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Assessment of Water Access, Quality, and Infrastructure using Kobo Toolbox in Mairi Ward, Jere LGA, Borno State, Nigeria

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Abstract: This study assessed water access, quality, and infrastructure in Mairi Ward, Jere LGA, Borno State, Nigeria, using Kobo Toolbox for real-time data collection. A systematic random sampling of households revealed that 68% rely on piped water, while others use boreholes (17%) and wells (3%). Most residents (63%) spend less than 1 hour daily collecting water, but 4% spend over 2 hours, indicating access disparities. Water quality perception indicated 33% "fair," 26% "good," 18% "excellent," and 23% "poor," highlighting contamination concerns. Infrastructure assessment showed 21% of pipe networks suffer leakages, with only 21% regularly maintained, while 79% face irregular or no maintenance. Socio-demographic analysis found 47% of respondents were civil servants and 66% had tertiary education. Notably, 55% of residents do not pay for water services, raising concerns about sustainability. Findings emphasize urgent interventions to improve water quality, infrastructure maintenance, and community engagement to ensure equitable access to safe water in Mairi Ward.

Keywords: *Water Access, Water Quality, Infrastructure Assessment, Kobo Toolbox.*

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I. INTRODUCTION

Access to clean and reliable water remains a fundamental human right and an essential component of sustainable development [22]. In many parts of Nigeria, especially in the northeastern region, water supply infrastructure is often inadequate, inconsistent, or compromised due to various socioeconomic and environmental challenges [21, 24]. Mairi Ward, located in Jere Local Government Area (LGA) of Borno State, is a semi-urban community that characterizes such challenges. Despite its proximity to Maiduguri, the capital of Borno State, residents of Mairi Ward face persistent issues related to water accessibility, quality, and infrastructure maintenance [2].

The assessment of water infrastructure and quality is critical for informing policy, improving community health, and planning sustainable development interventions [24, 25]. This study leverages Kobo Toolbox, a digital data collection platform, to gather accurate, real-time data on the status of water infrastructure, the quality of water consumed, and the socio-demographic characteristics influencing water use in Mairi Ward [9]. By analyzing various indicators, including the primary sources of water, time spent accessing water, leakages in pipe networks, and household perceptions of water quality, this study provides empirical insights necessary for informed decision-making [21].

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Digital tools like Kobo Toolbox have proven valuable in collecting real-time, geo-referenced data for water assessments in low-resource settings, enabling better planning and monitoring of water-related projects [9]. Despite the tool's increasing application in humanitarian and development contexts, limited studies have utilized it specifically to evaluate water access and infrastructure at the community level in northeastern Nigeria. This study fills that gap by applying Kobo Toolbox to assess water access, quality, and infrastructure in Mairi Ward, Jere LGA.

➢ *Statement of the Problem*

Access to safe and reliable water remains a persistent challenge in many low- and middle-income regions, including Nigeria. In the northeastern part of the country, the situation is exacerbated by infrastructural decay, population growth, urban sprawl, and security concerns, which have severely strained existing water systems [21]. Mairi Ward, situated in Jere Local Government Area of Borno State, reflects these issues, as many households rely on unsafe or unreliable water sources such as unprotected wells, boreholes, and seasonal streams.

Moreover, leakages in the water distribution network, lack of regular maintenance, poor institutional oversight, and inadequate public awareness have compounded the problem, leading to inefficient water supply systems [15, 2]. Despite investments and interventions by government agencies and NGOs, there is a critical data gap regarding the actual conditions of water infrastructure and the quality of water accessed by residents in semi-urban communities like Mairi.

A systematic assessment using modern tools such as Kobo Toolbox is essential to gather empirical data that can guide policy, enhance infrastructure planning, and promote sustainable water management practices. Understanding the community's socio-economic background, perceptions of water quality, and the challenges they face in accessing water will provide a holistic picture necessary for strategic interventions [25].

➢ *Objectives*

- To assess the demographic and socio-economic characteristics of residents in Mairi Ward, including occupation and educational levels, in relation to water usage and access.
- To identify the primary sources of water used by households and evaluate the average daily time spent on water collection and usage.
- To evaluate the quality and cost of water supply, including household perception of water quality and the frequency of bill payments.
- To assess the condition and maintenance of water supply infrastructure, particularly focusing on leakages and challenges in water distribution networks.

II. MATERIAL AND METHODS

➢ *Study Area*

This study was conducted in Mairi Ward, located in Jere Local Government Area of Borno State, Nigeria as presented in Figure 1. The area is characterized by a growing population and mixed residential-commercial land use, which places pressure on basic infrastructure, including water supply systems.

