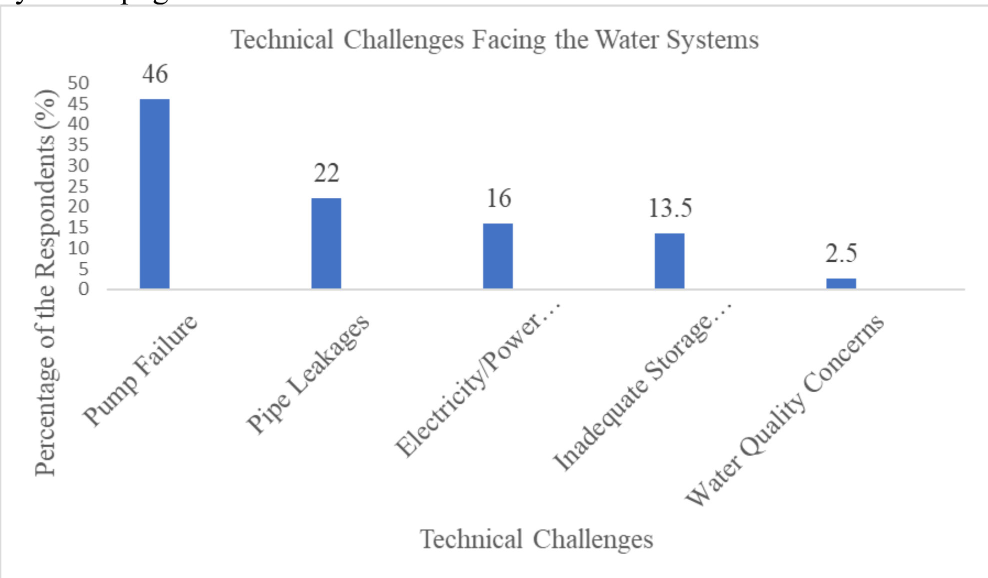

Figure 5: Technical Challenges Facing Small-Town Water Systems in the UWR

Many small-town networks rely on outdated, inefficient, or dilapidated pipes and equipment, and maintenance is frequently reactive rather than preventative, leading to long downtimes and interrupted service when systems fail (Spocter, 2023). Thus, regular maintenance, technical training for local operators, and reliable power supply solutions or solar-power water systems, alongside timely replacement of ageing infrastructure, are essential in ensuring sustainable water service delivery in the UWR.

Technical Capacity of the Water Systems Officials

The study revealed a significant gap in capacity building for those responsible for managing the water systems. Over half of the officials (52%) stated that no training was provided for the water committee members or the system operators. This lack of training limited their ability to carry out effective maintenance, problem-solving, and long-term system management. Nonetheless, 48% of the water systems officials reported that they had received some training; however, many of them noted that the training was irregular. Irregular training may provide some skills, but is insufficient to build the technical expertise and management capacity needed for reliable and sustainable water service delivery. The technical capacity of small-town water system managers is a critical factor in the sustainability of water supply systems, often constrained by limited resources, lack of specialised training, and reliance on reactive maintenance strategies (Angmor et al., 2024; Osumanu et al., 2022). Accordingly, in many developing contexts, particularly in rural Ghana, water management relies on Community Ownership and Management (COM) models, which often face challenges in technical oversight and maintenance (Kotoku & Kumasi, 2022; Lema, 2025).

Financial Challenges

The study indicated that financial constraints remain a major challenge to the effective operation and maintenance of small-town water systems in the UWR. The majority of the water systems managers (48%) identified irregular payments by consumers as the most critical issue, as shown in Figure 6. This irregularity often results in inadequate revenue generation, limiting the ability of management committees to fund repairs and operational costs. Furthermore, high repair costs (22%) were cited as another major challenge. The high cost of spare parts and technical services makes it difficult for communities to maintain systems regularly, especially when revenues are inconsistent. Additionally, other respondents mentioned a lack of external funding, suggesting limited financial support from government or development partners for system rehabilitation and expansion, and low tariff revenue was also highlighted, indicating that existing tariffs are often insufficient to cover operating costs.

