Maintenance of rural water supply facilities in the Builsa North District of the Upper East Region of Ghana

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Abstract

In Ghana, the sustainability of rural water supply facilities has been a recurring national issue. Therefore, this study examined the maintenance structures, as they exist for the effective management of water supply facilities in the Builsa North District. The study was descriptive, non-interventional and applied the mixed method approach to collect data from 138 water users who were randomly selected from hand pump communities. The study found that the management architecture of the water supply systems of the district hinged on the District Water and Sanitation Teams (DWSTs), Water and Sanitation (WATSAN) committees, area mechanics and pumped spare-parts dealers. The significant constraints to pump maintenance were inadequate logistics, finance, and remuneration of DWST, poor financial mobilisation, financial embezzlement, and high attrition among WATSAN committee members. Additionally, poor transport support for area mechanics, bad access routes, and scarcity of spare parts were also significant constraints to the maintenance architecture. The study recommends government and donor/agency to provide requisite financial and logistical support to the DWSTs, WATSAN committees and area mechanics and provision of spare parts at affordable prices.

Keywords: Effective Maintenance, Rural Water Supply Facilities, (at least 6) note avoid long phrases

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Introduction

The provision of adequate and sustainable rural water supplies remains a major challenge to governments and development practitioners in sub-Saharan Africa. With over 336 million rural people living without basic drinking water in the sub-Saharan region as of 2017, rural water supply coverage is currently around 47 percent (UNICEF/WHO, 2019). Ghana is no exception to the challenges inherent in the rural water supply. The Community Water and Sanitation Agency (CWSA) estimates that approximately 8.3 million Ghanaians, particularly in the rural areas, lack access to basic water services. This number rose to 23.1 million if measured against the benchmark of the Sustainable Development Goal 6.1 (Safe Water Network-SWN, 2018).

Ghana's policy to provide potable water in rural communities' dates back to the 'Supply-driven' approach in the 1970s. Under the supply-driven approach, the provision of safe water was solely the government's responsibility, and no pre-conditions were set for communities to fulfil before the provision of water. The aim of providing rural areas with water was to have equitable socio-economic development and universal accessibility to services. The main concerns of the supply-driven approach were the ability to achieve fast-passed coverage in rural communities and the long-term sustainability of the water points (DWD, 2011). These concerns mitigated against the government's successful use of this approach and led to a shift from the supply-driven approach to the demand-driven one. The demand-driven approach was a decentralised system and required beneficiary communities to contribute a percentage of the cost of providing the water point and participate in the construction and management of the facility.

In a bid to complement government's efforts, various NGOs and donor agencies involved in rural water delivery also shifted from the supply-driven approach to the demand-driven approach. This approach resulted in the Community Ownership and Management (COM) philosophy of rural water supply (Kumasi TC, 2018; NCWSS, 2014). Because of the change in approach, Ghana has seen tremendous progress in rural water supply coverage over the years. The country achieved about 60 percent rural water supply coverage as of 2019 (CWSA, 2020). For instance, the Upper East Region of Ghana recorded about 65.64 percent rural water supply coverage as at the end of 2019, with approximately 2,879 boreholes, 512 hand dug wells and 23 small-town water projects (CWSA, 2020). Of the regional rural water coverage, the Builsa North district recorded a coverage of about 64.65 percent at the end of 2019.

Although rural water supply coverage rates are increasing in the Upper East Region, one of the recurring issues in rural water supply has been how to ensure the sustainability of water supply facilities (Afriyie & Ferber, 2018). The attainment of significant sustainability of existing rural water supply facilities is essential to achieving the Sustainable Development Goal six target 6.1 which calls for the "availability and sustainable management of drinking water and sanitation for all" by 2030 (Kumasi TC, 2020; UN, 2015). Despite the investment of about half a billion US dollars in infrastructure development over the past 20-years by governments and development partners, non-functionality figures of water points established in various studies over the last decade have been consistently reconfirmed between 30 and 49 percent (Baumann, 2009; Sutton, 2005; RWSN, 2009; Lockwood and Smits, 2011; World Bank, 2017, SWN, 2020).

Ones installed, water supply systems are poorly maintained and eventually break down, leaving them with unreliable and disrupted water supply systems (Kumasi, 2020; Lockwood & Smits, 2011). Schemes such as boreholes and wells fitted with hand-pumps are often expensive and must be maintained effectively. For instance, the cost of installing a borehole in the Upper East Region increased significantly from USD 2,500 in 2010 to USD 4,700 in 2018 (CWSA, 2019). It has been argued that water supply facility sustainability is often threatened by unrealistic tariffs, negative attitudes towards payment, inadequate post-construction finance, and lack of focus on demand and pro-poor issues (Afriyie and Ferber 2018). Coupled with the fact that these schemes are very expensive, it becomes imperative, thus, to explore the opportunities for and constraints to the efficient and effective maintenance of rural water supply facilities in Ghana.

The Builsa North District has 284 boreholes, 46 wells fitted with hand pumps and 218 open wells (CWSP, 2016). These water points have been mainly community-based management (CBM) with little or no support

from the District Assembly. Nevertheless, after several years of practising the community-based management system, effective maintenance of the water supply facilities is still a major challenge in the Builsa North District. For instance, according to the 2016 Community Water and Sanitation (CWSA) fact sheet Report of the District, about 43 percent of the hand pumps and boreholes in the district were either not functioning or recorded a poor performance rate. The consequence of the poor state of these facilities is that the communities return to the use of their old unwholesome water sources. Such conduct negates the health and socio-economic objectives for which such rural water projects were executed.

Therefore, this study examines the efficiency and effectiveness of maintenance structures in ensuring the sustainability of water supply facilities in the Builsa North District of the Upper East Region of Ghana.

Literature review

Effective Maintenance

The effective maintenance of a water supply facility is an integral part of the project operation, and maintenance (O&M) irrespective of the management system adopted (Truslove et al., 2020). Maintenance plays a crucial role in ensuring the availability and reliability of facilities (Muchiri et al., 2011, Karamouzian et al., 2014). According to van Zyl (2014), community water supplies are often more difficult to keep functioning than construct. Water supply facilities should be designed using the appropriate technology necessary to meet their functional needs. The facilities need to be designed efficiently, accounting for both construction costs and O&M expenditures (Martin-Candilejo et al., 2020). Bazaanah (2019) also argues that effective operation and management of rural water supply facilities requires suitable capacities, including technology, human resources, adequate financial resources, and local community support. This is particularly for establishing new infrastructure, maintenance, repair and replacement of either malfunctioning or obsolete facilities.