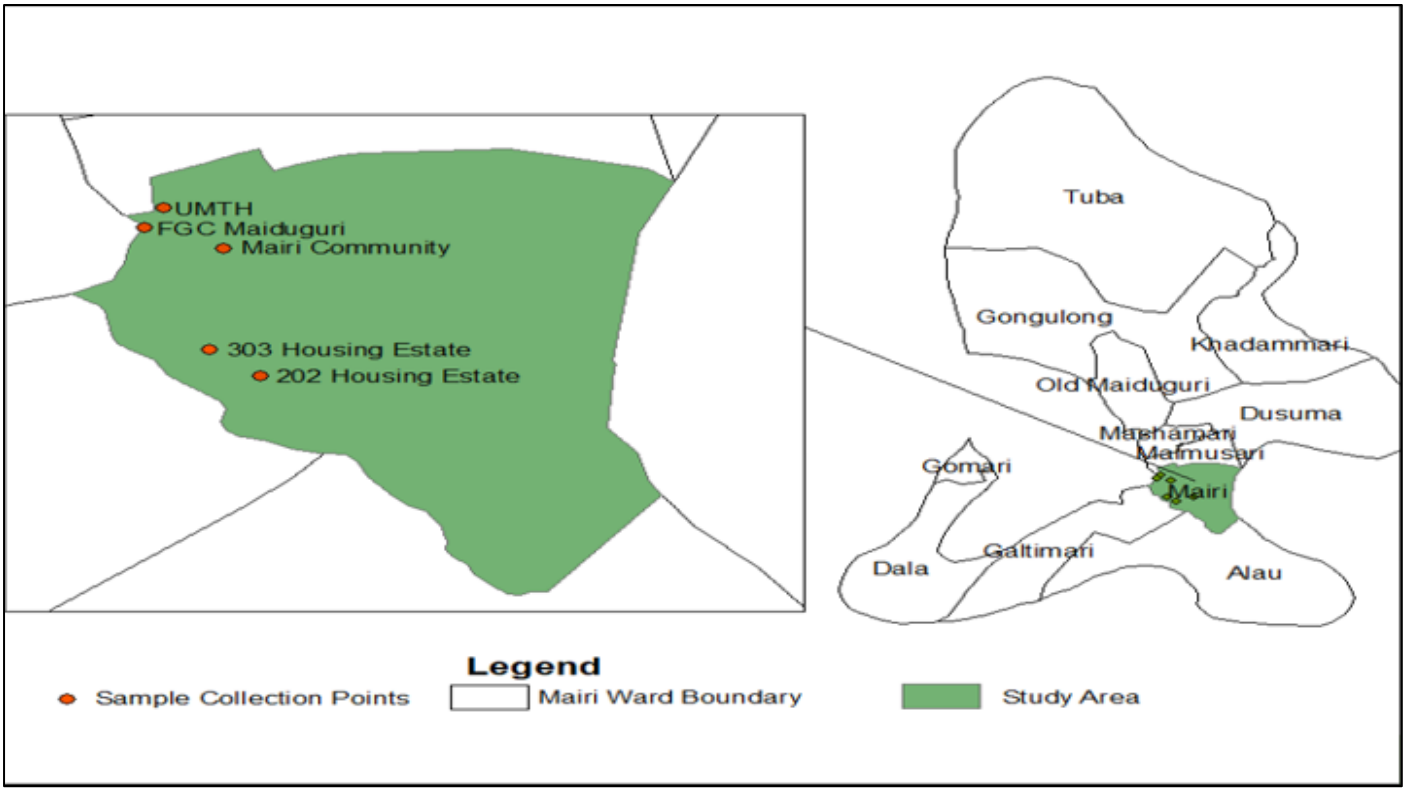

Fig 1 Map of Study Area Mairi Ward. Source: Esri. (2022).

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➢ *Data Collection Tool*

In this study, Kobo Toolbox, an open-source suite designed for digital data collection in challenging environments, was employed to develop and administer structured questionnaires. The platform facilitated the efficient gathering of geo-referenced, real-time data from respondents within Mairi Ward, Jere LGA. By utilizing mobile devices for fieldwork, the tool significantly minimized the risks of data loss, duplication, and entry errors commonly associated with traditional paper-based methods [9]. Furthermore, the ability to synchronize collected data with a central server in real time enhanced data accuracy, ensured timely monitoring of survey progress, and enabled faster analysis and decision-making [6]. The platform's user-friendly interface and offline data collection capability also made it particularly suitable for use in resource-limited and conflict-prone areas such as northeastern Nigeria [23].

➢ *Sampling Technique*

A systematic random sampling technique was employed to select households across various communities within Mairi Ward for data collection. This method involved choosing every fifth household starting from a randomly determined point, thereby ensuring an unbiased and evenly distributed spatial representation of the study area [12]. The use of systematic sampling allowed for a practical and efficient approach to gathering data in field conditions, particularly in areas with limited resources and where complete household listings were not readily available [7]. Enumerators followed a predefined interval, which minimized selection bias and facilitated broad community engagement during the survey process.

➢ *Data Collection Procedure*

Trained enumerators conducted face-to-face interviews using Kobo Collect on Android smartphones to gather real-time, geo-tagged data. A structured questionnaire with both closed- and open-ended questions was used, covering socio-demographics, primary water sources, average time spent collecting water, perceptions of water quality, water bill payment practices, the condition of water infrastructure, and challenges in accessing water. The use of Kobo Toolbox enabled accurate and efficient data collection suitable for the local context [9, 21, 25].

➢ *Data Analysis*

The data collected using Kobo Toolbox were exported into Microsoft Excel and SPSS for cleaning and analysis [9]. Descriptive statistics, such as frequencies and percentages, were employed to summarize the responses [18]. Visual representations, including pie charts, were generated to illustrate key findings across various indicators. These included occupational distribution, educational levels, primary sources of water, average time spent on water usage, water bill payment status, perceptions of water quality, pipe network leakages, pipe maintenance practices, and challenges in accessing water supply. This analytical approach provided a structured overview of the socio-demographic characteristics and the water infrastructure status in Mairi Ward, Jere LGA, facilitating evidence-based interpretation of the community's water access and quality.

III. RESULTS AND DISCUSSION

Access to clean and reliable water is essential for public health, economic development, and environmental sustainability. In Mairi Ward, assessing the current state of water infrastructure, identifying challenges affecting supply, and analyzing surface water quality are critical for effective water management. The Kobo Toolbox survey results provide valuable insights into these key aspects, helping to inform policy recommendations and community interventions.

