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Victor Adaka and Dr. Mercy Mugambi

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FACTORS INFLUENCING SUSTAINABILITY OF COMMUNITY MANAGED RURAL WATER SUPPLY PROJECTS IN PASTORALIST AREAS OF KENYA. A CASE OF MERTI SUB COUNTY, ISIOLO COUNTY

[1*]Victor Adaka
[1]Post Graduate Student: University of Nairobi, Kenya
[*]Corresponding Author's Email: vicdak@gmaill.com

[2]Dr. Mercy Mugambi
Lecturer: University of Nairobi, Kenya

Abstract

Purpose: The purpose of the study was to investigate factors influencing sustainability of community managed rural water supply projects in pastoralist areas of Kenya, A case of Merti Sub County, Isiolo County.

Methodology: The study used descriptive research design that entailed field surveys and cross-sectional research. The target population was 13,648 from six community managed water projects from which a sample of 384 was determined. Questionnaires collected primary data from management committee members and the projects' user beneficiaries whereas interview schedules collected information from key informant. Pilot of instruments was done in Isiolo Sub County. Quantitative data was analysed using Statistical Package for Social Sciences (SPSS V.20). Narrative analysis for qualitative data thematically linked the texts to the objectives and topic of the research hence giving the texts meaning and significance

Findings: The study findings indicated that technology adoption was the best predictor for sustainability and a positive unit change in technology adoption improved sustainability by 0.352 units. Water technologies that communities participated in selection and managed their operation and maintenance costs got easily adopted within the community and positively influenced sustainability. Management committee competencies influence on sustainability increased when communities had the requisite education and necessary skills in managing water projects hence any positive unit change on management committee competencies increased sustainability by 0.220 units. Due to low level of communities' unawareness of its contents and applicability, water regulatory policy had a low but significant positive relationship with sustainability but its influence greatly diminished in multivariate analysis of sustainability. Pastoralist cultural aspects

did not interfere with rural water supply project management but limited women participation in management.

Contribution to theory, practice and policy: The study recommended that County governments intensify awareness on water regulatory policy, continuously track progress on management committees performances and enhance their capacities through trainings, develop user friendly technologies for water supplies such as solar systems complemented with training packages in technology skills requirements and that mandatory women's participation in water management committees be instituted through key reserved positions.

Keywords: *Rural, sustainability, community, managed, projects*

1.0 INTRODUCTION

1.1 Background to the Study

Sustainability is a problem faced by any development in both developed and developing countries. On the global scene, sustainable development is defined as the development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs (United Nations [UN], 1987).Sustainable development cuts across many sectors and spheres including water supply development. According to UN (2015) estimates, about 79% of the people who do not have access to improved drinking water sources live in rural areas and water scarcity affects 40% of the global. Women world-wide spend up to 200 million hours each day walking in search for and collecting water (United Nations Children's Fund [UNICEF], 2016). Women and children have to also endure walking an average of 3.7miles (about 6Kilometers) a day to fetch water and the weight of water women carry on their heads is about 20 Kilograms at any one time (United Nations Office of the High Commissioner for Human Rights, [OHCHR], 2010).The distance is even more in pastoral rural settings of Africa

In most European countries, domestic water use is between two hundred and three hundred litres per person per day while in Sub -Saharan African countries like Mozambique it is less than ten litres. Highly formal water industries function within a robust and well defined regulatory framework in rich countries whereas poor countries have highly informal water economies that are difficult to regulate and govern (Van der Bliek, Mccornic & Clarke, 2014). In countries like Sweden, Canada and Australia community institutions have drastically declined and replaced by modern water industries (Van der Bliek et al., 2014). Since the 19th century rural communities in Switzerland have continued to construct and manage improved water supply leading to evolution of an institutional framework that gives much responsibility for the management of rural supply services at village level (Saladin, 2004). In developing countries, the community management model has developed for decades as a direct result of broader transition from centrally planned supply driven approaches to the demand driven approaches (Lockwood, 2004). According to Harvey and Reed (2006) communities are able to manage some aspects of water supply sustainability but fail to manage long term sustainability issues including assets replacements. Wide view shared by water sector practitioners on rural water supply unlike urban water supply is that rural water supply poses a challenge in development. This is due to the cost per capita of constructing a rural water supply which is higher than cost per capita of constructing urban water