Ihuah and Kakulu (2014) note that for the original design of a facility to retain its high quality, the maintenance of that facility must be of the highest standards. The true test of a successful maintenance programme is through the perceptions and reactions of the users. An acceptable facility maintenance programme should centre around:

- understanding and interpretation of original design elements that must be repaired or replaced over the life of the facility,
- development of a maintenance management system for daily and long-term operations that minimises environmental impacts,
- training and development of a local work force, and,
- the use of skilled artisans to instruct maintenance employees in traditional methods of construction to reflect and enhance local cultural values, facility maintenance and operations.

Essentially, facility managers must be trained to look beyond daily maintenance operations. They must anticipate and accurately predict component replacements since shipping and delivery of small orders usually delay, consume energy, and disrupt operations (Etongo et al., 2018; Ihuah & Kakulu, 2014). While technical training should begin in the early phases of design and construction, facility providers should also provide hands-on training in preventive and cyclic maintenance before handing over the water facility to the community (USAID, 2020: Etongo et al., 2018: Tadesse et al., 2013).

Conversely, Kumasi (2020) observe that much more attention has often been focused on the investment stage of water facilities than the maintenance costs. Kumasi argues that the provision of rural water supply services in Ghana does not adequately address critical issues that guarantee long-term sustainability, particularly the need for various forms of post-construction support. This negatively affects the maintenance and sustainability of water facilities since long term management policies are not incorporated in the planning stage. Thus, Machado et al. (2019) and Borja-Vega et al. (2017) suggested in their studies that sustainable management of the maintenance of rural water facilities requires consistent post-construction technical support as well as funding systems for long-term maintenance financing.

Maintenance of rural water supply in Ghana

The maintenance of rural water supply facilities in Ghana has been a major problem in the water sector. This is because that both government and donor agencies (including NGOs) have since the 1970s concentrated mainly on installing water facilities in rural areas without considering how to ensure their sustainability. These projects are generally characterised by poor management strategies leading to breakdowns of the facilities a few years after commissioning. Studies by Kumasi (2020) and Verdamato et al. (2011) revealed that a substantial proportion of water supply infrastructure in Ghana are either not functioning or functioning sub-optimally.

van Zyl (2014) also argued that managing a rural water supply project successfully means operating and maintaining the water systems on a day-to-day basis so that they continue to supply water as planned. Research surveys in the Savannah Region of Ghana by Bazaanah (2019), Rautanen (2018) and Kelly et al. (2017) revealed that there is a need for a clear understanding of community ownership and responsibilities to ensure effective community management. Furthermore, where community management bodies exist, the following challenges are identified as common among the management bodies; they may not function effectively because each committee may see the water facility as belonging to government; the role of a water committee is not clearly defined; members of the water committee are also members of political committees; management bodies are poorly trained; water committees have no real authority to act within the community; and where traditional structures exist, women who have interest in the management of water are excluded.

In response to the lack of a sense of ownership of water supply facilities in rural areas, the National Community Water and Sanitation Project (NCWSP) was established in 1994 by an Act of Parliament to oversee the implementation and management of these facilities (CWSA, 2003). Under the NCWSP several strategies and approaches were adopted to ensure effective management of water supply facilities. These strategies included community management of facilities and the adoption of a demand driven approach. Community Management is where communities are directly responsible for planning, operating, and maintaining their water facilities as well as collecting revenues to meet recurrent and replacement costs

To manage the NCWSP effectively, a demand-driven approach under which communities initiate their demand for facilities of their choice was adopted (Kumasi, 2020). This demand should be backed by the ability of communities to pay part of the total cost of providing the chosen facility. The approach also recommends that communities should be responsible for the maintenance of these facilities once offered. This approach had several advantages. Firstly, it commits the communities to the ownership and management of these facilities and thereby helps to ensure the sustainability of the facilities provided. Secondly, it ensures that limited government funds are channelled to communities to maintain their water systems. Additional elements of the strategies adopted under the NCWSP are:

- CWSA to play a facilitating role in ensuring equity and widespread coverage of water and sanitation facilities through targeted subsidies supporting basic service level,
- District Assemblies to play a central role in supporting community management,
- Private sector provision of goods and services,
- Special focus on women as the principal users of water, planners, operators and managers of community-level water systems,
- Integrated approach to hygiene promotion, water and sanitation.

NCWSP and the Decentralisation policy

The structure of the rural water sector in Ghana has been transformed over the years. The role of the central government has reduced and changed from controlling the planning, construction, and maintenance to a facilitating role. The private sector, District Assemblies (DAs) and communities have emerged as important players with primary responsibility for planning and implementation, as well as co-financing the construction and maintenance. The NCWSP was also fashioned to work within the national decentralisation policy framework since 1988 and backed by the Local Government Law 1988, PNDC Law 207 and now some provisions of the 1992 constitution (CWSA, 2003). The Programme sought to transfer authority,

responsibility, and capacity from the central government to the DAs. The policy also promoted participation in the management of water supply facilities at the grass-root level.
A community selects the type of water supply facility from a number of available options. The service options available under the programme are the pipe system, hand pump borehole and the hand-dug well. The demand for a particular water facility is based on the request of the community. Table 1 shows the population range and the water supply facility provided.

Table 1: Population Range and Type Water Supply Facility

Population Range	Type of Facility
1-150	One Hand Dug Well
151-300	One Borehole
301-600	Standpipe (Pipe System)

