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An Empirical Assessment of Sustainability of an Urban Water Supply Service Delivery

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Abstract**—**Urban population is rapidly increasing in Ilorin, (the capital of Kwara State of Nigeria) along with related increased water demand. The inadequacies of water supply services have forced the populace to depend on dug wells, boreholes, water tankers, street vendors etc. for their water needs. People spend hours daily carrying jerry can all around to collect and queue for water at the public water tap with high opportunity cost both in time and economic wastage. This situation motivated this study to assess the sustainability of an urban water supply services to unravel the factors undermining the effective delivery of services. Contingent Valuation Method was used to place value on water supply services using the Double Bounded Dichotomous Choice format for willingness to pay elicitation. A database was created with Microsoft Excel and Stata 12 Software to model and evaluate the variables that affect household willingness to pay. The results of the study reveal that about 92% of the total households surveyed were connected to the Government water supply out of which 87% reported that they were not satisfied with the existing services. The results furthered revealed that respondents are willing to pay ₦2500 monthly to enjoy sustainable water supply service delivery.

Keywords**—**Willingness-to-pay, contingent valuation method, Nigeria, service, delivery.

I. Introduction

THE provision of potable water supply to a host of African countries' citizens have remained daunting for decades. African countries also face lack of investment capital for expanding the existing water systems. The rapid expansions of cities create urban areas that do not have regular water supply or adequate water distribution system [1]. Many African countries especially Nigeria are in depressed economy which is manifested in low incomes and poor living conditions of their citizenry. This also limits the ability of their governments to have adequate funds for water supply sector. Privatization has been promoted as a solution to the current dire state of water supply; evidence shows, however, that this is not a panacea, especially where expectation of African government and the private sector incentives do not align. In general, water supply in these countries is undertaken by government parastatals with contradicting objectives of providing a social service while generating revenue to offset cost. That is a case of game keepers and poachers simultaneously. Hence this study is concerned with evaluating the sustainability of urban water supply service delivery in Ilorin metropolis. The result of the study will contribute to the attainment of sustainable water supply service delivery and policy on water supply improvement strategies.

The idea of Contingent Valuation Method (CVM) was first suggested by Ciriacy-Wantrup in 1947 and the first study ever conducted was in 1961 by Davis [2]. Considerable studies have established the CVM as a good and reliable technique for estimating willingness to pay (WTP) values for public decisions [3]. According to [4], [25], over 5000 contingent valuation studies were carried out in over 100 countries. Such studies included family medicine [5]; solid waste management [6], [7]; water supply [8]-[10]; environmental quality [11]; genetic testing [12], [13]; food nutrition [14] and academic libraries service [15]. For water supply, it is the maximum amount an individual who incur averting expenditure from poor level of service would pay to alleviate this and enjoy the benefit of the service. The major attraction of the CVM is its ability to address a broad range of policy interventions and to account for nonuse values [10]. This is the values that are not related to usage such as existence value, religious and cultural values, and bequest value.

II. Methodological Framework

The methodological approach comprises of both field and desk study. Preliminary work conducted involved review of literature and development of data collection techniques before the commencement of field work. Reconnaissance survey was done to collect basic information of the study area and discuss with the beneficiaries and key personality involved in the city water supply.

A. The Study Area

Ilorin is located on Latitude 83° North and Longitude 435° East of the Greenwich Meridian. It is occupying an area of about 100 km^2, situated in the transition zone between the deciduous woodland of the South and the savannah of the North of Nigeria, thus giving it a status of "Gate way City" in Nigeria [16]. Ilorin is a major Nigeria indigenous city which evolved through a period of traditional urbanization which took place in some part of West Africa. It has pass through three stages pre-colonial, colonial and post-colonial eras [17]. Both the Government Reservation Area (GRA) and Tanke chosen for this study fall within Ilorin south local government of Kwara State (Fig. 1). Ilorin metropolis has the tropical wet-dry climate; days are very hot during the dry season from November to January while temperatures typically range from 33 °C to 37 °C. The daily range of temperature in the raining season is between

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25 °C and 30 °C. There is a temporal and spatial variability in rainfall with the mean annual rainfall estimated at 1,318 mm. It normally starts in April and ends in October; however, the rainfall intensity, frequency and amount vary from month to month [18].