supply facility. The argument is that rural populations are sparsely scattered over a large area creating a challenge in recovering high cost of operating the system from a smaller population than in the urban areas, which normally are densely populated. This then poses a threat to sustainability of rural water supply systems in terms of cost recovery and per capita investment. Therefore keeping rural water supply systems running becomes more important than constructing them.

A major underlying issue normally overlooked by implementers when handing over completed rural water supply projects to communities is the management aspects of an operational water project that will be continuous as opposed to project construction that has a beginning and an end. A one-off training is always done for communities before handing over the water project with the assumption that it is adequate to realize sustainable management. Lenton and Wright (2004) consider constraints to success of water supply development to include political, financial, institutional and technical factors. Other countries such as South Africa considers efficiency in revenue collection, administration, technical operation, maintenance, governance and the requisite skills key to sustainable water services (Abrams, Palmer & Hart, 1994). Inability for rural communities to adopt technologies used in water supply leads to non-functionality hence poor sustainability. For example hand pump technology considered a robust and easy technology to operate and maintain in rural water supplies had an average failure rate of 36% in 20 Sub Saharan Africa countries (Rural Water Supply Network [RWSN], 2009).

In Kenya, data on rural water supplies performance remains inadequate (Water Services Regulatory Board [WASREB], 2015).Rural water services systems in the country are still not sustainable due to poor operation and maintenance by communities leading to breakdown of facilities, low access rate, poor water quality and increased disputes (Ministry of Water and Irrigation, [MW1], 2012). Differences in access to safe water are even more severe in the Arid and Semi Arid Lands (ASALs) that account for 80% land mass area of Kenya. The ASALs exert pressure on water as a natural economic resource due to scarcity (MWI, 2012). A water mapping study conducted for Isiolo County, an ASAL county, found that operation and maintenance (O&M) cost recovery and non collection of water revenue led to un-sustainability of community managed rural water supply projects (Kenya Water and Sanitation civil society network [KEWASNET], 2013). Through a preparatory water resources assessment study for Merti district (now Merti Sub County) over half of the community managed rural water supply projects were dependent on Non Government Organizations (NGOs), the Government and other developmental partners operating in the area for sustainability through support to boreholes (Kenya Red Cross Society [KRCS], 2012). Mays (2006) considers rural water supply sustainability to hinge on factors such as policy context, institutional arrangements, technology used , the natural environment settings, social aspects, financing and cost recovery in water supply, maintenance of the water supply, skill enhancement through training and capacity building on water management. In pastoralist, areas informal community based resource management methods apply to natural resource use while there are the formal management institutions also doing the same.

