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Factors Influencing Household Water Consumption and Revenue Generation in Urban Water Supply System in Southwest Nigeria

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Abstract
Water security is a pressing issue for most water utilities such as State Water Corporations (SWCs) in urban centres. This study investigated the factors influencing household water consumption and revenue generation in six States of Southwest Nigeria. The water distribution across various local government areas was divided into three clusters from which a total of 1,410 households were selected representing 0.1% of the estimated households in the study areas. Data were collected using household survey questionnaire and SWCs officials with key informant interview guide. Descriptive and inferential statistical techniques were used to analyse the data. Findings revealed that state water corporation revenue generation from the household water consumption could not meet the operational cost for recovery of the operation and maintenance costs of water supply in the urban areas of the six states. Sixty three percent of the households indicated willingness to pay for water services. Eighty percent of consumers have a negative perception of service delivery of which 43% of the households have access to public water and 57% depend on boreholes and well water. Private household deliveries accounted for almost 97% of the water supply in Ondo and Ekiti states while the other four states ranged from 90% to 85%. 80% of water users connected to public water supply were billed uniformly while the collection rate of SWCs across the study areas ranged from 11% to 50%. Only 15% of the households had their water piped, metred but received less than five cubic metres per month thereby hindering revenue generation. The study concluded that performance and revenue generation of the SWCs were below the standard best practices recommended for developing countries. Progressive tariffs and innovative collection methods should be employed in order to increase the revenue generation of SWCs in urban centres.

Keywords: Consumption, Household, Revenue generation, Urban, Water supply.

1. Introduction

Price does have an effect on the amount of water demanded by all classes of water consumers, and consumer's attitudes to water usage and their perception about water consumption may be changed by appropriate water payment strategies. Public water supply started in Nigeria early in the twentieth century in a few towns managed at the lowest administrative level. Amongst the early beneficiaries were Lagos, Calabar, Kano, Ibadan, Abeokuta, Ijebu Ode (Ogun State) and Enugu (FAO 2016; Owolabi, 2017). The schemes were maintained with revenue from water sales with virtually no operational subvention from government. With the creation of regional governments in the early 1950s the financial and technical responsibilities for developing new water schemes were taken over by the regional governments who also assigned supervisory high level manpower to oversee operations and maintenance (FAO 2016). Today, all 36 states and the Federal Capital Territory have water boards/corporations or public utilities boards managing their public water supply. Their efforts are supplemented, in many cases, by local governments who supply water to small villages in their areas of jurisdiction.

As the country was experiencing rapid development and urbanization, the need for expansion of provision of public water supply also increased. The schemes

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needed upgrading due to water consumption and competition among users- households, industries, manufacturing, agricultural sectors among others (FAO 2016).

In Nigeria, particularly in the Southwest, problems of water supply are usually not the lack of water or the lack of demand for water, but rather a series of non-technical factors to distribute the water to the users and to develop financially viable sustainable water treatment plants. The water management and service sectors of developing countries are facing the dilemma of lacking enough capital for investment and low revenue generation. In southwest Nigeria, water management services are largely provided by public sector and the government is the principal provider of water infrastructure (NWSP, 2000; Owolabi, 2017).

Water is rising on the policy agenda as population growth and climate change intensify scarcity, shocks, and access inequalities (Dustin *et al*., 2020). Water shortages consistently rank among the global risks of greatest concern to policy- makers and business leaders (World Economic Forum, 2019). Globally, it has been estimated that an average capital investment of US$114 billion/year is required through 2030 to meet the SDGs for water supply, sanitation, and hygiene (Hutton & Varughese, 2016). This is about three times the current expenditures for water supply, sanitation and hygiene. These estimates are only capital costs; after about 2023, the annual cost to operate and maintain the SDG facilities will even be larger. These costs are not evenly distributed with poorer regions often facing the largest relative cost to catch up. The annual, estimated costs of meeting SDG 6.1 is higher in rural Sub-Saharan Africa than any other region globally, totaling approximately US$5 billion annually in capital expenditures (Hutton and Varughese, 2016; Hope *et al*., 2020). In addition to the SDG goals, investment is needed for water infrastructure. Projections of the total global financing needs for water infrastructure are US$400–500 billion/year to 2030, more than doubling current water investment. Beyond then, investment needs increase greatly, with an estimate of total cumulative investment in water infrastructure of US$22.6 trillion by 2050 (OECD, 2018). Compared to other infrastructure, financing water is a particular struggle. As noted above, networked, surface water supply systems are exceptionally capital intensive. In the US, for example, the water industry is 2.3 times more capital intensive than the electricity industry in terms of dollars of assets per dollar of annual revenue, and 2.4 times more capital intensive than the telecoms industry (OECD, 2018).

The price of water almost never equals its value and rarely covers its costs (Grafton &Wheleer, 2020). The value of water is derived from multiple types of economic benefits; as a result, a single price will be ineffective due to the multiple, sometimes competing objectives of water management (Damania, 2020; Nguyen *et al.*, 2024). The cost of water includes the capital intensive, natural monopoly characteristics noted above, and externalities (Grafton & Wheleer, 2020). For many residential water users in a networked water supply system, price provides at best a shrouded signal. Surveys show that most residential water users have little idea of how much water they are actually using in their home, whether in total or for specific end uses (Nauges and Whittington, 2017). Moreover, residential water use is heavily dependent on physical features of the home (built-in fixtures and appliances, lot size, etc.) that are non-trivial to change. For many users, the specific amount of water that they use in their home is hardly a conscious choice.

Raising the price of water purely to send a signal to water users, when the increase is not cost-justified, is usually politically infeasible and sometimes illegal (Dustin et al., 2020). For many municipal water utilities, pricing every unit of water supplied at long-run marginal cost would generate a significant surplus of revenue, since their long-run marginal cost far exceeds their average cost and that, too, is politically challenging if not illegal (Pelekanos *et al.*, 2025; Dustin *et al*., 2020).

Nigeria has made considerable investment in water schemes and related activities in addition to being blessed with abundant water resources the desire to improve access to this resource was becoming more and more elusive because of the rapidly increasing demand for water. This rise in demand that was outstripping supply is consequent on high population growth rate coupled with increasing urbanisation, and rising living condition as a result of economic growth. The absence of financial discipline and accountability for performance, along with political interference in decisions about allocations and pricing are reflected in a litany of problems: inefficient operations, inadequate maintenance, financial losses and unreliable service delivery. All these have resulted in highly subsidized water use in irrigation, industry and domestic water use for the rich. This is financially burdensome to both the federal and state governments that are already faced with diminishing revenue base and must therefore have a higher proportion of their water resources financing derived from external sources.