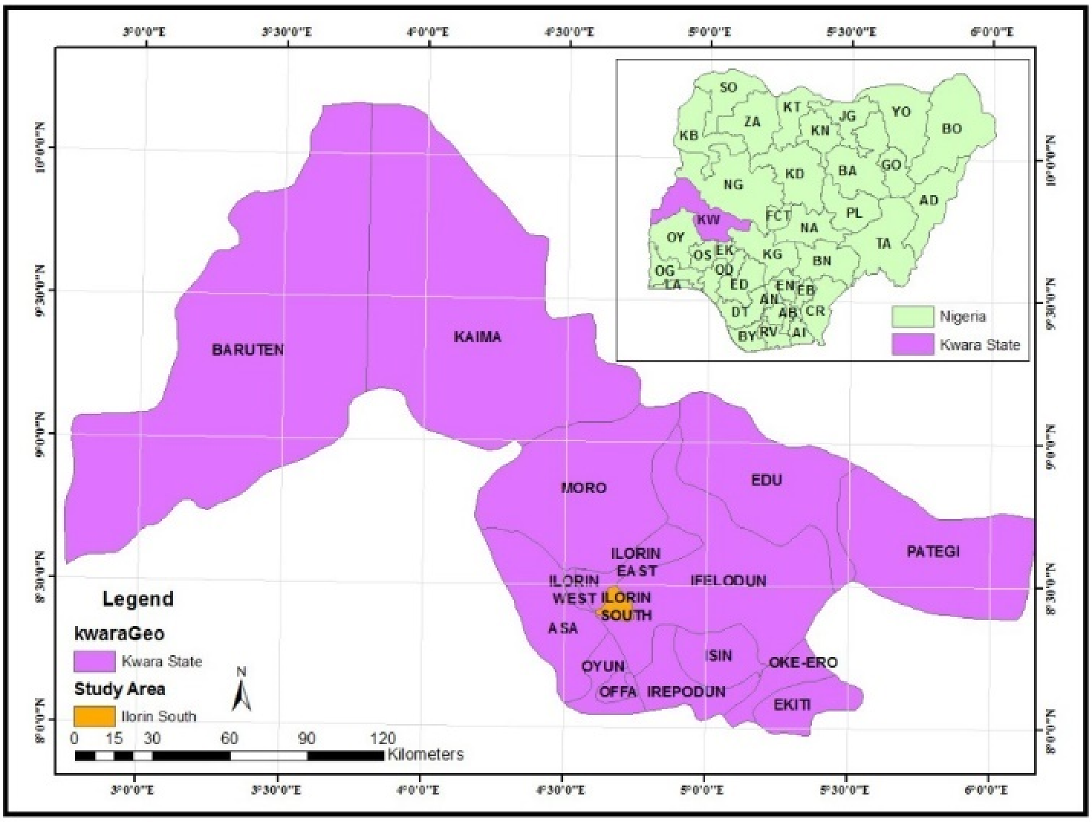

Fig. 1 Map of Nigeria showing Kwara State and Local Government of the study area

B. Theoretical Framework

An individual WTP for improvement in water supply service delivery can be expressed mathematically in (1):

$$V(y - WTP, p, q_1; z) = V(y, p, q_o; z) \quad (1)$$

where V = indirect utility function; y = income; p = vector of price faced by individual; z = set of socio-economic and demographic characteristics; q = quality of water supply service delivery which varies from q_o and q_1

In (1), the random utility function V depends on respondent's characteristics which include the trade-off that the respondents are prepared to make between income y and the quality of water supply. Consequently, this equation is further expressed (2) as a function of quality of water supply (q), respondent's income (y), vector of price (p) faced by respondents and finally set of respondents socio-economic and demographic characteristics (z):

$$WTP = f(q, y, p, z) \quad (2)$$

The Double Bounded Dichotomous Choice (DBDC) format for elicitation of willingness-to-pay was used in the CVM, in which the respondents were presented with two bids. Through this technique, four categories of response were derived thus: (Yes, Yes), (Yes, No), (No, Yes), (No, No), and yield the log likelihood function since the distribution of respondents WTP using contingent valuation estimate is not a normal distribution but a random utility variable and not subjected to direct observation. The follow up question stand to place upper and lower bounds of the true willingness to pay as expressed in (3) [19]:

$$\log L = \log[(WTP^H; \theta) - F(WTP^L; \theta)] \quad (3)$$

where WTPH and WTPL = Upper and Lower bound of the interval around WTP.

The households mean willingness to pay (WTP) is the variables of interest that are calculated from the CVM which was done by fitting special statistical models of the respondent's WTP. However before fitting the desired statistical models, a basic check was performed on the data collected with the structured questionnaire. This is to check if any respondents reported WTP figures in excess of 5% of their household's income which may unduly influence the WTP estimate. The purpose of using these two empirical statistical models is to predict the household mean WTP from the distribution based on the CVM responses. However, these two models have different functional forms but give similar results. The two models permit one to undertake a number of validity tests and consequently add credibility to the respondent's WTP estimates. The Contingent Valuation survey response provides direct answers to question related to household demand for sustainable water supply service delivery and the benefit derived from the water utility [20]. The mean WTP is given thus:

$$E(WTP) = \frac{(\ln(1+\exp(\alpha))}{/\beta_i/} \quad (4)$$

where α is the product of coefficient and mean values of all independent variables excluding the bid coefficient. βi is the absolute value of the bid coefficient. α and βi are the two variables of interest that would be estimated from the two statistical model by regressing dependent variable ("yes" or "no" response) on initial bid value while other explanatory variables held constant. Then, these estimated coefficients will be replaced in (4) to calculate the mean WTP value. Stata 12 software was adopted for this study to estimate and model the variables affecting household water use pattern and their WTP for improved water supply service delivery.

