How Technical and Governance Factors Influence Financial Sustainability of Community-Managed Borehole Water Kiosk Service in Kisumu county, Republic of 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

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, such kiosks often face financial setbacks. This study examined the influence of technical designs and governance factors on the financial sustainability of community-managed borehole water kiosk services in Kisumu County, Kenya. The specific objectives were threefold. The first objective was to analyse the influence of water kiosks' technical design and layout. The second was to examine the influence of borehole water committee governance. The final specific objective was to assess the influence of household participation in governance. 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, it was established that borehole kiosks that opened twice in a day (odds ratio = 3.58; p =.050) had statistical significance, while water kiosks discharging water with moderate pressure (odds ratio = 0.64; p =.070) had a statistically marginally significant influence on financial sustainability. For the second objective, the user households' knowledge of the water committee members (odds ratio = 0.54; p =.002) and the frequency of water committee members' meetings (odds ratio = 0.02; p =.026) were also established as statistically significant in influencing the financial sustainability of community-managed water kiosks. Finally, for the third objective, the household contributions towards the establishment of the borehole water kiosk (odds ratio = 0.01; p =.001) were established to significantly influence financial sustainability. 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 frequent breakdown of borehole water kiosks. Therefore, efficient service delivery and water quality maintenance are essential for financial sustainability. Furthermore, membership fees play a crucial role in providing financial support. Policymakers and stakeholders should consider these findings to develop subsequent strategies that ensure reliable access to safe drinking water not just in Kenya but across similar developing countries.

Keywords: Community-Managed, Financial Sustainability, Governance, Technical Design, Water Kiosk Service

I. INTRODUCTION

Continued access to safe water supply remains a critical issue in water resource management and development (Egbinola, 2017). The United Nations (UN) SDG 6 considers the availability and sustainable management of water and sanitation for all, with Target 6.1 providing 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 SDG6 targets 6.1 and 6b appreciate five (5) aspects of access to water, including universality, equitability, safety, affordability (Ojha et al., 2018), and participation of local communities. The Constitution of Kenya-2010 provides (CoK, 2010: 43 (1d)) that "every person has the right to clean and safe water" (Kenya, 2013), 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. As shown in Table 1, the history, nature of problems, and process effectiveness of water service provision at global, national, and county levels have been summarised.

Table 1

History and Problems for Water Service Provision at Different Levels

Areas	Global Arena	National Level	County Governments
History	MDG (2000-15) SDG 6; Target 6a and 6? (2015-30)	Water Acts, Chap 372. Sessional Paper 1999. Water Act 2002. Promulgation of CoK (2010). Water Act 2016.	Municipalities and urban centres. Self-help community groups. Promulgation of CoK (2010). Water Act 2002 & 2016.
Nature of Problems	Understanding access to safe and sufficient water as a basic need	Institutional weaknesses, inadequate funding, conflicts due to overlapping roles and responsibilities of key public sectors	Only about 59% of Kenyans have access to safe water. This figure varies from geographic location and residences. The counties being established.
Process effectiveness	Ensure availability and sustainable management of water and sanitation for all	Regulatory process of access, quality, quantity and impact of the use of water.	Continued functionality, reduced non-revenue water; and multiple uses

(Source: Author's Construct, 2023)

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% (Kisumu, 2018), with some areas like West Nyakach Ward being as low as 22% and Seme Sub-County being 42% of the people. 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 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 WASH-attributable (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. Whenever there is a frequent case of the water kiosks, there is a reverse of gains that might have been made on the incidences of water-related diseases, a burden on members of the family fetching water from a far distance, 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 kiosk technical designs and governance factors influence these dysfunctionalities.

This study sought to investigate the influence of borehole water kiosk technical designs and governance factors on the financial sustainability of community-managed borehole (CM-BH) water kiosk services within Kisumu County, Kenya. The specific objectives were threefold. The first was to analyse the influence of water kiosks' technical design and layout on the financial sustainability of community-managed borehole water kiosk services. The second objective was to examine the influence of borehole water committee governance on the financial sustainability of community-managed borehole water kiosk services. The third objective was to assess the influence of household participation in governance on the financial sustainability of community-managed borehole water kiosk services. The research was guided by the common pool resource (Ostrom & Gardner, 1993), which provided for the difficulty of the exclusion of any beneficiary from accessing the water service (with the possibility of free-riding) and substractability (with the understanding that the use by one household reduces the quantity of water available for the other). This theory supported the three objectives of the study.

II. METHODOLOGY

2.1 Study Design and Site

A mixed-methods design of the study was adopted, which involved cross-sectional data collection from January to April 2022, combining qualitative and quantitative research approaches guided by the pragmatic paradigm (Onwuegbuzie & Leech, 2005). The study site was comprised of three sub-counties (Nyakach, Nyando, and Seme). These sub-counties 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, including companies (private or otherwise), professionally managed by the committees of the schools or health facilities. The other models included privately operated boreholes and water user associations (WUAs). The WUAs are community-based organisations (CBOs) involved in the management of specific boreholes. From the data generated from the County Water Offices, Table 2 summarises the number of water boreholes managed through the different models within each of the sub-counties, which showed that 78% of community-managed boreholes were done through CBO structures referred to as the WUAs.

