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Effects of water demand management policy on household consumption in Sabon Gari Local Government Area of Kaduna State – Nigeria

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Abstract
The study evaluated how Sabon Gari Local Government Area of Kaduna State's households used water as a result of water demand management policies. Since there are eleven (11) wards in the local government, a household level survey was used for the study. The location and household characteristics, such as household income, education, age, and kind of residence (e.g., single vs. double story), as well as the time required to get water from various water sources, necessitated the usage of this design (filtered and unfiltered). By using a standardized questionnaire, the main data was gathered. Three hundred and thirty (330) respondents were selected using a purposive sampling technique from each of the eleven wards of Kaduna State's Sabon Gari Local Government Area, totaling a total of 330 respondents. There was a selecting process. Data analysis in the study is done using econometric tools like logistic regression. Because it can accept both simple and numerous regression variables, this econometric instrument is worth investigating. According to study results, households have a propensity to use water inefficiently when the cost of water supply is less than the cost, which has an impact on water supply and, as a result, on the quality of the service delivery system. So, among other things, the report suggests: (1) Encourage public-private partnerships to create competition in order to increase the supply of water to consumers; (2) Assure effective policy execution and the fight against corruption on the part of the government, personnel of the water supply board, and final consumers.
Keywords: Consumption, demand management policy, household.

1. Introduction

In many developing economies, managing the water supply has become a growing challenge. Rapid data collection and effective policy responses to problems with water demand will be necessary for strategies to reach the water sanitation targets of the United Nations Sustainable Development Goals (SDG 6) by 2030.As cities continue to develop in population, trends show that there are still problems with water quality and distribution equity. For efficient water distribution to metropolitan areas, which is crucial for socioeconomic growth, comprehensive water management policies must now be developed and put into practice. According to Ahamad, Mirza, Ali, and Lotia (2016), the availability of clean water enhances public health by avoiding water-borne illnesses and conserving natural and financial capital resources. For cost justification, policymakers require suggestions that are supported by evidence. Choices for effective supply that will provide a sufficient water supply for the expanding metropolitan population. To effectively manage the water supply in developing economies and meet the rising demand for water from growing populations, it is desirable to identify and assess which pricing or non-pricing policies are beneficial, and to what extent.

Urban inefficiency in the use of water, especially in Sabon Gari Local Government Area of Kaduna State, is a major issue in

developing nations like Nigeria. Finding inefficiencies in water use and supply as well as other related environmental and health issues can aid in influencing policy and decision-making for effective water supply to urban households. Additionally, according to best practices for international development, it is the responsibility of the state or local authority to provide inhabitants with access to safe drinking water (UNESCO, 2014). Water pricing is a crucial economic tool that aids in demand management strategies to conserve water resources and utilize them effectively. It also supports enhanced infrastructure development (through more revenue).

Findings on the demand and income elasticity of water in developing economies are diverse, and these findings have a variety of significant policy ramifications for the organizations in charge of managing the water resources in these nations. But according to research, there could soon be a global water crisis, which has shifted planners' focus. They assume that as the world's population and wealth rise, there will be an increasing demand for water for irrigation, industry, hydropower, and domestic use while freshwater supplies around the world stay stable. This leads them to foresee widespread water shortages. The potential for a water catastrophe has forced water managers to find practical solutions to meet future demands without endangering the long-term viability of existing water resource systems. Dziegielewski (2003). (2003). A lot of water industry experts concur the idea that a greater knowledge and careful management of water demand is essential to our ability to meet the demands of a growing population and economic development without compromising the ecosystems and natural settings that support water resources systems.

Water demand management goals are undermined by regulatory regimes in many nations. Because financial investments for water conservation measures are not permitted to be counted as capital expenditures on which the utility is guaranteed a rate of return on investment (Howarth, 1999), as cited in Dziegielewski, the recently privatized water utilities in England and Wales lack a direct economic incentive to reduce demands (2003).Conducting case studies to look at how the water industry has responded to previous policy adjustments is a crucial task for the scientific community.

A water resource management plan, which is mandated by law, must outline how water companies aim to balance supply and demand over the next 25 years. Water companies are responsible for designing and maintaining an efficient and economical system for supplying secure water supplies to users. The businesses must list every option that is open to them and demonstrate how they choose which possibilities to pursue. The public water supply infrastructure planning system received positive feedback from the Committee on Climate Change in its 2019 report to Parliament, which noted that the water resource management plans outline how water companies have committed to more ambitious targets and considered options for new water supply infrastructure. Water companies forecast what in their plans According to these projections, supply would begin to fall short of total demand in 2034–2035. (National Audit office 2020).