C. Nature and Source of Data

A household structured questionnaire was designed to collect data on household water use patterns and their WTP for improved service delivery. The questionnaire was the main quantitative data collection instrument used for the study because it states the problem of the study and sets terms clearly and precisely. This involves administering a set of formal questions to the respondents in the area. The questionnaire was first piloted to 15 households so as to remove all source of error, bias and to erase ambiguities. After the pilot test, a standard questionnaire was finalized and about 500 were administered to all the selected households out of which 457 were considered viable for the analysis. The study also used secondary data obtained from Kwara State Water Corporation in other to ascertain the tariff charges on each household. The household questionnaire sought to assess perception of the respondents with regards to the level of sustainability of service delivery, primary source of water and alternate sources, respondent's WTP, education status, quality of service delivered, impact of set of tariffs on service delivered to them, the contributing factors of high- or low-income level, impact of water price on households' WTP.

D. Data Analysis

CVM was used to place value on water supply services using the DBDC's WTP elicitation method. A database was created using Microsoft Excel and Stata 12 Software files where the questions were entered with respondent's responses coded with binary variable (1 and 0). Data from the questionnaires were entered in Microsoft Excel and later transferred to Stata 12 worksheet. Prior to the analysis, data were scrutinized for error in the data entering and later analyzed using the Probit, Logit and Ordinary Least Square models (empirical models) subroutine on Stata 12 Software package. Data were explored for statistical relationships at 10% and 5% level of significance to ascertain the effect of the independent variables on the household WTP and Pseudo R^2 was evaluated to explain the percentage variability in the dependent variable (WTP). Stata 12 software has excellent subroutine for analyzing Probit, Logistic and Ordinary Least square models. The choice of the empirical models was made based on the collected data and the aim of the study. PROG LOGISTIC was used for the Logistic regression model, PROG PROBIT was used for the Probit model and PROG OLS was used to perform Ordinary Least Square regression model.

III. Results and Discussion

A. Socio-Economic Situational Appraisal

The socio-economic characteristics of the study are captured from the surveys (Fig. 2); the average household size are 7 people. The respondents were middle class with 16.8% earning less than ₦50,000 per month, 31.3% earn between ₦50,000 and ₦100,000 per month while 51.9% earn more than ₦100,000 monthly. Analysis shows that about 66.3% of the respondents had a higher education, 25.4% had a secondary education, 7% had a primary education and 1.31% are without formal education. Considering the respondents' occupation, about 50% owned their businesses, 47% were civil servants while 3% were farmers. The dominant household type is block of flat with a percentage of 57.8% followed by bungalow, duplex and multi-tenant apartments.

B. Service Delivery Assessment

92% of the households surveyed were connected to the state water supply out of which 87% were not satisfied with the service delivery. The average number of hours' individual household received water from the piped system daily was 9 but intermittent supply. It was also found that only 56% of those that were connected received water 3 days per week. All respondents reported that their primary source of water was from state utility while for secondary sources; 71% depended on dug well, 15% on the borehole, 12% on water vendor, and 2% on bottled water. In addition, 96% of the surveyed households possess storage facilities inside their dwellings due to the fluctuating nature of water supply services. Consequently, 61% uses overhead tank, 32% uses jerry cans, 3% uses bucket while the remaining 6% utilizes other available water storage facilities such as plastic or metallic drums.

The study shows that most of the respondents were not satisfied with the quality of water supply due to the fact that a precautionary measure was always taken before the water is consumed. 44% of the households filters their water before consumption, 22% adopts boiling, 13% uses alum while the remaining 21% does not treat their water before consumption. As a result of the quality concern and unsustainable service delivery, more than 92% of the households spends substantial amount of their monthly income to purchase at least a bag of sachet water common in the area daily. About 98% of the respondents reported that they were willing to pay in order to contribute to the operation and maintenance costs of water supply service delivery and were even ready to pay higher tariff to facilitate sustainable water supply services irrespective of their monthly income. The general performance assessment is shown in Fig. 3.