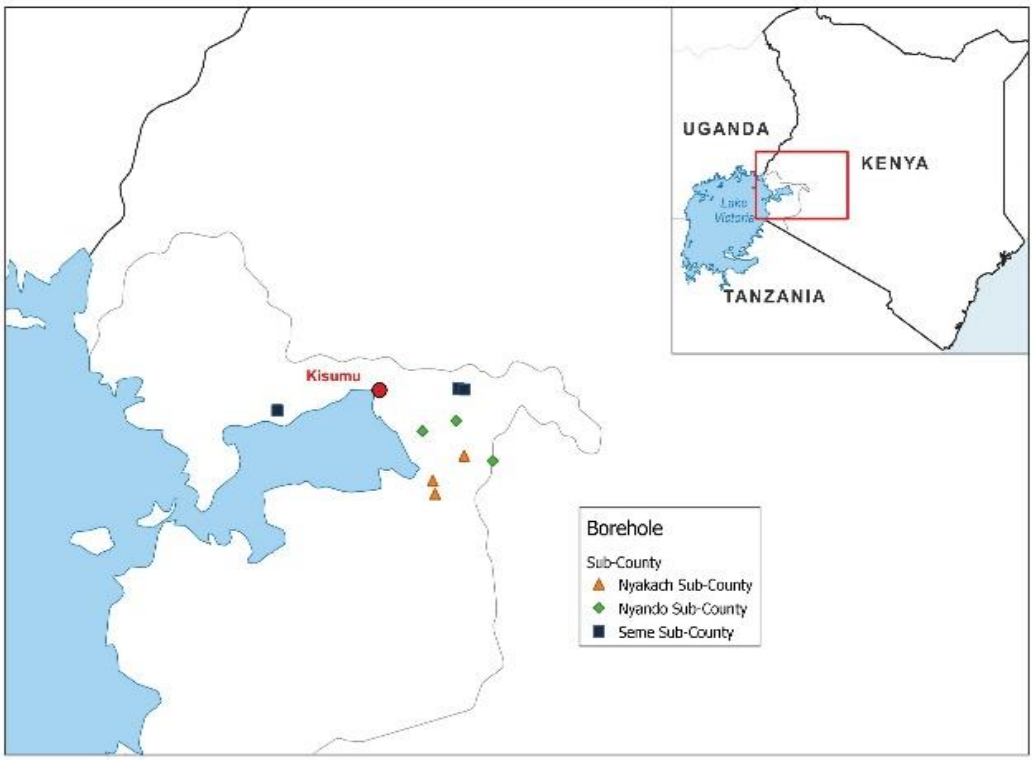

Figure 1
Borehole Study Sites

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.

In order to identify community-managed boreholes and water service points where data was to be collected, purposive elimination and selection were done. Applying the sampling methods used by previous researchers (Ibrahim, 2017; Masduqi, 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 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.

Table 2

Models of Water Borehole Management within Selected Sub-Counties

Water Management Models	Nyakach Sub-County	Nyando Sub-County	Seme Sub-County	Total
Company managed	1	2	2	**5**
Professional manager	0	1	0	**1**
Health facility managed	0	5	1	**6**
Private operator	0	2	0	**2**
School Board of Management	1	18	4	**23**
Water User Associations (WUA)	35	38	59	**132**
Total	**37**	**66**	**66**	**169**

(*Source:* Author's Construct, 2023)

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 Quantitative Data Collection and Analysis

The researchers collected and analysed quantitative data. The researchers used a questionnaire with closed-ended survey questions administered face-to-face and completed according to participants' responses. Binary logistic regression was used to assess the statistical significance of each of the independent variables (IVs) on the outcome variable. The IVs included borehole kiosk technical design, piping, and layout factors; user households' perceptions of the water kiosk's governance by the water committees; and user households' involvement and participation in borehole and water kiosks' governance. 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 borehole water technical design and governance influencing the financial sustainability of community-managed borehole water kiosk services in Kisumu County, a question was posed: did the borehole water technical design and governance factors 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 p<0.01, 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, technical designs and layout, and governance by the water committees. The technical design issues that were being probed included the water kiosk siting, layout of systems, and water collection point designs. In the governance of the water kiosks by the committees, issues probed included decisions of the committees on the amounts charged, composition of the committees disaggregated by gender, representation, local political experiences, appointments and remuneration of the kiosk operators and plumbers, and the schedule of opening and closing the kiosks.

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, with the minimum 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, 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 3 presents the socio-demographic characteristics of the sample.

Table 3

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%
How many people in TOTAL, including you, currently live in the household?		Mean = 2 Mode = 2 people

3.2 Influence of Technical Factors on Financial Sustainability of Borehole Water Kiosks

The technical factors examined included perceptions of water pressure from the borehole kiosk, availability of water when needed, hours when the kiosk is open, functional state of the water kiosk, time of day when the kiosk functions, and the presence of a technician or plumber.

As corroborated by the FGDs, the participants report that water pressure is low and decreases as the day goes by. Kiosk operators have developed a strategy to ensure that water supply is not severely affected by reduced water pressure. For example, one was quoted as saying:

> *"The pressure is never enough to fill more than one in a day. It was set up in such a way that the pressure decreases as the day progresses, so by 1 p.m., the pressure will have reduced considerably. Beyond that, the pressure will be too low, so the following day, I have to direct it to another pump that will serve a kiosk like..., which is about two kilometres above us. From there, it can flow to... We then monitor if there could be a line with too much pressure, so we ease the flow".* Female Operator 6 at Nyakach FGD

The data indicated that the perception of water pressure from the borehole kiosk varies among users. Approximately 11.5% of respondents reported experiencing low water pressure. In contrast, 35.3% of users reported having high water pressure, while a majority, accounting for 53.2%, perceived the pressure as moderate. Users who reported experiencing low water pressure were more likely to have high financial sustainability (52.8%) compared to those with moderate (32.0%) or high (40.1%) water pressure. As shown in Table 4.8, this finding establishes that water pressure has a statistically significant association with the financial sustainability of kiosk services ($p = 0.011$). This finding may suggest that efficient water usage due to lower pressure might potentially contribute to cost savings, leading to higher financial sustainability.

Regarding the establishment years of the boreholes and kiosks, the data shows that nearly half (49.8%) of the boreholes were established between 2017 and 2022. A smaller percentage, 13.7%, dates back to the period between 2009 and 2016, while 36.5% were established between 2001 and 2008. Similarly, the establishment years of the kiosks reveal that 42.2% of kiosks were established between 2017 and 2022, 27.4% between 2009 and 2016, and 30.4% between 2001 and 2008. Considering the establishment years of boreholes and kiosks, no statistically significant associations were found with financial sustainability ($p = 0.352$ and $p = 0.188$, respectively). These results may indicate that the year of establishment alone does not appear to be a significant determinant of financial sustainability for these services, and other factors may play a more prominent role. The findings on the association of technical design and layout factors are shown in Table 4.