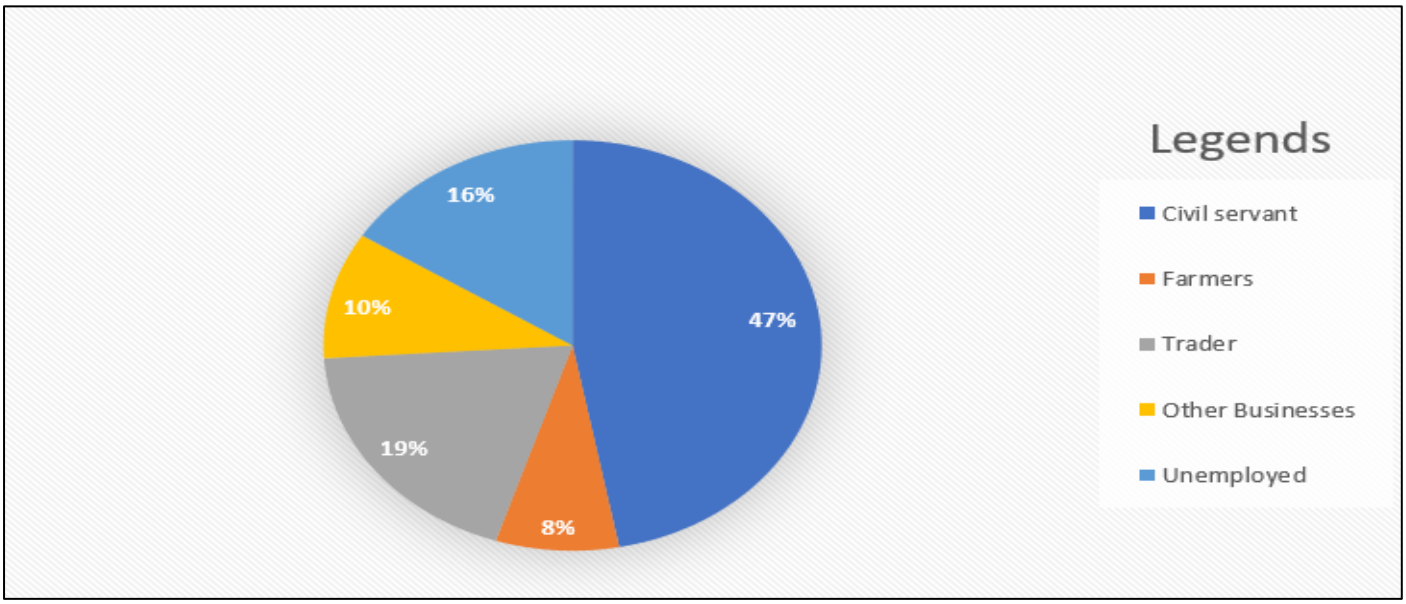

Fig 2 Occupational Distribution Chart

The occupational distribution of respondents in Mairi Ward reveals that civil servants constitute the majority at 47%, followed by traders (19%), unemployed individuals (16%), those engaged in other businesses (10%), and farmers (8%) as presented in figure 2. The dominance of civil servants suggests a significant presence of formal employment, likely

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influenced by nearby institutions such as the University of Maiduguri and UMTH. The relatively high proportion of respondents involved in trading and informal businesses (29% combined) indicates a vibrant informal sector, aligning with previous studies [26] that identified commerce as a key livelihood in peri-urban Maiduguri. The 16% unemployment rate highlights a considerable economic vulnerability, which may affect the community's ability to maintain water infrastructure and adopt household-level water treatment solutions. The low percentage of farmers reflects ongoing urbanization and reduced access to farmland, corroborating findings by [15] on land use changes and insecurity in urban Borno.

This occupational structure correlates with disparities in water access and quality, as lower-income or unemployed groups are more likely to depend on unreliable water sources, emphasizing the need for targeted infrastructure interventions [10, 27].