Municipal water supply is low in Nigerian urban areas. It is estimated that in urban areas the average water delivery is only 32 litres per capita per day and that for rural areas is 10 litres per capita per day (Ajibade *et al.*, 2015). In places with municipal water supply services, they are majorly in serious short supply, unreliable and of poor quality (Ogunbode et al., 2025; Oyerinde & Jacob, 2022; Abubakar, 2016). The Nigerian Water Policy indicates that water should be regarded as an economic good as well as social services and encourages the autonomy of SWAs. Water supplies are not sustainable in Nigeria because of difficulties in logistics, management, operation, pricing and failure to recover costs. This study aims to assess the revenue generation, financial sustainability, and service delivery in urban water supplies, which are crucial for setting socially acceptable water tariffs, and achieving

sustainable revenue generation objectives in household consumption in Southwest Nigeria.

2. Review of related literature

Previous studies have examined the revenue generation from household water consumption. For instance, Cominola *et al*. (2023) and Liu *et al*. (2024) argued that a proper pricing mechanism could improve water allocation and conservation. But in practice, deviations from the pricing principle of marginal cost are common (Soppest *et al*., 2018). Sereno (2022) estimates the welfare gains from reforming water prices for the Greater Vancouver Water District and finds that the prices charged to residential and commercial consumers are only a third and a sixth of the estimated marginal cost for water supply and sewage treatment respectively. Kim *et al*., (2024) estimates the cost of supply for a sample of 60 U.S. municipal water utilities and finds that prices exceed marginal costs for both residential and non- residential by 150 percent and 40 per cent respectively.

Oyebanjo (2015) studied the cost recovery of state water corporation and its impacts on the sustainability of adequate water supply in Ogun state. The study observed that an effective incentive tax or charge may undermine its own function as a source of revenues. If high water prices reduce water consumption, the supplier's revenues decrease and the cost of water supply may no longer be covered. If the water supplier further increases the prices in response, a vicious cycle may result. In practice, this will usually not happen, given the low price elasticity of water demand and the fact that water prices are only partially variable. Nevertheless, one should be aware of the fact that some users of water services have alternatives available, which may become attractive if the price of the water service becomes too high. They may, for instance, start drilling their own boreholes (legally or illegally), or, in the case of wastewater treatment, they may start building and operating their own private treatment plants. This not only affects the rate of revenue generation for the public (collective) water service investments, but it may also lead to a less efficient use of water resources. Clearly, prices for water services may not only be too low, but also too high to be called 'adequate incentives' (Owolabi, 2017)

2.1 Water demand

Water demand is the measure of the total amount of water used by the customers within a water system. World water demand is projected to increase 20 – 30% above current levels by 2050. Developing countries and emerging economies contribute the most to the rise in demand, stemming from growth in populations, socio-economic development, and changing consumption patterns population (Arshad *et al*., 2025; Li *et al*., 2025; European Environment Agency, 2015). Factors affecting water demand in developing countries include unmetered connections and unreliable meter readings persist in growing urban areas. For example, OECD (2018) expatiated that households consumed 72 liters per capita per day (lpcd) in Cambodia and 135 lpcd in Southwest Sri Lanka from piped water connections but this difference may be attributed to the fact that households are using a variety of water sources other than publicly-piped water.

2.2 Cost (revenue) recovery and the 'polluter pays' principle

The 'polluter pays' principle (PPP) was adopted by the OECD in 1972 as an economic principle for allocating the costs of pollution control. At that time, its main function was to prevent competitive distortions in international trade. In 1975, the use of the PPP was advocated by the European Commission, and since 1987 (Single European Act), it is also enshrined in the basic EU legislation (e.g. currently in Article 191(2) of the Treaty on the Functioning of the European Union). The PPP is not defined in EU law, which is justified on the grounds that the implementation of this principle across a wide range of policies is rather contextual (De Stefano et al., 2019). As a consequence, the interpretation of the PPP also leaves room for interpretation in the area of water policy

De Stefano et al., (2019) cited Article 9 of the Water Framework Directive (WFD) links the PPP with the principle of cost (revenue) recovery, both generally and with respect to the required 'adequate contribution' of the different water uses to revenue generation. Obviously, in the WFD context, the term 'polluter' must be interpreted in the broad sense, since several types of water use do not cause any pollution sensu stricto. The WFD requires those who benefit from water services to cover the cost of providing these services; therefore, the PPP should be extended here so as to include the 'user pays'/'beneficiary pays' principle as well

User willingness to pay (WTP) is fundamental to establishing a sustainable service system. Household income is positively correlated to WTP for improved water. Additionally, households tend to be more willing to pay for private water connections than public ones. Furthermore, WTP for proposed improvements in water access declines as a household's baseline access to other water services improves.

2.3 Cost (revenue) recovery and affordability of water services

Water pricing and taxing systems often include specific measures to ensure that water services remain affordable for low-income households, as outlined by OECD (2018). Here are some examples:

i. Unlimited 'free' water for all: Implemented in Ireland (under reconsideration), this system shifts the burden of water bills from users to taxpayers. It does not incentivize water conservation.
ii. 'Free' water up to a certain level: Used in Belgium's Flanders region, where each resident is entitled to 15 m^3 of 'free' water annually. Consumption above this limit incurs a relatively high price, which encourages conservation through cross-subsidies.

