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Operation and maintenance challenges in ensuring safe drinking water in Uganda

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Abstract

Ensuring safe drinking is a goal with profound implications for the achievement of various of various sustainable development goals, including health outcomes, education, and food security. This account examines the operation and maintenance challenges in ensuring safe drinking water in developing countries with particular attention put to Uganda. We find that the challenges to ensuring safe drinking water include operation and management, inadequate skilled labor, high operating costs, excessive repair and replacement expenses. Specifically, recognition of the challenges inherent in the ambitious targets is an urgent necessity is Uganda is to achieve the goal of quality water infrastructures, which involves restoring and maintaining clean water sources as well as promoting hygiene and investing in sanitation facilities. Furthermore, a national urban water and sanitation intervention is key to supporting urban authorities in the provision of safe drinking water. Community participation emerges as a desirable channel through which improved access to safe drinking water would be achieved in much of the country. Its main duties would be to set tariffs, provide consumer protection, and resolve disputes between sector stakeholders. We infer that the challenges facing provision of clean and safe water in Uganda revolve around poor consideration of operation and maintenance of water facilities in both rural and urban centers since limited consideration is given during planning, design, budgeting, monitoring and implementation of water projects. It is encouraged that government and development partners consider planning and allocation of resources in their quest to providing clean and safe drinking water to the population.

Keywords: Operation; Maintenance; Safe Drinking Water; Community Participation

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1. Introduction

This review seeks to analyze the operation and maintenance challenges in the provision of clean and safe drinking water in Uganda. Operation, on the one hand, denotes to the daily activities and measures desired to keep a water system working efficiently. It involves controlling the system's functions, monitoring its performance, and making alterations as needed. Operation is central primarily for the purpose of keeping a healthier population (Abdel-Rasheed et al., 2024), no matter the location. Maintenance, on the other hand, symbolizes the constant process of inspecting, cleaning, and managing water systems to ensure they are efficient, safe, and meet health regulations (Innocenti et al., 2025). In his training manual, Brikke (2000) opines that there is a close relationship between operation and maintenance though the relationship focuses on the immediate, routine tasks required for the system to deliver water activities of running and handling infrastructure. In the sanitation context, a study by Gilson et al. (2025) on the informality of water vendors in Kisumu argued that operation embraces the planning, control, and performance of the collection, treatment, and disposal and/or reuse of the waste; these are the practical and service activities necessary in running the set-up along with the accurate management and usage of the services by end users. Maintenance, on the other hand, involves the activities required to sustain existing assets in a serviceable condition running efficiently and after it has been constructed (Innocenti et al., 2025). This includes both the routine tasks, such as routine inspections and cleaning, and the more involved tasks such as repairs and replacements that ensure the system continues to deliver water and sanitation services as intended. It encompasses everything from operating pumps to managing inventory of spare parts, and aims to ensure the sustainability of the system.

Operation and maintenance refer to all of the activities needed to run a water supply and sanitation scheme, except for the construction of new facilities. The overall aim of operation and maintenance is to ensure efficiency, effectiveness, and sustainability of water supply and sanitation facilities (Innocenti et al., 2025; Gilson et al., 2025). Further, the Major objective of the operation and maintenance system is to provide sustainable, equitable, consistent, economic safe, and adequate water. It is clear that the operation of the system denotes to ensuring effective routine running of system timely and daily maintenance in general means upkeep of structures/system including planned, preventive or corrective maintenance, repairs, etc. in accordance with the Operations and Maintenance best practices guide, it is specified that operations and maintenance are the decisions and actions regarding the control and maintenance of property and equipment. These are inclusive, but not limited to,

- Actions focused on scheduling, procedures, and work/systems control and optimization; and
- Performance of routine, preventive, predictive, scheduled, and unscheduled actions aimed at preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety.

Consequently, operational efficiency tends to epitomize the life-cycle, profitable mix of precautionary, prognostic, and reliable maintenance knowhows, along with equipment standardization, trailing, and hi-tech upkeep management competences all of which aiming at consistency, protection, resident comfort, and organizational efficiency. With all these, the element of safe drinking water, in terms of water that does not represent any substantial danger to health over a period of consumption becomes central. Safe drinking water must be delivered that is pure, wholesome, healthful, and potable. Safe water is not necessarily pure; it has some impurities in it (Dinka, 2018).

Consistent with IRCWash (2025), maintenance is classified in terms of preventative, corrective and reactive. [a] Preventive maintenance includes regular and routine maintenance of equipment and assets in order to keep them running and prevent any costly unplanned downtime from unexpected equipment failure (Innocenti et al., 2025). It occasionally consists of inconsequential maintenances and replacement arising from repetitive inspections. [b] Corrective maintenance embraces either replacing or repairing or both of things that were done erroneously or that desires to be reformed, for instance, reorganization of a pipe direction or replacing a broken-down pump. [c] Reactive maintenance embodies a response to an emergency or grievances; it usually arises on account of letdowns and the faulty or collapse of equipment. So as to guarantee the regular maintenance and strength of the structure, the operator is expected to stick to a regular check-up. If done appropriately and on a consistent agenda, preventive measures can lessen the danger of inflated maintenances. The significance to guaranteeing active equipment care is to make sure that errands are plainly demarcated and maintenance workers have the gears and skills for doing their work excellently.