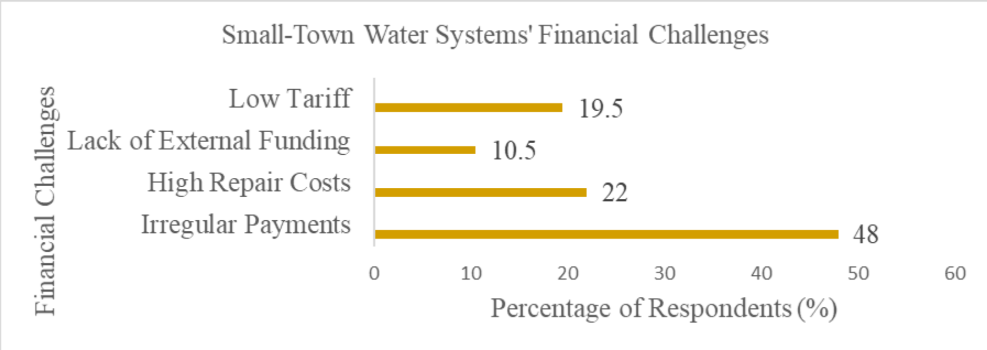

Figure 6: Financial Challenges facing Small-Town Water Systems in the UWR

Small-town water systems usually face critical financial instability due to inadequate revenue, high capital maintenance costs, and limited management capacity (Kosoe et al., 2025). These systems struggle with ageing infrastructure, low tariffs that fail to cover operating costs, and over-reliance on inconsistent donor funding.

Community Involvement in the Small-Town Water Systems Management

The study revealed that community participation in the management of small-town water systems was generally low. A majority of water users (56%) indicated that the communities were somewhat involved, while 36% stated that communities were not involved at all in management of the water systems, with only 8% of respondents reporting high levels of community involvement. Community involvement in small-town water systems, often structured as community-based management, is crucial for sustainable, locally appropriate water supply and sanitation, as it enhances accountability, fosters ownership, and utilises local knowledge for operation, maintenance, and, increasingly, water quality monitoring to ensure long-term resilience (Geremew et al., 2024; Machado et al., 2022). However, the role of communities in management, monitoring, and maintenance was limited. The moderate or low levels of participation may be attributed to weak institutional structures, lack of training, inadequate inclusion in decision-making, or a low sense of ownership among the community members. To improve system performance and ensure sustainability, there is a need to strengthen community involvement through capacity building, awareness creation, and inclusion of local representatives in water management committees. Empowering communities to take active roles in planning, monitoring, and financial oversight can enhance ownership and ensure the long-term functionality of small-town water systems.

Regarding support from government and NGOs for small-town water systems, the study found that this was generally limited and inconsistent**.** The most common form of assistance reported by the officials was financial support (28%), followed by training and capacity building (24%). Government and NGO support for small-town water systems, particularly in developing regions, focuses on funding infrastructure (boreholes, piped systems), technical assistance, and management capacity building (Dakyaga et al., 2023). Key initiatives include grants for solar-powered systems, rehabilitation of existing facilities, and promoting sustainable, community-led management models to ensure long-term, safe water access.

Furthermore, the study indicated that the CWSA, the agency responsible for rural water supply, played the most dominant role in managing small-town water systems in the UWR, as 76% of officials who responded to the study attested to this. This demonstrates that management of most systems remained highly centralised, with limited delegation to community or local authority levels. The dominance of CWSA in management may ensure some level of technical oversight; however, it can also limit local ownership, accountability, and responsiveness to community-specific issues. The limited involvement of system operators and local authorities may lead to weak maintenance practices, slow response to breakdowns, and low community participation, which ultimately undermine system sustainability.

Discussion

The findings of the study indicated that most small-town water systems in the UWR were functional but operated below optimal levels. This aligns with Sharpe et al. (2022), who reported that nearly 25% of rural and small-town water systems in sub-Saharan Africa are non-functional at any given time due to technical breakdowns and poor maintenance structures. The predominance of "fair" functionality ratings in this study (48%) suggests that while systems are operational, they face intermittent interruptions and reduced efficiency, a trend also identified by Nyanyofio et al. (2022), who noted that inconsistent service delivery often stems from irregular preventive maintenance and inadequate funding mechanisms.

