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The Development of Needs Assessment For Investable Water Project In Kogi Central District, Nigeria

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Abstract— *Water and water quality supply, availability and accessibility to household and other users in any giving community is of high essence. This study demonstrated comprehensively water survey provision as needs assessment study for the purpose of providing clean and reliable water supply to Okene and other parts of Kogi Central District aims at addressing the current water scarcity and quality challenges, improving the health, well-being, and economic development of the communities. The funding confirmed key challenges and limitations affecting water availability, utilization and accessibility in Okene to be addressed inclusive of water sources, treatment, quality, and billing systems. Improving strategies on water provision are provisions of water infrastructures, quality treatment and proper channels of supply significantly determine water availability, utilization and accessibility in Okene, Kogi State. Reticulation monitoring, storage service, treatment, effective usage, water connection and maintenance were stand out as the basic approaches for monitoring and managing water quality in while billing influence negatively effective approaches. Innovative water billing system adoption may promote efficient use and affordability of water. The study recommended: Government and other key stake holders in the community show painstaking identify the main challenges affecting water availability, utilization and accessibility that accounts for and limitations availability, utilization and accessibility water and address the challenges. Efforts should made the relevant ministries to device sustainable improved strategies on water infrastructures, treatment and supply for water availability, utilization and accessibility in Okene, Kogi State. Due to the topographical nature of the environment effective reticulation monitoring, storage service provisions, right quality treatment of water, campaign on effective usage, proper water connection and maintenance are mainly approaches suggested by the study the best approaches of monitoring and managing water quality in Okene. To avoid payment of water bills innovative water billing system adoption is very important with fair pricing mechanism. Due to paucity of fund, PPP on investible water projects should be encourage by the government at all levels in the state. Further studies in the area-Okene and Kogi Central suggested identifying qualitative measures of providing clean and reliable water supply to 80% of households to addressing quality water supply challenges.*

Keywords— *Investable, water, reticulation, innovative billing and infrastructures*

I. INTRODUCTION

Okene and Kogi Central local government areas in general face significant water supply challenges, with inadequate access to clean and reliable water supply over the years. This project seeks to address these challenges by developing a sustainable water supply system with high capability of revenue generation and sustainable environment for clean water and proper sanitation for better life and good health condition of the populace.

A. Problem statement

Access to safe, reliable, and affordable water is essential for human health, economic development, and environmental sustainability. However, many communities worldwide face significant challenges related to water sources, treatment, supply, quality, and billing. These challenges include: Water scarcity and variability: Changes in precipitation patterns, climate change, and increasing water demands strain existing water sources. Water pollution: Industrial, agricultural, and domestic activities contaminate water sources, threatening human health and ecosystems. Inadequate water treatment and supply infrastructure: Insufficient investment in water treatment and supply infrastructure leads to inadequate access to safe drinking water. Poor water quality monitoring and management: Inadequate monitoring and management of water quality leads to undetected contamination and health risks. Inefficient water billing and pricing: Ineffective billing and pricing mechanisms can lead to water waste, inefficient use, and unaffordability for vulnerable populations.

B. Objectives:

1. To identify and analyse the key challenges and limitations in ensuring water access, utility and availability.
2. To develop and evaluate strategies for improving water treatment and supply infrastructure.
3. To investigate effective approaches for monitoring and managing water quality.
4. To design and test innovative water billing and pricing mechanisms that promote efficient use and affordability.

C. Research Questions:

1. What are the key challenges and limitations in ensuring water access, utility and availability?
2. How can water treatment and supply infrastructure be improved to meet growing demands?
3. What are the most effective strategies for monitoring and managing water quality?
4. How can water billing and pricing mechanisms be designed to promote efficient use and affordability?

D. Research Hypotheses:

1. Ho1: Key challenges and limitations have no significant difference in ensuring water access, utility and availability in Okene.

2. Ho2: Improved has no significant difference in ensuring water access, utility and availability in Okene.

3. Ho3: There is significant influence of effective strategies for monitoring and managing water quality in Okene

4. Ho4: Water billing and pricing mechanisms d not significantly impact on the promotion of efficient use and affordability of water in Okene.

II. RELATED RESEARCH AND LITERATURE REVIEWS

A. Water Sources and Quality

Water quality index models assess surface water quality using various parameters like pH, temperature, and nutrient levels [1][2]. Researchers have applied these models to evaluate water quality in different contexts [3]. A study on surface water quality in a major city in Southeast China used multi-statistical analyses and machine learning models to identify pollution sources and evaluate water quality [4][5].