In their study, Katusiime and Schütt (2020) note that Uganda faces water resources management effectiveness challenges, irrespective of sector reforms and subscription to the integrated water resources management approaches. These challenges relate to formal funding and capacity, sectors coordination, management approaches, policy implementation and enforcement of legislation.

1.1. Background to the study

According to the Bureau of reclamation (2020), water covers more than two-thirds of the earth's surface, but is mostly salty and undrinkable. The available freshwater resource is approximately 3% of the available water on earth but only 1% of the available freshwater (in lakes, rivers, and groundwater) is accessible. Furthermore, much of the available freshwater resources are inaccessible because they are in the hidden part of the hydrologic cycles (deep aquifers) and in glaciers (frozen in the polar ice), which means safe drinkable water on earth has a very small proportion (~3%) in the freshwater resources. Freshwater can also be obtained from the seawater by the desalinization process. In their study on the impact of climate change on the development of water resources, Teweldebrihan and Dinka (2018) noted that in some countries, sufficient freshwater is not available (physical scarcity) yet in other countries, abundant freshwater is available though it is expensive to use (economic scarcity).

As a standard, satisfactory, clean and safe drinking water supply should be obtainable to various users. Even if there is no universally accepted definition of "safe drinking water"; it denotes to water that does not represent any significant risk to health over a lifetime of consumption. which quality is suitable for human consumption both for drinking or cooking purposes; it should be delivered purely, wholesomely, healthfully and, portably (Onyebuchi et al., 2022). Safe water is not necessarily pure; it has some impurities as it contains some traces of salts such as magnesium, calcium, carbonates, bicarbonates and others. The degree of purity and safety is a relative term and debatable. Clean/pure water has no minerals. According to the Monitoring organizations under the supervision of the Joint Monitoring Programme (JMP), "safe drinking water" is understood as water from an "improved water source," which includes household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collections. Accordingly, therefore, access to safe drinking water is described as the availability of at least 20 liters per person per day from an "improved" source within a kilometer of the user's dwelling.

Consistent with the above, water, sanitation, hygiene, environmental cleaning and waste management in health care facilities: 2023 data update and special focus on primary health care. Technical document. Safe drinking water is accepted as an international agenda and priority, which is evident from the millennium development goals (MDGs) and sustainable development goals (SDGs) of the United Nations (UN) initiative and vision (MDGs 7 and SDGs 6 respectively). Despite effort expressed under the MDGs, several people lack access to safe drinking water and or basic water. Worldwide, over a billion people lack access to safe drinking water. The population of the world is increasing and the available freshwater resources almost remain constant. The number of people lacking access to safe drinking water is growing; this is mainly associated with the ever-increasing population growth in the less-developing world and the failure of governments to make available adequate water supply facilities in these countries. By 2020, 26% of the global population did not have access safe to managed drinking water and 46% faced deficiencies in public health services. As stated by UN-Water (n.d), attaining widespread access to drinking water by 2030, necessitates considerable investment in water and sanitation facilities.

In 2022, approximately 27% of humans lacked safely managed drinking water in their homes and nearly 43% of the world's population lacked safely managed sanitation (World health organization, n.d). The advent of COVID-19 emphasized the urgence to guarantee that everyone can access basic sanitation. At the onset of the pandemic, 3 in 10 people worldwide could not wash their hands with soap and water within their homes. It is estimated that achieving universal access to safe drinking water and sanitation in 140 low and middle 6 income countries would cost approximately USD 114 billion per year. A study by Tumwebaze, Sseviiri, Bateganya, Twesige, Scott, Kayaga, Kulabako and Howard (2023) reveals that access to securely managed water and cleanliness facilities in eastern Africa's built-up areas stands at 53% for water and 27% for sanitation correspondingly. Consequently, the value lost in human life, in educational and in economic potential, is a burden on society. Thus, access to clean water and to safe sanitation services, contributes to a life of dignity and equality.

He further indicated that one of the biggest challenges across the globe, Africa included, is access to clean and safe water. Water is an essential basic need that must be available in order for human beings to survive the next day. Africa has a serious water crisis, despite the continent boasting of having numerous natural water sources such as lakes, rivers, streams, ponds, springs, rainwater, aquifers, and ocean waters. The World Health Organization (WHO) estimates that much of Africa's Sub-Saharan population still lacks access to safe water (Terefe et al., 2024). Africa's population has grown from 800 million in 2000, to a massive 1.2 billion todays. One of the UN's Sustainable Development Goals (SDGS) targets ensuring that all humanity has access to clean and safe drinking water (Tadadjeu and Soulemanou, 2025). By 2030, it is projected that the African population will have reached 1.7 billion, consequently, issues of water necessitate urgent address.

Correspondingly, over 300 million Africans lack access to clean and safe water for drinking and 700 million are living in poor conditions without adequate to sanitation (Shimamura et al., 2022). As a consequence, shortage of clean and safe water has frustrated poverty reduction efforts and hindered economic prosperity. For instance, Sub-Saharan Africa loses 5% of its GDP per year as a result of water-related challenges (Terefe et al., 2024). In addition, 40 billion hours per year, which could have otherwise been used on productive activities, are spent searching for water (Terefe et al., 2024). Nonetheless, Africa's water crisis has ensued and the continent now faces a serious problem where majority of the population faces difficulties to access clean and fresh water for both drinking and other daily household chores. Professionals emphasize that majority of

people in Africa rely on surface water yet the continent lacks the potential to invest in harnessing groundwater. The surging population along with the stress on obtainable water resources have contributed to an acute water scarcity, which has caused socioeconomic consequences (Terefe et al., 2024).