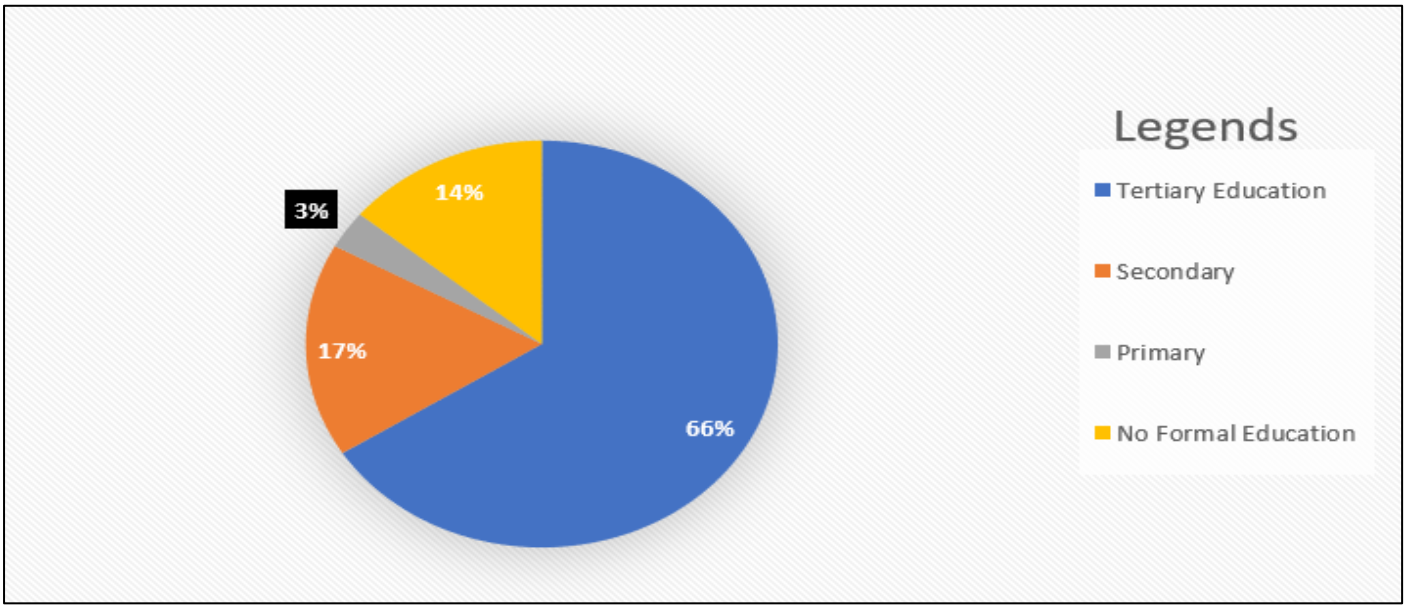

Fig 3 Educational Level Chart

The Figure 3 reveals that 66% of respondents in Mairi Ward have tertiary education, followed by 17% with secondary education, 14% with no formal education, and 3% with only primary education. This distribution indicates a highly educated population, which is advantageous for water resource management and awareness campaigns. Studies have shown that communities with higher literacy levels are more likely to understand, demand, and maintain safe water infrastructure [3, 26]. Furthermore, [10] emphasized that education significantly improves participation in environmental health initiatives.

The minority (17%) without secondary education may require targeted outreach to ensure inclusive engagement in water quality and infrastructure programs.

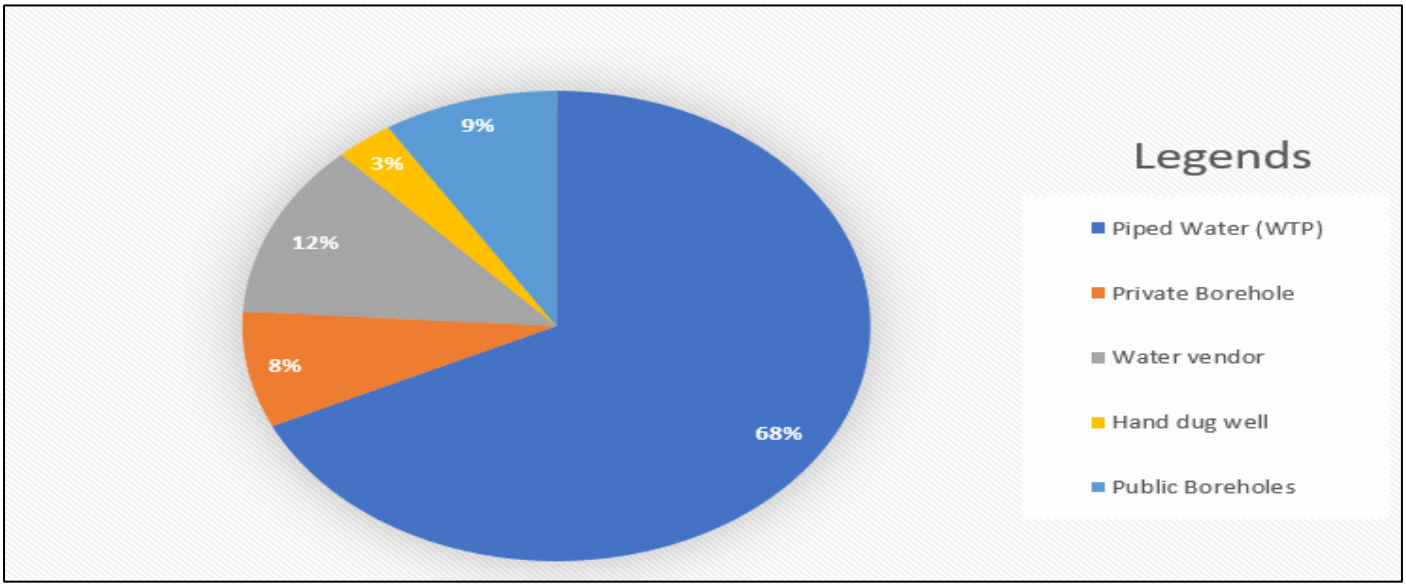

Fig 4 Primary Sources of Water Chart

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The figure 4 shows that 68% of Mairi Ward residents rely on piped water, indicating strong dependence on municipal supply. However, 12% use water vendors, 9% rely on public boreholes, 8% on private boreholes, and 3% on hand-dug wells, revealing service gaps and the need for supplementary sources. This pattern aligns with previous studies [1, 10] which highlight inconsistent water supply and infrastructural challenges. The low use of hand-dug wells also reflects broader trends [15, 21] showing a shift away from unsafe traditional sources. Improving the reliability of piped water could reduce dependence on alternative sources and health risks.