B. Water Treatment and Supply

A systematic review of wastewater treatment and reuse highlights the importance of sustainable water management practices, including water conservation and efficient use of water resources [6]. Researchers have explored various treatment technologies, including membrane bioreactors and advanced oxidation processes [7]. Water resources protection practices emphasize the need for sustainable water management, including water conservation, efficient use, and protection of water sources [8]. Study on urban water management highlights the importance of non-conventional water sources, such as reclaimed and desalinated water, in addressing water scarcity [9].

C. Water Billing

A study on water pricing reform highlights the importance of economic incentives in promoting water conservation and efficient use [7]. Researchers have explored various pricing strategies and their impact on water demand, including the use of hydroeconomic models [7][8][10].

By addressing these research questions and objectives, this study aims to contribute to the development of sustainable and effective solutions for ensuring access to safe, reliable, and affordable water for all in Kogi Central District.

III. MATERIALS AND METHODS

The study used quasi experimental design. It adopted triangulational methods of data collections and analyses.

A. Study Area Descriptions

Kogi State, Nigeria's "Confluence State," is strategically located in the North Central zone, famous for the meeting of the Niger and Benue Rivers near its capital, Lokoja, acting as a vital North-South link. Its central position connects it to numerous states (Nasarawa, Benue, Enugu, Delta, Ondo, Ekiti, Kwara, Niger, FCT). The state, formed in 1991, features diverse ethnic groups like the Igala, Ebira, and Okun, and its central area, including Okene, is characterized by Southern Guinea Savannah vegetation with hills and rocks.

- Key Landmarks (see fig. 1 and 2).

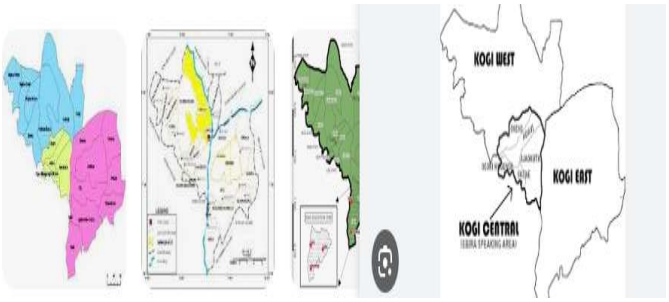

Fig 1: Descriptive Map of Kogi State and The Senatorial Districts

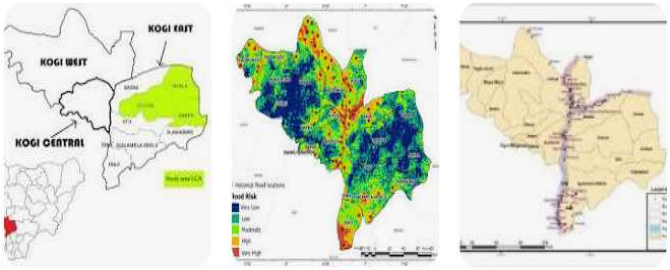

Fig 2: Illustrative of Kogi State Senatorial Districts Water Chennelling System Map

B. Central Location Descriptions

Kogi's location is defined by its unique status as the only Nigerian state to share boundaries with ten other states plus the Federal Capital Territory (FCT). Regional Position: It is a central transport corridor and a "gateway" between Northern and Southern Nigeria.

Kogi Central Senatorial District: This specific central zone comprises five Local Government Areas (LGAs): Adavi, Ajaokuta, Okehi, Okene, and Ogori-Magongo.

C. Population/Sample

The population of the Kogi State Central Districts of Five (5) Local Government Areas is estimated across ages 1.3million on average using the theory of population projection of 1991 and 2006 National Census Exercises reports. The target sample size for the survey is 5000 respondents maximum and minimum of 3000 respondents based on percentage ratio of 25% Adavi LG, 20% Okene LG.A,25% Okehi LG.A,10% Ajaokuta LG.Aand 10% Okene LG.A comprising 2122 respondents drawn samples from 10 locations in the Central Senatorial Districts across 5 Local Government Areas in the

KSCD using cluster, random sampling, snow balling and quota sampling approaches.