Since water is a core component for sustainable development in Africa and beyond, its readiness is key to ease human existence, socioeconomic progress, and healthy ecologies. For instance, when there is adequate water, it becomes easier to contain diseases thus making populations more creative. A good number of the misery seen by Africans is connected to water shortage which unswervingly affects human health, causes malnutrition and hunger, as well as influencing security as a consequence of water-related wars. Furthermore, sanitation is a serious challenge that faces the continent since countless people, particularly those living in needy urban localities, shortage of operational sewage systems, causes them to live in unhygienic environments increasing their vulnerability to diseases. After all, studies (such as Munro and Kweka, 2021; Shimamura et al., 2022) reveal that in developing countries, governments and several organizations are struggling to improve access to drinking water for their populations.

Although access to water supply and sanitation in Sub-Saharan Africa has been progressively improving over the last two decades, the region continues to lag behind other developing regions. Access to improved water supply had increased from 49% in 1990 to 68% in 2015, while access to improved sanitation had only risen from 28% to 31% in that same period. Sub-Saharan Africa did not meet the Millennium Development Goals (MDGs, 1990–2015) of halving the share of the population without access to safe drinking water and sanitation between 1990 and 2015. There exist large disproportions among countries, and between the urban and rural areas. The MDGs set International targets to reduce inadequate Water Sanitation and Hygiene (WASH) coverage and now new targets exist under the Sustainable Development Goals (SDGs, 2016–2030). The MDGs called for halving the proportion of the population without access to adequate water and sanitation, whereas the SDGs call for universal access, require the progressive reduction of inequalities, and include hygiene in addition to water and sanitation. Particularly, Sustainable Development Goal SDG6 focuses on ensuring availability and sustainable management of water and sanitation for all.

A number of low-developing countries, including Uganda, are experiencing enormous youth migrations from rural to informal urban settlements. High population growth stressed the water and sanitation services that exist (Arslan et al., 2020). In Uganda, seven million Ugandans lack access to safe water and 28 million do not have access to improved sanitation facilities. Further, due to disparities in water access in Uganda, the urban live-in deficiency as they pay as much as 22% of their income to access water from vendors. Spending such a high percentage of earnings on water reduces overall household income, limiting opportunities to build savings and break the cycle of poverty. In Uganda and around the world, millions are navigating the post-COVID-19 pandemic with an addition challenge of living without access to safe water. Now more than ever access to safe water is critical to the health of families in Uganda.

In 2015, around 24% of the population lacked access to "at least basic water" in Uganda. Access to at least basic water was 39% of the total population, or 73% of the urban population and 32% of the rural population. Regarding sanitation, only 19% of the total population had access to "at least basic sanitation", or 28% of the urban population and 17% of the rural population. Around 31 million people did not have access to "at least basic sanitation" in 2015.The Human Rights Measurement Initiative has given Uganda a score of 22.9% with regards to basic sanitation, and 9.5% for water supply. In earlier years, access to "improved water" had increased from 43% in 1990 to 72% in 2010, according to estimates by the Joint Monitoring Program for Water

Supply and Sanitation (JMP) of the UN. In the same period, access to "improved sanitation" increased slightly from 27% to 34%. The Water and Environment Sector Performance Report of the Ugandan Ministry of Water and Environment, however, showed markedly different access figures. According to this report, in 2011, access to "safe water" was 66 percent while access to improved sanitation was 70% in rural areas and 81% in urban areas. 87% of the population lived in rural areas in 2010.

The most common technology options for rural water supply are protected springs, boreholes, protected wells, and gravity flow schemes. Those who do not have access to an improved source of water must rely on unsafe sources such as rivers, lakes, and unprotected wells. One consequence of poor access and quality is that water-borne diseases are a major cause of infant mortality. Access to functioning water sources varied considerably among districts in 2007, from 12% to 95%. At present, the Uganda Water Supply Atlas, June 18th, 2022 Report indicates that the access rates in Uganda vary from 28% in Kyegegwa District to 95% in Obongi District. Uganda has 135,778 domestic water points which serve a total of 28,271,911 people to 23,127,293 in rural areas (Uganda bureau of statistics, 2022). An additional 5,312 sources have been non-functional for more than 5 years and are considered abandoned. Uganda has 1,211 piped schemes. The report further puts access at 65%, rural functionality 85%, equity 121%, management 90% and lastly gender 87%.

1.2. The problem statement

The water crises of the world are not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people and the environment suffer badly (Akali and Lorhemen, 2014). The report suggested that Water is a necessity for all living beings, and access to safe water is a basic human right. Despite the world experiencing exponential growth in all areas with advances in science and technology, 40% of people experience water scarcity (Liao, 2024). The country of Uganda is no exception; 8 million Ugandans lack access to safe water. This lack of clean water affects the health of the Ugandan people, their productivity, and their economy.