Many Mediterranean nations are already experiencing a water crisis, which threatens both their peoples' welfare and the countries' ability to thrive economically. We all worry that the issues will worsen. There are several thumbscrews turning on these limited and fragile fresh water resources. Strong driving forces include urbanization and population increase, industrialization and tourism, globalization, and climate unpredictability and change, which is leading to less precipitation and more frequent droughts. Countries have started changing their water sectors in

response to these problems and in line with a global push toward more integrated water resources management. Water management practices and attitudes are gradually changing. According to experience, addressing the issue of water scarcity necessitates a supply management plan that involves extremely selective development and the use of new water resources, both conventional and non-conventional, in conjunction with a fervent demand management strategy that includes thorough reforms and steps to maximize the use of current resources Depending on each country's level of development, governance system, and amount of water shortage, different supply and demand management strategies may be more or less appropriate. The benefits of and necessity for effective demand control, however, both considerably increase as economies develop and water's value rises (Global Water Partnership, 2012). It is likely that half of the population of Kaduna State lives in cities, and this trend of urbanization is accelerating. Urbanization in the nation is posing various problems and putting increasing pressure on the infrastructure and public services already in place, particularly the management of water demand and supply. The circumstances change. The growth of slums, which are informal, unplanned, and underserved settlements, and the ensuing congestion of cities, make the situation even more complicated. One of the main policy concerns for decision-makers now is how to manage and provide water to expanding cities. The study evaluates Kaduna State's water management policies and resource allocation through an analysis of pricing structures. Its rapid urbanization makes The State one of the nation's fastest-growing big cities and a growth engine for the whole economy. In this rapidly developing city, access to high-quality water is a major issue.

Statement of the Problem

Today, a big issue in our neighborhood is the lack of proper water supply. Because of this, there is an unusual lack of water in almost all societies, and Sabon Gari LGA in Kaduna State is no exception. Due to the inadequate water supply in the study region, dry water pipes, pipes leaks, and pipes exposure to sewage lines result in contaminated and unfit for drinking water, leading to ailments such diarrhea, dehydration, food poisoning, and cholera, especially during the dry season. Since different family groups employ a variety of sources to meet their water demands, analyzing the demand for water in developing economies is complicated and calls for rigorous examination in order to draw the proper conclusions for policy decisions. Price estimation that is precise and accurate and income elasticities would provide policy makers with information on how and to what degree these data can be used to create workable water-demand management plans. As a result, the study aims to assess how household water usage in Kaduna State's Sabon Gari LGA is affected by water demand management strategy. To address the problems in this study, the following research question was posed: How much does the study area's water demand management policy affect how much water is used by households there? The following was the generation of a null hypothesis for the study: In the Sabon Gari LGA of Kaduna State, there is no substantial or favourable correlation between the water demand management strategy and household water use.

2. Review of Empirical Literature

Household size and residential water demand: an empirical method by Arbue, Villanu, and Barbera'n (2009). The study makes use of a panel of individual data from a randomly selected sample of 1507 homes that are connected to the public water network in Zaragoza. The sample includes the following data: Using data at

the individual level, the study used empirical estimation of urban water demand in Zaragoza, Spain, to distinguish between homes of different sizes. The study used metered consumption of houses (10-time observations spanning the years 1996 to 1998). The outcome showed that the price elasticity of consumption affects how effective pricing regimes are. The report contends that regardless of size, all households are price sensitive. Small households are more susceptible to price changes, which is a more pertinent finding. Grafton, Kompas, and colleagues Examine home water use: A cross-country analysis, according to Hang To and Ward (2009). To simulate household water use, the study employed survey data from 10 OECD (Organisation for Economic Co-operation and Development) nations. Statistically significant findings include: (1) an inelastic average price response is estimated for every nation; (2) households not charged volumetrically consume more water than households that are; (3) household size, residence size, higher education, full-time employment, and household income increase water consumption; and (4) attitudes do not affect consumption statistically significantly but increase the likelihood of engaging in water conservation. Marginal chance of undertaking water was also advised by the study. Does a household pay a volumetric water fee? If so, saving practices may be encouraged. The paper goes on to say that if families were charged a volumetric fee for their water usage, water demand management programs such as those that encourage the use of dual-flush toilets and campaigns to encourage the use of water-saving behaviors and equipment would be more successful.