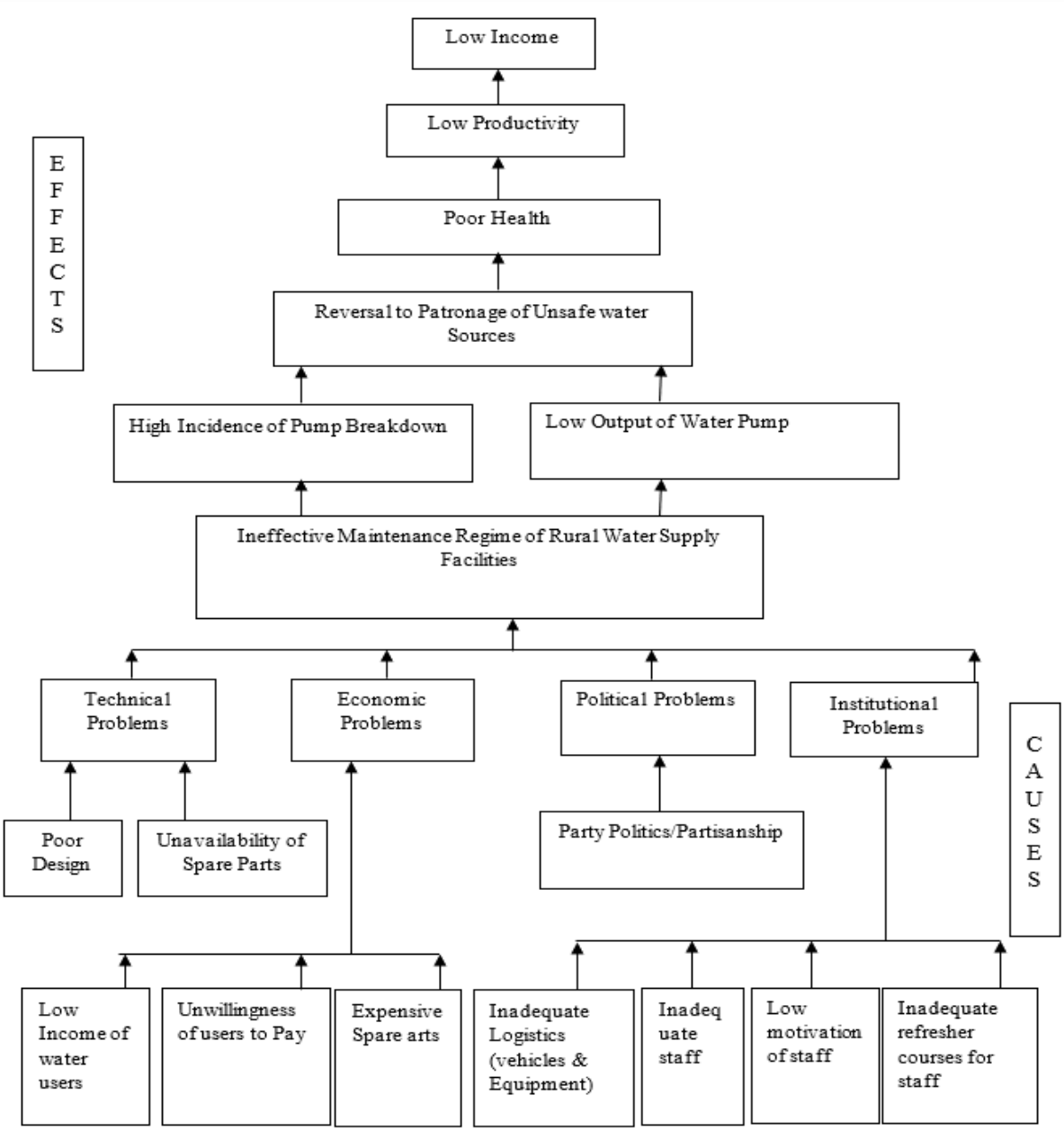
Source: Grönwall (2016: 4)

Each community established a seven-member WATSAN Committee. The WATSAN committee had the responsibility for the day-to-day running of the water or sanitation facility. The village extension workers of CWSA assisted communities in organising themselves to manage and maintain their water points. The WATSAN committees resolved problems encountered amongst themselves and other community members through the traditional leaders. Hence, a sense of belongingness and ownership amongst the people helped to achieve positive results (Bazaanah, 2019; Machado et al., 2019).
Financial management deficiency is one of the main obstacles to the smooth functioning of community-managed water systems (Kativhu et al., 2018; Behnke et al., 2017). Thus, while sound financial mobilisation and management methods are of importance, group management of funds and improved bookkeeping skills, enable communities to collect sufficient monies for pump maintenance. However, there are cases of financial mismanagement and user payment default for maintenance (Bazaanah, 2019; Manu, 2015).

Conceptual framework

The study adopted the Problem Tree Analysis (PTA) to examine the causes and effects of ineffective maintenance of rural water supply facilities in the Builsa North District. The PTA shows a complete hierarchy of causes and effects of the core problem in the form of a tree. The logic is that every problem has a root cause and effect emanating from the affected communities or external arrangements. The causes of the core problem are the roots of the 'tree', while the effects are the 'branches', and the trunk is the core problem.

The core problem of the study is the ineffective maintenance of rural water supply facilities. Studies categorise the immediate causes of this problem into; social, economic, political, institutional, and technical factors (Katiyhu et al., 2017; Huntchings et al., 2017; Van den Broke and Brown, 2015). These problems are caused by poor design, and inadequate funding (Katiyhu et al., 2018; Hutchings et al., 2015; Tigabu et al., 2013). Others are low or non-involvement of beneficiary communities, unfavourable government policies (Chukwuma, 2018; Braimah et al., 2016), unavailability of spare parts (Chukwuma, 2018; Etongo et al., 2018; Behailu et al., 2017; Leclert et al., 2016), low motivation of staff, conflicts, and political interference. The immediate effects of ineffective maintenance would include low output performance, high facility breakdown rate, and high patronage of unwholesome water sources, poor health, low productivity, low income, and poverty. Figure 2 depicts the PTA.



Source: Essaw (2001)

Methodology

Study area

Located in the south-western part of the Upper East Region, the Builsa North district lies between longitudes 10 05 "West and 10 35" West and latitudes 100 20" North. The district shares boundaries with Kassena–Nankana West District to the North, to the West with Sissala East District, to the East with Kassena–Nankana East Municipal, and to Builsa South District. The district covers an estimated land area of 816.44030 square kilometres. There are seven traditional divisions in the district with the nearest and farthest communities covering 2 and 7 kilometres from Sandema, the district capital. The district population is estimated at 56,477 of which females constitute 50.8 percent and males representing 49.2 percent. About

90 percent (89.2%) of the population is rural (Ghana Statistical Service, 2018). Figure 1 depicts the map of the Builsa North District of Ghana.