It further pointed out that, one in nine people worldwide has no safe alternative to contaminated water sources. The stress of economic growth over the last two decades in Uganda has put an enormous strain on the land and its resources. Approximately 19% of Ugandans only have access to streams, ponds, and unprotected hand-dug wells as sources of drinking water. Human waste, soil sediments, fertilizers, and mud all run into drinking water sources due to the widespread absence of proper toilets and showers. Additionally, the lack of adequate filtration systems and the loss of vegetation, which acts as a natural filtration system, lead to various health problems. According to BioMed Central, 22% of deaths of Ugandan children under the age of 5 are a result of diarrhea a. The water crisis in Uganda also results in 32% of Ugandans having to travel more than 30 minutes to access safe drinking water. The excess time that people spend on water provision hinders their ability to work, maintain the household and take care of children. Consequently, hundreds of projects around the world demonstrate how newly built Water, Sanitation and Hygiene (WASH) infrastructure deteriorates quickly after they are built if proper Operation and Maintenance (O&M) is neglected.

Operation and maintenance (O&M) of rural and urban water facilities is one of the key challenges of water supply in Uganda. While investment in new infrastructure continues, greater attention must be paid to the sustainability of those facilities. Every year, government and non-government actors invest billions of shillings in the construction of new facilities, as they strive to attain the national targets for access to safe water. Take government investment for example. The 2015 Water and Environment Sector Performance Report (SPR)

indicates that through the District Water and Sanitation Conditional Grant (DWSCG) a total of 729,868 people were served with new water supplies, in FY 2014/15 at an estimated per capita cost of UGX 116,897. Thus, UGX 94.61 billion was invested in the new rural water supplies, which was an increase in funding compared to the previous years as detailed in Table 1 below. However, this does not really translate into full access given that as of June 2015, rural water coverage stood at 65%, while urban coverage was at 73%. This is a slight improvement from 64% and 72.8% in June 2014, but still below the national 2015 target of 100% (urban) and 77% (rural). This means that 35% of the rural population and 27% of the urban population still do not have easy access to safe water.

Water is a social and economic good. When people don't have access to safe water it impacts on their health and their ability to engage in economically productive activities. When water supply facilities are not functioning it means there is idle capital. If functionality is low, then the net effect of the service provided is reduced. This can result into a multiplicity of negative effects on citizens and on national development. Such is the significance of O&M and it must be prioritized by all actors, especially the Government of Uganda IRC Uganda briefing note, October 2015. Thus, O&M is a crucial element of sustainability and its absence is a frequent cause of failure of water supply and sanitation service facilities. Many failures are not technical ones but may result from poor planning, inadequate cost recovery or inadequate outreach of centralised agencies in managing the O&M of facilitates. Operation and Maintenance (O&M) is a crucial element of sustainability and its absence is a frequent cause of failure of water supply and sanitation service facilities. Many failures are not technical ones but may result from poor planning, inadequate cost recovery or inadequate outreach of centralised agencies in managing the O&M of facilitates.

1.3. Objective of the study

This study aimed to discuss the operation and maintenance challenges in ensuring safe drinking water in Uganda. Consequently, three questions were answered, viz.; [a] What are the challenges faced in O and M in the provision of clean and safe water in Uganda? [b] What are the O and M policy measures undertaken to avert the challenges faced in the provision of clean and safe water in Uganda? And [c] What are the appropriate Solutions for O and M challenges faced in the provision of clean and safe water in Uganda? The study covers the rural and urban water supply facilities in Uganda with the major content of analyzing the contributing factors faced in the implementation, measures undertaken to avert the challenges, and suggest solutions for O and M challenges faced in the provision of clean and safe water in Uganda. The study will be significant to the Government of the Republic of Uganda and Civil Society Organisations (CSOs), international agencies, and other stakeholders facing the challenges of O and M in the provision of clean and safe water.

2. Methodology

The central method for this manuscript was a desk review of obtainable empirical besides conceptual literature on challenges emerging from both operation and maintenance in safe drinking water, together with available guidelines and solutions in the context of Uganda and other parts of the world. Desk research essentially encompasses gathering of information from existing resources, for instance, academic journals, the cyber space, the media, systematic and empirical publications as well as statistical publications. In accordance with the Management study guide (2013), this stage is followed by cross-referencing and the organization of

data into themes and emerging themes. The method has been recognized to be very effective and can be conducted in the preliminary chapter of a study given that a number of the basic material can effortlessly be collected and then used as a standard in the investigation process.

3. Findings and discussion

3.1. Analysis of the challenges faced in the operation and maintenance of clean and safe drinking water in Uganda

From obtainable literature, it is proposed that poor maintenance could be attributed to a number of factors such as a lack of qualified and competent technical staff, revenue management and limited funding (Boshoff, 2009). Due to lack of planned and preventative maintenance, municipal infrastructure assets deteriorated faster than anticipated. Infrastructure facilities that are in good working order are either overloaded, no longer operational or in need of a complete renewal or replacement. Reasons for non-functioning O&M services include lack of ownership or delegated responsibility for O&M, lack of skilled labor, high operating costs, excessive repair and replacement expenses. Additionally, the technical options chosen are not always the best suited to the local environment in which they shall be operated. Other reasons are closely related to the set-up of projects, which often focus only on construction of hardware instead of management components because hardware installations can be implemented faster and with fewer complications than management systems. Consultation with the local stakeholders and users regarding the most appropriate system for the local conditions often does not take place adequately. In most cases where the provision of sanitation services has failed, the root causes have been poor management, lack of planning, and failure to generate sufficient revenue to operate and maintain systems (UN Habitat and WHO, 2021).