IV. METHODS OF DATA COLLECTION

Enumeration to identify key areas of water project evaluation status, infrastructure deficiencies in line with the usability, availability, treatment, accessibility, channeling methods, cost evaluation, revenue generation, billing best methods, topology assessment and evaluation. To achieve these, the followings are required:

- i. Demarcation of the Kogi State Central Districts (KSCD) into convenient local government areas, wards and other units for ease of measurement and accuracy of data capturing in line with the items of (WPES) needs assessment
- ii. Stratification of the WPES in terms identification, availability, treatment, accessibility, channeling methods, cost evaluation, revenue generation, billing best methods, topology assessment and evaluation.
- iii. Development/administration of Water Evaluation Survey (WES) and Strategy Approaches Research-SAR items

Pilot survey to ascertain reliability/validity of the instrument and field administration of questionnaires-WES which confirmed 85% reliability with criterion and context validity measures. The research instruments-questionnaires and interviews were validated by professions in Urban Regional Planning of the district couple with Ministry Water Resources and Environment supported by academics in the area of water studies..

V. ANALYSIS AND RESULTS

To address the research objectives of the study, the following answers were provided to the research questions and test of hypotheses.

Research Question 1: What are the key challenges and limitations in water sources, treatment, supply, quality, and billing affecting water availability, utilization and accessibility in Okene.?

In analyzing research question 1, the mean ( ) and standard deviation (S.D) were used to examine the key challenges and limitations in water sources, treatment, supply, quality, and billing affecting water availability, utilization and accessibility in Okene.

TABLE 1:

Mean and Standard deviation Analysis on key challenges and limitations in water sources, treatment, supply, quality, and billing affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria

S/No.	Items Challenges	Total	Mean	S.D	Remark
1.	Water Sources	2122	1.43	0.49	High available
2.	Water Treatment	2121	1.15	0.36	Very poor
3.	Water Quality	2122	2.75	1.26	Moderate high quality
4.	Water Billing Services	2122	2.88	1.22	Not definite

Source: *SPPS Results Extract, 2025*

Result in table 1 showed that sources of water in the study area is highly available on the rating items with mean range values of 1.43 having standard deviation value of 0.49. The mean score of water treatment as its affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria was lesser than mean of (2.00<2.50) which is 1.15. Hence, the result showed that there is very poor water treatment in the study area. Majority of the household on the water survey rated water quality in Okene as low with the mean value of 2.75 greater than 2.50 indicates moderately high quality water existence in the area. The mean score of water billing services system as one of the key challenges and limitations of factors affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria was greater than mean score criteria (2.88>2.50). Hence, the result showed that the water billing service and system is high but not definite. The findings show that among the key challenges affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria.

Test of Hypothesis 1:

To test the hypothesis of the key challenges and limitations in water sources, treatment, supply, quality, and billing affecting water availability, utilization and accessibility in Okene.

TABLE 2:

Analysis of Variance of challenges and limitations in water sources, supply, quality and billing affecting water availability, utilization and accessibility in Okene ANOVA

Challenges variation	Sources of	Sum of Squares	Df	Mean Square	F	Decision rule P<0.05 at 5%Sig.	Remark
Water sources	Between Groups	36.94	2	18.47	0.26	0.000*	Significant
	Within Groups	778.84	2119	.368			
	Total	815.78	2121				
Water supply	Between Groups	324.98	2	162.49	203.16	0.000*	Significant
	Within Groups	1694.82	2119	.800			
	Total	2019.79	2121				
Water quality	Between Groups	222.89	2	111.45	322.01	0.000*	Significant
	Within Groups	733.38	2119	.346			
	Total	956.28	2121				
Water Billing services	Between Groups	142.09	2	71.05	376.27	0.000*	Significant
	Within Groups	400.12	2119	.189			
	Total	542.21	2121				

**F-value is statistically significant (p<0.05)*

In testing the hypothesis 1, there is no significant difference in the key challenges and limitations in water sources, treatment, supply, quality, and billing affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria. Analysis of variance (ANOVA) was used. The data in Table 2 showed that the F-value for water sources (WS) (F=50.26, P<0.05), water treatment (WT) (F=-203.16, P<0.05), water quality (F=376.27, P>0.05), and water billing system (F=99.20, P>0.05) were significantly different in the determinant among the key challenges that affect water availability, utilization and accessibility in Okene, Kogi Central District, Nigeria. Therefore, the null hypothesis was rejected. This implies different challenges and limitations affecting water availability, utilization and accessibility in Okene were different in Okene based on the study.

Research Question 2: What are the most effective strategies for monitoring and managing water quality? How to develop and evaluate strategies for improving water treatment and supply infrastructure?

In analyzing research question 2, the mean ( ) and standard deviation (S.D) were used to examine how to develop and evaluate strategies for improving water treatment and supply infrastructure for water availability, utilization and accessibility in Okene.