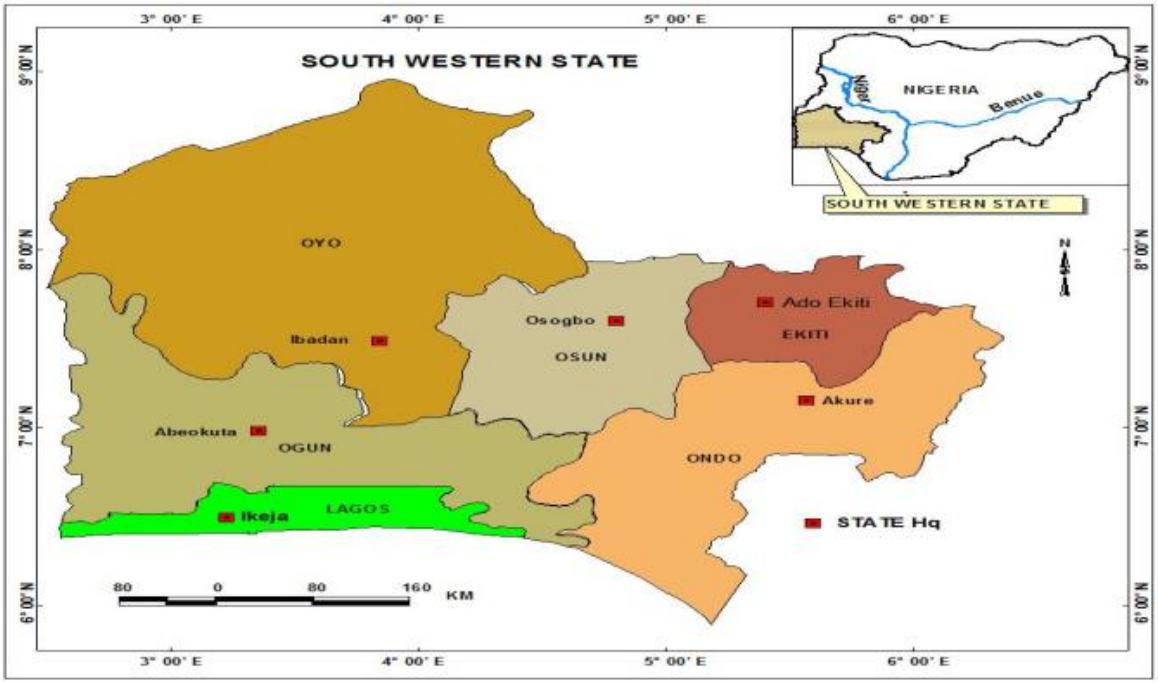

Figure 1: Map of Southwest showing the Selected Areas of Study in the six states

iii. Increasing block tariffs (IBT): These tariffs involve incremental price increases with higher consumption levels. Variations include uniform or variable block widths based on household size, often combined with a fixed charge. IBT systems strongly promote water conservation, particularly among high-consumption users such as those with private swimming pools or extensive gardens. However, their impact on low-income households can vary, depending on factors like shared water meters.

Reduced VAT rates: Commonly used across the EU, this instrument applies lower VAT rates to drinking water supplies in 10 EU member states. While it reduces the financial burden on consumers, it diminishes incentives for water conservation and does not differentiate between income groups. VAT does not directly contribute to cost recovery for water-related expenses.

Specific exemptions for low-income households: Some systems exempt low-income households from paying sewage and wastewater treatment charges. While this reduces cost recovery rates, it doesn't alter incentives for water conservation. There is a consensus in literature that artificially keeping water prices low may not effectively ensure affordability for low-income households. It can lead to underfunded service providers, inadequate infrastructure investment, and deteriorating services, ultimately reducing the benefits to users (OECD, 2019). Pricing strategies involving cross-subsidization between wealthy and poorer households can balance cost recovery and affordability goals, but they must be meticulously designed to generate sufficient revenue while effectively targeting subsidies to those in need.

3. Materials and Methods

3.1 Study area

This study was conducted in Southwest Nigeria, encompassing Oyo, Ogun, Lagos, Ekiti, Ondo, and Osun states. These states are situated along the narrow plain of the Bight of Benin, approximately between longitudes 2°42'E and 8°2'E, and latitudes 6°22'N and 6°2'N. The region experiences a bi-modal wind pattern, with peaks in April and August, which are associated with rainstorms that can lead to water source pollution (see figure 1).

3.2 Research Design

The research design employed mixed methods, combining preliminary in-depth interviews (IDIs) with officials from state water corporations (SWCs), zonal head waterworks, and district business officials. The sampling for the questionnaire distribution is the total number of estimated households in the study areas. The 1996 projected population figures was used for this study instead of 2006 population figures. This is because the 2006 figures for different communities used for the study are not available. The average household size reported in the 1995/1996 household survey conducted by the National Population Commission of Nigeria is 4.48. The anticipated 1996 population of the study areas was divided by this method to obtain an estimated number of households in the study areas. A total of 1,410 households were selected as the sample size. The sample size represents 0.1% of the estimated households in the study areas (Table 1). 12 field assistants and the researcher administered the copies of questionnaire over a period of 4 months.

Table 1: Sampling Plan and Survey Data Comparison (Source: National Bureau of Statistics (NBS) (2016)).

City	Population (N)	Calculated Sample size (n)	No of HHs (nHH) = (N/4.48)	Sample size using 0.1% of nHHs (0.001)
Ibadan	4,979,030	273	795,783	796
Abeokuta	828,323	273	184,894	185
Akure	587,047	273	131,037	131
Ado Ekiti	597,326	273	133,332	133
Ikeja	437,601	273	97,679	98
Oshogbo	299,152	273	66,775	67
Total		**1,638**	**1,407,500**	**1,410**

Table 2: Socio-Economic Characteristics of Households

STATE	Less than 5	5-10	11-15	Others
OYO	87	79	28	21
ONDO	94	68	32	18
OGUN	139	62	21	3
OSUN	133	74	5	-
EKITI	127	76	15	-
LAGOS	106	95	20	2
	686 (52%)	**454(35%)**	**121 (10%)**	**44 (3%)**

3.3 Data analysis

The data were statistically analysed using tables, chart, mean score and simple percentage in addressing the objectives of this study.

4. Results and Discussion

4.1 Socioeconomic Characteristics of Respondents

From the samples of 1,305 households, 686 (52%) households had less than five (5) number of people within the households in the SW, 454 households had households (5-10) number of people while 121 (10%) households (11-15) number of people within the households respectively and others 44 (3%) had households (table 2). The study reveals that water consumption in the study area should be less as the households with less than 5 and 5-10 had the larger percentages (87%) of number of people densely populated within the household in the study areas. This result contained in table 2 shows the cluster nature of households in the town which is quite convenient to share certain facilities including water at a cheaper rate. However, the cluster make it more economical to provide water and other utilities although the risk is in the billing of the house, they actually underestimate their consumption since a flat rate of ₦1950 - ₦2250 or less is collected per house in the study areas.