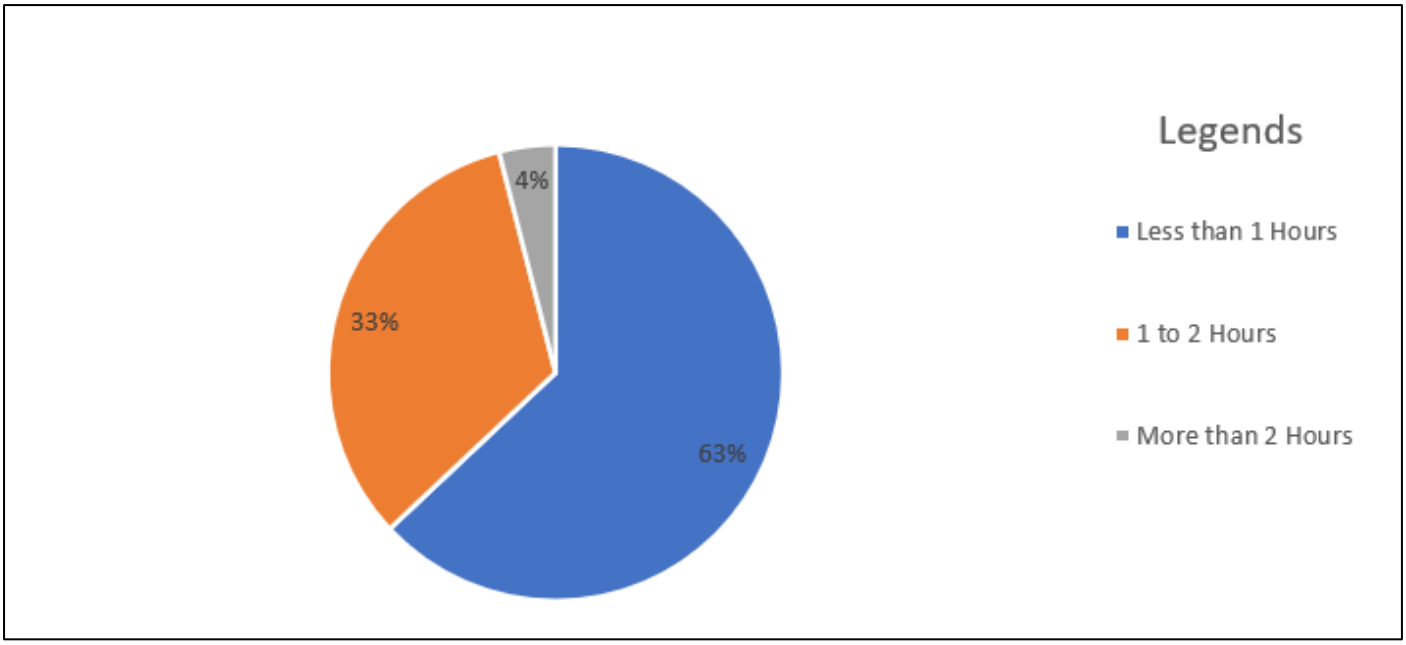

Fig 5 Daily Average Time Spent on Water Usage

The pie chart (Figure 5) illustrates the average daily time spent on water usage in Mairi Ward. A majority of respondents (63%) spend less than 1 hour, indicating relatively good access to water. About 33% spend 1 to 2 hours, suggesting moderate accessibility, while only 4% spend more than 2 hours, reflecting limited access or distant sources. This pattern aligns with [21], which states that water access should require less than 30 minutes round trip to avoid negative impacts. Similarly, [5] found that long water collection times in Nigeria affect productivity and health.

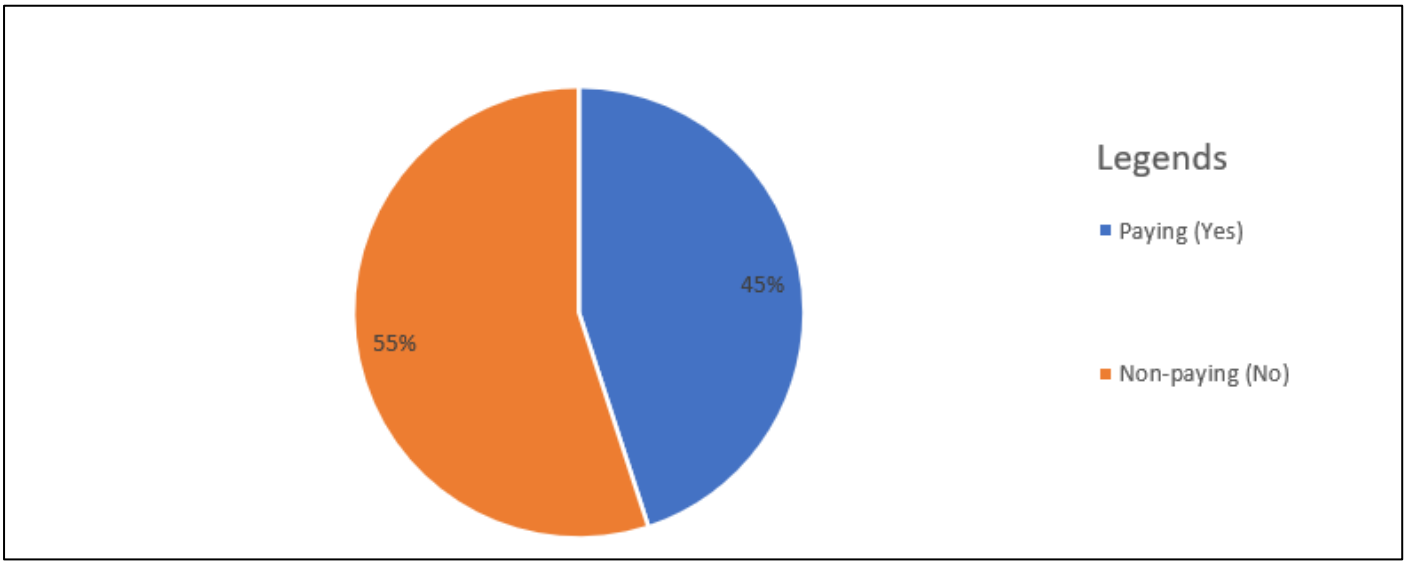

Fig 6 Payment of Water Bill

The Figure 6 illustrates the distribution of payment for water services in Mairi Ward. According to the data, 55% of respondents do not pay for water, while 45% do. This suggests that more than half of the population either accesses free water sources (such as public boreholes or natural sources) or possibly relies on informal arrangements. The relatively high percentage of non-payment may indicate issues in water supply regulation, affordability, or willingness to pay. This aligns with [17], who found that households often avoid paying for water where service quality is poor or where