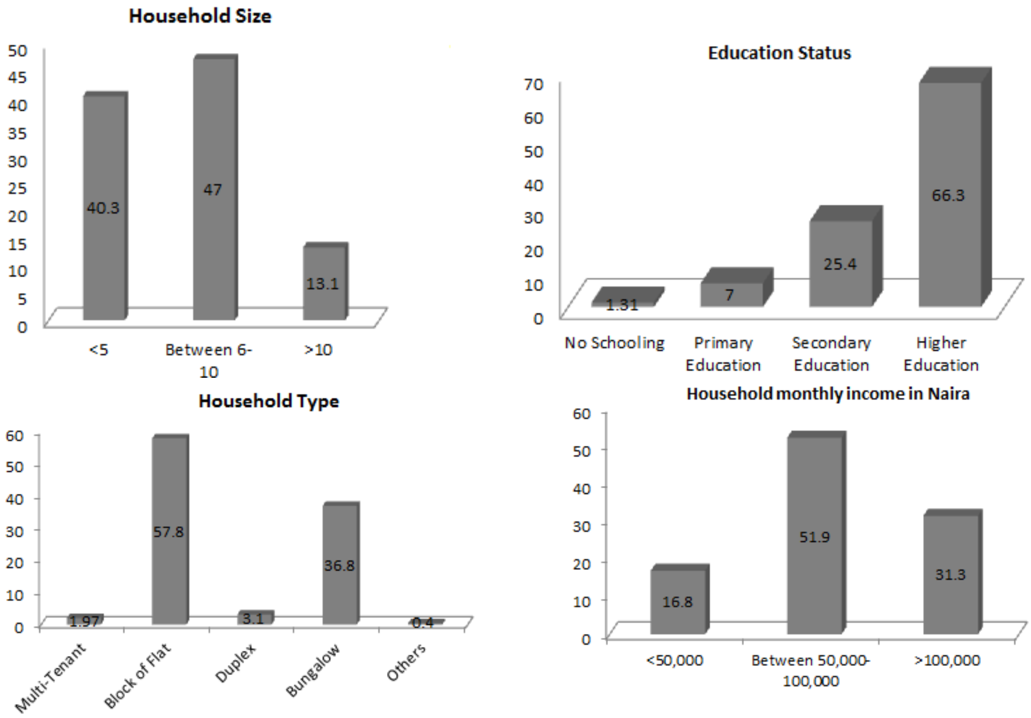

Fig. 2 Socio-Economic Characteristics

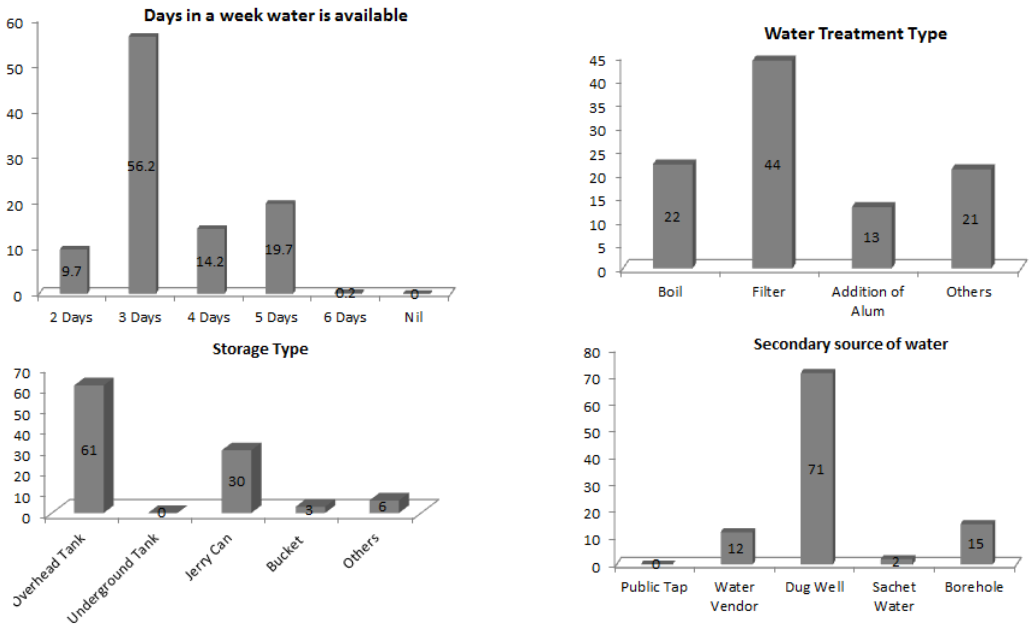

Fig. 3 Level of service delivery

C. Evaluation of WTP for Sustainable Water Supply Service Delivery

The sample household is either willing or not willing to pay the initial bid value offer for improved urban water supply services. Consequently, the variable WTP for improved urban water supply services was used as a binary dependent variable taking value 1 indicating the respondent's WTP to enjoy sustainable water supply services and 0 otherwise. The parameter estimates for WTP model are stated as:

$$WTP = F(a,b,c,d,e,f,g,h,I,j,k,l,m,n,o,p,q,r,s,t)$$

where F is a binary Logit or Probit function, a = Household Head, b = Years of stay, c = Gender, d = Education, e = Occupation, f = Household type, g = Household size, h =

Tenurial state of the house, i = Income, j = Source of water, k = Do you get water at all, l = Satisfaction with the quantity of water supplied, m = Hours per day respondents received water from the piped, n = Days per week respondents received water from the piped, o = Respondent's perception on water quality supplied, p = How do you treat water, q = Storage type, r = Number of sachet water buy daily, s = water adequacy.

The model was estimated using 18 identified explanatory variables. The variables considered and evaluated are presented in Table I. However, before analysis 12 of these explanatory variables were first fitted to the ordinary least square (OLS) regression model to observe the explanatory power of the two models. It is instructive to note that statistically for any empirical model to be predicted, it must first fit the OLS model in order to observe the behavior or association of the corresponding coefficients. The estimates of the Logistic regression model results are presented in Table II. Among the 18 explanatory variables, 12 variables were found to have significant impact on respondent's WTP for improved water supply services at 5% probability level while 4 variables were significant at 10% probability level and the other 2 variables are not significant. Household head, gender, education, household size, household type, tenurial state, quality of water supplied, number of days weekly respondents received water, storage type, number of sachet water purchased, whether respondents get the total water needed for their household upkeep, and secondary source of water are all significant at 5% probability level while years of stay, occupation, income, and satisfaction are found to be significant at 10% probability level.