Additional challenges have been indicated by the Uganda Bureau of Statistics (UBOS), the SPR 2015 suggesting that out of a total population of 34.8 million, 82% live in rural areas. With the current water coverage at 65%, nearly 10 million Ugandans in rural areas do not have access to safe water. In urban areas where 15% of the total population lives, nearly 1.5 million people do not have access to safe water. Moreover, the population counted as served stands a risk of losing access to safe water. This is because of the functionality rate, which currently stands at 88% for rural having improved from 84% where it had stagnated for over five years. Functionality for urban water sources currently stands at 89%. In rural areas, out of the estimated 109,000 rural water point sources in Uganda, 16,350 sources are not providing water as expected. Low functionality is a manifestation of operation and maintenance failures. The National O& M Framework (2011) describes O&M as the sum of activities required to achieve smooth running and continuous sustenance of a water facility to ensure long service, leading to a wide range of benefits to a community such as condensed time in water collection especially for women and children who assume a dominant role in water collection; Time saved to participate in other productive activities; Improved health and family well-being as a result of easy access to safe water; Less dependence on external organizations that often have limited resources. Poor O&M, apart from leading to breakdown of sources, contributes to contamination of water hence undermining the goal of improving the quality of life through provision of safe and clean water. When a community member goes to the source and finds it non-functional, it impacts greatly on their health as well as their ability to engage in more productive activities. Often, the people will resort to unsafe alternative sources of water; or they will

pay exorbitant prices for an alternative good service; or they will trek long distances in search of the next good source.

In Uganda, particularly in the countryside areas, the O&M of water facilities is largely a community responsibility as provided by the Community Based Maintenance System (CBMS). Users are expected to own and manage their water supply facilities. Where a source has a major break down which the community cannot deal with, the MWE as well as the Local Governments, may come in to support. A number of factors continue to undermine the effectiveness the CBMS and hence O&M for water facilities. These range from inconsistent government policies; dysfunctional Water User Committees (WUC); inadequate numbers of Hand Pump Mechanics and lack of tools for them; shortage of hand pump spare parts as well as dealers in the spare parts; inadequate technical support from district and sub-county staff; unclear ownership of facilities; inappropriate technology choices; inadequate community mobilization and training and gender-related challenges that put women and girls more at risk. There are a number of factors challenging WSS. Some of the factors are aging infrastructure, water service provision thinking horizons, catchment (mountain)-specific issues, climate change, knowledge gaps with respect to present and future hydrology, accurate water demand prediction, land use/cover change, optimal operation of water supply systems, cost recovery, operating cost, water quality (water pollution), water scarcity, water leaks, low water pressure, over-use, response to drought and natural disasters, rapid urbanization, population growth, migration, demographic changes, economic development, consumer behavioral patterns, efficiency and reliability of a water supply system, self-sufficiency through use of alternative water sources, dynamic and uncertain urban water systems, complex dynamic human-environment coupled systems (non-holistic or siloed management), lack of adaptive capacity indicators to assess sustainability of water systems, scant attention of smart water grids (not supported by information and communications technology), lack of policies and programs that consider rural diversity and cultural differences and neglecting wastewater management are cited as challenges to water supply systems for provision of sustainable and reliable water services, which meet acceptable standards for present and future generations (Liu et al., 2017).

A study by Nelson-Nuñez et al. (2021), reveals that low levels of functionality of water and sanitation facilities remain an area of concern to the government and development partners. While there has been improvement of functionality for urban water supplies, functionality for rural water systems remained static at around 80% for the last five years. The Sector Performance Report (Ministry of Water and Environment, 2010) identifies issues affecting functionality to include poor O&M practices and overall functioning of the community-based operation and maintenance system. Other issues include dry/low yielding; water quality; poor and below standard installations of facilities; ageing systems beyond economic values needing total replacement; WSC not functioning; silt and leakages; vandalism; repairs beyond community capacity; and inadequate prioritization of community mobilization activities to ensure ownership and care by the communities. Given limited funds for new investments and replacements, the Ministry recommends that issues affecting O&M and functionality and, ultimately, sustainability be addressed, including through strengthening regulatory functions, at both central and local government levels, and compliance by districts with sector implementation guidelines.