Examine water demand and the urban poor: examination of the elements that affect water use, in the words of Jansen & Schulz (2006) Using information gathered from families in the Western Cape Province of South Africa's Cape Flats, the study also attempted to provide an estimate for the price elasticity of water use. The information spans up to 60 months, from July 1998 to June 2003.Data on water use was gathered from the local authority, the City of Cape Town (CCT), and a survey study conducted in five nearby areas. The price of water is one of many variables that affect water use, as shown by a panel data analysis (adjusted for heteroscedasticity and serial correlation).The findings show that The data show that while the richest group of families react to price changes substantially more, the poor are less responsive to changes in prices in their consumption. As a result, they apply a 2SLS analysis to their model because the study's findings also demonstrate that using actual prices in the estimation does not address the simultaneity in the data. The findings show that short-term water demand is negatively elastomeric to price. The study also shows that the lowest income group's price elasticity for water demand is only -0.23, while the highest income groups is -0.99.Their findings might increase our understanding of how to enhance an IBT structure to promote better equity. According to research done by Kenney, Goemans, Klein, Lowrey, and Reidy in 2008a study on home water demand control. According to their findings, socioeconomic and meteorological factors as well as prices affect water demand differently from each other. In order to decrease waste and enhance water savings in either strategy, they also advise that price and outside policies on water use restrictions interact with one another.

A number of minute but practically significant uncertainties are nested inside the literature evaluation on price elasticity. The most important of them is the idea that a lot of people don't comprehend their water bill and tariff structure well enough to know which pricing signals customers actually pay attention to. In the present day, an increasing number of customers worldwide

must deal with an IBR system, which means that as their level of use takes them into and through pricing levels intended to discourage excessive use, water becomes progressively more expensive (Western Resource Advocates, 2003).This strategy's foundation is the idea that consumers react to marginal prices, or the price of the most recent unit purchased; nevertheless, there is reason to believe that this perspective is Customers rarely have anything resembling real-time information about their current level of consumption, making it difficult for customers to understand their rate structure (Foster and Beattie, 1979; Arbue's et al., 2003; Carter and Milon, 2005), as cited in Kenney, Goemans, Klein, Lowrey, and Reidy (2008).Olmstead et al. (2003) pointed up a further difficulty, demonstrating that a growing block structure alone can diminish demand without regard to price change. The observation that price elasticity can differ greatly among seasons, applications, areas, and diverse social and economic contexts, as well as the existence of alternative demand management measures, leads to yet more difficulties in measuring and applying pricing elasticities. Block rate pricing The connection between price and consumption is unusually intricate since pricing (either average or marginal) not only affects consumption, but also how much consuming is done, which in turn affects price.

Three broad categories—public education, technology advancements, and water restrictions—can be used to classify the variety of non-price solutions for managing water demand. Most water demand studies, like this one, don't provide much quantitative analysis on this variable because it's difficult to (1) distinguish between the effects of educational initiatives and those of other pricing and non-price initiatives, (2) distinguish between the nearly infinite variety of educational initiatives, and (3) determine the long-term contribution of public education to the development of a conservation ethic.

3. Methodology

The research used a household-level survey. The location and household characteristics, which could include household income, education, age, kind of residence (e.g., single vs. double story), and time to fetch water from various water sources, were factors that made this design necessary (filtered and unfiltered).

Population of the Study

All sorts of people that are involved in the water sector in Kaduna State's Sabon Gari LGA make up the population of this study. The Local Government was divided into eleven (11) wards, from which thirty (30) respondents were purposefully selected, totaling three hundred and thirty (330) respondents in total.

Sample and Sampling Techniques

Following the procedures outlined in the table below, a purposive sample of thirty (30) respondents was chosen at random from each of the eleven wards of Kaduna State's Sabon Gari Local Government Area.

Table 1: Sample Size

S/n	Names of Wards	Sampled Responds
1	Samaru Ward	30
2	Jama'a Ward	30
3	Bassawa Ward	30
4	Hanwa Ward	30
5	Dogarawa Ward	30
6	Chikaji Ward	30
7	Muchia Ward	30

S/n	Names of Wards	Sampled Responds
8	Zabbi Ward	30
9	Jushi Ward	30
10	AngwanGabas Ward	30
11	Bomo Ward	30
	Total	**330**

Source: Field Survey 2022

Models/Analytical Techniques

Logit Model

Logit regression was used to accomplish the study's goal. Based on the response variable, the likelihood of implementing the water pricing policy will be affected. Multivariate logit regression is used to define the foundation of the response variable Y* in the situation of binary choice.