1.2 Statement of the Problem

Whereas community management approach for rural water supply projects is viewed as a sound concept that leads to sustainability when communities are empowered to own, manage and make decision regarding their own water projects, rural water supply sustainability continues to remain a challenge in most developing countries. Community managed rural water projects left on their own are unable to expand access or replace assets and need regular support on functionality issues such as operation and maintenance. World Bank (2009a) reports that in Africa though there is a variation from country to country a median of 24-30% of rural water supplies are not functioning. In Kenya other than inadequacy of data on rural water performance, unsustainable poor rural water services puts 75% rural population at risk of lack of water. In pastoralist areas such as Merti sub county water scarcity affects an already fragile livelihood that has to contend with few scattered permanent water sources. Coverage of safe drinking water is quite low - at 14.62% (Northern Water Services Board [NWSB], 2012). Over 50% of the sub county's community managed water supplies are at the periphery of collapse due to poor management. Water as a support pillar to development for this sub county and other pastoralist areas becomes a mirage due to unsustainable rural water supply projects. This also means that Kenya's vision 2030 and Sustainable Development Goal (SDG) targets to ensure water availability and universal access to all by 2030 will not be feasible unless factors influencing sustainability of community managed rural water supply projects in this region are unearthed and addressed. Furthermore, value for money for investments in rural water supplies in the country estimated by the World Bank at 303 million US $ annually will continue to waste due to unsustainable water projects management. Other economic and health benefits that arise from improved health, reduced mortality and morbidity coupled with good lifestyle as a result of engaging in poverty reducing activities rather than trekking to search for water will remain unattainable unless community managed rural water supply projects in this region are addressed. By investigating on factors that influence sustainability of community managed rural water supply projects in Merti Sub County, policy makers and communities will be informed of actionable strategies that bring about beneficial change in pastoralists areas through improved community management of rural water supplies. The study will also inform future research on community approaches to water supply development.

1.3 Objectives of the Study

The study aimed to achieve the following objectives:

i. To examine the influence of the water regulatory policy on sustainability of community managed rural water supply projects in Merti sub county,

ii. To establish the influence of water management committee competencies on sustainability of community managed rural water supply projects in Merti sub county,

iii. To determine the influence of pastoralist cultural aspects on sustainability of community managed rural water supply projects in Merti sub county,

iv. To establish the influence of technology adoption on sustainability of community managed rural water supply projects in Merti sub county.

2.0 LITERATURE REVIEW

2.1 Concept of Sustainability and Sustainable Water Supply

Therefore community water projects that focus on day to day operations of the water schemes with minimal capital maintenance or system expansion may face sustainability challenge. Lenton and Wright (2004) identified sustainable water supply development constraint factors to include political factors, financial factors, institutional factors and technical factors. A water mapping study showed that technical breakdowns accounted for 46% non-functionality of water points in Kisumu County, 76% in Kwale County, 31% in Kajiado County and 32% in Isiolo County (KEWASNET 2013). The study found that where enhanced functionality occurred, it was due to a responsible O&M recovery mechanisms and a working revenue payment system.

2.2 Rural Settings and Rural Water Supply Projects

In Kenya, rural water services is generally provided through community managed point sources unlike urban areas where water services are provided through utility managed piped systems that are licensed to provide the service. About 85% of the rural households' still lack access to piped water (Kenya Demographic and Health Survey Report [KDHS], 2014).

2.3 Concept of Community Management Institutions in Water Supply Projects

Community management model for rural water supplies places the main responsibility of sustaining the water supply projects squarely on communities because they are fully charged with making and taking responsibility for the decisions about their water supply (McCommon, Warner, & Yohalem, 1990). This entails community responsibility for owning and attending to the obligation of the system, authority to make decisions regarding the system on behalf of users and controlling the outcomes of the decisions.

2.4 Cultural Aspects and Community Managed Rural Water Supply Projects Sustainability

This diversity is manifest in the uniqueness and plurality of the identities of groups and societies. Many communities share and enjoy a way of life that does not only sustain the local environment but also nourishes the social relationships and cultural meanings that define the community and this knowledge is then embedded in spiritual values and preserved in customary laws (Johnston, 2012). Cultural practises vary from country to country and within communities in the same country. There still exist systems of social rights and responsibilities that remain traditional and are manifested in cultural expectations rather than written rules.For example Katiko (1997) documentation on evolution of Finland's water supply and sanitation from the 1800s to 2000s, says that traditional believes to water were reality.