Table 4

Association between Technical Factors and water kiosk Financial Sustainability

Technical factors	Response	Overall Percentage	Financial Sustainability of water kiosk services		P-value
			Low	High	
Water pressure					0.011
	Low pressure	11.5%	47.2%	52.8%	

	Moderate pressure	53.2%	68.0%	32.0%	
	High pressure	35.3%	59.9%	40.1%	
Borehole establishment (Year)					0.352
	2017-2022	49.8%	61.6%	38.4%	
	2009-2016	13.7%	57.1%	42.9%	
	2001-2008	36.5%	66.7%	33.3%	
Kiosk establishment (Year)					0.188
	2017-2022	42.2%	61.9%	38.1%	
	2009-2016	27.4%	57.9%	42.1%	
	2001-2008	30.4%	68.6%	31.4%	
Water available when needed.					0.744
	No	2.6%	58.3%	41.7%	
	Yes	97.4%	62.9%	37.1%	
Duration opens per day (hours)					0.054
	Once per day	1.0%	25.0%	75.0%	
	Twice per day	4.6%	42.1%	57.9%	
	Thrice per day	3.6%	66.7%	33.3%	
	More than 4 times	89.6%	64.2%	35.8%	
	Not applicable	1.2%	100.0%	0.0%	
Functional state					0.74
	Yes, functioning but not well	58.2%	62.9%	37.1%	
	Yes, functioning well	41.8%	62.5%	37.5%	
Time of day when Open					0.71
	All day long	74.3%	63.7%	36.3%	
	6-10 AM	12.6%	58.6%	41.4%	
	4-7 PM	4.8%	68.2%	31.8%	
	No time schedule	4.3%	65.0%	35.0%	
	Other times	3.9%	50.0%	50.0%	
Availability of technician or plumber					0.001
	No	26.3%	39.2%	22.9%	
	Yes	73.7%	60.8%	77.1%	

The data established that water was available when needed, with 97.4% of respondents reporting consistent access to water. Only 2.6% of respondents indicated that water was not available when needed. Similarly, the presence or absence of water when needed did not show a statistically significant association with financial sustainability (p = 0.744). This suggested that consistent water availability alone may not be the sole driver of financial success for kiosk services.

Regarding the duration of time kiosks remain open per day, 89.6% of kiosks open more than four times a day. Smaller percentages indicate kiosks with varying opening frequencies, including once per day (1.0%), twice per day (4.6%), or three times per day (3.6%). Additionally, a small fraction (1.2%) of reported opening hours were not applicable, possibly indicating unique operational circumstances. The duration for which a kiosk opens per day shows a statistically significant association at the 10% significance level (p =.054, <.1). It was evidence that there was a trend suggesting that kiosks opening more times per day (e.g., twice or three times) may be associated with higher financial sustainability. However, the result is not robust enough to draw definitive conclusions.

The functional state of the kiosks was diverse, with 58.2% of respondents reporting that the kiosks' function was not well, while 41.8% reported that the kiosks' function was well. These findings suggest that while a significant portion of kiosks may have operational issues, there were also a substantial number that were functioning efficiently. The functional state of kiosks, whether functioning well or not, did not show a statistically significant association with financial sustainability (p = 0.740). This may imply that the functional state of the kiosk, as reported by users, does not significantly impact financial sustainability.

Regarding the time of day when kiosks are open, the majority of users (74.3%) reported that the kiosk is open all day long. Other reported time slots include 6–10 AM (12.6%), 4–7 PM (4.8%), no specific time schedule (4.3%), and other unspecified times (3.9%). The time of day when the kiosk is open does not appear to be a significant factor in determining financial sustainability (p = 0.710). Users seem to have similar levels of financial sustainability, regardless of the kiosk's operating hours.

Regarding the presence of a kiosk technician or plumber, the data established that 73.7% of respondents reported the presence of a technician or plumber and 26.3% indicated the absence of one. The presence of a technician at the kiosk shows a statistically significant association with financial sustainability (p = 0.001). While strongly statistically significant, there was a trend that kiosks with technicians (77.1%) may have higher financial sustainability compared to those without technicians (22.9%). This result could be due to the critical role associated with having technicians and the potential benefits of reducing disruptions in the water flow at the kiosks.

Results show users who reported experiencing low water pressure were found to be 1.32 times more likely to have high financial sustainability compared to those users experiencing high water pressure. However, this result was not statistically significant at the 0.1 level (p = 0.443). Alternatively, users with moderate water pressure were 0.64 times as likely to have high financial sustainability compared to those with high pressure, whose statistical significance is at the 0.1 significance level (p = 0.060). These findings suggest that while there may be a slight association between water pressure and financial sustainability, it is not strong enough to be considered significant. These findings are shown in Table 5.

Kiosks associated with their establishment between 2009 and 2016 were 1.61 times more likely to have high financial sustainability compared to the reference category (2001–2008), although this result was not statistically significant at the 0.1 level (p = 0.107). Similarly, users associated with kiosks established between 2017 and 2022 were 1.44 times more likely to have high financial sustainability compared to the reference category (2001–2008), but this result also did not reach statistical significance (p = 0.165).

Table 5

Influence of Technical Factors on Water Kiosk Financial Sustainability

Predictor	B	SE	Odds ratio	P-value
Water pressure				
(High pressure)				
Low pressure	0.28	0.36	1.32	0.443
Moderate pressure	-0.44	0.24	0.64	0.060
Kiosk establishment (Year)				
(2001-2008)				
2009-2016	0.47	0.29	1.61	0.107
2017-2022	0.36	0.26	1.44	0.165
Water available when needed.				
(Yes)				
No	0.71	0.83	2.04	0.392
Duration opens per day (hours)				
(More than 4 times)				
Thrice per day	0.01	0.67	1.01	0.988
Twice per day	1.27	0.65	3.58	0.050
Once per day	1.84	1.30	6.29	0.157
Not applicable	-14.98	712.68	0.00	0.983
Functional state				
(Functioning but not well)				
Functioning well	-0.11	0.23	0.90	0.631
Time of day when Open				
(All day long)				
6-10 AM	0.16	0.34	1.18	0.635
4-7 PM	-0.69	0.58	0.50	0.235
No time schedule	-0.78	0.67	0.46	0.244
Other times	0.05	0.70	1.05	0.947
Availability of attendant				
(No)				
Yes	-0.27	0.22	0.76	0.209

*Note. Estimates represent the log odds of "Financial Sustainability = High" vs. "Financial Sustainability = Low"
*Reference Categories in Brackets

Respondents who reported that water was not available when needed were 2.04 times more likely to have high financial sustainability compared to those with water available when needed. However, this result was not statistically

significant at the 0.1 level (p = 0.392). Plausible reasons for this lack of significance could include variations in the reasons for water unavailability, differences in users' coping mechanisms, or the influence of other factors not included in the analysis.