$Y^*=\sum X, \beta j + \mu$

Where:

Bj = β1, β2, β3, β4, β5, and μ

Xi = X1, X2, X3, X4, X5,

Where:

Y* = Household Water Consumption

X1 = Full cost of pricing of water

X2 = Public (administrative) water pricing

X3 = Increasing and decreasing blocks tariffs

X 4= Two – Part pricing Tariffs

X5 = Effects pricing policy

μ = Random error

βi = The coefficient for the respective variables in the logit function

Result Presentation and Analysis

The implications of the respondents' households' water use on the water demand management policy are examined in this section. Three hundred and eleven (311) of the 330 questionnaires that were sent were completed and returned.

4. Results and Discussion

Table 2: Binary Logit Analysis of Water demand management Policy on Household Water consumption

Variables	Coefficient	Std. Error	Z-Statistics	Prob.
C	-3.338511	0.757283	-4.408536	0.0000
PWP	0.802171	0.818622	0.979904	0.0271
FCPW	0.278827	0.671470	0.415248	0.6780
TPPT	2.337887	0.682892	3.423510	0.0006
IDBT	1.700977	0.790874	2.150757	0.0315
EPP	3.862556	0.682375	5.660462	0.0000

McFadden R-squared 0.653495

Prob (LR statistic)0.000000

An assessment of the relative changes in probabilities can be made by interpreting the coefficients' results. The Public Water Price (PWP) policy coefficient demonstrates a substantial correlation between household water use and public water pricing at the 5% level of significance. Having a probability value of 0.0271, which is less than 0.05.The chance that government policies on water pricing in a third-world country are reasonable, fairly distributed, and assess the worth of water to its populace is shown by the coefficient of 0.802171.Through this method, a third-world country's government has been able to advance equity, which does not take demand and supply into account.

The coefficient on the full cost pricing of water policy (FCPW) demonstrates a negligible association between household water use and the full cost of pricing at 5% significant level. As 0.6780 has a probability greater than 0.05, we accept the Ho and its conclusion that there is no correlation between home water use and full cost pricing of water. These can be attributed to the fact that households have a propensity to use water insufficiently where the cost of water supply is less than the price, which negatively affects water supply and, as a result, results in a subpar service delivery system.

The Two-Part Pricing Tariffs (TPPT) Policy Coefficient indicates a Positive Relationship Between the5% level of significance study on household water uses and two-part pricing tariff. We accept the H1 and get to the conclusion that there is a substantial correlation between home water use and the two-part pricing tariffs policy according to the probability of 0.0006, which is less than 0.05. These may be attributed to the fact that the policy has a stable revenue base, protecting supply from demand swings and lowering supplier risks, which in turn offers a steady stream of income to pay overhead costs. On the other hand, the policy charges each customer in accordance with the amount of water he uses, which promotes water efficiency.

A significant correlation between household water use and the policy on increasing and reducing block tariffs is shown by the coefficient of the policy on increasing and lowering block tariffs (IDBT) at the 5% significance level less than 0.05 and with a probability value of 0.0315. As a result, we accept H1 and draw the conclusion that there is a considerable connection between home water use and rising and falling block tariffs. These could imply that the policy is based on basic necessities and equity considerations. Because the strategy is based on the concepts of marginal and average cost pricing, economic efficiency is also a factor. The program is designed to lower prices in relatively impoverished areas so that they can afford to provide water for basic requirements, however a sizable fraction of households may not be able to afford this. Above this threshold, the household is required to pay an escalating per-unit cost.

At the 5% level of significance, the policy on effect of pricing (EPP) and household water use are positively and significantly correlated, according to the coefficient of the EPP. It is less than 0.05 and has a probability value of 0.0000.Due to the p-value of 0.0000, we accept H1 and draw the conclusion that there is a strong correlation between home water use and the pricing strategy (EPP).This might mean that the balance between the goals that are crucial to the community is achieved by the policy, which would be ideal. Consumers demand high-quality water at reasonable and consistent pricing, while suppliers prefer to cover all costs and have a steady source of income. You can determine this by looking at the water fees and anticipate the increase profit, welfare, and equity.