For the Probit model analysis, two variables (Wsource and Gwater) could not be regressed because they were omitted in the analysis due to their collinearity with the model. Consequently, the Probit Log-likelihood was also used to observe the significance of all the independent variables in the model and predict the respondent's WTP for improved services. Thus, household head, gender, household size, tenurial state, number of hours daily water received, number of hours weekly water received, water quality, water treatment, storage type, number of sachet water purchased by respondents and secondary source of water are found to be significant at 5% probability level while years of stay, education, occupation, household type, income, satisfaction and the total water needed by respondents for their household upkeep are found to be significant at 1% probability level. The results are shown in Table III. The coefficient of multiple determination (R^2) for the OLS regression model results is 0.4013 (40.13%) which means that the two models are adequate as they explain 40.13% of the variability of the WTP estimate. The OLS Regression Model results are shown in Table IV.

D. Mean WTP for Improved Service Delivery

In calculating WTP, a completely different model with the data pooled for all the bid amounts was estimated so that the coefficient on the monetary bid amount could be established. Upon this model, the average WTP are calculated from (4) [9], [21]-[23], where α is the product of the coefficients and mean values of all independent variables excluding the bid coefficient, β is the absolute value of the bid coefficient (Table V). In this study protest responses are not included because it is not a knowledgeable idea in developing countries such as Nigeria.

TABLE I
VARIABLES CONSIDERED IN THE MODEL

Variable	Definition	Mean
	Dependent	
WTP	Willingness to pay for sustainable water supply services.	
	Independent	
HHead	Interviewee is the household head (Coded 0 = No, 1 = Yes)	0.479
Ystay	Have you been living in this house more than 10 years	0.444
Gender	Respondent's gender (0 = Female, 1 = Male)	0.595
Education	Education status of respondents (0 = No schooling, 1 = Pry, 2 = Sec, 3 = Higher Education)	2.538
Occupation	Occupation (0 = Farmer, 1 = Owned, 2 = Civil servant)	1.449
Htype	Type of residence (0 = Multi-tenant, 1 = Block of flat, 2 = Duplex, 3 = Bungalow, 4 = Others)	1.746
Hsize	Number of people in households (0 = <5, 1 = Btw 6-10, 2 = >10)	0.731
Tstate	Tenurial state (0 = Owned, 1 = Rented, 2 = Mortgaged)	0.702
Hincome	Monthly income of household (in ranges)	1.14
Wsource	Source of water (0 = House connection, 1 = Borehole, 2 = Well, 3 = Sachet water, 4 = Public tap)	0.001
Gwater	Do you get water at all (0 = No, 1 = Yes)	0.991
Satisfaction	Satisfaction with the quantity of water (0 = No, 1 = Yes)	0.133
HRWP	Hours per day respondents received water from the piped System (in ranges)	1.961
HDWP	Days per week respondents received water from the piped System (in ranges)	1.453
WQuality	What is your perception about the quality of water supplied (0 = Bad, 1 = Fair, 2 = Good)	0.569
Wtreatment	How do you treat water (0 = Boil, 1 = Filter, 2 = Alum, 3 = Others)	1.309
Stype	What type of storage do you have (0 = Overhead tank, 1 = Underground, 2 = Jerry can, 3 = Bucket, 4 = Others)	0.851
Swater	How much sachet of water do you buy daily (in ranges)	1.624
Hwater	Do you always get the total water needed for your household upkeep from water supply service provider (0 = No, 1 = Yes)	0.129
Ssource	What is your secondary source of water (0 = Pulic tap, 1 = Water vendor, 2 = Dug well, 3 = Sachet water, 4 = Borehole water)	2.193
Bid	Bid amount (₦2250 - ₦3000)	2583

E. The Model Result

Using the explanatory variables presented in Table I, the following regression equations were deduced from the Logistic and Probit models results using the significant variables.

$$Logit\ (WTP) = 1.76 + 0.59Hhd + 0.39Yst - 0.34Gen + 0.22Edu + 0.09Occ + 0.14Ht + .39Hsz - 0.39Tst + 0.07Hinc - 0.16Satis + 0.15HDWP - 0.63Wqua - 0.16Styp -).65Swater + 0.74Hwater - 0.18Ss0 \quad (5)$$

$$Probit\ (WTP) = 1.01 + 0.36Hhd - 0.02Yst - 0.21Gen + 0.12Edu - 0.05Occ + 0.07Htyp + 0.23Hsz - 0.24Tst + 0.04Hincom - 0.13Satis + 0.10HDWP + 0.35Wqua - 0.09Styp - 0.36Swater + 0.44Hwater - 0.11Sco \quad (6)$$