3.2. The analyses of policies and guidelines in the O & M of safe drinking water in Uganda

An evaluation of Water and Sanitation Sector Reforms, in Uganda, indicates that a Government-Led Transformation in 1998, confirmed its commitment to reaching the PEAP targets by beginning the reform of the water and sanitation sector (Water and sanitation sector reform in Uganda: a government-led transformation, n.d). The stated aims of the sector reform were: to ensure that water supply and sanitation services were provided with increased performance and cost-effectiveness; and to reduce the government's financial burden without compromising the provision of equitable and sustainable services. This is further linked to other allied sectors, especially the health sector, as it relates to the day-to-day work and/or motivation of health workers handling cases which spring from reliance on unsafe water in homes and communities (Komakech et al., 2021). The first step in the reform process was to strengthen the regulatory framework and provide a basis for cost recovery through the introduction of the 1999 National Water Policy. Next came the development of a comprehensive sector strategy, based on sub-sector studies in the following areas: Rural Water Supply and Sanitation, Urban Water Supply and Sanitation, Water for Production, and Water Resources Management, The Rural and Urban studies were completed in 2000/2001, and provided specific recommendations for the reform of these sub-sectors. Reasons for water and sanitation sector reform Substantial investments have been made in the provision of rural and urban water supply and sanitation services, most notably within the last decade. However, these investments have failed to improve coverage or service levels as extensively as expected, and at present less than 60% of the population has access to safe water supply or sanitation services. Furthermore, many rural facilities no longer function, and since decentralisation, local authorities have been struggling to operate and maintain urban systems. The poor performance of previous investments illustrates the magnitude of the task implied by the PEAP targets, and recent sector reviews have identified further constraints to progress, including but not limited to: insufficient sector funding, ineffective sector coordination, inadequate local capacity, inefficient resource use, and supply-driven project approaches.

Recognition of the challenges inherent in the ambitious PEAP targets, and the sector's structural constraints made reform of the water and sanitation sector an urgent requirement. The subsequent allocation of a large share of the HIPC debt relief money to the water and sanitation sector, and the heightened scrutiny of the sector's performance that this allocation inevitably involved, was another factor driving the reform. Under the Reform of rural water supply and sanitation, the focus of the rural WSS sub-sector reform was on strengthening the decentralised provision of services. The central government was to coordinate the sector and facilitate technical assistance to local governments, while funds for rural WSS were to be channeled directly to district authorities, and the water and sanitation capabilities of the district authorities are to be substantially enlarged.

Demand-responsive and integrated approaches are to be introduced, based on community ownership and management of rural WSS facilities, with increased attention paid to hygiene promotion, gender awareness, and participatory planning. No wonder, Operation and maintenance costs are to be borne by the users, with support for rehabilitation and major repairs from central and local government. Clearly, these new approaches would require major increases in capacity, and operational adjustments, both in government and among user communities.

Table 1. Summary of the key challenges, policies, and solutions to safe drinking water in Uganda

Challenges	✓ Lack of planned and preventative maintenance ✓ Overloaded and in operational facilities ✓ Non-functioning O&M services ✓ Lack of skilled labor ✓ High operating costs ✓ Excessive repair and replacement expenses ✓ Poor management ✓ Lack of planning ✓ Failure to generate sufficient revenue to operate and maintain systems
Policies or approaches	• Water and sanitation sector reform ✓ to ensure that water supply and sanitation services were provided with increased performance and cost-effectiveness; ✓ to reduce the government's financial burden without compromising the provision of equitable and sustainable services. • Demand-responsive and integrated approaches ✓ hygiene promotion ✓ gender awareness ✓ participatory planning • The Water Act (1997) ✓ Protection and management ✓ Devolution of water supply and sewerage undertakings. • The Water Policy (1999) ✓ Water Source Committees ✓ water boards to collect funds for preventive maintenance and repairs. • The Local Government Act (1997) ✓ Provision and maintenance of water supplies ✓ Making bye-laws • The Land Act (1998) • The National Water Policy (1999) ✓ Integrated managing water approach • The National Gender Policy (1999) ✓ Gender equity in the national socio-economic activities ✓ Women to play a major role in decision-making.
Solutions	• Investing in quality water infrastructures, which involves restoring and maintaining clean water sources as well as promoting hygiene and investing in sanitation facilities. • Planning and budgeting to carry out the necessary tasks Preventive maintenance ✓ Network inspection, ✓ Cleaning and greasing of mechanical parts ✓ Replacement of items with a limited lifespan. • Reactive maintenance ✓ support Hand Pump Mechanics Associations ✓ Initiate market-based approaches ✓ Allow the private sector actors to play a more important role in O&M and lastly ✓ Apply the Life Cycle Cost Approach for all prospective installations.

During the transition phase, Technical Support Units were established in each region. Their aim was to build local capacity and to encourage the adoption of new ideas while ensuring a uniform application of national policies and sector approaches to the small town groups, which comprises the 43-48 urban WSS systems not included in the lease group, was that both responsibility and ownership of the systems would remain with local governments, which would also be responsible for ensuring that the systems are managed on a commercial basis. To this end, service delivery would be contracted out, either to newly created local water and sanitation authorities or to local private operators. Where possible, multiple systems would be consolidated in order to capture economies of scale in their management and make the operation of the systems more attractive to private operators. In addition, a national urban water and sanitation development agency would be created to support local government and local WSS authorities in the provision of effective decentralised urban WSS services. Private sector participation needed some form of regulation, and an independent regulatory institution would be created in Uganda. Its main duties would be to set tariffs, provide consumer protection, and resolve disputes between sector stakeholders.

Another feature of the rural WSS sub-sector reform was the promotion of private-sector involvement in service delivery. District authorities are encouraged to develop and utilise local private-sector capacity for design, construction, operation, and maintenance (DCOM) of rural water supply and sanitation facilities and for the supply and distribution of spare parts and appropriate equipment. A major output of the rural WSS sub-sector study was an investment plan for the period 2000-2015. This plan was developed by the Directorate of Water Development (DWD) of the Ministry, of Water, Lands, and Environment (MWE), and separates investments for rural water supply from those for rural sanitation. This was a significant point, reflecting both the complex institutional arrangements for the provision of rural sanitation and government policy on latrine subsidies.