The likelihood ratio is implied by the McFadden R-squared i.e is comparable to the data presented in linear regression models. It has the qualities of being halfway between 0 and 1. The reported McFadden R-squared value in this case is 0.653495. The McFadden R-squared score implies that the collection of independent variables in the model together account for 65 percent of the variation of the dependent variable. The model is best-fit for forecasting as seen by the 65 percent variation. The McFadden R-squared and the significance of the coefficient of the features of household water consumption support the rejection of the null hypothesis, which claims that water demand management policy in Kaduna state's Sabon Gari LGA has no appreciable impact on household water consumption.

Discussion of Findings

The data from the field provided helpful insights regarding the impacts of water demand management policies on household consumption in Kaduna state's Sabon Gari LGA. The totality of the variables suggests that water demand management policies have an effect on household water use in the area under examination. This may be explained by the fact that many government policies on water pricing in third-world countries are affordable, evenly distributed, and assess the worth of water among its populace. Through this method, a third-world country's government has been able to advance equity, which does not take demand and supply into account. This assertion is consistent with Dziegielewski's results from 2003, who predicted that there would be a severe water shortage due to global expectations. Population expansion and rising wealth will result in rising water demands for irrigation, industry, hydropower, and domestic supply, but freshwater supplies globally remain constant. The potential for a water catastrophe has forced water managers to look for efficient solutions to meet future demands without endangering the long-term viability of existing water resource systems.

The results also show that rules were made in order to achieve a suitable balance between the dominant community goals. While producers prefer to pay all costs and have a fixed income, consumers are rational in how they choose the quality of their items, how prices fluctuate, and how much they can afford. Revenue is produced as a result, and welfare and equity are also improved. This is consistent with research by Arbue, Villanu, and Barbera (2009), which found that the success of pricing regulations depended on the price elasticity of consumption. All homes, regardless of size, appear to be price sensitive, according to their data. Small households were found to be more susceptible to price increases, according to their study's findings.

As a result of the policy's foundation in the principles of marginal and average cost pricing, the study also reveals elements of economic efficiency. Although a sizable part of households might not have access to private metered connections, the program is designed to cut prices in relatively impoverished areas below cost to cover the provision of water for essential needs. If the household consumes more than this amount, each extra unit of consumption costs more. This is consistent with the findings of Kenney, Goemans, Klein, Lowrey, and Reidy (2008), who found that the demand function for water is affected by pricing as well as outside policy on the limits of the use of water. Together in order to enhance water savings in either policy and decrease waste.

5. Conclusion and Recommendations

Ensure that policies are implemented effectively and combat corruption among the government, water supply board employees, water customers, and the general public. The actions of the Water Boards, particularly its management, should be under government scrutiny. This can be accomplished by passing unambiguous legislation that directs how the water boards should operate. This is because the Water Boards' personnel frequently complain about the management board, poor management, and disregard for employee incentives.

Incentives should be provided for public-private partnerships. In order to prevent exploitation and unfavorable competition, this should be closely watched as it may lead to competition to increase supply.

People's attitudes about water use should change, and they should pay their water bills on time and understand the worth of water in order to prevent waste. Public education and the use of local leaders can accomplish this. The government ought to invest more resources to supplying water. In order to facilitate and improve water delivery, it should be proactive and offer

the necessary infrastructure and environment.

Water should be properly treated before being supplied in order to guarantee high-quality water. This will aid in lowering the rate at which cholera, diarrhea, and other water-borne diseases spread. increasing the capacity of the current water supply dams and building new ones. Since the expected demand for the entire state is 751 mld, the capacity of the current water works, which is 209 mld, is insufficient.

In order to reduce illicit connections, there should be frequent monitoring and evaluation as well as encouragement of public education on water conservation. This has the potential to significantly alter how people feel about paying their water bills and promote water usage efficiency. In order to make sure that equity and welfare are taken into account, the government should enhance financing and determine an appropriate water price that may generate the Water Board enough revenue/funds.

It is important to have a sufficient number of motivated employees, maintain a high standard of care, and have adequate facilities and equipment available. Without a doubt, this will help the industry operate better.

To prevent wastage and loss of water from the distribution network, exercise equipment should be replaced, damages should be repaired, and old pipes should be replaced. Due to this issue, a significant portion of the total water supply is lost during distribution. Providing power plants to adequately power the pump station and reviewing personnel compensation to increase productivity and efficiency will help to ensure a consistent supply of electricity. The entire system needs to be reorganized in terms of both human and material resources, and control measures should be put in place to reduce theft and vandalism. Water usage ought to be metered so that customers only pay for what they really use. This can be used to monitor how individuals utilize water.

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