Users associated with kiosks that open twice per day were 3.58 times more likely to have high financial sustainability compared to those associated with kiosks that open more than four times per day, and this result was statistically significant at the 0.1 level (p = 0.050). While users associated with kiosks opening once per day were 6.29 times more likely to have high financial sustainability, this result did not reach statistical significance (p = 0.157) because of the negligible number of respondents who fall into this category, leading to an inflated odds ratio. Plausible reasons for the significance of opening twice per day could include increased convenience for users or more efficient water management practices, which contribute to higher financial sustainability.

Respondents associated with kiosks functioning well were 0.90 times as likely to have high financial sustainability compared to those with kiosks functioning but not well. However, this result was not statistically significant at the 0.1 level (p = 0.631). Plausible reasons for this lack of significance could include variations in what constitutes "functioning well" across different kiosk locations and differences in user perceptions of functionality.

The results from the analysis of data from FGDs and KII corroborated the findings from the household data. These were categorised as kiosk network design and layout. Some of the voices of the operators included the fact that the design layout for the kiosks varied from one water kiosk to the next. For example, a water operator from Nyakach shared that their borehole has two raised tanks, while the kiosks have only one tank each.

> *"The boreholes each have two raised tanks, while the kiosks only have one tank each"* (Male Operator #2 Nyakach, FGD).

This description differs from that of the BH1 borehole, where the operator shared that the water stand was constructed about 100 metres away. The rationale for the design was to optimise the water rotation. However, this design interfered with the pressure, and people close to the borehole were not receiving adequate water. He continues to say that the community was not receiving enough water whenever the volume of water was reduced because the water pressure was reduced in such instances. Those with stepped-down pipes were the most affected and were not getting adequate water supply.

> *"The borehole at BH1 was drilled, and the water stand was constructed about 100 metres away so that the rotation does not interfere with the borehole. This brought a problem in that it interfered with pressure so that some people living very close to the borehole could not get water. This brought a lot of problems to the community; whenever the volume of water was reduced, the pressure would not be enough to get water to people who had stepped down pipes. We can therefore say here that the design actually interfered with the supply"* (Male Operator #1 Nyakach, FGD).

Two participants were of a contrary opinion. One respondent believed that the design was fine and a proper assessment was done before installation, but an assessment was not done to establish the actual water demand.

> *"In my opinion, there was nothing wrong with the design; the problem comes about when there are a number of people who have diverted the water. The area is flat, so issues of pressure or lack thereof do not arise. The water engineer needs to be consulted in order to help identify the actual problem. Maybe the water operator or technician can say something. Personally, I really do not have a problem, even with my pipes."* (Female Operator #3: Nyakach, FGD).

The other respondent believes that the main problem is people diverting the water. He believes that since the area is flat, the issue of pressure does not suffice. He believes that there is a problem that needs to be identified and resolved by experts. The inadequate water supply creates tensions when consumers do not receive a regular supply.

> *"The way I see it, the design was fine. A proper assessment was done before installation except that the needs assessment was not done to establish the actual demand and strategies for meeting it. Therefore, with time, demand outstrips the supply, and this creates tensions when some people, especially private consumers, fail to get their regular supply* (Female Operator #3 Nyakach, FGD).

3.3 Influence of Household Perception on Water Committee and Financial Sustainability

The influence of borehole water committee governance on financial sustainability looked at household perceptions of the borehole water committee and the association and influence of the water committee on financial sustainability. It was assumed that there existed a water management committee for each borehole and water kiosk. As to the existence of the committees, 78.7% of households affirmed that their water systems had a management committee, while 21.3% reported non-existing water committees. This was corroborated by feedback from the focus group discussions with operators, who also reported that some borehole and kiosk committees either did not exist or

were non-functional. In such water boreholes and kiosks, the discussions revealed that the functions of committees were handled by either one of the community members, in most cases the chairperson or treasurer. However, such arrangements demonstrated limited accountability to the members or users of the water kiosks.

A majority (73.3%) of households indicated the committee was responsible for the management of the borehole water kiosk. Furthermore, 26.7% indicated the committee did not perform such management tasks for borehole water kiosks. The management of the borehole also entailed the establishment of a water operation schedule that scheduled opening and closing times. Furthermore, the majority of households (77%) who reported the water committees' functions included management of water kiosks, maintenance, repair coordination, use control, and generating and spending revenue. They also responded that there was a time when water was not available for more than one week.

The majority of respondents (78.7%) indicated there was a committee in place to manage the borehole kiosk. When we compare the financial sustainability levels between those with and without a committee, both groups had a similar percentage, with 63.0% of kiosks with a committee in the low financial sustainability group and 37.0% in the high financial sustainability group. The p-value for this comparison is 0.893, indicating the presence of a committee does not seem to be statistically associated with financial sustainability.

Among the respondents, about half (50.2%) reported that they did not identify with committee members, while the remaining 49.8% indicated that they were aware of committee members. When we compare the financial sustainability levels, a noteworthy pattern emerges. Those who reported not identifying with committee members had a majority (55.4%) in the low financial sustainability group and 44.6% in the high financial sustainability group. On the other hand, among those who knew committee members, a substantial 70.3% were in the high financial sustainability group, while only 29.7% were in the low financial sustainability group. This indicates a significant association between knowing committee members and higher financial sustainability, as evidenced by a p-value of 0.001. The results of the association between the governance of the water committee and financial sustainability have been summarised in Table 6.

Table 6

Association between Water Committee Governance and Water Kiosk Financial Sustainability

Governance factors	Response	Overall Percentage	Financial Sustainability of water kiosk services		P-value
			Low	High	
Committee in place to manage borehole kiosk					0.893
	No	21.3%	62.2%	37.8%	
	Yes	78.7%	63.0%	37.0%	
Do you know committee members					0.001
	No	50.2%	55.4%	44.6%	
	Yes	49.8%	70.3%	29.7%	
Frequency of management committee meetings					0.106
	Never	36.7%	56.8%	43.2%	
	Monthly	23.9%	66.4%	33.6%	
	Bimonthly	1.1%	40.0%	60.0%	
	Once every 3 months	2.0%	77.8%	22.2%	
	Once every 6 months	3.7%	88.2%	11.8%	
	Once per year	13.3%	60.7%	39.3%	
	As needed	19.3%	66.3%	33.7%	
Committee in place to manage borehole kiosk					0.893
	No	21.3%	62.2%	37.8%	
	Yes	78.7%	63.0%	37.0%	
There is schedule for opening and closing borehole kiosk					0.119
	No	8.5%	51.3%	48.7%	
	Yes	91.5%	63.9%	36.1%	

The respondents reported various frequencies of management committee meetings. It was found that 36.7% of respondents said they never had frequent meetings to discuss water systems. The majority mentioned meetings occurring either monthly (23.9%) or "as needed" (19.3%), with lower percentages for other frequencies. When comparing financial sustainability levels, some interesting observations emerge. For instance, those who reported

meetings happening "once every 3 months" had a remarkable 77.8% in the high financial sustainability group and 22.2% in the low financial sustainability group. However, the p-value for this comparison is 0.106, which exceeds the significance level of 0.1. This suggests that while there are differences in financial sustainability across meeting frequencies, they are not statistically significant.