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alternative sources are available. Similarly, [6, 10] identified a strong link between socio-economic status and willingness to pay for improved water services in Nigerian communities. In conclusion, while 45% of households contribute financially to water access, the 55% who do not may reflect gaps in infrastructure, enforcement, or economic constraints. Addressing this imbalance is critical to ensuring sustainable water service provision in the region.

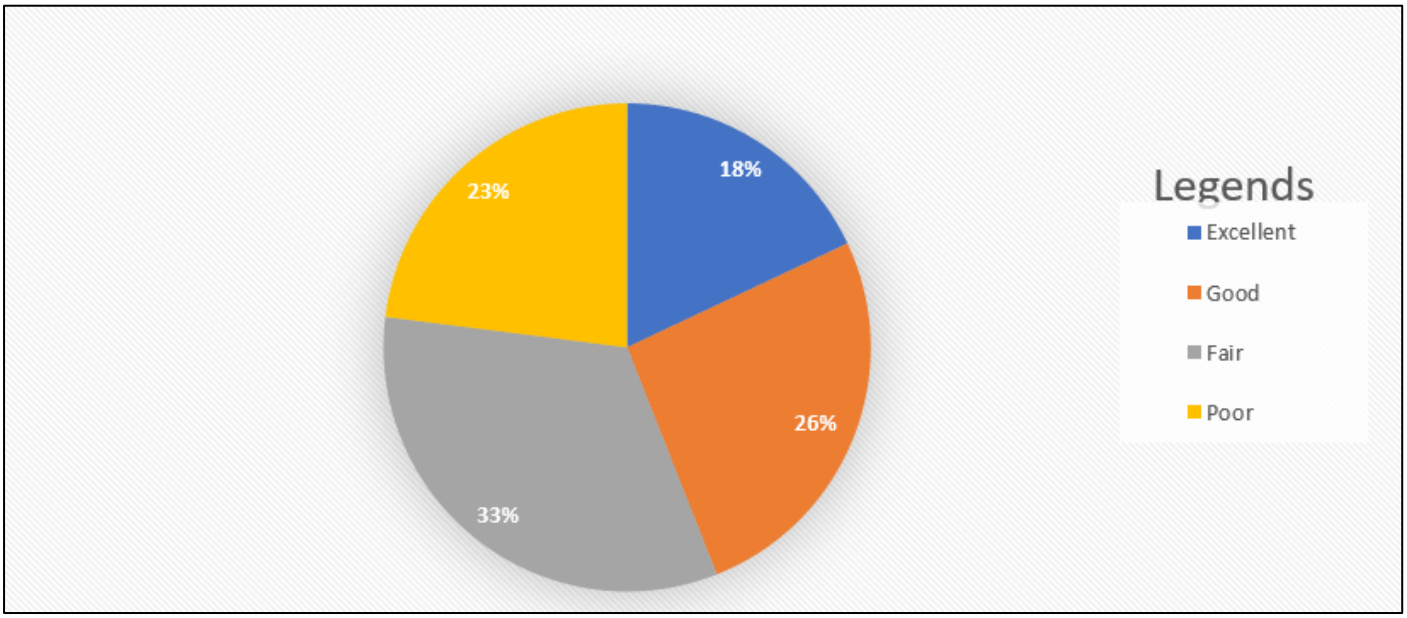

Fig 7 Water Quality Chart

The largest proportion of water sources (33%) falls under the "fair" category, indicating water that is moderately clean but may require some treatment before use as shown in Figure 7. "Good" water quality accounts for 26%, suggesting a relatively safe water source for domestic consumption, possibly meeting basic WHO standards [25].

"Excellent" water, which is highly desirable for both drinking and cooking without additional treatment, is at a relatively low 18%, highlighting limited access to high-quality sources. The "poor" category (23%) is concerning, indicating the presence of contaminants that may pose health risks to the population, potentially due to bacterial contamination, industrial effluents, or poor sanitation [4]. Several studies corroborate these findings. [13] found that in urban–rural fringes of Borno State, over 30% of wells exhibited only fair water quality due to surface runoff and inadequate sanitation. Similarly, [13, 16] reported that access to excellent water in Maiduguri metropolitan was limited to areas with boreholes drilled deeper than 120 m and protected from surface influence. The 23% of poor-quality water aligns with results from [20], who reported coliform contamination in shallow wells in Jere LGA due to proximity to pit latrines and refuse dumps.