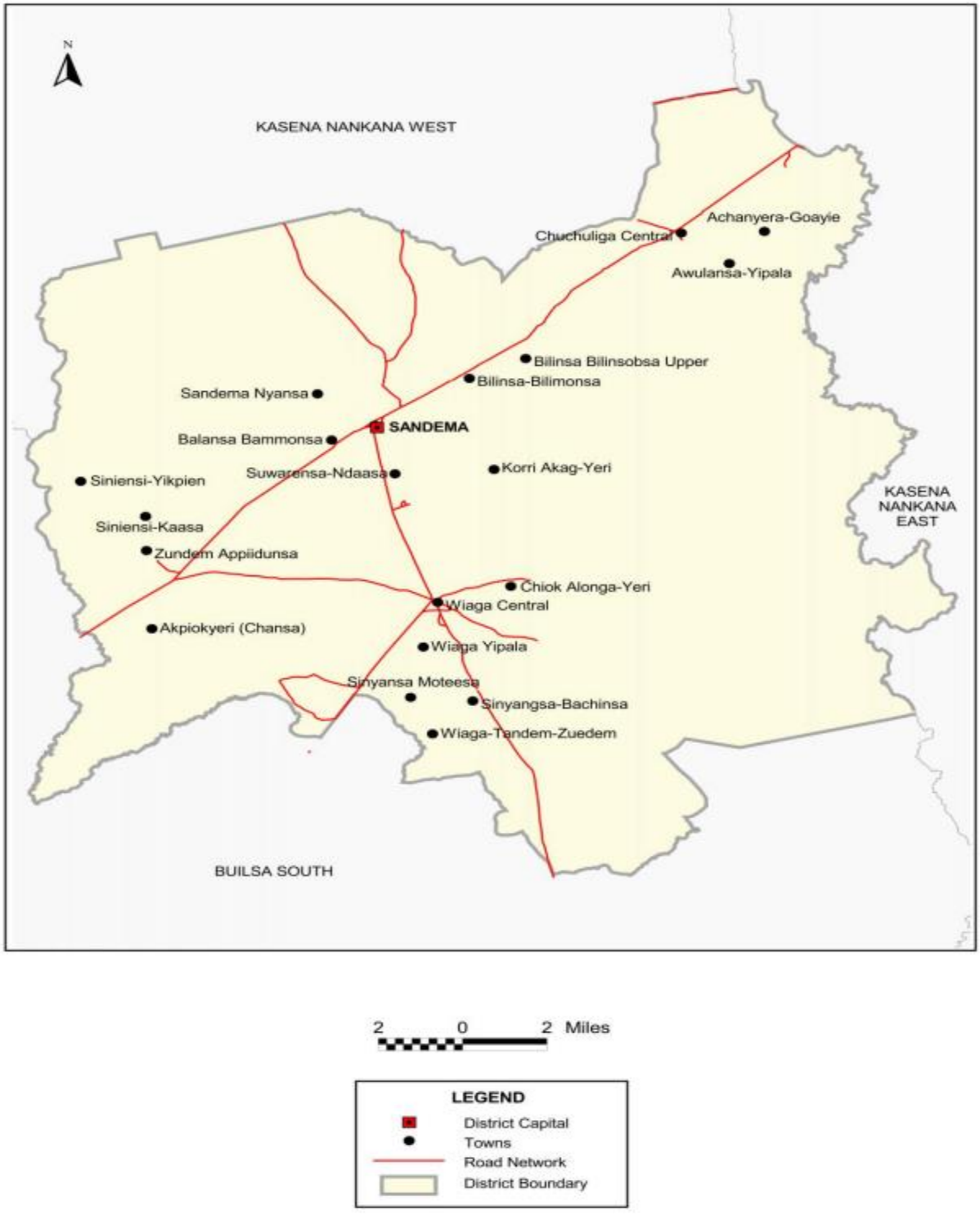


Figure 1: Map of Builsa North District

Source: Ghana Statistical Service, GIS (2014)

The sources of drinking water in the district are small town water system, borehole, well fitted with hand pump (WFHP), and open well (CWIQ, 2012). The district has two small town water systems, 225 boreholes, 46 wells fitted with hand pumps and 218 open wells. The majority of these water points were constructed under the Canadian International Development Agency, Upper Region Water and Sanitation Project (CIDA-URWSP). Others include the United Nations Children's Fund (UNCF), the Japan International Cooperation Agency (JICA), the European Union (EU), the Adventist Development Relief Agency (ADRA), and government agencies including the Community Water and Sanitation Project II (Builsa DWST, 2012). The following comprise the distribution of water sources in the district: public outdoor tap (7.0%), piped inside the dwelling (5.1%), boreholes (49.7%), well fitted with handpumps (15.9%), unprotected well (10.3 %) and 11.4 percent of the people have their water from other sources (GSS, 2014). With more than half of the population depending on boreholes (49.7%) and wells fitted with handpumps (15.9%) as their main source of potable water, effective maintenance of water points becomes paramount to guarantee a sustainable supply of water.

Study design

The study adopted a non-interventional, descriptive research design and a mixed-method approach. The descriptive design was employed to facilitate the systematic collection and presentation of data that give a clear picture of the causes of ineffective maintenance of the rural water supply facilities in the district.

The philosophical orientation of the study was pragmatism. Pragmatism is a paradigm that claims to bridge the gap between the scientific method and structuralist orientation of older approaches and the naturalistic methods and freewheeling orientation of newer approaches (Creswell. 2013; Creswell & Clark, 2011). Pragmatism promotes applying the mixed-methods approach as the most appropriate methodology in research. The mixed-methods approach promotes the application of both quantitative and qualitative methods of social research. This method gives a clearer understanding of a phenomenon and helps to identify similarities and differences in research findings and observations (Kaushik & Walsh, 2019). The mixed methods allow for easy inferences with confidence since both quantitative and qualitative methods complement each other (Jogulu & Pansiri, 2011).

Study population and Sample Size

The target population for the study comprised all traditional divisions with bore holes, wells fitted with hand pumps as their main sources of water; all WATSAN Committee members; all pump repair mechanics; pump spare parts dealer; community leaders & assembly members; and District Water and Sanitation Team (DWST). Based on the homogeneous nature of the people with respect to facility maintenance practices, governance, culture, and the wide distances between communities in the district, the sample estimation arrived at 200 respondents. The key subgroups of respondents are shown in Table 2.

