How Household Water Use Characteristics and Sense of Water Kiosk Ownership Influence Financial Sustainability of Community-Managed Borehole Water Kiosk Service in Kisumu County, Kenya

Jacktone Omullo Akelo[1]
Daniel Muasya Nzengya[2]

[1]joakelo1971@gmail.com
[2]dmuasya@spu.ac.ke

[1]https://orcid.org/0000-0001-9812-3401
[2]https://orcid.org/0000-0001-6588-364X

[1,2]St. Paul's University, Department of Social Science, P.O. Private Bag, Limuru 00217, Kenya

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ABSTRACT

Access to safe drinking water is a global challenge, with approximately one-quarter of the world's population lacking such access. Kenya, like many Sub-Saharan African countries, grapples with water insecurity, leading to the establishment of water kiosks as a solution. However, these kiosks often face financial sustainability challenges. This study examined the influence of user household characteristics, technical designs, and governance factors on the financial sustainability of community-managed borehole water kiosk services in Kisumu County, Kenya. The specific objectives were twofold. The first objective was to analyse the influence of water kiosk household characteristics. The second objective was to assess the influence of user households' sense of ownership on the financial sustainability of community-managed water kiosk services. A mixed-methods research design was employed, combining qualitative data from three focus group discussions with 31 water kiosk operators and quantitative data from questionnaires administered to 460 user households. Descriptive statistics and binary logistic regression were used to analyse quantitative data, while thematic analysis was used to analyse qualitative data. In the first objective, the study findings revealed that user satisfaction had a statistically significant influence on the financial sustainability (odds ratio = 3.36; p =.01) of community-managed borehole water kiosk services. Other statistical significance was revealed for time taken to fetch water (odds ratio = 3.52; p =.001) and household seasonal use of the water from the water kiosks (odds ratio = 11.20; p =.001). For the second objective, study findings revealed that payment for membership to the borehole water kiosk (odds ratio = 3.64; p =.001) and users' perception of ownership of the water kiosk for the people living within the village (odds ratio = 0.41; p =.001) were revealed to be statistically significant in influencing the financial sustainability of community-managed borehole water kiosk services. Results from qualitative analysis triangulated these findings from statistical analysis. For instance, during the focus group discussions, the kiosk operators were equally concerned about the seasonal patterns of fetching water from the borehole water kiosks. Therefore, efficient service delivery, water quality maintenance, and responsiveness to seasonal variations are essential for financial sustainability. Membership fees play a crucial role in financial support, while the complexity of ownership beliefs suggests the need for tailored engagement strategies. Finally, land tenure issues should be addressed to enhance kiosk sustainability. Policymakers and stakeholders should consider these findings to develop strategies that ensure reliable access to safe drinking water in Kenya and similar regions.

Keywords: Financial Sustainability, Seasonal Patterns, Sense of Ownership, User Households, Water Kiosk

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I. INTRODUCTION

Continued access to a safe water supply remains an important issue in water resource management and development (Egbinola, 2017). The United Nations (UN) SDG6 Target 6.1 advocates for achieving universal and equitable access to safe and affordable drinking water for all. On the other hand, Target 6b calls for support and strengthening of the participation of local communities in improving water and sanitation management (Ortigara et al., 2018). The five aspects of these two targets for access to water include universality, equitability, safety, affordability (Ojha et al., 2018), and participation of local communities. The Constitution of Kenya-2010 provides that "every person has the right to clean and safe water" (Kenya, 2013) in Section 43 (1d), while Kenya's Vision 2030's goal is "to increase both access to safe water and sanitation in both rural and urban areas beyond present levels." These global and national-level policy documents acknowledge and commit to the importance of water resources and related services as a basic need and the desire for their optimal management.

Access to at least basic drinking water is about 63% in Kenya (WHO/UNICEF JMP, 2023), with a wide discrepancy between the rural and urban communities. Access to improved water in Kisumu County was 58%, according to the County Government of Kisumu (2018), with some areas like West Nyakach Ward being as low as 22% and Seme Sub-County being 42% of the population. While water service provision is infrastructure-intensive with complex engineering processes, a limited number of government and development agencies are unable to start or successfully finish their water projects (Hamlet et al., 2020). Therefore, many funders and development agencies resort to establishing boreholes with kiosks extended from such boreholes as improved sources of water. Though it is a noble idea to reach out to community members, these borehole water kiosks are insufficient in number. Furthermore, they frequently become dysfunctional within a short period of time (Moriarty et al., 2013). For example, while a study reported that 19 of 25 (76%) donor-funded water projects were non-functional in September 2018 (Nyakwaka & Benard, 2019), the mapping by the Water Department of the County Government of Kisumu (CGK) conducted in 2021 showed a non-functionality of 24%.

The frequent breakdown of boreholes and borehole water kiosks implies that the kiosk water service is not available during such a time, therefore not providing the user households with the safe and regular water service that was aimed at the time of establishment. The users of such non-functional water kiosks are faced with the option of lacking access to the right quantity and quality of water with the desired regularity. Hence, the users of such non-functional water kiosks revert back to using the water from sources that might not be safe, far away, or in sufficient quantity. It is estimated globally that 829,000 deaths are attributed to water, sanitation, and hygiene (WASH-attributable) causes (Prüss-Ustün et al., 2019), with many countries in the SSA, including Kenya, having one of the highest disease burdens associated with poor water, sanitation, and hygiene. When there are frequent cases of water kiosks, there is a reverse of the gains that might have been made on the incidences of water-related diseases, a burden on members of the family collecting water from far distances, or a loss of regained time and livelihood activities that might have already been realized. Furthermore, the turn-around time before such water systems (kiosks, boreholes, or piping) are restored to operate, the frequency of their breakdown, and the continuous operations and maintenance of the water kiosks are key components of the technical designs and governance of such community-based water systems. On the other hand, there is currently limited research conducted and documented on how the kiosk user households' characteristics influence these dysfunctionalities.

This study investigated the influence of borehole water kiosk user household characteristics on the financial sustainability of community-managed borehole (CM-BH) water kiosk services within Kisumu County, Kenya. The specific objectives were twofold. The first was to analyse the influence of water kiosk user household characteristics on the financial sustainability of borehole water kiosk services. The second objective was to assess the influence of user households' sense of ownership on the financial sustainability of community-managed borehole water kiosk services.