The 1,305 household surveys show that females had the highest percentage (57.2%) in number of adults in SW among the respondents except in Ekiti state where male had 51% while female adults was 49%. From the total households, Female had the highest percentage in number of adults. This implies that more water will be used and cost of the water services is expected to be paid since most female adults are engaged in income generating ventures to support the male adults especially in urban centres to enhance cost recovery level.

The study reveals that out of the six states in SW Oyo state female has the highest (57.8%) number of children, while male counterparts recorded 42.2%. In this study it shows the number of female children's responses were more than their male counterparts. Also, this is in agreement with the fact that more water will be consumed and in effect increases cost of water services in the study area. Result of the survey indicates that respondents with collective income of between #50,000 and #100,000 has the highest percentage (51.8%) in collective monthly income followed by collective monthly income of ₦100,000 and above in the household. From the survey, it is clear that majority of the respondents are not very poor considering the quantum of collective income within the environment and means that the people can actually pay for the water they use.

Majority (68.5%) of the respondents are civil servants or formally employed by private and public enterprises in the urban centres followed by traders (15.2%) within the study areas in SW Nigeria. It implies that most of the people are regular income earners and are expected to be able to meet the tariff monthly rates fixed by the Water Corporations. Also, the implication of this result is that there are morning and the evening peak in the use of water before they go to work as well as when they return from work. This in essence means that people may be more enlightened and could appreciate

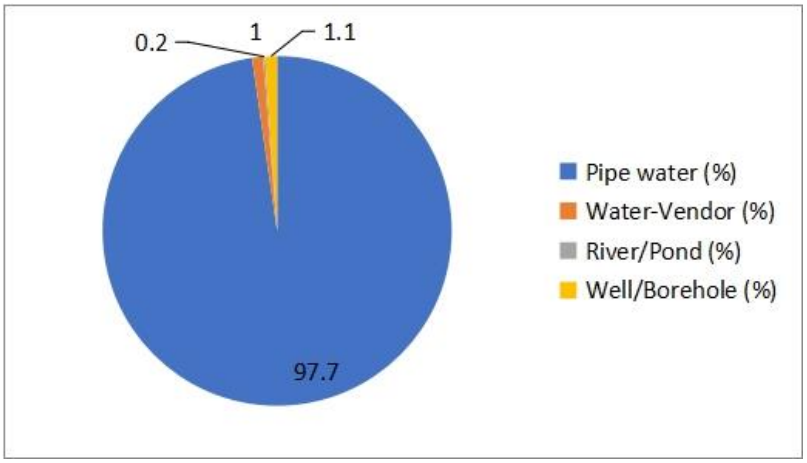

Figure 2: The distribution of water sources used by the household

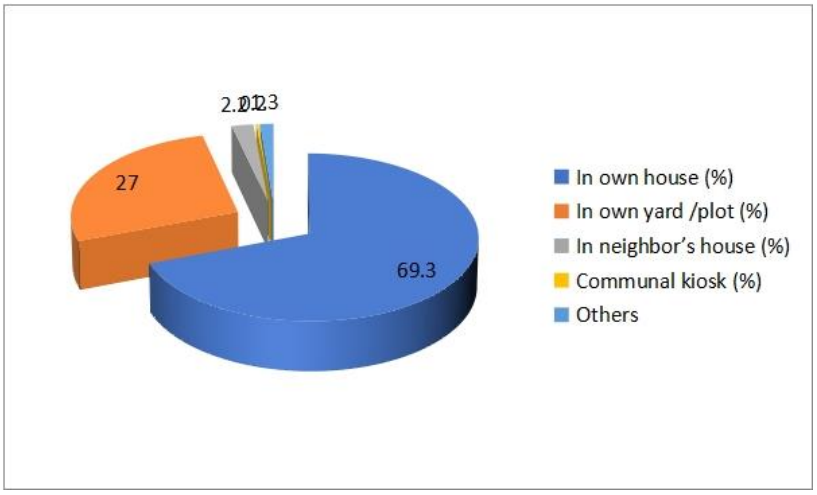

Figure 3: The building characteristics of where the source is connected.

the need for cost recovery on water services to enhance sustainability of the quality water service in the study areas. People formally employed have the highest percentage in income generating activities carried out in the households.

From the study, the frequency distribution of the heads of households reveals that the majority (74.7%) of household heads were the respondents, except in Ondo State, where a higher percentage (58%) of respondents were speaking on behalf of the household heads. It means the categories of people who responded are by implication, adults and family men and women who are responsible for payments of water services in the SW Nigeria. Other respondents who are related to the head of the household in the study include spouses (62.5%) while sons and daughters accounted for 32 % and other (5.5%) relations to head of household such as cousins and niece has the lowest percentage in the area of study.

The study showed that there are more married respondents (82%) while the singles accounted for 13.3%. Divorced and the widowed were very few 1.8% and 2.2% respectively. From the survey, respondents between 20-29 years of age accounted for 5.2% while ages between 30-39 years of the respondents were 17.2%. Respondent ages between 40-49 years and 50-59 years accounted for 34% and 32.2% respectively. Sixty years and above recorded the lowest percentage of 11.3%. The results revealed that there are more adults and family men respondents who could afford to pay for water services in the SW Nigeria. Also, the results showed the frequency distribution of education levels among respondents across six states in the study area in Southwest Nigeria. The survey indicated that the majority of respondents (43.8%) attended tertiary education and the least academic qualification is the National Diploma (ND) which was 26.5% while holders of MSc and PhD degree accounted for 21.8% and 0.8% respectively. This in essence means that people are more informed and could appreciate the importance of cost recovery in urban water supply system in SW Nigeria.