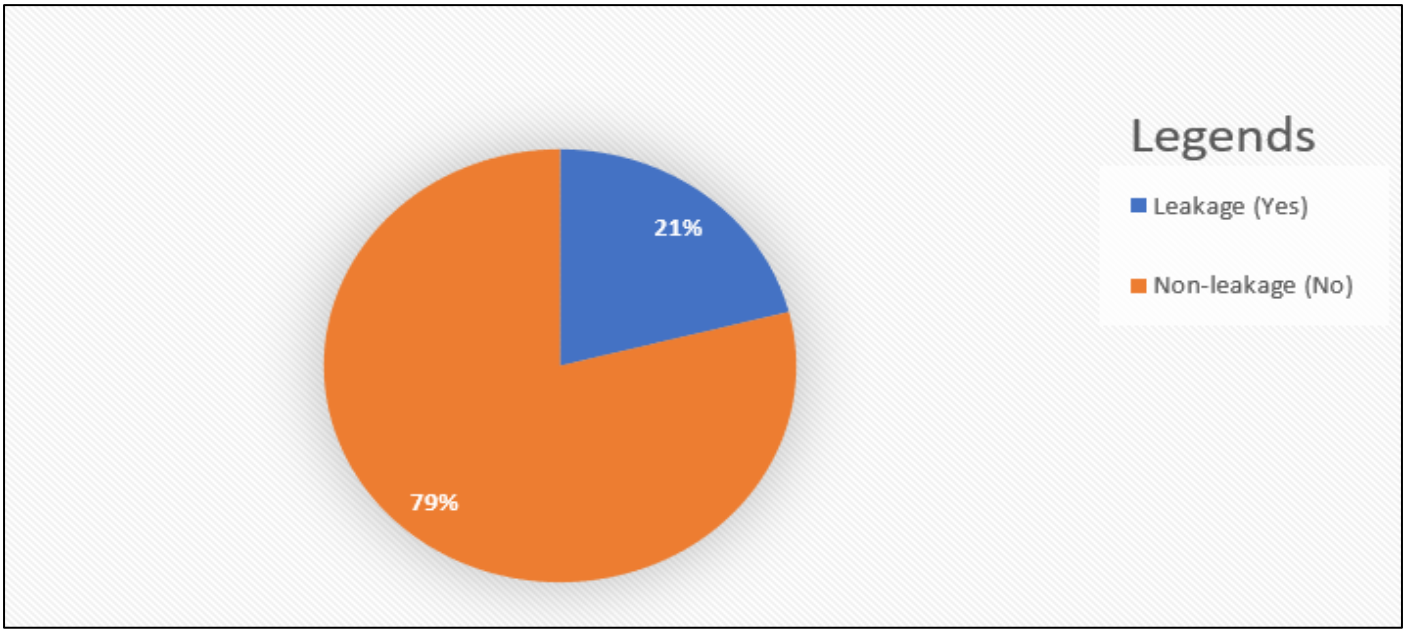

Fig 8 Water Supply Pipe Network Leakages

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The pipe-borne water distribution in Mairi Ward reveals that 21% of the network experiences leakages, while 79% remains leak-free as indicated in Figure 8. This indicates that although the majority of the water infrastructure is functional, over one-fifth suffers from physical deterioration, likely due to aging pipes, poor maintenance, and fluctuating water pressure. Such leakages not only result in significant water losses but also pose contamination risks, especially in areas with intermittent supply.

This finding aligns with [27], who reported similar leakage rates of 18–25% in Maiduguri's urban network, and with [5, 2], who linked high leakage rates in Nigerian cities to corroded materials and inadequate repair systems. The persistence of these leakages suggests that water infrastructure in Mairi Ward requires urgent attention through regular monitoring, improved maintenance, and community engagement to prevent further losses and ensure safe, continuous supply. Without intervention, these losses could compromise both public health and water availability.

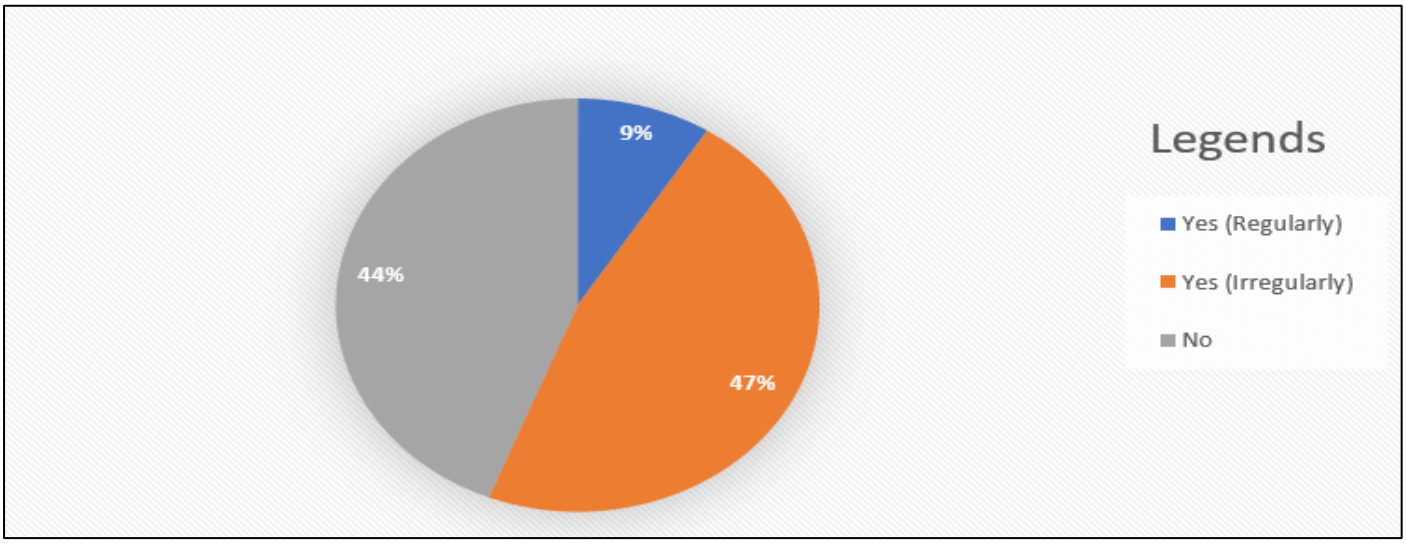

Fig 9 Water Supply Maintenance Pipe Network

The figure 9 reveals that only 21% of the network receives regular maintenance, 47% is maintained irregularly, while 32% is not maintained at all. This pattern indicates a serious gap in the systematic upkeep of water infrastructure, with over three-quarters (79%) of the network either poorly maintained or entirely neglected. The irregular maintenance (47%) likely results from a lack of structured maintenance schedules, insufficient funding, or poor institutional coordination, which increases the risk of leakages, contamination, and service disruptions.