The research was guided by socio-technology theory (Ropohl, 1999), which provided that the technical systems that ignore social requirements are bound to fail, while the social systems that ignore technical support do not run well. Three key issues were looked at by the proponents of this theory. First, it was the temptation to use water engineering technology that is alien to users, taking more than authorised access outside the agreed-upon time, or some members vandalising the systems. The second was that there should be an overlay between the social and technical aspects of the water system establishments. Finally, there was a need for both technical and human factors to be given the same weight in the establishment of the water system. The socio-technology theory bases both the user household characteristics and sense of ownership on the community-managed borehole water kiosk.

II. METHODOLOGY

2.1 Study Design and Site

The mixed-methods design of the study was adopted, which involved cross-sectional data collection from January to April 2022. It combined qualitative and quantitative research designs with a pragmatic paradigm, giving the researcher an opportunity to learn and use both traditions in qualitative and quantitative approaches (Onwuegbuzie & Leech, 2005). The study site was comprised of three sub-counties, namely Nyakach, Nyando, and Seme, which were considered appropriate to the research objectives because the majority of the rural residents rely on community-managed water kiosks receiving water from community-managed boreholes.

The management of borehole water service provisions in Kisumu was undertaken through various models of governance. These included those that were managed through companies (private or otherwise), professionally managed, or managed through the committees of the schools or health facilities. The other models included privately operated boreholes and community management through water user associations (WUAs). The WUAs are community-based organisations (CBOs) involved in the management of specific community-managed boreholes.

From the data generated from the County Water Offices, it was established that 78% of community-managed boreholes were done through CBO structures referred to as the WUAs. As observed by other authors, the strategies on WUAs provide flexibility in the rules and regulations for adjustments (Engler et al., 2021). These authors also acknowledged that the possible challenges of WUAs include the size of WUAs and community homogeneity that has implications for voting or non-voting patterns; monitoring of the water systems through patrons or self-inspection; the implementation of effective graduated sanctions; and the power difference between the WUA members.

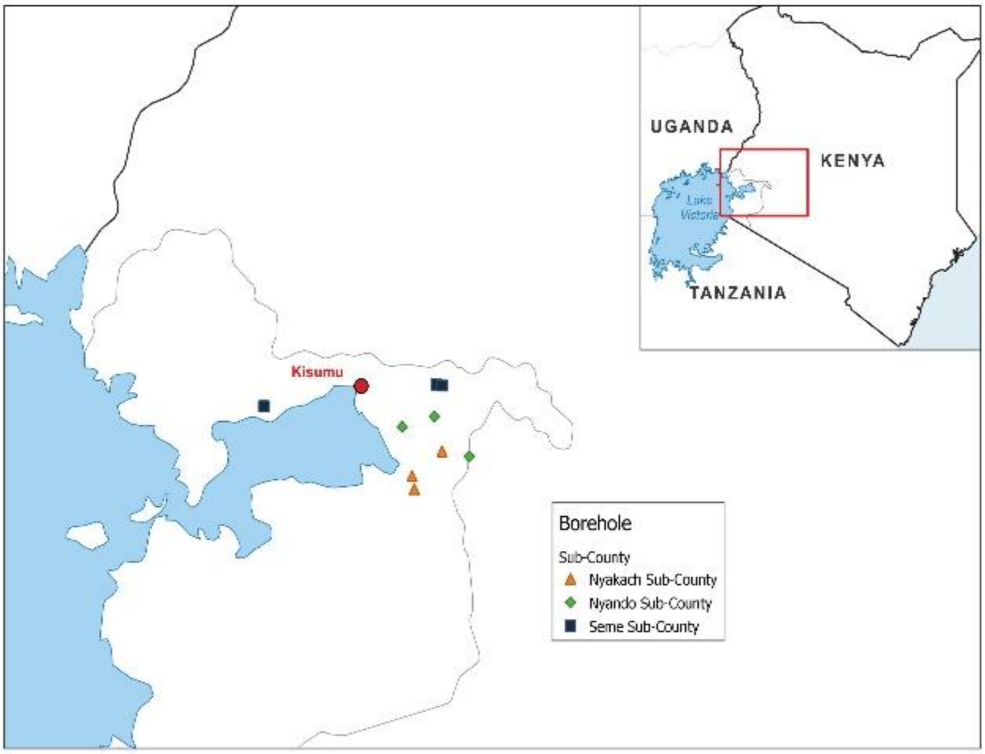

Figure 1
Borehole Study Sites

In order to identify community-managed boreholes and water service points where data was to be collected, purposive elimination and purposive selection were used. Applying the sampling methods used by previous researchers using the modelling methods (Ibrahim, 2017; Masduqi et al., 2010), nine boreholes were purposefully selected from the three sub-counties, with each sub-county having three community-managed boreholes. The target population from these boreholes is comprised of 3,375 households that use the borehole water from kiosks. The target population also included the 31 water kiosk operators, attendants, or salespersons responsible for the day-to-day operation of the services; nine secretary or treasurers of the water committees; and four water officers. The sample size comprised 460 households selected from the target of 3,367 households using the Krejcie and Morgan (1970) formula. Stratified random sampling was used to select a sample size from each of the sub-counties, proportional to the estimated number of users of the borehole and water kiosk. The sampled households participated in the completion of the study questionnaires.

Purposive sampling was used to select a total population of 31 participants for data collection using the FGDs and 3 participants for the KII. There were 3 FGDs conducted, one in every sub-county, disaggregated into females and males. The criteria for inclusion were that one must be attached as an operator, attendant, or salesperson at a borehole water kiosk, reporting to a water users' committee. As well, the exclusion included those who might have been hired less than six months before the time of data collection. Three KII participants were purposefully selected. One was the county water officer responsible for coordinating the WASH network within Kisumu County. The others were the secretary and treasurer of the water committee from two of the sampled boreholes within the selected sub-counties.