4.2 Main source of water used by the household

Given that the copies of questionnaire were administered using an analogue mapping guide from State Water Corporations (WCs), where the primary water source for households is piped water, almost 97% of households rely on this supply. The exceptions

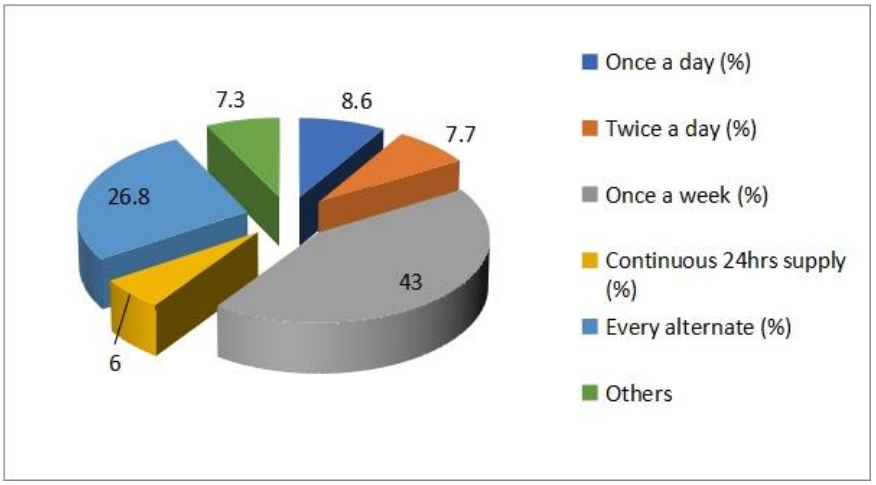

Figure 4: The regularity of piped water supply

are households whose water supply has been disconnected due to defects caused by road construction or accumulated debts from intermittent water supply, which households perceive as overestimated charges.

This in turn led the remaining households to employ other alternative water sources such as boreholes or well as captured by key informants from WCs in the study areas in SW Nigeria. These water sources accounted for the remaining 3% as shown in figure.2. In certain regions, the government has installed boreholes to supplement the existing water supply sources.

The building characteristics as revealed in figure 3 shows that in own house connection had 69.3% while the source connected to own yard/plot had 28%, while others accounted for 3.7%. This is expected in housing development for urban dwellers which in turn makes billing less cumbersome for water providers in order to recover costs of water services in the study areas in six states of SW Nigeria.

4.3 Alternative source of water

This study categorizes water supply into two main types: supply from the state water corporation and other sources. These other sources include boreholes, wells, streams, vendors, and rainwater harvesting. The field survey results, based on 1,305 respondents in Southwest Nigeria, indicate that 75.2% of respondents use water from boreholes, 13.5% from water vendors (water tankers), 5.1% from streams or rivers, and 6.2% rely on wells and rainwater harvesting.

While respondents identified specific sources, it is evident that most use multiple sources. For instance, it is common for individuals in areas like Magodo, Agidingbi, Opebi, Ojodu, and Maryland in Ikeja, Lagos State, to use a combination of tap water, wells, boreholes, and water vendors. The prevalence of wells and boreholes varies across states, and the use of streams is typically associated with those living nearby. Majority (95%) of the boreholes (private) and wells are owned by the household in the study areas. Others (5%) belong to community and neighbours. Water vendors supply water mostly to areas within GRA and some low densities areas in urban centres of the study areas of SW Nigeria. Rain harvesting is actually seasonal specifically, during the rainy season. There are no improvised methods of storing rainwater and more so, the duration of the rain period is fairly long, sometimes throughout the year

Figure 4 shows that a significant proportion of respondents (43%) receive water once a week. While this may be considered acceptable in areas where the water supply is irregular due to issues faced by the Water Corporations in Southwest Nigeria, the main concern is the inconsistency of tap water distribution within municipalities. The survey results also reveal that some areas receive water only every other day (26.8%) from the Water Corporations, whereas some urban areas receive water more frequently. This discrepancy is largely due to geographic location; lower-lying areas have an advantage over higher-altitude regions such as Ekiti, Ondo, and Ogun states. Certain parts of Lagos State (30%) and Oyo State (6%) benefit from continuous 24-hour water supply, as these areas are close to waterworks and experience minimal unaccounted water losses.

The survey within the study area indicates the periods of water availability to households. It shows that some residents receive water once a day (8.6%), twice a day (7.7%), once a week (40%), continuously for 24 hours (6%), and 7.3% have other varying availability. Continuity of supply is defined by the average hours of service per day. The water supply delivery system in the selected locations is facing significant discontent among respondents. The main issue is the abundance of burst pipes that occur frequently. Respondents believe that these pipes are not being fixed fast, resulting in disruptions to the supply of water.

In Oyo State, the survey reveals that 25% of households consume less than 50 litres of water per day, another 25% consume between 100 to 150 litres,

Table 3: Household survey on average water consumption per day

STATE	30-50 litres	50- 100 litres	100-150 litres	150-200 litres	Others
OYO (%)	25.0	-	25	50	-
ONDO (%)	-	58	26	9	7
OGUN (%)	9.0	80	10	1	-
OSUN (%)	6.0	60	26	7	1
EKITI (%)	6.0	61	26	7	-
LAGOS (%)	10.0	65	15	10	-
Average	**9.33**	**54**	**21.33**	**14**	**1.33**

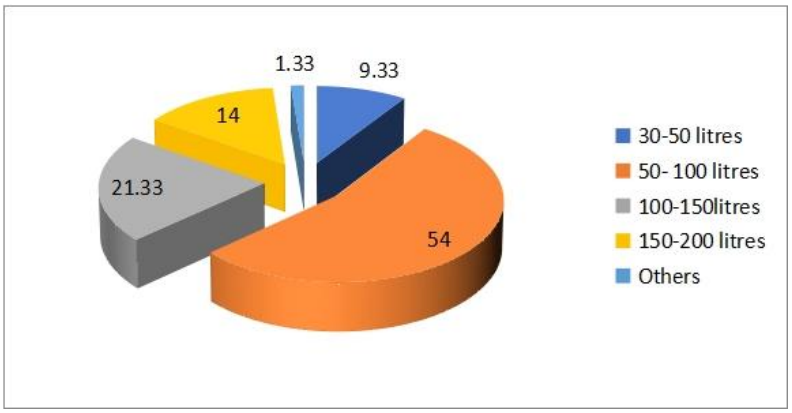

Figure 5: Frequency distribution of average water consumption per day

and 50% consume between 150 to 200 litres (Table 3). Therefore, 150-200 litres represents the highest average daily water consumption for households in Oyo State. On the other hand, in Ondo State, 58% of households consume 50-100 litres, 26% consume 100-150 litres, and 9% consume 150-200 litres, with 7% falling into other categories. Thus, 50-100 litres is the most common average daily water consumption for households in Ondo State.

Similarly, in Ogun State, 80% of households consume 50-100 litres, 9% consume 30-50 litres, 11% consume 100-150 litres, and 50% consume 150-200 litres. Therefore, 50-100 litres is the predominant average daily water consumption for households in Ogun State. In Osun State, 61% of households consume 50-100 litres, 26% consume 100-150 litres, and 7% consume 150-200 litres, with 6% consuming 30-50 litres and 1% falling into other categories. Hence, 50-100 litres is the most common average daily water consumption for households in Osun State.