Table 2: Distribution of respondents by Subgroups

Respondent/Category	Total Population	Total Interviewed
Community leaders	10	10
Assembly members	10	10
WATSAN Committee members	70	20
Women representative	10	10
Water users	4260	138
Staff of the DWST	7	7
District area mechanics	4	4
Spare parts dealers	1	1
Total	4372	200

Source: Field Data, 2019

Essentially, all seven officers of the DWST and the four-area mechanics and spare parts dealer in the district were purposively selected. The study randomly sampled 138 water users from 10 hand pump communities because of the homogeneity of the communities in water facility maintenance practices, governance, and culture. The simple random sampling technique offered each hand pump community and water user an equal chance of being selected. A hand pump community refers to a group of people numbering from 151 to 300 depending on one hand pump (borehole or well fitted with hand pump) for portable water (Grönwall, 2016). Finally, the purposive sampling technique was adopted to select from each hand pump community the following subgroups: community opinion leader, assembly members, and WATSAN committee members. The purposive technique is appropriate for soliciting expert or special information regarding the subject matter of interest (Taherdoost, 2016).

Data collection and analysis techniques

The researcher administered questionnaires to collect primary data from water users. At the same time, in-depth interviews were used for WATSAN committees, women representatives, community elders, area mechanics and the spare parts dealer. The self-administered questionnaire collected primary data from the district water and sanitation teams (DWST) and the Assembly members. Data on sanitation at the water facility site and activities of the WATSAN committees were obtained through observational techniques.

The secondary source constituted textbooks, published and unpublished articles in the dailies, magazines, journals, library and internet search, government publications, official documents from the district assembly, the regional CWSA, the DWST and other related literature.

Data collected from the field were analysed by way of frequencies, and percentages. The Statistical Product for Service Solutions (version 18.0) was employed to run frequencies and percentages of the various responses from the field. Data were presented in a tabular form depicting the frequencies and percentages for effective interpretation of the results of the study.

Results and Discussion

Status of Water Supply Facilities

The Builsa North District at the time of the study had 330 water supply facilities. This figure comprised 284 boreholes and 46 wells fitted with hand pumps. The district also has three small-town water supply systems and 218 open wells. At the time of the survey, it was reported that 38 of the 330 water supply facilities (boreholes and wells fitted with hand pumps) were broken down due to lack of periodic maintenance, non-availability of spare parts in the region. Additionally, 19 of the water supply facilities recorded poor yields particularly during the long dry season. However, the remaining 273 water supply facilities were in good condition but not optimum at the survey time. This further supported the findings of Kumasi (2020), Etongo et al. (2018) and Cronk and Bartram (2017) on the functionality of rural water systems in Ghana and Sub-Saharan Africa.

The survey revealed that, the reasons for the breakdowns were mostly (44.4%) due to worn-out T-bars (Nira pumps). Other reasons found to be responsible for the breakdowns were the ineffectiveness of the WATSAN members to manage the water facilities, excessive pressure and misuse of the water facilities by users. Poor financial mobilisation for regular servicing was also identified as a cause for breakdowns. The duration for water supply facility breakdown ranged between one month and five months. The duration before pump breakdown reduces to between one week and three months in the long dry season when the pressure on the water facilities is at its highest.

The Builsa North District Rural Water Supply Project

The study discovered from reports of the CWSA that the rural water supply project in the Builsa District was fashioned along the National Community Water and Sanitation Project (NCWSP), which was designed in the late 1980's and implemented in 1994. The NCWSPs operation was in two phases (CWSP-1 from January 1994 to 2000 and CWSP-2 from 2000 to 2008). The project's main objective was to provide cheap and safe water supply and transfer management and maintenance responsibilities of the water facilities to the communities. It was, therefore, imperative to develop strategies to enhance capacity building in knowledge, skills, and problem resolution methods at the community level.

To achieve community commitment to the maintenance of the water facilities, the DWST, under the CWSA and the District Assembly's supervision, organised capacity-building meetings with the communities. These meetings include the district information meetings, village sensitisation meetings, community mobilisation meetings, decision-making meetings, water committee meetings and training. To this effect, beneficiary communities with existing water supply facilities were to comply with the following:

a) Open a bank account at the Builsa rural bank where annual tariffs for water facility repairs and maintenance would be deposited;
b) Set-up Water and Sanitation (WATSAN) committees to manage the operation and maintenance of the water facilities. The WATSAN committee comprised a chairman, treasurer, secretary, two care takers, and two women responsible for sanitation at pump site.

However, communities that needed new water supply facilities were to:

a) Apply to the engineer of the DWST to be forwarded to the regional CWSA for consideration;
b) Open a bank account in the Builsa rural bank purposely for saving annual tariffs for water facility maintenance;
c) Form a WATSAN committee;
d) Contribute five percent of the cost of the water supply facility;
e) Provide labour during the installation of the water supply facility.

With support from the CWSA a pump spare parts shop was established in Sandema the district capital. The area mechanics were artisans; selected, trained, and equipped by engineers from the CWSA and the DA to carry out major repairs and maintenance of the water facilities in the hand pump communities.

Maintenance structure

The maintenance structure put in place by any water supply facility-implementing agency is crucial to the sustainability of the water facility. The main management philosophy underlying Builsa rural water supply system was the Community-based Management (CBM) strategy. The implementation of CBM depends on various community characteristics, including size, composition, socio-economic conditions, and complexity (Kumasi, 2018; NCWSS, 2014; Burr et al., 2013). Under CBM, the water supply facilities are expected to be managed and paid for by the users. Day to day management lies with the community WATSAN committees. It was revealed that, the maintenance structure comprised four important actors, that is: the District Water and Sanitation Team (DWST), area mechanics, spare parts dealers, and WATSAN committees. These four main actors worked together as a team, but most importantly, the DWST served as a supervisory body to the WATSAN committees.

This composition is a decentralised form of ensuring effective maintenance of water supply facilities in the district. There is a strong inter-relationship among the various actors. For instance, in the event of a breakdown of a water facility, the WATSAN committee immediately informs the area mechanics for their expertise and the spare parts dealer for spare parts to carry out repairs. Thus, each of the actors has an important role in ensuring the long-term sustainability of the water supply facilities. Within the maintenance structure, the WATSAN committee is the first group or actor to contact when there is a breakdown in the pump community. Figure 2 depicts the maintenance structure of the Builsa North rural water scheme.