The high rate of pump failures (46%) and pipe leakages (22%) reflects persistent technical challenges observed in previous studies. ActionAid Ghana (2025) and Achum Adeenze-Kangah, (2022) both emphasized that frequent mechanical breakdowns are typically linked to limited technical skills, poor access to spare parts, and weak local maintenance systems. Similarly, the instability of power supply (16%) mirrors findings by Geremew et al (2024) in Eastern Ethiopia, which highlighted the vulnerability of small-town systems to unreliable grid connections, underscoring the need for alternative energy sources such as solar power, as recommended in this study.

The study's observation that over half of system operators had not received regular training agrees with Abubakari et al. (2025), who found that many Water and Sanitation Management Teams (WSMTs) in Ghana lack the technical capacity to manage infrastructure sustainably. The absence of structured training programs leads to prolonged system downtime and reliance on external technical support, as also reported by the International Water and Sanitation Centre (IRC) Ghana (2025). This reinforces the argument by Powe et al. (2022) that the sustainability of small-town systems depends heavily on continuous local capacity development and institutional support. Financial constraints emerged as another key issue, consistent with findings by the Safe Water Network (2021) and Cannon et al. (2022), who noted that irregular tariff payments and high maintenance costs undermine cost recovery in community-managed water systems.

Low community participation in water management, reported by 56% of respondents, also echoes the findings of Rijal (2023) and Abas et al. (2023), who observed that limited involvement in decision-making reduces local ownership and accountability. When community participation is weak or symbolic, system maintenance declines, as noted by Abid et al. (2024). Conversely, studies by Mutanda & Nhamo (2024) show that inclusive participation, particularly involving women, improves system functionality, transparency, and long-term sustainability. This supports the present study's recommendation for gender-inclusive and participatory management practices.

The limited government and NGO support identified in this study mirrors similar trends documented by Ngochemmbo et al. (2025), who found that post-donor withdrawal often leaves systems without consistent oversight or funding. The finding that most management roles are dominated by the CWSA (76%) highlights the persistent challenge of over-centralisation noted by (Hamzah et al., 2026). This management model, while technically beneficial, often weakens local accountability and community ownership, a concern echoed by Sofyani et al. (2022) with evidence in Indonesia, where they advocated for decentralisation and local empowerment.

In general, the results of the study align closely with prior literature, reinforcing that the sustainability of small-town water systems depends on a balanced combination of technical reliability, financial stability, institutional support, and community participation. However, the persistent gaps in training, maintenance, and policy enforcement highlight the need for systemic reforms that go beyond infrastructure provision to include long-term governance and financial planning mechanisms.

Conclusion

This study assessed the performance of small-town water systems in the UWR of Ghana, focusing on the systems' functionality, operational challenges, and management practices. The study adopted an exploratory research design and applied both qualitative and quantitative research methods. The study found that although most small-town water systems are functional, they operate below optimal levels. Coverage remains very low, below 3% across all selected districts. Frequent pump failures (46%), pipe leakages (22%), and unstable power supply (16%) were identified as major factors limiting consistent service delivery. In addition, technical breakdowns, inadequate spare parts, and poor maintenance practices were the most pressing challenges. Weak technical capacity was also evident, as over half of the operators and water committee members reported receiving no formal training. Financial difficulties, including irregular user payments (48%) and high repair costs (22%), further reduce the systems' ability to sustain operations. These findings align with previous studies emphasising that insufficient funding and lack of technical support undermine rural water system performance. Furthermore, management of most systems was overly-centralised under the CWSA, with limited involvement of local authorities or community representatives, which reduced community ownership and responsiveness to local challenges. To ensure long-term sustainability and optimal performance of small-town water systems in the UWR and similar systems in other developing countries, the study recommends a holistic approach that integrates technical efficiency, financial accountability, strong institutional collaboration, and inclusive community ownership in the management of water systems.

Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

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