2.2 Data Collection and Analysis

A questionnaire, organised in three sections, with closed-ended survey questions. The questionnaire was administered face-to-face, with research assistants completing the questionnaire according to participants' responses. Binary logistic regression was used to assess the statistical significance of each of the following independent variables

(IVs) on the outcome variable. The IVs included households' use patterns of the water kiosk water service and user households' sense of ownership of boreholes and water kiosks. The binary logistic regression model adopted as the dependent variable (financial sustainability) had only two possible outcomes. First, the financial sustainability condition of the community-managed borehole water kiosk could be considered low depending on whether the user households paid to access the water at the kiosk and whether such payments were sufficient to meet the recurrent running costs of the borehole water kiosk service. Second, the financial sustainability condition of the community-managed borehole water kiosk could be considered high depending on when the user households paid to access the water at the kiosks, and such payments were sufficient to meet the recurrent running costs of, with some reserved for future eventuality, the borehole water kiosk service.

In order to model the binary logistic regression for the financial sustainability Y (0 or 1), E(Y) = P(Y=1), the dependent variable Y was transformed into a logit form, which is the description of the probability of the presence of the character on interest. In this study, it was high financial sustainability. Thus,

$$logit(p) = \beta o + \beta iXi$$

Where; $logit(p) = \ln(\frac{p}{1-p})$, which is a log of the odds for success; and

βiXi describes a linear combination of a set of user households' characteristics, technical designs and governance factors used as drivers of the financial sustainability.

In assessing the significance of user household characteristics and sense of ownership of the water kiosks influencing the financial sustainability of community-managed borehole water kiosk services in Kisumu County, a question was posed: did user household characteristics and sense of ownership have an influence on the financial sustainability? The most appropriate cut-off level of p = 0.05 was used, as noted in advances in statistical practice and methodologies that report p-values (particularly p = 0.10, p = 0.05, and p = 0.01) with respect to the p = 0.05 benchmark while indicating the significant estimates with *, **, or ***. As well, the confidence levels of logistic regressions were evaluated at 95% (p = 0.05) or 90% (p = 0.10), depending on the nature of the association presented by the p-value. If the $p < 0.05$, then reject the null hypothesis with the βi in the logistic model.

2.3 Qualitative Data Collection and Analysis

The researchers conducted in-depth interviews with purposively selected county water officers in charge of coordination of water supporters within the county, one water committee secretary, and another committee treasurer. The information gathered from the water officer included the implementation policy and legal frameworks for the water borehole water services within respective jurisdictions, appropriate technology, design and layout of the borehole, maintenance of quality, enforcement of management, and functionality of water service systems. At the beginning of each KII, the purpose of the study was explained, an assurance of confidentiality was given, and consent to participate was sought from the participants. For the secretary or treasurer, the information revolved around the frequency of meetings, the training of operators, the corporation with other agencies, budgeting, record-keeping, and savings and spending policies. Other information regarded the costs of construction and future plans for the borehole expansion or otherwise.

The FGD tool was comprised of open-ended questions with the community-managed borehole water kiosk operators. The FGD questions were categorised into three components, including financial sustainability, user households' characteristics, and sense of ownership. For household water use characteristics, the issues probed included seasonal variation in fetching water from the kiosk, payment patterns, container types, and the sizes they use. Finally, financial sustainability issues probed included daily payment collections and use, saving and spending, sales, and record-keeping, among others.

Data from KII and Focus Group Discussion was first transcribed verbatim into readable texts (MS Word). The transcripts that had been recorded in Dholuo were translated into English. This was followed by a qualitative thematic analysis. The FGD and KII data (from the notes and audio transcripts) were analysed manually. This involved the preparation and organisation of the data; reviewing and exploring the data; creating initial codes; reviewing and creating themes; and presenting the themes and findings in a coherent manner. Thus, the transcripts were imported into an Excel file before data analysis started. In the reviews and exploration of data, before the actual analysis of the data began, all the available data was read through. Materials with regard to the FGDs, including the transcripts, notes, observation report, and data collection tool used to collect the data, were reviewed. As the process of going through was going on, notes about any thoughts, ideas, excerpts, or observations were taken from the data that would be helpful during coding.

2.4 Reliability, Validity and Ethical Issues

The questionnaire was pre-tested at the Rabuor Community Water Project, and the collected data showed reliability with a Cronbach's alpha result of about 0.72, indicating a satisfactory level of reliability (Bonett & Wright, 2015). A few actions were taken based on the individual item's content and construct validity. The researchers adjusted the questionnaire to fit in and include these aspects after the pilot. The pretesting of the qualitative data tools was also done to enhance the repeatability, stability, and consistency of the participants' responses and the ability of the researcher to collect and record information accurately. The necessary licences, permits, and approvals for undertaking research in Kenya were sought and obtained.

III. FINDINGS

3.1 Demographic Information of Respondents

The majority of the household heads who responded to the questionnaires were men. The mean age of the household head was shown to be 49 years (± 14 years), with the minimum head being 22 years and the maximum being 87 years old. The average number of children between 0 and 18 years old in the household was found to be 2 children (SD = ±1), with the median and mode being 2.00 children. As well, households with the highest number of children had a maximum of seven children. The average number of children below the age of 5 years was found to be one child per household, with the median and mode being 0.0. As well, the households with the highest number had a maximum of seven children.

The main household members' occupations were found to be farming, business, and self-employment, accounting for over 72%. The proportion of households involved in fishery activities was revealed to be 2%. This finding on fishery activity was surprising, as a number of households were close to Lake Victoria. Table 1 presents the socio-demographic characteristics of the sample.

Table 1

Basic Socio-Demographic Characteristics

Characteristics	Frequency	Percent
What is the gender of head of household?		
Female	194	42.2%
Male	266	57.8%
What is the highest education level of the head of household completed?		
No school	25	5.4%
Primary level	178	38.7%
Secondary level	152	33.0%
College (artisan, certificate, diploma)	81	17.6%
University (Bachelors, Masters, PhD)	24	5.2%
What is the main occupation of the head of household?		
Farming	177	38.5%
Business	104	22.6%
Fisher-folk	9	2.0%
Employed	43	9.3%
Daily Labour	35	7.6%
Self-employed	51	11.1%
House wife/husband	41	8.9%
Wealth Status		
Poorest	158	34.3%
Poor	148	32.2%
Least poor	154	33.5%

3.2 Households Fetching of Water for Domestic Use

The study revealed that about 79% of households acknowledged paying to fetch their water from kiosks. The sufficiency of the amount charged for running the kiosks was reported by slightly less than 58% of the households. The majority of households (89%) used plastic jerricans (20 litres), making at least two trips in a day. About 65% of the households reported that they used the same containers used to transport the water to store it at home. As shown in Table 2, these findings and others have been provided.