TABLE II
LOGIT LOG-LIKELIHOOD REGRESSION ANALYSIS RESULTS

WTP	Coefficient	Standard Error	Z	P>Z	95% Confidence Interval	
Hhead	0.5970265	0.3430032	1.74	0.082	-0.0752474	1.2693
Ystay	-0.038184	0.2904162	-0.13	0.895	-0.6073894	0.5310213
Gender	-0.3347925	0.3351823	-1	0.318	-0.9917378	0.32215828
Education	0.2178906	0.2323236	0.94	0.348	-0.2374553	0.6732365
Occupation	-0.0992234	0.2724546	-0.36	0.716	-0.6332245	0.4347777
Htype	-0.1363222	0.1627168	-0.84	0.402	-0.4552412	0.1825968
Hsize	0.3895543	0.2351959	1.66	0.098	-0.0714211	0.8505297
T state	-0.3974091	0.2351959	-1.59	0.112	-0.8872724	0.0924543
Hincome	0.07405	0.2154692	0.34	0.731	-0.3482619	0.496362
Satisfaction	-0.1626445	0.8252429	-0.2	0.844	-1.780091	1.454802
HRWP	0.535861	0.1598621	3.35	0.001	0.222537	0.849185
HDWP	0.1479246	1653842	0.89	0.371	-0.1762226	0.4720717
W quality	0.6319639	0.2873216	2.2	0.028	0.6889239	1.195104
Wtreat	-0.3395581	0.1303257	-2.61	0.009	-0.5949918	-0.0841243
Stype	-0.1602888	0.1154072	-1.39	0.165	-0.3864828	0.0659052
Swater	-0.6489666	0.2910777	-2.23	0.026	-1.219468	-0.07846648
Hwater	0.7362612	0.8902365	0.83	0.408	-1.00857	2.481093
Ssource	-0.1753038	0.1595505	-1.1	0.272	-0.488017	0.1374094
Constant	1.767618	1.038945	1.7	0.089	-0.2686769	3.803912

Number of observation = 455,LR chi²(18) = 64.46. Prob>chi² = 0.0000, Pseudo R^2 = 0.1452log likelihood = -189.79758S

TABLE III
PROBIT LOG-LIKELIHOOD REGRESSION RESULTS

WTP	Coefficient	Standard Error	z	p>z	(95% confident interval)	
Hhead	0.3583775	0.190714	1.88	0.060	-0.0154151	0.7321701
Ystay	-0.0206833	0.165127	-0.13	0.900	-0.3443262	0.3029597
Gender	-0.2089609	0.1843247	-1.13	0.257	-0.5702307	0.152309
Education	0.1177062	0.1316438	0.89	0.371	-0.140311	0.3757234
Occupation	-0.0517091	0.1555461	-0.33	0.74	-0.3565739	0.2531557
Htype	-0.0704381	0.0914734	-0.77	0.441	-0.2497226	0.1088464
Hsize	0.2251845	0.1311964	1.72	0.086	-0.0319558	0.4823248
Tstate	-0.2435274	0.1442045	-1.69	0.091	-0.5261631	0.0391083
Hincome	0.0416592	0.1224002	0.34	0.734	-0.1982408	0.2815591
Satisfaction	-0.1292764	0.456286	-0.28	0.777	-1.02358	0.7650277
HRWP	0.3153213	0.0914446	3.45	0.001	0.1360932	0.4945493
HDWP	0.1032482	0.0958565	1.08	0.281	-0.0846271	0.2911235
Wquality	0.350986	0.1624223	2.16	0.031	0.032644	0.6693279
Wtreat	-0.1995383	0.0746715	-2.67	0.008	-0.3458918	-0.0531847
Stype	-0.0856034	0.0659849	-1.3	0.195	-0.2149315	0.0437246
Swater	-0.355696	0.1501194	-2.37	0.018	-0.6499246	-0.0614674
Hwater	0.4395619	0.4846037	0.91	0.364	-0.5102438	1.389368
Ssource	-0.1106888	0.0889331	-1.24	0.213	-0.2849944	0.0636168
Constant	1.009418	0.580905	1.74	0.082	-0.1291348	2.147971

Number of observation = 455,LR Chi² (18) = 66.24, Prob > chi² = 0.0000, Pseudo R^2 = 0.1492; Log likelihood = -188.90626

F. Assessment of Model Fitness

It is important to examine whether or not those who are willing to pay the initial bid amounts are different from those who are not willing to pay with regards to the household socio-economic survey, water use patterns as well as existing water supply situations. Table VI presents the distribution of the sample size and the mean for the sequential responses to the bid amounts. Statistical goodness-of-fit tests were applied to test the explanatory power of the models. From the study conducted by the California Urban Agencies (CUA) [26], it was found that regression model uses coefficient of multiple determination (R^2) as a measure of goodness-of-fit while discrete models like Logistic regression model and Probit model use other statistics to measure the explanatory power of the models. Such measures are similar to the traditional R^2 such as McFadden's R^2 and Psuedo R^2. In a DBDC format, the structure is more complex. No easy approach is available for allocating respondents to the four categories of responses without the model. The reason for this difficulty is that the second response is a function of the first, so one cannot allocate observation based on a joint response. The DBDC responses to the three bid amounts entered in the Logistic and Probit models as dependent variables. The summary of the logistic and probit model results for the three WTP bid amounts are indicated in Table VI.

The Logistic and Probit Model results for the three bid amounts reveal that the ₦2500 bid amount has the higher Pseudo R^2 value of 36.12% with ±0.44 and ±0.23 confidence interval respectively for both models. In other words, one can say with 95% certainty that the WTP ₦2500 bid amount lies within ±0.44 and ±0.23 of the estimated WTP.

IV. Conclusion

The study revealed some salient factors undermining the sustainable water supply service deliveries which included poor quality water, intermittent supply and lack of customer care service in the eyes of the consumers. It is therefore not surprising that the citizenry was already incurring averting expenditure on for example bottle water, dug well, alum etc. For water supply, the WTP is the maximum an individual would pay to alleviate averting expenditure and subsequently enjoy the benefit of good service delivery. The results also reveal that people are willing to pay ₦2500 per household per month to contribute to operation and maintenance cost of water supply delivery. It is also important to note that consumers' higher WTP is however contingent on the improvement on the current level of service delivery.