There was also the reform of urban water supply and sanitation of the urban WSS sub-sector centres on the introduction of commercialised operations, chiefly through increased private sector participation. The sub-sector recommended a public-private partnership(PPP), whereby the public sector retains ownership of urban WSS assets, but private operators carry out service delivery. In practice, this has translated into slightly different approaches in 'large towns' and 'small towns'. Under Large towns, the strategy for the large town group, which will comprise some 30-35 towns with populations above 15,000, the is to give responsibility for management of all urban WSS services to a single international private operator under a ten-year lease contract. The urban WSS assets involved would be vested in a wholly government-owned Asset Holding Authority, which will monitor the operator's performance, manage the leased assets, and plan future investments.

The unprecedented participatory process, with strong links to the PRSP process, and thus to the government's primary objective of poverty alleviation. This participatory process has been, high quality, sustained and influential. It brought civil society, NGOs, external support agencies and government together, leading to real partnerships and mutual understanding among sector stakeholders. It has also fostered the development of networks of policy advocates, such as the Uganda Water and Sanitation Network (UWASNET), and legitimised civil society's role in monitoring the use of poverty alleviation funds. The evidence of these processes in action was manifold. There has been a large amount of activity in the sector in a very short time: sub-sector studies and strategy papers have been completed; memorandums of understanding have been

signed; new co-ordination bodies were initiated; substantial government arrears have been settled; and, more than half the districts set up fully staffed District Water and Sanitation Teams.

The other guidelines set in by the "National Framework for Operation and Maintenance of Rural Water Infrastructure in Uganda" provided the overall guidance in the management of rural water supply systems outside the jurisdiction of the public water utilities managed under or by the National Water and Sewerage Corporation (NWSC) and Umbrella Authorities (UA). The new framework focuses on professionalising the management of water facilities in rural areas by bringing on board new aspects to address the gaps in the current Community-Based Management System (CBMS). The new approach referred to as CBMS+ is where the District Water Authority through the Water Supply Services Board (WSSB) formally outsources the O&M function to an entity called Area Service Provider (ASP) that operates on a contract management arrangement. The ASP might be a Private Sector Organisation (PSO) or Non-Governmental Organisation (NGO), or the Hand Pump Mechanics Association (HPMA) with the requisite training, skills, and experience.

The purpose of the O&M framework was to provide guidance, strengthen and streamline rural water O&M at all levels in order to ensure the long-term sustainability of the rural water facilities and to ultimately guarantee safe water supply services to the end-user. The national goal of Uganda's water supply and sanitation sector is to increase access to water supply and sanitation services from 65% and 70% respectively in 2010 to 100% by 2035. The objective of the proposed Water Supply and Sanitation Programme (WSSP) is to support the Government of Uganda's (GoU) efforts to achieve sustainable provision of safe water and hygienic sanitation, based on management responsibility and ownership by the users, to 77% of the population of the small towns' population by the year 2015. However, operation and maintenance and CBMS of rural water facilities in Uganda is anchored in a number of Government of Uganda laws, policies, strategies and planning documents and international conventions mainly the Sustainable Development Goals (SDGs) 2016 – 2030.

- The Uganda Vision 2040 singles out water development as one of the opportunities that can foster socio-economic transformation.
- The Constitution of Uganda (1995) provides that clean and safe water as a right is enshrined in the Constitution as objective 21. including other legal documents:
- The Water Act, Cap 152(1997), provides for the use, protection and management of water resources and supply & facilitates the devolution of water supply and sewerage undertakings. The Water Policy (1999); provides for the Water Source Committees/water boards to collect funds for preventive maintenance and repairs.
- The Local Government Act (1997); Functions and services for which district councils are responsible, subject to article 176(2) of the Constitution and sections 96 and 97 of the Act include, the provision and maintenance of water supplies in liaison with the Ministry responsible for natural resources, where applicable. The Local Government Act also empowers Local Councils to make bye-laws, subject to certification by the next higher Council or the Attorney General.
- The Land Act (1998); vests all rights to water resources in the Government.
- The public Health Act (2000); consolidates the laws and regulations on public health.
- The National Water Policy (1999); promotes an integrated approach to managing water sources sustainably to benefit the people of Uganda.

- The National Gender Policy (1999) enshrines the affirmative action by GOU in support of gender equity in the national socio-economic activities and encourages women to play a major role in decision-making.