Table 2
Household Drinking Water Practices

Characteristics	Frequency	Percent
Do you pay to collect your water from the kiosk?		
No	97	21.1%
Yes	363	78.9%
Is the amount charged sufficient for running of the water kiosks?		
No	196	42.6%
Yes	264	57.4%
What kind of containers do you use to fetch and transport water from the Borehole water kiosk?		
Plastic jerricans (20-litre)	410	89.1%
Plastic jerricans (10-litre)	23	5.0%
Plastic bucket with large opening	23	5.0%
Clay pot	4	0.9%
Do you use the same container for water transport and water storage?		
No	162	32.2%
Yes	298	64.8%
What kind of containers do you use to store the drinking water?		
Clay pot	201	43.7%
Small container with a tap	35	7.6%
Small container without a tap	71	15.4%
Large container with a tap	48	10.4%
Large container without a tap	105	22.8%
How many trips did you make to the water source yesterday?		Mean = 2 trips Mode = 0
Was the water you collected yesterday sufficient for your household need?		
No	135	29.3%
Kind-off	233	50.7%
Yes	92	20.0%
How satisfied are you with your kiosk as drinking water source kiosk?		
Dissatisfied	49	10.7%
Satisfied	411	89.3%

3.4 Influence of User Households' Characteristics on Water kiosk Financial Sustainability

The influence of water kiosk user household characteristics on the financial sustainability of borehole water kiosk services assessed the main sources of household drinking water, the frequency of collecting water from the borehole water kiosk, and the seasonality of use (in dry or rainy seasons) of water kiosk services. The uses included drinking, bathing, cleaning, and washing.

When the households were asked what their main drinking water sources were, they shared various options. The results showed that the majority of households (more than 74%) got their main drinking water from borehole water kiosks, followed by open sources (dam, pan, river, lake). The least preferred source of water was vendor or bottled water at 0.2%. It was shown that around 62% of the households always fetched their water from the borehole water kiosks. The finding showed that almost two-thirds of the households always fetched their water from the borehole water kiosks as their main source. However, the 29% who fetched water only half the time and about 10% who never fetched water from the water kiosks showed a likely fluctuation of incomes at the water kiosks. It is also important to note that two-thirds of the households responded that they were only rather committed to fetching their water from the water kiosks all year long.

The household uses borehole water during rainy and dry seasons. The questions on the seasonality of use sought variables such as the sources, reasons for use of that source, frequency, and time taken for a round-trip to collect water. The study showed that over 35% of the households did consider the frequency of fetching water during rainy seasons (not applicable for these households) for drinking, bathing, cleaning, and washing. However, the proportion of households that considered the frequency of fetching water was reduced to 7% or less during dry seasons. The households that considered the frequency not applicable were those who had water within their compounds. Furthermore, while only around 48% of households made up to two trips daily to fetch their water from their preferred source during rainy seasons, 65% to 73% made up to two trips daily to fetch their water from their preferred source during dry seasons, depending on the use.

Table 3

Household Borehole Water Kiosk Seasonal Use Patterns

Characteristics	Frequency	Percent
Rainy Seasons		
How often do you go to this water source during rainy season to collect the water for drinking purpose?		
Not applicable	180	39.1%
Once per daily	138	30.0%
Twice per daily	84	18.3%
Thrice per daily	31	6.7%
More than thrice per daily	27	5.9%
How often do you go to this water source during rainy season to collect the water for cleaning and washing purpose?		
Not applicable	169	36.7%
Once per daily	119	25.9%
Twice per daily	97	21.1%
Thrice per daily	44	9.6%
More than thrice per daily	31	6.7%
How often do you go to this water source during rainy season to collect the water for bathing purpose?		
Not applicable	164	39.1%
Once per daily	142	30.0%
Twice per daily	101	18.3%
Thrice per daily	31	6.7%
More than thrice per daily	21	5.9%
Dry Seasons		
How often do you go to this water source during dry season to collect the water for drinking purpose?		
Not applicable	31	7.0%
Once per daily	180	39.1%
Twice per daily	155	33.7%
Thrice per daily	59	12.8%
More than thrice per daily	35	7.6%
How often do you go to this water source during dry season to collect the water for cleaning and washing purpose?		
Not applicable	32	7.0%
Once per daily	116	25.2%
Twice per daily	187	40.7%
Thrice per daily	61	13.3%
More than thrice per daily	64	13.9%
How often do you go to this water source during dry season to collect the water for bathing purpose?		
Not applicable	31	6.7%
Once per daily	181	38.3%
Twice per daily	155	33.7%
Thrice per daily	59	12.8%
More than thrice per daily	34	7.4%
In what season do you go several times to collect water from the kiosk?		
Same across seasons	14	3.0%
Rainy seasons	4	0.9%
Dry seasons	442	96.1%

Table 3 provides the descriptive findings of the daily frequencies of the trips the households made to fetch water for different uses during rainy and dry seasons. On the other hand, Table 6 is a summary of findings on the household daily frequencies to select water sources and the reasons for the households choosing those water sources for seasonal water use.

Table 4

Seasonal Water Use Reasons and Frequencies

Water Use	Rainy season	Dry season
Drinking	About 58% fetching three time a day, with reasons • Appealing colour • Source closest to the households	About 86% fetching three time a day, with reasons • The only source available. • Source closest to the households
Washing and cleaning	About 56% fetching three time a day, with reasons • Charge low amount • Source closest to the households	About 59% fetching three time a day, with reasons • The only source available. • Source closest to the households
Bathing	About 60% fetching three time a day, with reasons: • Charge low amount. • Source closest to the households	About 86% fetching three time a day, with reasons • The only source available. • Source closest to the households

Table 5 below presents a cross-tabulation between user characteristics and the financial sustainability of water kiosk services. The overall percentage column shows the proportion of each of the response categories, which is further clustered into individual portions of low or high financial sustainability of water kiosk services for comparative purposes. The statistical significance of the proportions is reported based on Pearson's chi-square test of association at 0.1 and 0.05 significance levels, respectively. Most users (74%) rely on the borehole kiosk (public) as their primary source of drinking water, indicating its significance as a central water supply for the community. Tap water (public or private plot) and open sources (dam, pan, river, or lake) each account for 7% and 8% of users, respectively, suggesting that some users may have alternative water sources. The analysis indicated that the main source of drinking water has a statistically significant relationship with the financial sustainability of water kiosk services ($\chi2 = 0.506$, $p > 0.05$). Notably, users who primarily relied on borehole kiosk water for drinking contributed to higher financial sustainability, with 28.0% reporting high financial sustainability. In contrast, those who rely on tap water (public or private) and open sources (dam, pan, river, or lake) have lower proportions of high financial sustainability at 2.6% and 2.8%, respectively. These findings are provided in Table 5.