2.5 The Theory of Change

The theory of change is a theory-based approach to planning, implementing or evaluating change at an individual, organization or community (Laing & Todd, 2015). A theory of change provides a comprehensive and clear picture on how a long-term goal will be met, the pre-conditions necessary to achieve the goal, and the interventions required to meet these pre-conditions. Laing and Todd (2015) say that there are various models of expressing a theory of change. The

deductive method uses existing research to develop a theory of change from evidence collected from literature and from existing knowledge. The inductive model builds theory from observing phenomenon in action. The mental model builds a theory of change from stakeholders' knowledge, experiences and ideas about how things work whereas the collaborative model for building a theory of change entails the researcher and stakeholders working together to produce both an academic and practical view of how things work in real situations. Theory of change approach in this study recognizes that the long-term goal is to realize sustainable community managed rural water projects and from which backward mapping is necessary to establish what needs to exist for the accomplishment of this goal.

2.7 Conceptual Framework

The conceptual framework consists of third level theory that consist of the systems of categories that are systematically placed within broad structure of explicit as well as assumed propositions (Mutai, 2000). A conceptual framework is "a pictorial representation where descriptive categories are systematically placed in a broad structure of explicit propositions, statements of relationships between two or more empirical properties to be accepted or rejected" (Stone & Archibald, 1993). The variables for this study were captured in the conceptual framework as depicted in Figure 1. The independent variables for the study were water regulatory policy, management competencies, pastoralist cultural aspects and technology adoption. Sustainable community managed rural water supply projects was the dependent variable. The intervening variable for this study was the attitude of community members whereas the moderating variable for the study was the weather condition due to aridity of the study area.