Koestler (2009) states that there is a general weakness in the current environment and project approach concerning the operation and maintenance framework. The author argues that the private sector is more effective in providing services than the local government structures, because of their flexibility and adaptability to user demands. The author recommends a 'water persons a year' tool to justify long-term commitment for operation and maintenance from government, NGOs, and developing partners. However, more funding will not be sufficient: focus should be given to the establishment of systems, structures, the and institutions to ensure sustainability of rural water sources. These could be semi-autonomous maintenance units, private sector service contracts, water utilities, or local community groups being contracted. This review suggests that the private sector and supply chains are crucial in the sustainable rural water supply. This private sector has significant potential but cannot be driven by profit mechanisms alone in rural Africa. There is a need for supporting mechanisms that should fit into the local socio-economic environment

3.3. The appropriate solutions for operation and maintenance in the provision of clean and safe drinking water in Uganda

Water and sanitation systems are critical for a healthy society and a stronger economy. In many countries, organizations such as UNICEF have made efforts to combat water issues. This is especially true in the fellow country of Liberia, where the organization strived to develop water, sanitation, and hygiene systems (WASH), with 65% of such machinations functionally today. The Ugandan government now aims to have clean water and improved sanitation for everyone by 2030. Uganda plans to reach this goal by investing in quality water infrastructures, which involves restoring and maintaining clean water sources as well as promoting hygiene and investing in sanitation facilities. Organizations, such as Water.org and ILF, are helping realize this ambitious goal (Tara, 2021).

Sustainable O&M requires planning and budgeting to carry out the necessary tasks. Decisions on who should fund sanitation O&M and how receives far less attention than design and construction activities (Sohail and Cavill, 2001). Thus, maintenance can be either preventative, corrective, or reactive as adapted from Castro (2009). Preventive maintenance: includes work that is planned and carried out on a regular basis to maintain and keep the infrastructure in good condition, such as network inspection, flushing of the water wells and water lines, disinfection of water tanks, cleaning and greasing of mechanical parts and replacement of items with a limited lifespan. Preventative maintenance not only extends the lifetime of WASH infrastructure but also saves costs in the long term-term as it reduces the frequency of costly breakdowns and also reduces the frequency with, which expensive reactive maintenance or emergency backup solutions are required (Harvey et al., 2015). It sometimes includes minor repairs and replacements as dictated by the routine monitoring and inspections.

It is essential to schedule preventive maintenance to ensure the routine maintenance and health of the system. This can be done by way of routine check-up inspections. The camp manager or the person in charge of the WASH services will need to ensure that the technician is doing his/her job. The key to ensuring effective equipment maintenance is to make certain that responsibilities are clearly defined and maintenance personnel

have the tools and skills to do their job effectively. Corrective maintenance: replacing or repairing something that was done incorrectly or that needs to be changed: an example is the reallocation of a pipe route or replacement of a faulty pump.

Reactive maintenance: a reaction to a crisis or public complaint; it normally occurs because of failure and the malfunctioning or breakdown of equipment. Responsive maintenance should allow for a quick and efficient response to WASH-related problems that occur suddenly. This is best handled by mobile WASH teams that should be properly trained and equipped (with spare parts and tools) to immediately respond to infrastructure failure or breakdown and handle the situation (Harvey et al., 2015). In August 2015, IRC International Water and Sanitation in Uganda and the Uganda Water and Sanitation NGO Network (UWASNET) undertook a documentation exercise, to gather evidence of the key issues surrounding O&M in different areas, with a view to advocating for increased funding for Operation and Maintenance (O&M) and effective management of water supply facilities. The study identifies the following points of action:

- Focusing on management because that is where the biggest challenge is, professionalise CBMS to enhance WUC functionality and accountability.
- Allocating O&M funds based on the needs of individual districts, indeed the new DWSCG allocation has been revised on that basis.
- Supporting Hand Pump Mechanics Associations (HPMAs) to turn into viable entities so that they are able to undertake timely monitoring and assessment of sources before they completely breakdown.
- Initiating market-based approaches and allow the private sector actors to play a more important role in O&M.
- Applying the Life Cycle Cost Approach (LCCA) for all prospective installations.

This is the 'life-cycle' at the heart of the life-cycle cost approach (LCCA) what costs are needed to sustain, repair, and replace a water system throughout its cycle of wear, repair, and renewal so it provides a service forever? Water is a social and economic good. When people don't have access to safe water it impacts their health and their ability to engage in economically productive activities. When water supply facilities are not functioning it means there is idle capital. If functionality is low, then the net effect of the service provided is reduced. This can result in a multiplicity of negative effects on citizens and on national development. Such is the significance of O&M and it must be prioritized by all actors, especially the Government of Uganda.

4. Conclusion

As water is a basic need for human life, access to clean and safe drinking water is a basic human right but the challenges facing the provision of clean and safe water in Uganda is largely tagged to poor consideration of operation and maintenance (O&M) of water facilities in both rural and urban centres. This is due to the fact that little consideration is given during water projects: planning, design, budgeting, implementation, and monitoring, and lack of integrated water asset management systems (WAMSs). However, it is noted that most scholars pointed out other factors impacting on the provision of sustainable water supply such as; old water infrastructures, clean water issues (quality, scarcity), natural factors (climate change, flood and drought), human factors (population growth, migration, demographic change, economic development, willingness to pay for water supply services, overuse), water management and delivery problems (pressure, leakages, lack of smart water meters, cost recovery, operation costs to mention but few.

5. Recommendations

The government of the Republic of Uganda and CSOs can consider;

- Planning and allocation of resources backed up by an Integrated Water Asset Management Systems (WAMS) in their quest for the provision of clean and safe drinking water to the population and ensure that the water facilities installed at both rural and urban centres remain functional.
- Operation and maintenance should be included and considered in the policy guidelines and implementation as it has proven to be the umbilical cord of water asset management systems and the answer to improved functionality.

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