A significant portion of users (62%) always fetched water from the borehole kiosk, reflecting a high demand for the kiosk's services. Approximately 29% fetched water from the kiosk half the time, indicating some variability in usage patterns. However, 10% of users never fetched water from the borehole kiosk, suggesting they may rely on other water sources or face specific circumstances. The frequency of fetching water from the borehole kiosk also showed a relationship with financial sustainability, although it was not statistically significant ($\chi2 = 0.245$, $p > 0.05$). Users who fetched water always tended to have a higher proportion of high financial sustainability at 24.8%, while those who never fetched water from the kiosk had the lowest proportion at 2.9%.

Table 5

Association between User Characteristics and water kiosk Financial Sustainability

User characteristic	Response	Overall Percentage	Financial Sustainability of water kiosk services		P-value
			Low	High	
Main source of drinking water					0.506
	Tap (public/private plot)	7%	4.8%	2.6%	
	Borehole kiosk (public)	74%	46.3%	28.0%	
	Hand pump (public/private)	2%	1.7%	0.4%	
	Spring (protected/unprotected)	1%	0.9%	0.0%	
	Dam/Pan/River/Lake	8%	5.0%	2.8%	
	Vendor/Bottled water	0%	0.2%	0.0%	
	Harvested Rainwater	7%	3.9%	3.3%	
Frequency of collecting water from borehole kiosk					0.245
	Never	10%	6.8%	2.9%	

	Half the times	29%	18.9%	9.7%	
	Always	62%	36.9%	24.8%	
Satisfaction with kiosk water for drinking					0.001
	Dissatisfied	11%	8.9%	1.7%	
	Satisfied	89%	53.9%	35.4%	
How long it takes to fetch water from borehole kiosk (Minutes)					0.001
	Below 10	35%	17.5%	17.2%	
	10 -19	17%	10.9%	6.6%	
	20 - 29	22%	15.8%	5.8%	
	30 & above	26%	18.2%	8.0%	
Seasonality in Household Water Kiosk Use					0.001
	Low	54%	46.5%	7.8%	
	High	46%	16.3%	29.3%	

The data show that a large majority of users (89%) were satisfied with the quality of the kiosk water for drinking. This high level of satisfaction was a positive sign for the service's sustainability. It indicated that satisfied users were likely to continue using the service and support its long-term viability. Nevertheless, it was essential to acknowledge that 11% of users expressed dissatisfaction. User satisfaction with the quality of kiosk water for drinking was strongly associated with financial sustainability, with a statistically significant relationship ($\chi 2 = 0.001$, $p < 0.05$). Among users who were satisfied with the water, 35.4% reported high financial sustainability, whereas only 1.7% of those who were dissatisfied contributed to high financial sustainability.

The time users take to fetch water from the borehole kiosk varies. About 35% of users could obtain water in less than 10 minutes, indicating relatively quick and convenient access to the kiosk. However, approximately 17% spend 10–19 minutes, 22% spend 20–29 minutes, and 26% spend 30 minutes or more fetching water. The time it took to fetch water also demonstrated a statistically significant relationship with financial sustainability ($\chi 2 = 0.001$, $p < 0.05$). Users who spent less than 10 minutes and 10–19 minutes to fetch water from the borehole kiosk contributed significantly to high financial sustainability, with proportions of 17.2% and 6.6%, respectively.

Seasonal patterns in water kiosk use were evident among users. Around 54% have low seasonality in their household water kiosk use, indicating consistent reliance on the kiosk throughout the year. In contrast, 46% of users had high seasonality, implying that their water needs fluctuated significantly depending on the time of year. The seasonality of household water kiosk use was significantly related to financial sustainability ($\chi 2 = 0.001$, $p < 0.05$). Users with low seasonality in their water kiosk use exhibit a higher proportion of high financial sustainability at 29.3%, whereas those with high seasonality contributed to high financial sustainability at a lower rate of 7.8%.

Table 6

Influence of User Characteristics in Water Kiosk Financial Sustainability

Predictor	B	SE	Odds ratio	P-value
Main source of drinking water				
(Borehole kiosk (public))				
Dam/Pan/River/Lake	-0.07	0.57	0.93	0.90
Hand pump (public/private)	0.59	0.98	1.80	0.55
Harvested Rainwater	0.53	0.51	1.69	0.30
Spring (protected/unprotected)	-15.37	714.71	0.00	0.98
Tap (public/private plot)	0.34	0.54	1.40	0.54
Vendor/Bottled water	-15.86	1,455.40	0.00	0.99
Frequency of collecting water from borehole kiosk				
(Never)				
Half the times	0.28	0.53	1.32	0.595
Always	0.84	0.57	2.32	0.142
Satisfaction with kiosk water for drinking				
(Dissatisfied)				
Satisfied	1.24	0.49	3.46	0.011

How long it takes to fetch water from borehole kiosk (Minutes)				
(30 & above)				
20 – 29	0.09	0.37	1.09	0.815
10 – 19	0.75	0.39	2.12	0.052
Below 10	1.26	0.33	3.52	< .001
Seasonality in Household Water Kiosk Use				
(Low)				
High	2.42	0.26	11.20	< .001
*Note. Estimates represent the log odds of "Financial Sustainability = High" vs. "Financial Sustainability = Low" *Reference Categories in Brackets				

Table 6 shows the summary of a binary logistic regression analysis showing user characteristics as predictors of the financial sustainability of water kiosk services. The odds ratios and p-values help us understand the strength and significance of the relationships between user characteristics and financial sustainability. Table 6 provides the output of the regression analysis on the influence of household water use characteristics on financial sustainability.