TABLE 3:

Mean and Standard deviation Analysis on development and evaluation of strategies for improving water treatment and supply infrastructure for water availability, utilization and accessibility in Okene Kogi State, Nigeria

S/No.	Items Challenges	Total	Mean	S.D	Remark
1.	Water infrastructures	2122	3.73	1.42	High Provision
2.	Water Treatment	2121	3.18	1.36	Very high
3.	Water Supply	2122	3.98	1.28	High quality

Source: SPPS Results Extract, 2025

Result in table 3 showed that water infrastructure in the study area is highly available on the rating items with mean range values of 3.75 having standard deviation value of 1.62. The mean score of water infrastructure is highly significant determinant of development and evaluation of strategies for improving water availability, utilization and accessibility in Okene Kogi State, Nigeria with mean scores of (3.73<2.50). Water treatment result showed that there is very high impact on development and evaluation of strategies for improving water availability, utilization and accessibility in Okene Kogi State, Nigeria

Water treatment in the study area with the mean scores of 3.18. Households on the water supply survey rated water quality supply in Okene to high quality in terms of supply as development and evaluation of strategies for improving water for availability, utilization and accessibility in Okene Kogi State, Nigeria

Hence, the result showed that the water infrastructures and supply are the main development and evaluation of strategies for improving water availability, utilization and accessibility in Okene Kogi State, Nigeria

TABLE 4:

Simple Linear Regression of strategies for improving water treatment and supply infrastructure to enable water availability, utilization and accessibility in Okene, Kogi State.

AEU

R=0.637[a], R Square (R^2)=0.406, Adjusted R Square (R^2)=0.405, Fcal.(241.327)= .000

Coefficients[a]

Model	Unstandardized Coefficients β	Std. Error	Standardized Coefficients Beta	t	Decision rule P<0.05 at 5%	Remark
1 (Constant)	2.825	.072		39.420	.000	Significant
Water Infrastructures	0.579	.031	0.442	18.943	.000	Significant
Water treatment	.270	.019	.398	14.422	.000	Significant
Water supply	0.554	.031	0.561	17.979	.000	Significant

a. Dependent Variable: Water availability, utilization and accessibility

b. Predictors: (Constant), Water Infrastructures, Treatment, and Supply

*t-values and f-value are statistically significant (p<0.05)

In testing the hypothesis 2: Strategies for improving water treatment, infrastructure and supply do not significantly predicted enable water availability, utilization and accessibility in Okene, Kogi State. The data in Table 2 showed that the t-value for water infrastructures (t=18.943, =-0.579, P<0.05), Water treatment (t=14.422, =0.270, P<0.05), and water supply (t=17.979, =0554, P>0.05) predicted. Therefore, the null hypothesis was rejected in favour of alternative hypothesis. This implies Strategies for improving water treatment, infrastructure and supply not significantly predicted water availability, utilization and accessibility in Okene, Kogi State. The R2 square and adjusted R values (0.406 and 0.405) showed that approximately 40.5% variations in improved strategies on water (infrastructures, treatment and supply) combined significantly determined water availability, utilization and accessibility in Okene, Kogi State.

Research Question 3. How can water treatment and supply infrastructure be improved to meet growing demands? In clear

terms to investigate effective approaches for monitoring and managing water quality.

Ho9: There is no significant difference in effective approaches for monitoring and managing water quality in Okene Kogi State, Nigeria.

TABLE 5:
Measure of Coefficient of effective approaches for monitoring and managing water quality in Okene Kogi State, Nigeria.

S/No.	Approaching for monitoring and managing water quality	Co efficient value	Sign	Remark
1.	Reticulation monitoring	0.615	-	Positive Influence
2.	Storage services	0.823	+	Positive Influence
3.	Billing Services	-0.452	-	Negative Influence
4.	Water Connection/maintenance	0.770	-	Negative Influence
5.	Treatment	0.890	+	Positive Influence
6.	Effective usage	0.610	+	Positive Influence

Source: *SPPS Results Extract, 2025*

Result in table 5 correlation coefficient measures effective approaches for monitoring and managing water quality in Okene. The result confirmed that reticulation monitoring, Storage service, Treatment, Effective usage, Water Connection and maintenance influence are positively and highly correlated elements of effective approaches for monitoring and managing water quality in Okene at 50% and above while billing influence negatively effective approaches for monitoring and managing water quality in Okene is 45%.

Test of Hypothesis 3:

TABLE 6:
Measure of Coefficient of effective approaches for monitoring and managing water quality in Okene Kogi State, Nigeria.

S/No.	Approaching for monitoring and managing water quality	Co efficient value	P<0.05	Remark
1.	Reticulation monitoring	0.615	0.000	Sig.
2.	Storage services	0.823	0.000	Sig.
3.	Billing Services	-0.452	0.000	Sig.
4.	Water Connection/maintenance	0.770	0.000	Sig.
5.	Treatment	0.890	0.000	Sig.
6.	Effective usage	0.610	0.000	Sig.