Regarding the schedule for opening and closing the borehole kiosk, the majority of respondents (91.5%) reported that there was a schedule in place. When comparing low and high levels of financial sustainability, those without a schedule had 51.3% in the low financial sustainability group and 48.7% in the high financial sustainability group. In contrast, those with a schedule had 63.9% in the high financial sustainability group and 36.1% in the low financial sustainability group. However, the p-value for this comparison is 0.119, which is above the significance level of 0.1. This suggests that the presence of a schedule for opening and closing the kiosk is not statistically associated with financial sustainability.

Respondents who reported that they did not know committee members were associated with lower log odds of achieving high financial sustainability. The odds ratio of 0.54 suggests that those who do not know committee members are approximately 0.54 times as likely to achieve high financial sustainability compared to those who do know committee members. Importantly, the p-value for this predictor is 0.002, which is below the significance level of 0.1, indicating a statistically significant association. In practical terms, this may mean that knowing committee members is linked to higher financial sustainability.

Table 7

Influence of Water Committee Governance on Water Kiosk Financial Sustainability

Predictor	B	SE	Odds ratio	P-value
Committee in place to manage borehole kiosk				
(No)				
Yes	0.13	0.26	1.13	0.624
Do you know committee members				
(No)				
Yes	-0.62	0.20	0.54	0.002
Frequency of management committee meetings				
(Never)				
As needed	-0.41	0.29	0.67	0.152
Bimonthly	0.76	0.94	2.13	0.421
Monthly	-0.48	0.27	0.62	0.071
Once every 3 months	-0.95	0.83	0.39	0.251
Once every 6 months	-1.74	0.78	0.18	0.026
Once per year	-0.21	0.32	0.81	0.512
Committee in place to manage borehole kiosk				
(No)				
Yes	0.13	0.26	1.13	0.624
There is schedule for opening and closing borehole kiosk				
(No)				
Yes	-0.49	0.35	0.61	0.157
*Note. Estimates represent the log odds of "Financial Sustainability = High" vs. "Financial Sustainability = Low" *Reference Categories in Brackets				

The presence of a committee in place to manage the borehole kiosk was not statistically significant at the 0.1 level. The odds ratio of 1.13 implies that having a committee in place is associated with a slight increase in the odds of achieving high financial sustainability. Importantly, the p-value for this predictor is 0.624, which is above the significance level of 0.1. This indicates that the presence of a committee does not have a statistically significant impact on financial sustainability.

The frequency of management committee meetings showed varied effects on financial sustainability. Respondents who reported meetings "once every 6 months" are associated with significantly lower odds of achieving high financial sustainability. Other categories of meeting frequency displayed different impacts on financial

sustainability, but none of the odds ratios for these categories were below 0.1, which is the significance level considered here. The p-values for the different categories ranged from 0.026 to 0.624. Among these, only the category "once every 6 months" had a p-value below 0.1, indicating a statistically significant association between this infrequent meeting frequency and lower financial sustainability.

The presence of a schedule for opening and closing the borehole kiosk was associated with financial sustainability. Respondents who reported not having a schedule were associated with lower log odds of achieving high financial sustainability. The odds ratio of 0.61 suggests that those without a schedule are approximately 0.61 times as likely to achieve high financial sustainability compared to those with a schedule. However, the p-value for this predictor is 0.157, which is above the significance level of 0.1. This implies that the presence of a schedule for opening and closing the kiosk is not statistically significant in relation to financial sustainability.

The operators FGDs and KII data also provided some results that triangulated the findings already presented, especially in the area of kiosk operations. Some participants stated that the water kiosk functions differently in terms of the volume of supply, timing of operations, as decided by the committee, and source of energy. The common phenomenon was that pumping water into the tank was the first activity of the day. According to the participants, the source of power was either electricity or solar. However, to use the solar energy, one has to wait until the sun is hot. As guided by the water committee, the operators often supply schools and other institutions first before serving domestic and private consumers.

> *"Every morning on waking up, I make sure I pump water so that the two schools I serve with water are well supplied. It is important for the students to have water for drinking and washing their hands, so I pump water by 6 a.m. When using a solar pump, I have to wait for the sun to get hot, then I switch on the pump, and water begins to flow around 9 a.m. I direct it to the school tank, which is the first storage. After it gets to a good level that can then overflow and serve others, I direct it to other tanks. The first tank serves four kiosks, namely KSK1, KSK2, KSK3, and KSK4".* Male Operator #3 Nyando FGD

3.4 Influence of User Households' Participation in Governance on Water Kiosk Financial Sustainability

This looked at whether or not a member of the user household was involved either in water supply management or as a committee member. It also looked at whether the user household contributed towards the establishment of the borehole kiosk and their participation in the previous committee meeting with the kiosk water users. The researchers investigated whether user households participated in the governance of the community-managed boreholes and related water kiosks. On the other hand, 91.7% of households reported not participating in the establishment of the borehole-water kiosk, but only 8.3% affirmed their participation in such an establishment. In another aspect of residence, 62.8% of households reported they were living in areas that were beneficiaries of the established borehole-water kiosks. However, 37.2% of households benefiting from the borehole water kiosks reported not to be living within benefiting areas.

Regarding household (HH) member involvement in the management of water supply services, it was evident that a significant majority of households, accounting for 86.3%, do not have a household member actively participating in the day-to-day management of the kiosk or water service. It was found that, among households, no member was involved in the management of the kiosk or water service. It was established that about 63.5% experience low levels of financial sustainability, while 36.5% have a high level of financial sustainability. In households with at least one member involved in management, 58.7% experience low financial sustainability, and 41.3% have a high level of financial sustainability. The associated p-value of 0.469 suggests that the difference in financial sustainability between these two groups is not statistically significant. This indicates that having a household member involved in management does not appear to significantly impact the financial sustainability of the borehole kiosk. These findings have been presented in Table 8.