TABLE IV
OLS Regression Analysis Result

Variables	Coefficient	Standard Error	t-value	p>/t/	(95% Confident Interval)	
Ystay	0.0246423	0.0407332	0.60	0.546	-0.0554115	0.1046961
Gender	0.5677717	0.0385401	14.73	0	0.492028	0.6435154
Occupation	0.0259779	0.0359266	0.72	0.470	-0.0446293	0.0965851
Hsize	-0.1265993	0.0299503	-4.23	0	-0.1854612	-0.0677374
Tsize	-0.0058359	0.0311377	-0.19	0.851	-0.0670316	0.0553597
Hincome	0.0207741	0.0290507	0.72	0.475	-0.0363198	0.0778681
Gwater	0.7562159	0.2847293	2.66	0.008	0.196631	1.3158
Satisfaction	-0.1768146	0.0951288	-1.86	0.064	-0.3637732	0.010144
Wquality	-0.0013951	0.0412956	-0.03	0.973	-0.0825542	0.079764
Wtreatment	0.0318835	0.0184527	1.73	0.085	-0.0043821	0.068149
Stype	0.0035751	0.0159617	0.22	0.823	-0.0277949	0.034945
Hwater	-0.1275152	0.0961356	-1.33	0.185	-0.3164524	0.0614221
Constant	-0.5911661	0.2958179	-2	0.046	-1.172543	-0.0097889

TABLE V
Calculated WTP Result

Bid Intercept and slope (α and β)	Logit	Probit	Mean WTP	
			Logit	Probit
Intercept of the Bid (α)	1.70	1.74		
Slope of The Bid (β)	1.768	1.009		
			0.50	0.82

TABLE VI
Distribution of the Sample Size

Bid Amount	2250	Mean	2500	Mean	3000
Household	48No				
Responses	95Yes	0.665	142No		
			315Yes	1.01	195No
Total Sample					120Yes
Size	143		457		315
Mean	0.539				

The key to sustainability is to ensure that the condition existS to re-establish the required thresholds and to regenerate the service without falling into dereliction, therefore requiring it to be completely rehabilitated or abandoned. However, water supply particularly in Nigeria and Africa countries, unlike other public utilities, such as communication are unique in externalities issue and nonexcludability of service make it difficult to attract private capital to water supply. It has been recognized perhaps as the most natural monopolistic. There are three options for managing natural monopolies, according to Nobel laureate Milton Fiendman [24]: private unregulated monopoly, private monopoly regulated and public monopoly. This study has revealed incentives for private sectors participation in business of water supply. But then the government role as a provider and regulator has compounded the problem. The role of government is to make sure that services are provided, and not necessarily to provide service. It is possible to introduce competition with enormous gain in efficiency by separating infrastructure investment from service operations.

Operational efficiency is a crucial factor to attain a high level of service delivery. The State public utility agency cannot meet up in this respect. Therefore, outsourcing of operations through service contract in a PPP arrangement will be a steppingstone in the direction of service improvement. It is possible to introduce competition with enormous gain in efficiency by separating infrastructure investment from service operations. A sound financial management improvement and cross-subsidization of the urban poor, an economic price should be implemented for industries, commercial enterprises and exotic government reservation and other VIP residential areas. Also, a deliberate involvement of stakeholders and water literacy campaign on issues of water supply will facilitate transparency, support, and interest in measures to improve service delivery. Water literacy is crucial in the development of sustainable water supply services strategies. The aim should be to inform, guide and create a conscious feeling of responsibility among the general public just like what National Agency for Food and Drug Administration and Control (NAFDAC) is doing on drug, cosmetic and beverage industries.

TABLE VII
SUMMARY OF LOGIT AND PROBIT MODEL RESULTS FOR THE THREE WTP BID AMOUNTS

Model	significance	Goodness-of-Fit measures (R^2)		(95% confidence interval)	
	Variables	Logit	Probit	Logit	Probit
WTP 2250	Hsize*				
	Tsate*				
	Hincome*	0.1173	0.115	±0.11	±0.72
	Wht				
	HDWP*				
WTP 2500	Hsize*				
	Tstate*				
	Hincome**	0.3617	0.3611	±0.44	±0.23
	Wht				
	HDWP*				
WTP 3000	Hsize*				
	Tstate*				
	Hincome*	0.0233	0.0232	±0.26	±0.15
	Wht**				
	HDWP*				
	*5%, **10%				

REFERENCES

[1] Uusitalo, K. (2002) An evaluation of urban water system using environmental sustainability indictors. A case study in Adenta, Ghana. Chalmers University of Technology. Water Environmental Transport. Goteborg, Sweden

[2] Alpizar, F., Carlson, F., and Martinsson, P. (2001) Using choice experiments for non-market valuation. Economic Issues. (8)1: 83-100

[3] Venkatachalam, L. (2004). The contingent valuation method: a review. Environmental Impact Assessment Review. (24)1: 89-124

[4] Ahtiainen, H. (2007) The willingness to pay for reducing the harm from future oil spills in the Gulf of Finland –an application of the contingent valuation method. Discussion Paper No:18. Environmental Economics. University of Helsinki, Finland.