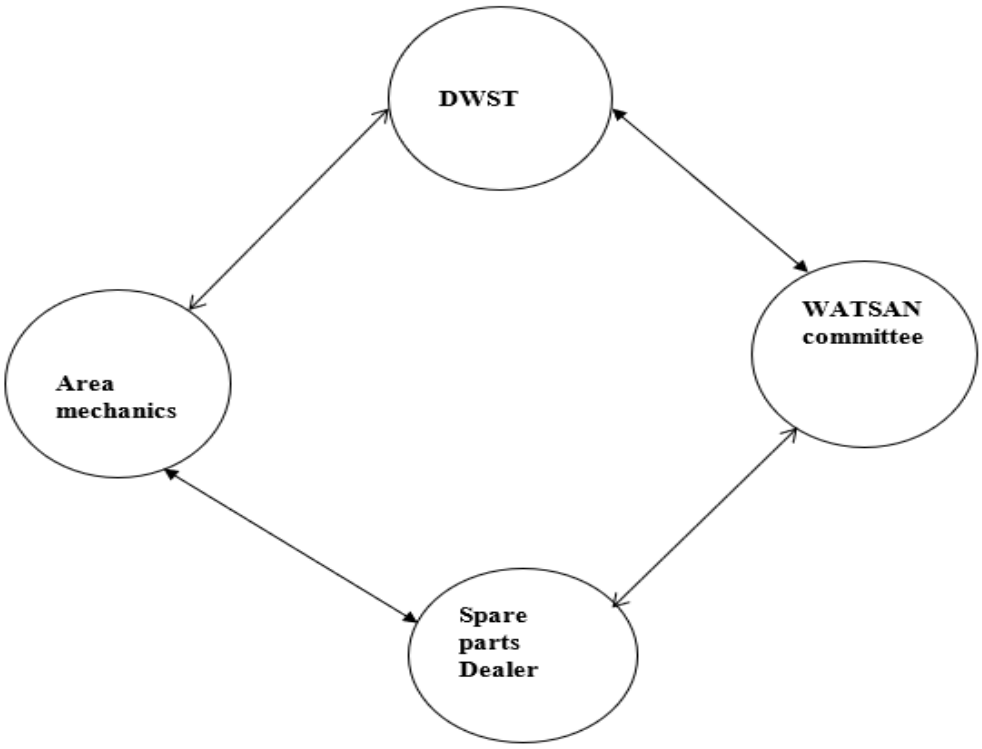


Figure 2: Maintenance structure of the rural water scheme
Source: Author's Construct, 2019

District water and sanitation team (DWST)

The DWST forms an integral part of the structure of the CWSA under the NCWSP. The DWST works directly under the regional water and sanitation team (RWST) and the District Assemblies (DA). The DWST is responsible for delivering, monitoring, and evaluating water and sanitation facilities at the district level. The team is also responsible for providing private sector support in the water and sanitation sector of the district (that is, the area mechanics and spare parts dealers). This further explained the important role

the DWST played in the maintenance structure. The DWST in the Builsa North District is a ten-member team composed of a team leader, a water engineer, a community development officer, a hygiene, and sanitation officer, and six field officers. The team leader supervised the team's activities and reported on the state of the district's water supply and sanitation facilities to the DA, RWST, CWSA and partner agencies.

The water engineer provides technical backstopping to the area mechanics and WATSAN committees. They are responsible for monitoring and supervising water supply related activities in the district. The hygiene and sanitation officers render expert advice on water and sanitation to the communities. They are mostly associated directly with the water supply facilities to ensure that communities practised personal hygiene and sanitation at the pump site.

The community development officer served as a link between the community and District Assembly on the one hand, and the team leader of DWST on the other hand. The community development officer is responsible for mobilising community members through the WATSAN committees for community sensitisation and other related programmes. The development officer is also responsible for ensuring that communities adopt superior financial mobilisation and management systems that will guarantee the long-term sustainability of the water facilities.

The DWST has six field officers in charge of all the communities in the district. The field officers are responsible for inspecting water facility site, identifying worn-out pump parts, and disinfecting open wells and wells fitted with hand pumps. They also offer education on pump site sanitation and maintenance techniques and pump maintenance bank account. They regularly visit the pump communities to ensure they complied with maintenance and pump site sanitation directives.

At the time of the survey, the DWST was in charge all 330 water supply facilities. It was revealed that the DWST periodically organised refresher training for area mechanics and WATSAN committees. However, the refresher training had not been organised for area mechanics for almost two years. The DWST also ensured that spare parts dealers sold parts at the CWSA approved prices. The team supported communities financially where the price of a spare part exceeds USD 60.10.

Finally, the DWST received annual budgetary allocations from the CWSA and the DA to cater for their annual programmes. Furthermore, the team was also provided with tools, periodic refresher training and three motorbikes to help facilitate easy transportation around the communities. Thus, remarkable strength of the DWST over the years was the tremendous support they received from the area mechanics, spare parts dealer and WATSAN committees in the district.

Challenges faced by the DWST

Like any other institution, the DWST encountered several challenges that seriously hampered its ability to deliver the requisite services to the hand pump communities in the district. According to team, their challenges included but not limited to insufficient skilled work force, insufficient logistics, the lack of a laboratory, low salaries, non-payment of allowances and lack of fringe benefits. Additionally, the team complained of inadequate budgetary allocations and delays in fiscal allocation from both the CWSA and the District Assembly. It was also revealed that due to financial constraints, the DWST was not able to organise, regularly, water and sanitation sensitisation programmes in the hand pump communities. There was also political interference in the DWST and political partisanship work among members of the DWST and staff of the District Assembly.

Finally, as part of restructuring rural water supply and maintenance by the CWSA, training of WATSAN committee members was the sole responsibility of the private firms that drilled and installed the water facilities. This resulted in WATSAN committees either not being sufficiently trained or never receiving any form of training. It was observed that, there was a high incidence of poorly trained WATSAN members in Wiaga Guuta, Siniensi and Bilinsa, which contributed immensely to the poor maintenance of their water supply facilities. For instance, the DWST team leader expressed that;

> *...The new training arrangement for WATSAN committees by private firms has rather resulted in committee members either being poorly trained or not trained at all. We are usually compelled to*

retrain these committee members with our limited resources (interview of DWST Team Leader, 2019).

Area Mechanics

The study discovered that the attrition rate of area mechanics was very high. Two out of the four area mechanics in the district had resigned at the survey time. The two-area mechanics indicated an increase in repair activities over the years. On average, the area mechanics conducted about 17 repairs in 2015 and about 24 repairs in 2018. The number of repairs exceeded the CWSA (2018) standard for the number of pump repairs or breakdowns per year by three times. Table 3 indicates that the area mechanics had more repair calls from Sandema than the other pump communities did.