Similarly, when considering whether a HH member was a committee member, the majority, at 90.4% of households, do not have a household member serving as a committee member responsible for overseeing the kiosk or water service. It was observed that among households where no member serves as a committee member, 63.0% experience low levels of financial sustainability, while 37.0% have a high level of financial sustainability. In households with at least one member as a committee member, 61.4% experience low financial sustainability, and 38.6% have a high level of financial sustainability. The associated p-value of 0.833 suggests that there is no statistically significant difference in financial sustainability between these two groups. Hence, household representation on the committee does not seem to be significantly associated with the financial sustainability of borehole kiosks.

Table 8

User Households' Involvement in Governance and Water Kiosk Financial Sustainability

HH participation in Governance	Response	Overall Percentage	Financial Sustainability of water kiosk services		P-value
			Low	High	
HH member involved in management					0.469
	No	86.3%	63.5%	36.5%	
	Yes	13.7%	58.7%	41.3%	
HH member is committee member					0.833
	No	90.4%	63.0%	37.0%	
	Yes	9.6%	61.4%	38.6%	
HH member attended last committee meeting					0.459
	No, a meeting was not held	22.2%	58.8%	41.2%	
	No, was not invited	51.3%	61.9%	38.1%	
	No, was invited but did not attend	7.8%	72.2%	27.8%	
	Yes, attended	18.7%	66.3%	33.7%	
HH contributed to establishment of Kiosk					0.001
	No	89.3%	70.1%	29.9%	
	Yes	10.7%	2.0%	98.0%	

Results revealed that in households where members were invited but did not attend the last committee meeting, 72.2% experience low financial sustainability, and 27.8% have a high level of financial sustainability. Among households where at least one member attended the last committee meeting, 66.3% experience low financial sustainability, while 33.7% have a high level of financial sustainability. The associated p-value of 0.459 indicates that there is no statistically significant difference in financial sustainability based on attendance at the last committee meeting. Therefore, attending or not attending the meeting does not appear to be significantly associated with financial sustainability.

Regarding households' contribution towards the establishment of Kiosk, the majority of households (89.3%) did not contribute to the establishment of the kiosk or water service, suggesting that most households were not financially or otherwise involved in the initial setup or funding of the service. In contrast, a smaller fraction, 10.7%, reported contributing to the establishment of the kiosk. Households that did not contribute to the establishment of the kiosk are significantly more likely to experience low levels of financial sustainability, with 70.1% in this category. In contrast, households that contributed to the establishment of the kiosk experience a high level of financial sustainability, with 98.0% falling into this category. The highly significant p-value of 0.001 demonstrates a strong and statistically significant association between household contributions to the kiosk's establishment and high financial sustainability. This suggests that households that were involved in the kiosk's initial establishment are far more likely to have a high level of financial sustainability.

Table 9

Influence of Users Participation in Governance on Water Kiosk Financial Sustainability

Predictor	Estimate	SE	Odds ratio	P-value
HH member involved in management				
(No)				
Yes	-0.1035	0.41	0.90	0.801
HH member is committee member				
(No)				
Yes	0.0373	0.484	1.04	0.939
HH Member attended last committee meeting				
(No, a meeting was not held)				
No, was invited but did not attend	0.3308	0.432	1.39	0.444
No, was not invited	0.3346	0.268	1.40	0.213
Yes, attended	0.2139	0.338	1.24	0.527
HH contributed to establishment of Kiosk				
(No)				
Yes	-4.7509	1.019	0.009	< .001

*Note. Estimates represent the log odds of "Financial Sustainability=High" vs. "Financial Sustainability=Low";*Reference Categories in Brackets

The analysis indicated that household members' involvement in the management of the kiosk does not significantly impact the odds of achieving high financial sustainability. The odds ratio associated with this predictor is 0.90, suggesting that households with members involved in management are approximately 0.90 times less likely to achieve high financial sustainability compared to those with no involvement. The p-value for this predictor is 0.801, which is much higher than the significance level of 0.1, indicating that involvement in management is not statistically significant in relation to financial sustainability. Similarly, the presence of household members as committee members does not have a statistically significant impact on financial sustainability. The odds ratio for households with committee members is 1.04, indicating a slight increase in the odds of achieving high financial sustainability compared to households with no committee members. However, the p-value for this predictor is 0.939, which is much higher than the significance level of 0.1, indicating that committee membership is not statistically significant. Table 9 shows the outcomes of the binary logistics regression analysis. Attendance or non-attendance at the last committee meeting also does not significantly affect financial sustainability. The odds ratios for different attendance categories range from approximately 1.24 to 1.40, suggesting marginal increases in the odds of achieving high financial sustainability, but none of these differences are statistically significant. The p-values for all attendance categories are above 0.1, further supporting the lack of statistical significance in this context.

On the other hand, household contributions to the establishment of the kiosk have a highly significant and substantial influence on financial sustainability. The odds ratio for households that did not contribute is 0.009, indicating that they are approximately 0.9% as likely to achieve high financial sustainability compared to those that did contribute. The p-value for this predictor is less than 0.001, signifying strong statistical significance. This underscores that household contributions to the kiosk's establishment are a critical factor associated with achieving high financial sustainability, with those who contributed far more likely to attain it.

The participants reported that repairs to broken-down equipment take time, and other equipment is never repaired. For instance, the BH2 kiosk pump broke down but has not been repaired; hence, the kiosk has not been able to supply the community with water. The pump broke down in 2016. The other challenge is vandalising taps and pipes and frequent breakages of pipes.

> *"I am in charge of BH Kiosk. At first, my grandfather was the one in charge; then he died, and because I was around, I stepped in to represent him. Currently, there is no water flow; there was low pressure, which was not rectified. Whenever the pressure was good, I would be the one to pump the water; the old man could not manage. I could turn it on before going to school, and the water would flow throughout. This particular kiosk also has a pump. I would only turn it off to make way for other tanks to also get their supply; otherwise, once pumped, our water could flow continuously. We went on until the pump broke down and has never been repaired to date".* Male operator #5 Nyakach, FGD.

A respondent reported that remittance of payment for water used is a challenge, and they have had to cut supply to consumers sometimes.