[5] Martín-Fernández, J., Cura-González, M.I., Gómez-Gascón,T., Oliva-Moreno, J., Domínguez-Bidagor, J., Beamud-Lagos, M., and Pérez-Rivas, F. J., (2010) Differences between willingness to pay and willingness to accept for visits by a family physician: A contingent valuation study. BMC Public Health, 10:236 Available at http://www.biomedcentral.com/1471-2458/10/236

[6] Manga, V.E., Oru, O. T., and Ngwabie, M.N. (2019) Household perception and willingness to pay for improved waste management service in Mamfe, African Journal of Environmental Science and Technology Vol. 13(9), pp. 354-364, DOI: 10.5897/AJEST2019.2681

[7] Jamelske, E. and Kipperberg, G. (2006) A contingent valuation study an benefit-cost analysis of the switch to automated collection of solid waste with single stream recycling in Madison, Wisconsin. Public Works Management and Policy 11, 89–103

[8] Ifabiyi, I.P (2011) Willingness to pay for water at household level in Ilorin, Kwara State, Nigeria. Global Journal of Human Social Science, (11)2: 14-24. Publisher: Global Journals Inc. (USA)

[9] Madhoo, N. Y. (2007) Estimating the budgetary impact of higher willingness to pay for residential water using CVM: A case study of Mauritius. Asian Journal of Water. Environment, and Pollution (4)2: 57–64.

[10] Minten, B., Razafindralambo, R., Randriamiarana, Z., and Larson, B. (2002) Water pricing, the new water law, and the poor: An estimation of demand for improved water services in Madagascar. USAID – Ilo program – Cornell University. No. 687-A-00-00-00093-00.

[11] Olorunfemi, F. B. (2009) Willingness to pay for improved environmental quality among residents living in close proximity to landfills in Lagos Metropolis, Nigeria. African Research Review 3 (1): 97-110

[12] Tubeuf, S., Hewison, J., Willis, T. A., Potrata, B., Grant, H., Allsop, M. J., Ahmed, M. and McKibbin, M. (2015) Willingness to pay for genetic testing for inherited retinal disease European Journal of Human Genetics (23): 285–291.

[13] Kimenju, C. H. and Groote, D. H. (2008) Consumer willingness to pay for genetically modified food in Kenya. Agricultural Economics (38), 35–46.

[14] DeGroote, H. and Kimenju, S. C. (2008) Comparing consumer preferences for color and nutritional quality in maize: Application of a semi double-bound logistic model on urban consumers in Kenya. Food Policy (33), 362–370.

[15] Seifouri, V., Babalhavaeji, F., Nooshin fard, F., and Matlabi, D.(2018) Analysis of Factors that Influence Users's Willingness to pay for the services of iranian academic libraries by using the contingent valuation method. Library Philosophy and Practice (e-journal). 1755. Available at https://digitalcommons.unl.edu/libphilprac/1755

[16] Ajadi, B. Adeniyi, A. and Afolabi, M. (2011) Impact of climate change on urban agriculture: Case Study of Ilorin City, Nigeria. Global Journal of Human Social Science: Double Blind Peer Reviewed International Research Journal, USA. Vol. 11, Issue 1.

[17] Ajadi, B. (1996) Pattern of water supply in Ilorin City. B.Sc Thesis, Department of Geography, University of Ilorin, Ilorin, Nigeria.

[18] Ajadi, B. (2010) Potable water availability and consumption pattern in Ilorin Metropolis, Nigeria. Global Journal of Human Social Sciences, Vol 10(6). 44-50.

[19] FAO (2000) Applications of contingent valuation methods in developing countries. Economic and Social Paper 146. (http://www.fao.org)

[20] Lema, Z. and Beyene, F. (2012) Willingness to pay for improved rural water supply in Goro-Gutu District of Eastern Ethiopia: an application of contingent valuation. Journal of Economics and Sustainable Development, Vol (3), No 14.

[21] Loomis, J. B., Le, H. T., and Gonzales-Caban, A. (2005) Testing transferability of willingness to pay for forest fire prevention among three states of California, Florida and Montana. Journal of Forest Economics (11), 125–140

[22] Kaval, P. and Yao, R. (2007) The value of native biodiversity enhancement in New Zealand: A case study of the Greater Wellington Area. Working Paper in Economics 7/22. Department of economics. University of Waikato. New Zealand.

[23] Gonzalez-Caban, A., Loomis, J. and Gregory, R. (1995) Protecting Oregon old-growth forests from fires: How much is it worth. USDA Forest Service Gen. Tech. Rep. Pacific Southwest-156 sustainability: The Biogeophysical Foundations. Washington, D.C, USA: The World Bank: 3–17.

[24] Hukka J.J. and Katko T.S. (2003). Water privatization revisited - panacea or pancake? IRC Occasional Paper Series No, 33. Delft, the Netherlands. 159 p. Available: http://www.irc.nl/pdf/publ/op_priv.pdf.

[25] Hoyos, D. and Mariel, P. (2010) Contingent valuation: past, present and future. Prague Economic Papers (4): 329-343.

[26] Barakat and Chamberlin, Inc (1994) The value of water supply reliability: Results of a contingent valuation survey of residential customers. California Urban Water Agencies. USA

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