Table 3: Repair activities over four years

Pump communities	Number of Repair Activities			
	2015	2016	2017	2018
Belinsa	14	16	13	19
Chuchuliga	16	19	17	25
Sandema	23	26	24	32
Wiaga	18	20	21	29
Siniensi	12	14	9	17
Total	83	95	84	122

Source: Field data, 2019.

As the number of repairs increased, the charge per repair for hand pump communities increased following the distance of the community from the area mechanic's shop. Table 4 shows the repair charges and distance covered from 2015 to 2018.

Table 4: Distance and repair charges

Distance	Charges (USD)			
	2015	2016	2017	2018
< 1	10.4	12.5	14.6	16.7
1-3	12.5	14.6	16.7	18.8
3-5	14.6	16.7	18.8	20.8
5-7	16.7	18.8.	20.8	22.9
7-9	18.8	20.8	22.9	25.0
>9	20.8	22.9	25.0	29.2

Source: Field Data, 2019.

It was realised that the average yearly maintenance cost for tools for 2015 to 2018 was around USD 370. Additionally, the average annual income per area mechanic in 2018 was USD 2,289.69. The average monthly income of USD 190.81 was inadequate. The area mechanics disclosed that, they enjoyed a cordial relationship with the WATSAN committees and spare parts dealer, except for the cases of price hikes of spare parts. The repair charges of the area mechanics comprise three main components namely workmanship, transportation, and tools maintenance.

The area mechanics charged for workmanship based on their hourly labour rate and the time spent in repairing the faulty pump. The amortisation cost for tools was calculated per repair. Using the historical cost of the tool spread over its estimated life span (5 years), an average charge per repair per year was calculated by the area mechanic to the hand pump community. However, they indicated that the life span of some tools was not up to a year due to high frequency of usage.

The area mechanics complained of not having motorbikes or any form of transport to carry out their duties and had to rent or borrow motorbikes to travel to distant hand pump communities. For instance, the arear mechanic in Sandema indicated that:

> *... Ever since our motorbike broke down, it has been very difficult responding to repair calls from distant communities. We are usually compelled to wait for market days to board the market vehicles to the communities in need of our services. At times, the community members come and pick us with their motorbikes to go and work on their pumps. This has increased our response time by three days (Interview of Area Mechanic, 2019).*

Additionally, bad roads linking the hand pump communities particularly in rainy seasons made accessibility difficult for the area mechanics. Hence, their response time to pump repair calls exceeded the CWSA (2018) standard time of three (3) days to respond to repair calls.

The spontaneous rate of increased spare parts prices was identified as a major challenge to area mechanics and pump communities. For instance, according to the CWSA (2017) approved spare parts price list for 2017 and 2018, a "cylinder with brass liner" and "foldable spanner" in 2017 (for Afridev pump) cost USD 27.5 and USD 10.8, respectively. The corresponding prices in November 2018 were USD 38.3 and USD 17.6, respectively. This represented a 58 percent and 62 percent price increase, respectively over the 2017 prices.

Spare parts dealer

The district had two spare parts dealers. The CWSA supported them to setup the sale of spare parts. The spare parts dealer had his supplies from both the CWSA and Water Vision Technology (WVT) at subsidised prices. However, the scarcity of spare parts in the district and the region compelled the dealers to travel to Tamale, Kumasi or Accra to buy these parts. The number of days spent in acquiring these spare parts exceeded the CWSA (2018) standard of 3 days maximum to acquire spare parts for repair and maintenance. At the same time, total sale of spare parts had increased over the years. For instance, total sales for 2016 were USD 3,275.7, while 2018 was USD 5,832.5. The spare parts prices were on the ascendancy over the years due to scarcity. This caused problems between the area mechanics, WATSAN committees and the spare parts dealers.

The survey discovered that 73.7 percent of the WATSAN committees had problems with the spare parts dealer due to price hikes. However, it is essential to note that the manufacturers (mostly Afridev and Nira pumps) determine the prices of the spare parts based on the international price standards. This has been a major factor accounting for the price hikes of spare parts since the dollar-cedi equivalence keeps fluctuating. Table 5 shows the price change trend of four commonly used parts in the last four years.

Table 5: Trend of prices of four most commonly used parts over the past four years.

Parts	2015 (USD)	2016 (USD)	2017 (USD)	2018 (USD)
U seal	2.50	4.00	5.90	7.90
Foot Value Receiver O-Ring	1.50	2.50	3.50	4.70
Bush bearing	4.00	6.90	7.97	9.80
Rod Centrilizers	3.50	5.50	6.80	8.60

Source: Field Data, 2019

Structure of Water and Sanitation (WATSAN) committees

A successful operation and maintenance (O&M) are attained based on strategic planning and effective managerial strategies and techniques. Essentially, managing a rural water supply project successfully means

operating and maintaining a system on a day-to-day basis to continue to work and supply water as planned (Machado et al., 2019; Kendie, 1992). This means there is the need to put in place competent managers, who would be charged with the responsibility of ensuring sustainable water delivery. Hence, the establishment of the WATSAN committees.

The WATSAN committees in the pump communities were trained by the DWST and charged with ensuring the day-to-day operation and maintenance of the water supply facilities. The survey discovered that all WATSAN committee members were selected by their respective communities based on a criterion of proximity to the water facility. Of all the WATSAN committees in the hand pump communities, 80 percent (8 committees) of them were composed of four males and three females. The remaining 20 percent (2 committees) of the committees were composed of five males and two females. This met CWSA operations standards of a minimum of 30 percent women in the WATSAN committees (CWSA, 2016; Operational Manual-CWS-2, 2008). Positions within the WATSAN committee were made of a chairman, treasurer, secretary, two caretakers, and two women in charge of sanitation. Their specific responsibility was to achieve the overall goal of managing the maintenance of the water facility.

The survey revealed an increasing attrition rate among members of the WATSAN committees. Of all the WATSAN committee members surveyed, 71 percent (14 members) indicated that they had lost some of their original members. However, 29 percent (6 members) indicated that they had all their committee members intact. The replacement rate was higher for males (78%) than females (22%). It was found that replacement of WATSAN members was generally very slow; about 65 percent of the vacancies had not been replaced at the time of the survey. The departure of WATSAN committee members was due to various reasons. Table 6 presents the reasons for the departure of WATSAN committee members in all 10 communities surveyed.