For Ekiti State, 61% of households consume 50-100 litres, 26% consume 100-150 litres, and 7% consume 150-200 litres, with 6% consuming 30-50 litres and 1% falling into other categories. Therefore, 50-100 litres is the predominant average daily water consumption for households in Ekiti State. According to Table 3, in Lagos State, 61% of households consume 50-100 litres, 6% consume 30-50 litres, and 7% consume 150-200 litres, with 1% falling into other categories. Thus, 50-100 litres is the most common average daily water consumption for households in Lagos State. Overall, the consumption patterns in Table 2 indicate that a significant majority (89%) of respondents consume well above the minimum daily water requirements, typically within the range of 60 to 80 litres per capita per day (lcpd), as estimated by respondents. This level of consumption is sufficient to meet basic hygiene needs according to WHO (2004, 2017), assuming regular water supply.

Figure 5 displays the frequency distribution of average daily water consumption. Human physiological needs typically range from 2 to 10 litres per day, depending on factors like climate and physical activity levels. Approximately 1 litre of water is typically obtained through daily food consumption. The total water consumption per capita per day is influenced by several factors, including water availability, quality, cost, income, family size, cultural practices, living standards, methods of distribution, and climate conditions (WHO/UNICEF JMP, 2019).

Water metering

In the context of water supply in Southwest Nigeria, only a small fraction of respondents (15.2%) indicate that their piped water is metered across the six states. For this minority, tariffs are structured to achieve cost recovery, typically applicable to users consuming around 5 cubic meters per month. However, the vast majority (84.8%) of respondents are unmetered, and their charges are based on average fixed rates, such as ₦1500.00 per month. These unmetered customers often consume closer to 10 cubic meters per month, yet their charges do not adequately cover operation and maintenance (O&M) costs. Official meter coverage figures may overstate actual metering due to several factors, including non-functional meters due to equipment quality issues, intermittent water supply, and deliberate tampering by households (Ncube et al., 2015; JMP, 2017). Consequently, many metered customers end up paying fixed charges rather than based on actual water consumption.

Table 4: Household survey on piped water metering

STATE	Yes (%)	No (%)
OYO	22	78
ONDO	10	90
OGUN	20	80
OSUN	7	88
EKITI	7	88
LAGOS	25	75
Average	**15.16**	**84.84**

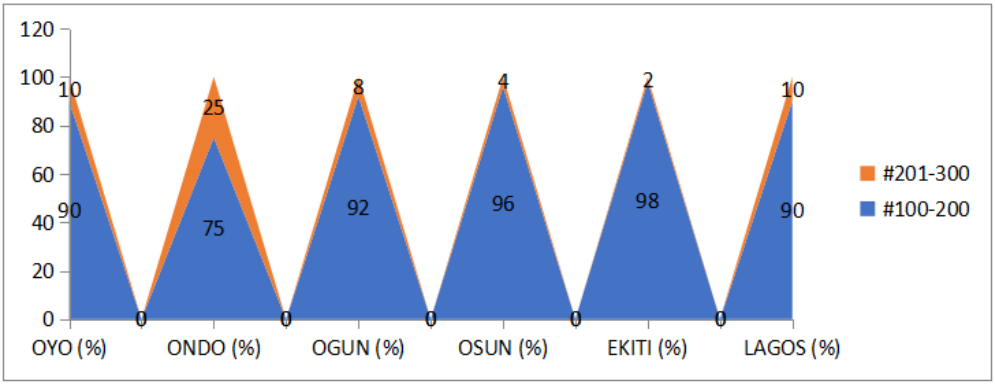

Figure 6: Household survey on water price per cubic metre paid by respondents

Given the limited availability of water in many cities, there is little incentive for customers to conserve water, exacerbated by low tariffs and inadequate metering coverage. The World Health Organization (WHO) suggests that water consumption up to 5% of the family budget is essential for subsistence, typically ranging from 5 to 20 cubic meters per month worldwide. In selected areas of cities like Elega Housing Estate and Ibara Housing Estate in Abeokuta, there has been some success in achieving substantial meter coverage. Similar progress has been observed in notable areas of Lagos, Osogbo, Akure, and Ibadan.

Specifically, in the surveyed states:

a) Oyo State: 33% of respondents have metered piped water, while 67% do not.
b) Ondo State: 10% have metered piped water, while 90% do not.
c) Ogun State: 27% have metered piped water, while 72% do not.
d) Osun State: 7% have metered piped water, while 88% do not.
e) Ekiti State: 7% have metered piped water, while 88% do not.
f) Lagos State: 25% have metered piped water, while 75% do not.

From Table 4, it is evident that less than 35% of the water sold is metered across all six states in Southwest Nigeria. This percentage exceeds the 20% reported by the World Bank in 2015, indicating a limited implementation of reliable commercial systems with monitored meter readings in the urban water supply systems of Southwest Nigeria.

The responses on water price per cubic metre paid by respondents in the study areas in SW Nigeria are presented in Figure 6. To a large extent the proportion of respondents (90.2%) who paid ₦200.00 per cubic metre is significant and the views expressed on intermittent water supply in the study areas cannot be overlooked as they perceived the amount as unfair. Those who paid between ₦200 and ₦300 accounted for 9.8%.

The survey highlights the highest amount paid per cubic meter of water recorded in the six states within the study areas, which is lower than what the International Benchmarking Network (2013) reported for a well-managed utility (Figure 6). Water corporations often do not have the authority to set tariffs or regularly review them; instead, tariffs are typically set by state governments. This situation suggests that without viewing water as an economic good, where customers are charged for the service and receive bills, generating adequate revenue will remain stagnant and low. A significant percentage of customers, including commercial and industrial users in the study area, pay on a monthly basis. Residential customers pay between ₦1250 to ₦1950 per cubic meter, while industrial customers, such as block industries, pay between ₦2250 to ₦3500 per cubic meter, as confirmed by key informants from the Water Corporations.