The analysis revealed that the choice of the main source of drinking water does not have a statistically significant impact on the financial sustainability of water kiosk services. Users who primarily rely on water from open sources (such as dams, rivers, and lakes), hand pumps (whether public or private), harvested rainwater, springs (whether protected or unprotected), taps (whether on a public or private plot), vendors, or bottled water do not significantly differ in their likelihood of contributing to high financial sustainability when compared to users who depend on the borehole water kiosk (public). This suggests that regardless of the main source of drinking water, users have similar odds of supporting the high financial sustainability of the kiosk service.

The frequency of fetching water from the borehole kiosk, whether "never," "half the times," or "always," was not found to be a significant predictor of financial sustainability. Users who fetch water more or less frequently from the kiosk did not exhibit significant differences in their likelihood of contributing to high financial sustainability. This suggests that frequency of use does not significantly affect the odds of contributing to the high financial sustainability of the kiosk service. Other factors may be more influential in this regard.

User satisfaction with the quality of kiosk water emerged as a significant predictor of financial sustainability. Those who express satisfaction with the water they obtain from the borehole water kiosks were significantly more likely to support high financial sustainability (odds ratio = 3.46, $p = 0.011$). This means that users who were satisfied with the water quality have 3.46 times higher odds of supporting high financial sustainability compared to users who were dissatisfied. Ensuring water quality that meets users' satisfaction is crucial for financial sustainability.

The time it takes users to fetch water from the borehole kiosk was also an important predictor. Users who spent less than 10 minutes fetching water from the kiosk have the highest odds of contributing to high financial sustainability (odds ratio = 3.52, $p < 0.001$). Users who spent 10–19 minutes had moderately increased odds of high financial sustainability, although this result is only marginally significant (odds ratio = 2.12, $p = 0.052$). However, users who took longer, specifically 20–29 minutes or 30 minutes and above, did not show a significant difference in financial sustainability when compared to those who spent 30 minutes or more. This means that users who spend less than 10 minutes collecting water have 3.52 times higher odds of supporting high financial sustainability compared to those who spend 30 minutes or more. Shorter waiting times appeared to be crucial for financial sustainability.

The seasonality of household water kiosk use was a robust predictor of financial sustainability. Users who experienced high seasonality in their water kiosk use, meaning their usage patterns varied significantly throughout the year, were markedly more likely to contribute to high financial sustainability (odds ratio = 11.20, $p < 0.001$). This means that users with high seasonality in water kiosk use have 11.20 times higher odds of supporting low financial sustainability compared to users with low seasonality. Understanding and adapting to these seasonal usage patterns is essential for maintaining high financial sustainability.

The results suggest that user characteristics such as the source of drinking water, satisfaction with kiosk water, time spent collecting water, and seasonality in use are important factors associated with the financial sustainability of water kiosk services. These findings can guide strategies to improve financial sustainability, including addressing user satisfaction, reducing waiting times, and promoting consistent use throughout the year.

As a conclusion, the quotes from one operator capture:

> *"The kiosk operator in my area has a myriad of challenges; the villagers are rude and non-cooperative when it comes to making payments. This is owing to the fact that they live close to River XYZ, where they draw and use untreated water. There are also some manually constructed boreholes*

that supply water. The few who come to our kiosks, therefore, would be looking for water for cooking and drinking. This then leads us to lower the price of water to five shillings for two twenty-litre containers. Another challenge is that our water is salty, and there is nothing you can do to mediate this saltiness." Female Operator #3 Seme FGD.

3.5 Influence of User Household Sense of Ownership on water kiosk Financial Sustainability

The sense of ownership was assessed based on individual household payments of borehole kiosk membership fees and the belief that the drinking water system was community-owned or that the water system was owned by people in the village. The cross-tabulations in Table 7 show the association between the user households' sense of ownership and the financial sustainability of borehole water kiosk services.

In terms of the payment of membership fees, it is evident that a substantial majority of respondents, accounting for 87.2%, do not pay these fees. Conversely, only 12.8% of the respondents indicated that they do pay membership fees. This suggests that a significant portion of user households were not financially contributing to the operation of the borehole water kiosk services. Users who choose to pay membership fees are notably more likely to be associated with a high level of financial sustainability, constituting 62.7% of this group. Conversely, among users who do not pay membership fees, the majority, accounting for 66.6%, are associated with a low level of financial sustainability. These findings suggest that financial contributions from users, in the form of membership fees, play a critical role in strengthening the financial sustainability of water kiosk services. The p-value for this metric is less than 0.001, confirming a statistically significant association, as shown in Table 7.

Table 7
Association between User Sense of Ownership and water kiosk Financial Sustainability

Ownership aspect	Response	Overall Percentage	Financial Sustainability of water kiosk services		P-value
			Low	High	
Payment of membership	Pay	12.8%	37.3%	62.7%	>.001
	Don't Pay	87.2%	66.6%	33.4%	
Community own water system	Not true at all	3.3%	60.0%	40.0%	0.793
	Very true	96.7%	62.9%	37.1%	
Village people own water system	Not true at all	34.8%	50.0%	50.0%	>.001
	Very true	65.2%	69.7%	30.3%	

Regarding the belief that the drinking water system is community-owned, an overwhelming 96.7% of the respondents expressed a strong belief in this idea. This high percentage underscores the perception among user households that the drinking water system is indeed a community-owned resource. However, further analysis reveals that whether users strongly believe that the water system is community-owned or not at all, the percentages of those associated with low and high levels of financial sustainability remain similar. Among users who do not believe at all that the water system is community-owned, 60.0% are associated with a low level of financial sustainability, while among those who strongly believe in community ownership, 62.9% share this association. Similarly, in terms of high financial sustainability, 40.0% of users who do not believe at all in community ownership are associated with it, compared to 37.1% of those who strongly believe in community ownership. With a p-value of 0.793, it is evident that the belief in community ownership does not significantly impact the financial sustainability of these services.

According to the belief that the water system is owned by people in the village, the responses are less skewed in distribution. While 65.2% of respondents strongly believe that the water system is owned by individuals in their village, a notable 34.8% do not share this belief. Users who strongly believe that the water system is owned by people in the village are more likely to be associated with a low level of financial sustainability, constituting 69.7% of this group. Conversely, among users who do not believe at all that the water system is owned by people in the village, 50.0% are associated with a low level of financial sustainability. In contrast, when it comes to high financial sustainability, 50.0% of users who do not believe at all in village people ownership are associated with it, compared to 30.3% of those who strongly believe in village people ownership. This intriguing result suggests that strong beliefs in village ownership may be negatively affecting the financial sustainability of water kiosk services.