> *"Another issue: a number of people with water in their homes have run in with the management; they decided not to forward money, with the result that they often have a lot of accrued debts, as much as 10,000 shillings. The management locks up the water, and people suffer, especially women, and so the management opens up the water again, but they still do not pay, and wrangling continues".* Female Operator #1 Seme, FGD.

These results show the other critical role that operators play in the availability of the water service provision, to the extent that sometimes members of the user household would love to volunteer to support the supply of water. One participant, however, reported that kiosk operators had several challenges. In such cases, the cost of water is therefore relatively lower in this area, i.e., two (2) Kenya shillings per 20-litre jerrican. The other challenge was uncooperative customers who, at times, would decline paying for water fetched.

IV. DISCUSSIONS

The heightened in-access to improved water services occasioned by infrastructure-intensive requirements for establishing water kiosks for communities in rural areas coupled with the frequent breakdown of such facilities are among the challenges that reverse the gains realised against the deaths attributable to water. This study examined the borehole water kiosk technical design factors and governance factors' influence on the financial sustainability of community-managed borehole (CM-BH) water kiosk services within Kisumu County, Kenya.

4.1 Technical Designs and Water Kiosk Financial Sustainability

The study findings indicated that perceptions of water pressure from borehole kiosks vary among users. The users who reported experiencing low water pressure were more likely to have high financial sustainability (52.8%) compared to those with moderate (32.0%) or high (40.1%) water pressure. The previous studies in these areas looked more at the volume discharged from the kiosks (Sima et al., 2013) than the pressure of discharge. This study established that water pressure has a statistically significant association with the financial sustainability of kiosk services ($p = 0.011$), a finding that suggests that efficient water usage due to lower pressure may contribute to cost savings, leading to higher financial sustainability.

The study established the critical role and significant association of the presence of a kiosk technician or plumber with financial sustainability. This compares with earlier findings that community management of relatively complex piped systems delivering household water supplies (and community water supplies) requires the payment of paid staff such as plumbers (Moriarty et al., 2013). While the cited study established that hired staff were on salaries, the findings from the current study showed that many water committees only paid the technicians and plumbers based on the work done. However, most borehole and water kiosk studies were unable to meet their own revenue and work requirements to sustain monthly payments for such labour.

4.2 Water Kiosk Governance and Water Kiosk Financial Sustainability

The frequency of management committee meetings showed varied effects on financial sustainability. Respondents who reported to meetings "once every 6 months" were associated with significantly lower odds of achieving high financial sustainability. A previous study indicated that access to drinking water could be improved through addressing certain water governance challenges, such as monitoring and enforcement of water quality policies and sufficient capacity for administrative and technical management (Huang et al., 2020). The frequency of the committee meetings is thus critical for the committee to regularly receive, review, and discuss matters relating to the performance of their water system.

The majority of households (89.3%) did not contribute towards the establishment of the kiosk or water service and were thus significantly more likely to contribute to low levels of financial sustainability. In contrast, households that contributed to the establishment of the kiosk demonstrated a strong and statistically significant association with high financial sustainability.

4.3 User Household Participation in Governance of Water Kiosk and Influence on Financial Sustainability

The study revealed that a significant majority of households (about 86%) do not have any household members actively participating in the day-to-day management of the water kiosk. This finding was in line with another, which concluded that there is low participation of community members in the management of water projects (Moraa et al., 2016). Though the referred study was within the Nyando Plains in Nyando Sub-County, it showed the current realities that also exist today within the study area. While this finding shows that households are not actively participating, there are only a limited number of processes for participation. However, the other authors had also established that for the active participation of communities and households, there is a need for dividends to the beneficiary community and the extension of institutional formalisations (Ananga et al., 2017). Such formalised structures include well-defined roles, from the water committee management to the water kiosk operators, attendants, or salespersons. In the current studies, some of the formalised structures have not been developed and may need to be worked on in policy and practice.

About half of respondents reported they did not know committee members, with those not knowing committee members having low financial sustainability. Studies in this aspect of household involvement are limited. However, knowledge of the committee, from experience, is either through participating in their elections, attending meetings with the users, or frequently fetching water from one of the kiosks the committee members were in charge of. Hence, as the study established among those who knew committee members, a substantial 70.3% were in the high financial sustainability group. This established a significant association between knowing committee members and higher financial sustainability, as evidenced by a p-value of 0.001.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The study established a statistically significant association between the pressure with which the borehole kiosk discharged the water and the financial sustainability of the community-managed borehole kiosks. Other

associations included the year of establishment of the kiosk, the availability of a technician or plumber, and the duration of the kiosk remaining open. The kiosks with technicians demonstrated higher financial sustainability compared to those without, as disruptions in the water flow were controlled. The year of establishment of the kiosk, its functional state, and its operating hours had no significant impact on the financial sustainability of community-managed water kiosk services.

As to examining the influence of borehole water committee governance on the financial sustainability of community-managed borehole water kiosk services, the study showed a statistically significant association between user households knowing the committee members and the financial sustainability of the community-managed borehole water kiosk services. However, there were statistically significant influences, in a negative direction, of user household perceptions of water committee members and the frequency of committee meetings on the financial sustainability of community-managed borehole kiosk services.

As for the third objective, that is, assessing the influence of user household participation in governance on the financial sustainability of community-managed borehole water kiosk services, "It was established that there was a statistically significant association between the user households contributing towards the water kiosk establishment and the financial sustainability of the water kiosk services. Moreover, having a household member involved in management did not appear to significantly impact the financial sustainability of the borehole kiosk.

5.2 Recommendations

5.2.1 Recommendations for Policy

Several policy implications emerged from the findings of this study. As to the first objective, it was established that borehole kiosks were the chief source of drinking water across the community under investigation. As such, Kenya's national government and also the county government of Kisumu need to invest in water harvesting as a means of securing water security for the residents.

Such investments may include sand dams, which could be set in areas with boreholes to ensure that associated aquifers supply adequate water to the communities. Such an investment would go a long way towards reducing waiting times during the fetching of water, as shorter waiting times were noted as crucial for high financial sustainability.

Based on the third objective on the influence of technical factors on the financial sustainability of borehole water kiosk services, it was established that kiosks with technicians had higher financial sustainability compared to those without, as disruptions in the water flow were controlled. Additionally, repairs to broken-down equipment take time, and other equipment was never repaired. Therefore, it would be necessary to have technicians, plumbers, attendants, or salespersons appropriately remunerated for the borehole and water kiosk services. Such would ensure someone would be responsible for caring for the water point.