Based on the present income levels, if tariffs surpass ₦200 per cubic metre, a considerable proportion of the population would be unable to pay water services. However, considering that operational and maintenance

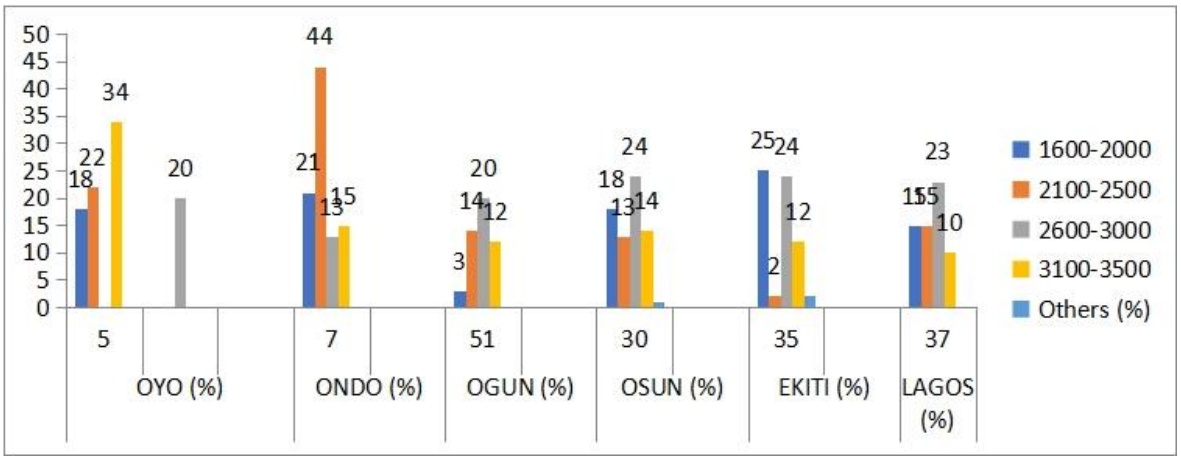

Figure 7: Respondents' perception of water price in SWN

Table 5: Household survey on customers perception of water price

STATE	High (%)	Fair (%)	Low (%)	Other (%)
OYO	6	87	7	-
ONDO	22	67	3	-
OGUN	20	76	4	-
OSUN	12	81	4	3
EKITI	10	81	7	2
LAGOS	30	70	-	-
Average	16.7	77.0	4 .2	0.8

(O&M) costs stand at ₦400 per cubic meter under inefficient management, closing the gap between affordable tariffs and cost recovery tariffs could be possible by enhancing utility performance. Therefore, raising tariffs closer to the O&M cost level and introducing targeting mechanisms could lead to significant improvements in cost recovery performance without severely compromising affordability.

Figure 7 illustrates the coping costs incurred by respondents on a monthly basis for obtaining water from alternative providers, a trend that is particularly notable with water tankers. In Southwest Nigeria, reliance on alternative sources is prevalent in some states, with costs ranging from ₦1,000 to ₦3,500 per cubic meter within the study areas. The perceived high prices for alternative water sources are somewhat offset by the fact that customers typically purchase small volumes, such as 20-liter plastic cans, making each transaction appear affordable despite the relatively high-quality water obtained (Berta *et al*., 2015).
Respondents indicate a willingness to pay these higher costs to alternative providers because they are already paying substantial amounts for water from these sources and for self-provisioning. This suggests that achieving cost recovery for Water Corporations (WCs) is feasible if water service quality is improved.

The survey results reveal that customers perceive water prices as very low for revenue generation, largely due to low consumption caused by erratic electricity supply to state water corporations, impacting water supply in the study areas (Table 5). State water corporations often lack clarity on their own operational and maintenance (O&M) costs and are mandated only to provide annual reports on inputs and their associated costs.

A majority (77%) of respondents perceived current water prices as fair, indicating challenges in achieving cost recovery due to inadequate quality of water supply services relative to consumption costs. The rationale behind water pricing considers the provision of drinking water as an economic activity involving costs at various stages: from water extraction to treatment (where applicable) and distribution to end-users. Pricing water becomes essential to recover these costs from users (Ncube, 2011; Koundouri *et al.*, 2019).

In theoretical terms, pricing based on marginal cost aligns with efficiency in resource allocation compared to traditional accounting approaches that may not guide optimal resource allocation. Prices should reflect how consumers value a product relative to its costs, varying according to consumer valuations and directing resources towards those who value water most. Aligning price with marginal cost can ideally balance production and consumption patterns by discouraging excess consumption and limiting production to necessary levels (Wang *et al*., 2024; Choe *et al*., 2019). However, water pricing is not the sole method to ensure cost recovery for water services. Regulatory instruments, such as connection obligations and environmental charges, are often used to make users pay for the environmental and resource costs associated with water services. These instruments help spread investment costs over a larger customer base and ensure sustainable funding for water infrastructure (Grafton *et al*., 2011; Helm, 2020; Dustin *et al*., 2020). The principle of cost recovery can be aligned with even

Table 6: Household distribution on affordability of payment for water services

STATE	Yes (%)	No (%)
OYO	78	22
ONDO	82	18
OGUN	84	16
OSUN	86	14
EKITI	76	24
LAGOS	85	15
Average	**81.8**	**18.2**

Table 7: Projected Production cost (#Million) for 2012-2022

State/Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Lagos	182.4	398.4	403.2	403.2	398.4	398.4	393.6	393.6	388.8	384	384
Ogun	724.8	643.2	648	652.8	652.8	643.2	643.2	628.8	624	624	624
Ekiti	672	475.2	475.2	470.4	470.4	465.6	465.6	460.8	460.8	451.2	451.2
Ondo	1,521.6	945.6	945.6	940.8	940.8	936	931.2	931.2	926.4	921.6	921.6
Osun	110.4	220.8	220.8	216	211.2	211.2	206.4	206.4.	201.6	201.6	196.8
Oyo	316.8	240	240	235.2	235.2	230.4	225.6	225.6	225.6	220.8	211.8

Table 8: Projected Revenue billed (#Million) for 2012-2022

State/Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Lagos	153.6	148.8	148.8	144	144	139.2	139.2	134.4	134.4	129.6	129.6
Ogun	288	321.6	321.6	316.8	316.8	312	312	302.4	302.4	297.6	297.6
Ekiti	172.8	91.2	91.2	91.2	86.4	86.4	81.6	81.6	76.8	76.8	72.0
Ondo	100.8	96	96	96	86.4	86.4	81.6	81.6	76.8	72.0	67.2
Osun	28.8	52.8	57.6	57.6	67.2	67.2	62.4	62.4	57.6	57.6	52.8
Oyo	979.2	312	312	312	288	288	283.2	283.2	278.4	278.4	268.8

subsidies and public expenditures on water services, particularly when serving the public good, where benefits accrue broadly across communities and households in a jurisdiction (Helm, 2020).