Table 6: Reasons for leaving WATSAN committee

Reasons	Frequency	Percentage
Death	4	20.0
Not economically beneficial	9	45.0
Resettlement	2	10.0
Other reasons	5	25.0
Total	20	100

Source: Field Data, 2019. n=20 WATSAN committee members

While most WATSAN committee members left because the work was not financially rewarding, 25 percent of the departures were attributed to other reasons like health problems, old age, engagement elsewhere, and resignations due to mismanagement of funds.

Overall, the rate of departure of members of the committee was greater for males than females because of the financial pressures from their families, hence, the need to engage in other financially rewarding activities. Women were more stable than their male counterparts in the WATSAN committees due to marriage, care for children, and the importance of potable water. This further supports the findings of Boateng and Kendie (2015) and Boatenge et al. (2013) on the important role women play in the management of rural water supply projects.

Challenges faced by WATSAN Committees

The survey revealed that a major challenge confronting the WATSAN committees in the district was the unwillingness of members of communities with hand pump to make financial contributions towards maintenance and repairs. Table 7 shows the challenges encountered by the 20 WATSAN committees surveyed.

Table 7: Problems encountered by WATSAN committees

Challenges	Frequency	Percentages
Lack of incentives	5	25.0
Defiance of byelaws	2	10.0
Unwillingness to pay	7	35.0
Poor sanitation	3	15.0
Embezzlement	3	15.0
Total	20	100

Source: Field Data, 2019. n=20

Based on table 7, the WATSAN committee members complained of the unwillingness of members of communities with hand pump to make financial contributions. This was a major setback in their work since the availability of funds formed the backbone of pump maintenance. For instance, pump users in Wiaga-Farinsa, and Siniensa Zundema were unwilling to contribute financially towards pump repairs. This supports the findings of Kativhu et al. (2018), Hutchings et al. (2015) and Tigabu et al. (2013) that a leading challenge in water facility maintenance has been insufficient financial resources due to weak tariff schemes and unwillingness to pay for water facility maintenance.

Additionally, WATSAN committee members lack incentives to motivate them to carry out their duties. This was confirmed when all the water users surveyed indicated that WATSAN committee members were not paid for their services. This usually results in some committee members' occasional embezzlement of pump maintenance funds to meet their personal financial needs. The lack of incentives also explained the high attrition among members. For instance, the WATSAN committee secretary of Wiaga-Farinsa indicated that:

> *...The Committee members had to sack to treasurer because he could not account for the annual contributions from pump users meant for repairs and maintenance. It was later discovered that he used the money to fund his personal financial needs. This led to a fall in the number of pump users willing to contribute money towards repairs (Interview of WATSAN Committee Secretary, 2019).*

Finally, poor sanitation practices at the pump site and the non-enforcement of byelaws were also identified as challenges confronting the WATSAN committee. All the communities had byelaws for facility maintenance; however, enforcement was not effective due to lack of supervision. This was prominent in the rainy season and in pump communities like Chuchuliga, Sandema, Bilinsa and Wiaga.

Water User Funding Arrangement for Water Facility Maintenance

All the hand pump communities either practised the tariff system {35% (48 water users)} of financial mobilisation or made contributions {65% (90 water users)} when their water facility breaks down. The tariff system of contribution towards pump maintenance conforms to WHOs "Flat Rate" system and the findings of Machado et al. (2019), Hope (2015) and Mimrose (2011) among others. About 70 percent (96 water users) of water users indicated that they saved their community funds for pump repairs and maintenance with the WATSAN treasurer or chairman instead of a community bank account. The practice of keeping financial contributions for pump repairs and maintenance with the WATSAN executives led to financial misappropriation and embezzlement among the caretakers. Finally, about 30 percent (42 water users) said their pump maintenance and repair contributions were saved in a community bank account recommended by the DWST and the CWSA and COM philosophy.

Poor financial mobilisation and management did not guarantee the availability funds for pump maintenance and repairs. The total amount available to maintain the 26 water supply facilities in all the 10 surveyed hand pump communities was USD 262.5. Thus, the annual amount per pump at the survey time was USD 10.1. This amount is too scanty for use in major repairs and this lack of sufficient funds would trigger poor maintenance and delays in pump repairs. This further highlights the arguments of Kativhu et al. (2018), Hutchings et al. (2015), and Tigabu et al. (2013), among others, that insufficient financial resources and weak tariff schemes have been instrumental in pump failure of rural water services.

Conclusion

The study draws several significant conclusions on the maintenance structure of water supply facilities in the district, which have policy implications. The study concluded that maintaining the water supply facilities in the district was built on the DWST, WATSAN Committees, area mechanics, and pump spare parts dealers. Embedded in the WATSAN committees are the water users. The continued coordination and cooperation between the District Assembly, WATSAN committees, area mechanics, spare parts dealers and water users will allow for future maintenance of the water facilities.

The study further concluded that the structure faced challenges that affected its function effectively. While the DWST were faced with inadequate funds, low remunerations, logistical constraints and political interferences, the area mechanics lacked the means of transport for real-time response to repair calls. There was also the scarcity of spare parts, price hike of spare parts, high attrition of WATSAN committee members, and non-enforcement of pump maintenance by-laws. Finally, the study concluded that the financial arrangement for pump maintenance experienced poor financial mobilisation, financial mismanagement, and non-payment of contributions towards pump maintenance. These challenges negatively affected the efficiency of the management structure of ensuring effective maintenance of the water supply facilities in the Builsa North District.

The study recommends that the CWSA and the district assembly should provide improved employee remuneration, increased human capital and sufficient logistics to staff of the DWST. The study also recommends that area mechanics be provided with motorbikes to facilitate their movements. The scarcity of spare parts in the district must be addressed immediately by CWSA and the DA to guarantee the availability of spare parts for pump maintenance and repairs. This would also help address the constant hike in prices of spare parts.

Considering the frequency with which the WATSAN members leave the committee due to lack of motivation. It is recommended that the DA and CWSA should institute an allowance scheme that would make their work more attractive to potential staff.

The study further recommends the active participation of communities in the design and implementation of water projects to guarantee a sense of ownership and motivation to maintain the water supply facilities. Finally, the challenge of unwillingness to pay and alternative funding arrangements must be addressed by the CWSA and donor organisations in designing and implementing rural water supply projects.

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