In the binary logistic regression analysis, the researcher examined payment of membership, the community's own water system, and village people's own water system as predictors of the financial sustainability of water kiosk services. Table 8 shows a binary logistic regression model summary result of user households' sense of ownership and financial sustainability of water kiosk services. The reference categories are in brackets, and each regression coefficient is associated with the standard error, the odds ratio, and Pearson's chi-square p-value as a test of statistical significance at 0.1 and 0.05. The focus is on the odds ratio and the p-value (significance level) to understand the influence of these predictors on financial sustainability.

Table 8

Influence of Sense of Ownership on water kiosk Financial Sustainability

Predictor	B	SE	Odds ratio	P-value
Payment of membership				< .001
(Don't Pay)				
Pay	1.291	0.297	3.638	
Community own water system				.799
(Not true at all)				
Very true	0.146	0.571	1.157	
Village people own water system				< .001
(Not true at all)				
Very true	-0.894	0.208	0.409	
*Note. Estimates represent the log odds of "Financial Sustainability = High" vs. "Financial Sustainability = Low" *Reference Categories in Brackets				

Results show that users who reported that they pay membership fees were approximately 3.638 times more likely to have high financial sustainability compared to those who do not pay. The p-value (p<.001) indicates strong statistical evidence that payment of membership significantly influences financial sustainability, with a positive association. This result may suggest that financial contributions in the form of membership fees play a crucial role in ensuring high financial sustainability for water kiosk services. Users who contribute financially are likely to have a vested interest in the borehole kiosk's well-being. This financial commitment strengthens the service's overall sustainability because member contributions may imply having more funds for maintenance, repairs, and improvements to the water facilities.

On the other hand, the results indicated that users who strongly believe that the water system is owned by people in the village are approximately 0.409 times less likely to have high financial sustainability compared to those who do not believe this strongly. The p-value (p<.001) confirms the statistical significance of this association, suggesting that strong beliefs in village people's ownership have a counter-intuitive negative impact on financial sustainability. This result is intriguing and could mean that beliefs in village ownership may imply a perception that other villagers are responsible for the system's functioning, potentially leading to reduced individual contributions.

Users who believed that the water system was community-owned were 1.157 times more likely to have high financial sustainability compared to those who did not. However, the difference is not statistically significant (p =.799). This result suggests that while there is a positive trend in favour of users who believe in community ownership, this association is not statistically significant. It implies that the strength of belief in community ownership alone may not be a strong determinant of financial sustainability.

By looking at the consistent evidence from the cross-tabulation and logistic regression, we can draw the conclusion that paying membership fees greatly raises the chances of being able to keep the business going. This is potentially due to individual initiatives towards borehole kiosk well-being. On the other hand, perceptions of community ownership of water systems may not always translate into tangible financial support and hence do not positively or significantly contribute to the financial sustainability of borehole water kiosk services.

IV. DISCUSSIONS

This study examined the influence of user households' characteristics, borehole water kiosk technical design factors, and governance factors on the financial sustainability of community-managed borehole (CM-BH) water kiosk services within Kisumu County, Kenya. This section discusses the findings, comparing and contrasting them with other previous studies, where available, as well as presenting the implications of such findings.

4.1 User Socio-Demographic Characteristics

The majority of the household heads who responded to the questionnaires were men, and the mean age of the household heads was shown to be 49 years (± 14 years). Most households had 42% females and 58% males, a finding that mirrored that of a different study, which also found about 41% and 59% females and males, respectively (Omondi et al., 2019). This finding confirms the patriarchal nature of the households within Kisumu County and, in general, the majority of the Luo community living in the region.

The study showed that over 79% of households paid for their water, but the payments varied from one borehole location to another, with a 20-litre jerrican remaining the main container for fetching water. Through the FGDs and KII, the tariff for the 20-litre jerrican ranged between KES 2.50 and 5.00. Comparing this tariff to that in a previous study showed that the average price for a 20-litre jerrican was KES 3.01 in the urban informal settlements of Kisumu in 2017 (Nzengya, 2018). This finding suggests that the pricing of community-managed water service seemed to have remained fairly constant within a period of 7 years, despite the economic changes, thus having implications for kiosks to attain financial sustainability.

The study showed that over 65% of households used 20-litre or less jerricans to store their water in the house, and about 33% used larger containers for storage. In another study in Sodo Zuria District of rural Ethiopia, it was revealed that around 45% of the households used 20-litre or less jerricans to store their water, while around 45% stored their water in containers larger than 20-litre jerricans (Admasie et al., 2022). The size of the containers used in fetching, transporting, and storing water at home has a bearing on the financial sustainability of community-managed borehole water kiosks. If the size of the container for fetching water is the same as that for storage, it implies that the user household must wait until the collected water is used. However, if they are different and the storage is larger, the user can make more than one trip and must not wait until the water is exhausted before making a trip to the borehole kiosk.

The study showed that over 70% of households fetched water the previous day, which was sufficient water for their household needs. This result represented household consumption, which could be influenced by factors such as availability of water, distance to and from the water kiosk, and satisfaction with the water from the source. Another study showed that household consumption and water collection distance were strong determinants that influenced household water consumption in a day (Basu et al., 2017). Since distance to the water kiosks (rather time taken) was outside the scope of the study, it would be important to look at this aspect in future studies. Further, an inquiry into why almost 30% of the households did not have sufficient water for their needs would be relevant to explore.

4.2 User Households' Characteristics and Water Kiosk Financial Sustainability

The user households' satisfaction with the borehole water kiosk as the source of drinking water was 89%. This compared closely with the findings of another study, which showed 63% satisfaction by borehole kiosk users in Kyuso, a semi-arid area in Eastern Kenya (Goodall et al., 2016). Additionally, users who primarily relied on borehole kiosk water for drinking contributed to higher financial sustainability than those who did not. User satisfaction with the quality of kiosk water emerged as a significant predictor of financial sustainability in this study, with those expressing satisfaction with the water they obtained from the borehole water kiosks more likely to support high financial sustainability. Moreover, users who were satisfied with the water quality have 3.46 times higher odds of supporting high financial sustainability compared to users who were dissatisfied. Ensuring water quality that meets users' satisfaction is crucial for financial sustainability.