Source: *SPPS Results Extract, 2025*

Result in table 6 The test of hypothesis suggested that reticulation monitoring, storage service, treatment, effective usage, water Connection, billing system and maintenance are statistically significant at 5% level.

- *Research Question 4:* How can water billing and pricing mechanisms be designed to promote efficient use and affordability? This also to design and test innovative water billing and pricing mechanisms that promote efficient use and affordability.

TABLE 7:
Measure of Coefficient of innovative water billing and pricing mechanisms that promote efficient use and affordability.

S/No.	Promote efficient use and affordability.	Co efficient value	Sign	Remark
2.	Innovative water billing	0.623	+	Positive Influence
3.	Pricing mechanism	-0.452	-	Negative Influence

Result in table 7 the correlation coefficient measures (– or + sign) of impact or influence of innovative billing and pricing mechanism on the promotion of effective use and affordability of water in Okene, Kogi State, Nigeria shows that innovative water billing has positive impact of 62% and pricing mechanism has negative influence of 45% on efficient use and affordability of water in Okene Central District of Kogi State.

Test of Hypothesis 4:

TABLE 8:
Measure of Coefficient of effective approaches for monitoring and managing water quality in Okene Kogi State, Nigeria.

S/No.	Approaching for monitoring and managing water quality	Co efficient value	P<0.05	Remark
1.	Innovative water billing	0.623	0.000	Sig.
6.	Pricing mechanism	-0.452	0.000	Sig.

Source: *SPPS Results Extract, 2025*

Result in table 8 The test of hypothesis suggested that innovative water billing and pricing mechanism adoption are statistically significant at 5% level

A. Findings

- 1. The findings show that among the key challenges affecting water availability, utilization and accessibility in Okene Kogi State, Nigeria. In addition, different challenges and limitations affecting water availability, utilization and accessibility in Okene were different in Okene based on the study.
- 2. Findings indicated that improved strategies on water (infrastructures, treatment and supply) combined significantly determined water availability, utilization and accessibility in Okene, Kogi State.
- 3.The findings confirmed reticulation monitoring, Storage service, Treatment, Effective usage, Water Connection and maintenance influence positively effective approaches for monitoring and managing water quality n Okene while billing influence negatively effective approaches for monitoring and managing water quality in Okene.
- 4. The findings show that innovative water billing system adoption in the study area predicted and significantly promote positive efficient use and affordability of water. However, poor pricing mechanism account negatively to the promotion of efficient and affordability of water in Okene The word “data” is plural, not singular.

VI. CONCLUSION

The study concluded to manage water provision in the central senatorial district of Kogi State there are key challenges and limitations affecting water availability, utilization and accessibility in Okene to be addressed inclusive of water sources, treatment, quality, and billing systems. To improve the strategies on water provision in the study area water infrastructures, quality treatment and proper channels of supply could significantly determined water availability, utilization and accessibility in Okene, Kogi State. The research also confirmed reticulation monitoring, storage service, treatment, effective usage, water connection and maintenance are the basic approaches for monitoring and managing water quality in Okene while billing influence negatively effective approaches for monitoring and managing water quality in Okene. Finally, innovative water billing system adoption in the study area may promote efficient use and affordability of water.

A. Recommendations

Based on the study findings and conclusion, the following recommendations are made:

1. Government and other key stake holders in the community show painstaking identify the main challenges affecting water availability, utilization and accessibility that accounts for and limitations availability, utilization and accessibility water and address the challenges.

2. Efforts should made the relevant ministries to device sustainable improved strategies on water infrastructures, treatment and supply for water availability, utilization and accessibility in Okene, Kogi State.

3. Due to the topographical nature of the environment effective reticulation monitoring, storage service provisions, right quality treatment of water, campaign on effective usage, proper water connection and maintenance are mainly approaches suggested by the study the best approaches of monitoring and managing water quality in Okene.

4. To avoid payment of water bills innovative water billing system adoption is very important with fair pricing mechanism.

5. Due to paucity of fund, PPP on investible water projects should be encourage by the government at all levels in the state.

B. Further studies

Suggestion for further research in the area-Okene and Kogi Central:

- To identify qualitatively measures of providing clean and reliable water supply to 80% of households.
- Identify methods of improving water quality and reduction of water-borne diseases.
- Creating links to increase access to water for use, irrigation, and supporting agricultural development.
- How to Strengthen community involvement in water resources management.

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