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 would also ensure that broken-down equipment does not fail to be repaired or take long before such repairs are implemented.

Subject to the sixth objective on moderating factors and their effect on the financial sustainability of borehole water kiosk services, this study established that local communities risked the disinheritance of boreholes and kiosks established on individual land whose owners were never paid for or gave land for the projects without proper documentation of the process. It is therefore recommended that the water committees in place engage with the affected individual land owners, government offices, and ministry of land officials to regularise such allocated land into community ownership for the facilities (boreholes or kiosks) that would be located on individual land.

5.2 Recommendations for Future Studies

Sustainability has been noted as a multidimensional concept with functionality, financial, social, and environmental paradigms. This study focused on the financial sustainability of the community-managed borehole water kiosks. There is a need to explore the same issue further in other dimensions, including functionality, inclusivity, equity, environmental, and health. As well, the user households' patterns in the use of water kiosks influence on the financial sustainability of community-managed borehole water kiosk services need to be studied further.

It would be consequential to identify water kiosks that function without operators and compare their functionality with those that have operators. Such a comparative study would have significant implications in terms of reducing the human resources required to man water kiosks. Aside from that, investigating specific in-kind

contributions most appropriate for both the 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 and institutional-community-based management, would be influential in the demonstration of higher levels of effectiveness and sustainability of such water systems.

Funding Acknowledgement

This research project was made possible with funding support from Swiss Federal Institute for Aquatic Research (EAWAG), and ETH4D Doctoral Mentorship Programme.

REFERENCES

Ananga, E. O., Njoh, A. J., Anchang, J. Y., & Akiwumi, F. A. (2017). Participation-related factors influencing performance in four urban-based community-operated water schemes in Kisumu, Kenya. *Community Development Journal*, *52*(2), 319–336. https://doi.org/10.1093/cdj/bsw014

Bonett, D. G., & Wright, T. A. (2015). Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behaviours*, *36*(1), 3–15. https://doi.org/10.1002/job.1960

Egbinola, C. N. (2017). Trend in access to safe water supply in Nigeria. *Journal of Environment and Earth Science*, *7*(8), 89–96.

Engler, A., Melo, O., Rodríguez, F., Peñafiel, B., & Jara-Rojas, R. (2021). Governing water resource allocation: Water user association characteristics and the role of the state. *Water*, *13*(17), 2436. https://www.mdpi.com/2073-4441/13/17/2436

Hamlet, L. C., Mwiti Kamui, M., & Kaminsky, J. (2020). Infrastructure for water security: Coping with risks in rural Kenya. *Journal of Water, Sanitation and Hygiene for Development*, *10*(3), 481–489. https://doi.org/10.2166/washdev.2020.038

Ibrahim, S. H. (2017). Sustainability assessment and identification of determinants in community-based water supply projects using partial least squares path model. *Journal of Sustainable Development of Energy, Water and Environment Systems*, *5*(3), 345–358. https://hrcak.srce.hr/186482

Huang, W. W., Chen, X. J., Fan, Y. R., & Li, Y. P. (2020). *Management of Drinking Water Source in Rural Communities under Climate Change*. https://doi.org/10.3808/jei.202000431

Kenya, L. O. (2013). *The constitution of Kenya: 2010*. Chief Registrar of the Judiciary.

Kisumu, C. G. (2018). Kisumu County Integrated Development Plan II, 2018-2022. *County Government of Kisumu: Kisumu, Kenya*.

Krejcie, R.V., & Morgan, D.W. (1970) Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 30(1), 607-610.

Masduqi, A., Endah, N., Soedjono, E. S., & Hadi, W. (2010). Structural equation modelling for assessing of the sustainability of rural water supply systems. *Water Science and Technology: Water Supply*, *10*(5), 815–823. https://iwaponline.com/ws/article-abstract/10/5/815/25109

Moraa, O. S., Nyonje, R., & Kyalo, D. N. (2016). *The Influence of Community Participation in Management of Water Shed as a Flood Mitigation Strategy on Household Livelihood in Nyando Flood Plains, Kisumu County*. https://www.academia.edu/download/50429149/1968.pdf

Moriarty, P., Smits, S., Butterworth, J., & Franceys, R. (2013). Trends in rural water supply: Towards a service delivery approach. *Water Alternatives*, *6*(3), 329. https://www.water-alternatives.org/index.php/allabs/220-a6-3-1/file

Nyakwaka, S., & Benard, M. K. (2019). Factors Influencing Sustainability of Community Operated Water Projects in Central Nyakach Sub-County, Kisumu County, Kenya. *International Journal of Academic Research in Business and Social Sciences*, *9*(7), Pages 108-130. https://doi.org/10.6007/IJARBSS/v9-i7/6096

Ojha, R., Thapa, B. R., Shrestha, S., Shindo, J., Ishidaira, H., & Kazama, F. (2018). Water taxation and subsidy analysis based on consumer water use behavior and water sources inside the Kathmandu Valley. *Water*, *10*(12), 1802.

Onwuegbuzie, A. J., & Leech, N. L. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology*, *8*(5), 375–387.

Ortigara, A. R. C., Kay, M., & Uhlenbrook, S. (2018). A review of the SDG 6 synthesis report 2018 from an education, training, and research perspective. *Water*, *10*(10), 1353.

Ostrom, E., & Gardner, R. (1993). Coping with asymmetries in the commons: Self-governing irrigation systems can work. *Journal of Economic Perspectives*, *7*(4), 93–112.

Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K., & Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. *International Journal of Hygiene and Environmental Health*, *222*(5), 765–777. https://doi.org/10.1016/j.ijheh.2019.05.004

Sima, L. C., Kelner-Levine, E., Eckelman, M. J., McCarty, K. M., & Elimelech, M. (2013). Water flows, energy demand, and market analysis of the informal water sector in Kisumu, Kenya. *Ecological Economics*, *87*, 137–144. https://doi.org/10.1016/j.ecolecon.2012.12.011

WHO/UNICEF JMP. (2023, October 20). *WHO/UNICEF Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP) – Progress on household drinking water, sanitation and hygiene 2000-2022: Special focus on gender*. p. 1. https://www.unwater.org/publications/who/unicef-joint-monitoring-program-update-report-2023