The results showed that taking a shorter duration (below 10 minutes) to fetch water had a positive significant influence, and between 10 and 19 minutes had a marginally positive significant influence on the financial sustainability of community-managed borehole water kiosks. In one other study, it was revealed that when the time for fetching water was reduced, the available time could now be used for other productive activities (such as gardening) or other socio-economic responsibilities (more time on household chores, working more outside the home, among others) (Winter et al., 2021). In another study, the time spent on water collection was found to be inversely related to household water consumption (Basu et al., 2017). Thus, when time for water collection is reduced, it most likely implies that the user household might make more trips to get the service as opposed to those who spend more time at the water kiosk. As observed in the previous study, high collection times limit the volume of water used by limiting the number of trips the household is likely to make for fetching water. The frequent trips to the water kiosk with reduced time translate to more revenue for the water kiosk.

Seasonal patterns in water kiosk use were evident among user households, indicating consistent, or otherwise, reliance on the kiosk throughout the year. This is well established in many previous works (Akelo & Nzengya, 2021; Thomson et al., 2019; Kelly et al., 2018). Seasonality affected the ability of the water committee to carry out their required activities, while also reducing the number of visits by users to the borehole kiosks during rainy seasons and reducing user community participation during such rainy seasons (Kelly et al., 2018). However, this study has been able to quantify and develop indices for the low and high seasonality seasons, which showed that seasonality in household water kiosk use was significantly related to financial sustainability ($\chi 2 = 0.001$, $p < 0.05$). As well, the seasonality of household water kiosk use was a robust predictor of financial sustainability, with users who experienced high seasonality being markedly more likely to contribute to high financial sustainability (odds ratio = 11.20, $p < 0.001$). In another work, using the seasonal revenue at community-managed water kiosks, it was described as seasonal peaks and drops (Akelo & Nzengya, 2021). Thus, understanding and adapting to these seasonal usage patterns is essential to maintaining high financial sustainability in community-managed borehole water kiosks.

4.3 User Households' Sense of Ownership and water kiosk Financial Sustainability

A substantial majority (about 87%) of user households did not pay these fees, suggesting that a significant portion of user households were not financially contributing to the operation of the borehole water kiosk services. Users who choose to pay membership fees were notably more likely to be associated with a high level of financial sustainability, as opposed to users who do not pay membership fees, who are associated with a low level of financial sustainability. Payment for membership fees is also seen as a way of expressing users' involvement in the project. This supported the earlier finding, which observed that community members involvement could be noted in roles such as the contribution of resources (Nyakwaka & Benard, 2019). These findings suggest that financial contributions from users, in the form of membership fees, play a critical role in strengthening the financial sustainability of water kiosk services because they are likely to have a vested interest in the borehole kiosk's well-being.

The responses are less skewed in distribution when it comes to the notion that the village owns the water system. While 65.2% of respondents strongly believe that people in their village own the water system, users who strongly believed this were more likely to be associated with a low level of financial sustainability. In another study, however, users' confidence and system management were positively associated with households' sense of ownership; all else held constant (Marks et al., 2013). Conversely, among users who do not believe at all that the water system was owned by people in the village, 50.0% are associated with a low level of financial sustainability. These intriguing results suggest that strong beliefs in village people owning the borehole water kiosk may negatively affect the financial sustainability of water kiosk services by restricting the number of users or the volume of consumption from outside the village. Nonetheless, village ownership provides the community-managed water kiosk with a specific geographical boundary of catchment for planning purposes.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

In analysing the influence of water kiosk user household characteristics on the financial sustainability of borehole water kiosk services, a study revealed that there was a statistically significant association between satisfaction with kiosk water for drinking and the financial sustainability of community-managed borehole water kiosks. Other significant associations were also shown for the time taken to fetch water from the water kiosks and seasonal household use of water from water kiosks. As well, there was a positive influence of the three predictors (satisfaction with kiosk water for drinking, time taken to fetch water, and seasonal use of water kiosks) on the financial sustainability of the community-managed water kiosks.

In assessing the influence of user households' sense of ownership on the financial sustainability of community-managed borehole water kiosk services, the study showed that there was a statistically significant association between the financial sustainability of community-managed water kiosks with payment for membership and village people owning the water kiosks. In addition, most of the respondents believe that the water is community-owned, while a few strongly believe in village ownership. Nonetheless, these perceptions were insignificant, since ownership of the water systems may not always translate into tangible financial support.

5.2 Recommendations

5.2.1 Recommendations for Policy

Several policy implications have emerged from the findings of this study. The findings related to the first objective show that the borehole kiosk is the chief source of drinking water in the community under investigation. Therefore, the Kenyan Government and the County Government of Kisumu need to invest in water harvesting in this county to ensure water security for the residents. The investments may include sand dams that can be set in areas where we have boreholes to ensure that associated aquifers supply plenty of water to the community. Such an investment will go a long way towards reducing waiting times during the fetching of water, as shorter waiting times appear to be crucial for high financial sustainability.

It is also recommended that development partners consider re-training additional skill sets amongst local community members, operators, technicians, and water committees in relevant areas for effective and efficient performance. This will also ensure that broken-down equipment does not fail to be repaired or take long before being repaired.

5.2.2 Recommendations for Future Research

This study focused on the influence of user household characteristics on the financial sustainability of the community-managed borehole water kiosks. There is need for further study on the water kiosk technical and governance factors' influence on the financial sustainability of community-managed borehole water kiosk service. Furthermore, there is need to explore further the same issues on the sustainability dimensions of functionality, inclusivity and equity, environmental and health.

It would be consequential to identify water kiosks that function with no operators and compare their functionality with those that have operators. Such a comparative study would have significant implications in terms of reducing the human resource required to man water kiosks. Aside from that, investigating specific in-kind contributions most appropriate for both giver as well as the management of the water system and comparing the performance of boreholes with and without water committees as well as exploring governance systems, institutional-community-based management would be influential in the demonstration of higher levels of effectiveness and sustainability of such water systems.

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