The absence of maintenance for 32% of the network is particularly alarming, as it reflects high vulnerability to infrastructure failure and public health hazards. These findings align with [16, 19], who reported that inadequate routine checks and reactive repair strategies dominate water utilities in northeastern Nigeria. Similarly, [27] found that irregular maintenance contributed to prolonged leakages and water losses in Maiduguri's distribution system.

The relatively low figure (21%) for regular maintenance suggests the need for policy reforms, improved budgeting, and community-based monitoring to ensure the sustainability and safety of the water supply network.

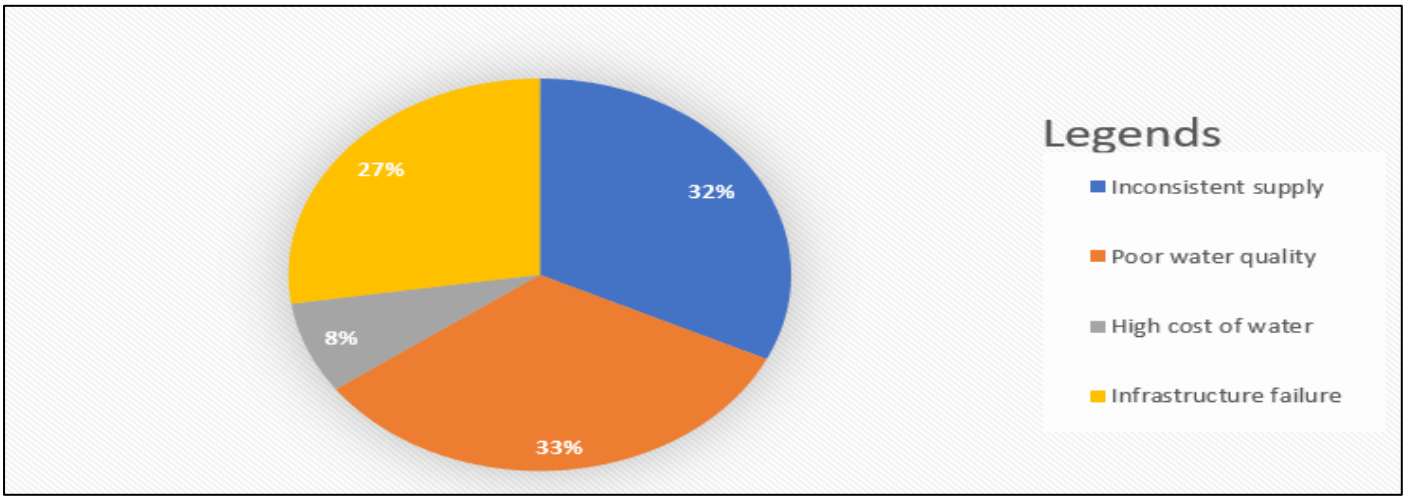

Fig 10 Challenges of Accessing Water Supply

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The figure 10 presents that 33% of residents identified poor water quality as the most critical issue, followed closely by inconsistent water supply at 32%. Infrastructure failure accounts for 27% of the challenges, while 8% cited the high cost of water as a significant barrier.

These findings highlight that the majority (92%) of the problems relate directly to supply reliability and quality, indicating systemic issues in the water management framework. Poor water quality suggests contamination risks from inadequate treatment or intrusion into aged or leaking pipelines a concern echoed by [11, 13], who reported microbial contamination in shallow boreholes in Maiduguri. The prevalence of inconsistent supply reflects limited infrastructure capacity and erratic power for pumping, consistent with observations by [19], who noted that water delivery in Jere LGA depends heavily on boreholes with irregular power access. Infrastructure failure, accounting for over a quarter of challenges, reflects pipe burst issues, valve malfunctions, and lack of timely maintenance. Although only 8% reported high water cost as a primary issue, it remains a constraint for low-income households relying on water vendors.

In conclusion, the dominant challenges poor quality, supply inconsistency, and failing infrastructure demand comprehensive policy reform and investment in water infrastructure, treatment systems, and community engagement for sustainable water access.

IV. CONCLUSION

The assessment of water access, quality, and infrastructure in Mairi Ward reveals mixed outcomes. While the majority benefit from piped water and relatively short collection times, the presence of poor water quality for 23% of sources and significant pipe network leakages (21%) threatens public health and water availability. The low rate of regular maintenance (21%) exacerbates infrastructure degradation, risking further service interruptions. Socioeconomic factors, including a high rate of non-payment for water services (55%) and unemployment (16%), may hinder sustainable water system management. The high educational attainment (66% tertiary) offers potential for community-led initiatives and awareness. Overall, despite progress, Mairi Ward faces critical challenges in ensuring safe, reliable, and sustainable water supply, necessitating coordinated efforts from government agencies, NGOs, and the community. Improving water infrastructure, reducing pipeline leakages, monitoring water quality, promoting affordable and reliable water supply, raising community awareness on water safety, and utilizing digital tools like Kobo Toolbox are continuously contributing to effective data collection and management.

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