The survey results indicate that 81.8% of respondents in the study areas can afford to pay for water services, while 18.2% express their inability to do so (Table 6). Current water charges in Southwest Nigeria are lower than the World Health Organization's (WHO) benchmark of expenditure, which suggests that water expenses should ideally not exceed 5% of monthly household income for a consumption level of 20 cubic meters per capita. The burden of current water charges generally falls within this notional 5% monthly limit.
To evaluate the affordability of existing water charges, particularly in the context of subsistence consumption ranging from 5 to 20 cubic meters per month, WHO emphasizes the necessity for pro-poor strategies in service delivery. It underscores the importance of reforming these strategies to enhance efficiency and effectiveness in implementation. Ensuring that services are accessible to low-income populations is integral to a viable strategy for both cost recovery and performance enhancement.

Key informants claimed that they embarked on public awareness campaign through radio jingles and TV to reduce unaccounted water loss coupled with prompt attendance to pipe bursts and leakages or water cut. The study shows that the present billing is inadequate resulting to a cost (revenue) recovery ratio of one to four. This observation aligns with estimates by Hutton and Varughese (2016), who indicated an annual requirement of approximately US$5 billion in capital expenditures to operate and maintain Sustainable Development Goals (SDG) facilities. This financial burden is notably higher in sub-Saharan Africa compared to other regions globally, as supported by research by Garrick et al. (2020).

Key informants from WCs indicated that Oyo and Ogun states current production percentage and coverage is between 41-50% while Osun state and Lagos state recorded 31-40% simultaneously. Ondo state and Ekiti state current production percentage and coverage is between 41-50%.

4.4 Revenue billed

In Oyo and Ogun states, the revenue billed by the water corporation is between #260-300/m^3, while Ondo and Osun states recorded values ranging from 100-150/m^3, and this is also applicable to Ekiti and Lagos states where the revenue billed by the water corporation ranged from #100-150/m^3 simultaneously. All the six water corporations reported that they issued bills to customers and collected payments as revenue and that the sources of their income are from customer fees and government funds (subsidies). However, many public institutions such as fire departments, schools, hospitals, and public buildings often delay or fail to pay their water bills. In some cases, these institutions even

receive subsidies or compensation from the government to ensure that water corporations (WCs) can continue to provide water services. Water being an economic good could hardly be sustained on revenue billed and this grossly affects the revenue generation of the WCs.

4.4 Collection rate

Key informants have indicated that the collection rates of Water Corporations in Southwest Nigeria vary widely, ranging from 11% to 50%. This range falls below the findings of a survey conducted by Berta *et al*. (2015) on water supply assessments in the region. The inconsistency in financial policies has contributed to these challenges, where costs and revenues often exceed the capabilities of the Water Corporations (WCs) (Table 8). In Southwest Nigeria, revenue generation efforts rely on direct subsidies to Water Agencies (WAs) and government payments covering their operational costs, including labor and electricity. The low collection rate is primarily attributed to operational limitations within the WCs, which mainly focus on technical operations. Most water supply connections lack meters, with a metering ratio as low as 1%. Additionally, over 80% of piped water users are billed at flat rates, further complicating the collection process, as a majority of users are not accurately recorded in the billing database.

4.5 Performance rate of water supply utility

The key informants' opinion from the WCs in the SW performance rate of water supply utility is average based on the daily water production and distribution even though specific details as quantities are not stated. This is contrary to views expressed by the respondents (customers) within the study area, the performance rate of water supply utility being rated as fair and majorly, in some states as poor. The performance indicators highlight the dire condition of urban water supply in Southwest Nigeria, a situation described as calamitous (Ncube, 2011). Despite the national and regional aspirations to achieve the 2030 Sustainable Development Goals for water and sanitation, the current state falls short, providing only basic water services intermittently. The system is plagued by high rates of non-operational systems and non-revenue water, making it financially and operationally unsustainable (Berta *et al*., 2015). Moreover, the price of water in the region seldom reflects its true value and rarely covers its production costs (Dustin *et al*., 2020).

4.6 Tariff update

Currently, there is no standardized water tariff system in place across the six states of Southwest Nigeria in the study areas, with Water Corporations (WCs) selling a cubic meter of water for as little as ₦150. This rate is exceptionally low compared to private vendors in Lagos State who charge ₦200 for just 20 liters of water. Consequently, some of the poorest families end up paying more per month for water than wealthier families who can afford a connection.

The actual cost of water provision is only 2% of the tariff revenues generated by WCs. Revenue losses are further exacerbated by outdated information systems and inconsistent invoicing practices, which result in collection rates that occasionally fall below 10% of the billed amounts. The lack of metering, coupled with ineffective billing practices, contributes significantly to these financial challenges. WCs struggle with customer billing and fee collection, leading to poor cash flow and an ongoing dependence on government subsidies to cover operating expenses.

Key informants reported that tariff updates in the six states occurred intermittently between 2011 and 2015. Infrequent tariff adjustments have had detrimental effects on the financial stability of water operators, particularly in the face of inflation averaging close to 9% annually, which erodes the real value of existing tariffs over time. Tariffs are often set arbitrarily and vary widely among different customer groups, sometimes by as much as 20%, without clear linkage to the actual costs of service provision. This lack of tariff regulation and the operators' reluctance to adjust tariffs adequately to maintain their value contribute to inconsistent policy implementation and hinder the ability to meet the basic water needs of the population effectively (Berta *et al*., 2015)

5. Conclusion

The study concludes that revenue generation and household water consumption in the six states and subsidies do not meet the foremost important policy objectives except affordability. Also, there is no standardized water tariff system in place across the six states of Southwest Nigeria in the study areas. The actual cost of water provision is only 2% of the tariff revenues generated by WCs. Revenue losses are further exacerbated by outdated information systems and inconsistent invoicing practices, which result in collection rates that occasionally fall below 10% of the billed amounts.

6. Recommendations

From the analysis and conclusion, the study recommended that restructuring tariffs to increase the revenue generation of the WCs and better targeting for subsidies, would strengthen the financial position of water utilities and allow them to provide better service for all.

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