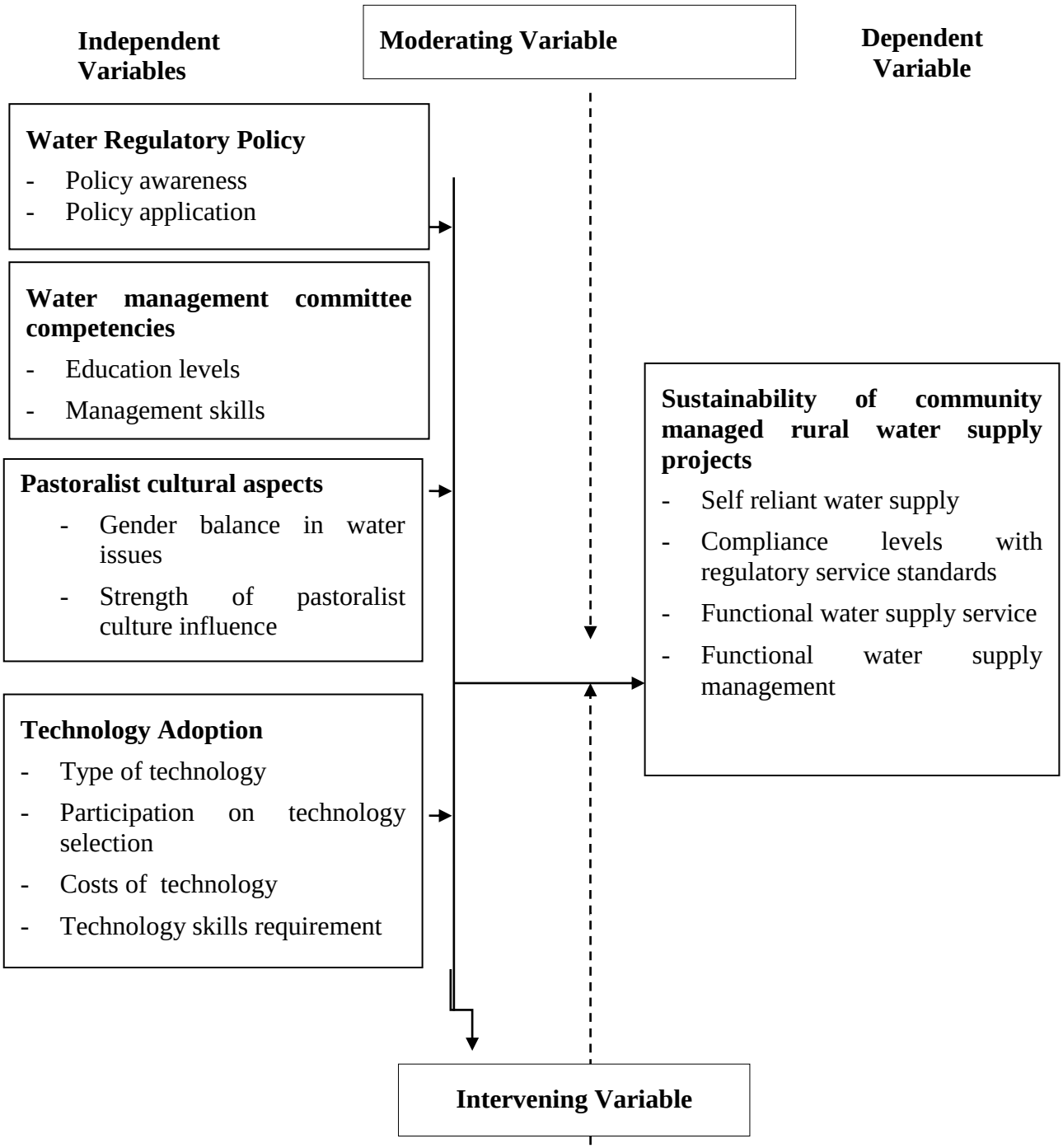

Figure 1: Conceptual Framework

The study employed cross-sectional survey design. The study was in Merti Sub County. The study area consisted of two wards namely Cherab Ward and Charri ward. The target area for the study was in six locations of the sub county as shown in appendix IX-Map showing Isiolo County administrative boundaries. Each location had a community managed water project and six water projects serving a population of 13,468 were identified for the study. The sample size was 384. The study employed both probability and non probability sampling methods to draw samples from the target population. Purposive and Quota sampling methods were used to select the desired number of individuals for the study. The study used interview schedules and questionnaires to collect primary data. Statistical Package for Social Sciences (SPSS Version 20) was used to analyze quantitative data to generate descriptive and inferential statistics. A multivariate regression model in the form

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$$

was determined to relate the importance of each of the four independent variables with respect to the dependent variable The independent variables in the equation were depicted as; Water regulatory policy ($\mathbf{X_1}$), Management committee competencies($\mathbf{X_2}$), Pastoralist cultural aspects($\mathbf{X_3}$) and Technology adoption ($\mathbf{X_4}$). The dependent variable was sustainability of community managed rural water supply projects (**Y**).

Where;

β_0 = Intercept/Constant

β_1 = Coefficient of Water regulatory policy

β_2 = Coefficient of Management committee competencies

β_3 = Coefficient of Pastoralist cultural aspects

β_4 = Coefficient of technology adopted

e = Standard error of estimate

The data analysis results were presented in frequency distribution tables, cross-tabulation tables, correlation matrices, percentages and in a regression equation. The interpretation of the results based on the objectives and topic of the study. Qualitative data analysis and interpretation through narrative analysis entailed generating meaning and significance of the textual information to the topic and objectives of the research.

4.0 DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Demographic Characteristics of Water Management Committee Respondents

The study sought to establish the water management committees' demographic characteristics such as age, gender, level of education and position held in the management committee structures.

Table 1: Water Management Committees' Composition by Age

Age of Respondents	Frequency	Percent	Cumulative Percent

18-25	3	5.8	5.8
26-35	13	25.0	30.8
36-45	14	26.9	57.7
46-55	15	28.8	86.5
Above 56	7	13.5	100.0
Total	**52**	**100.0**	

The findings in Table 1: Water management committees'compostion by age, indicated that 3(5.8%) out of 52 management committee respondents were aged between 18-25 years, 13(25%) were aged between 26-35%, 14(26.9%) were aged between 36-45 years, 15 (28.8%) were aged between 46-55 years, 7(13.5%) were aged above 56 years. These results indicated that youth (18-35 years) comprised 30.8% of the management committee members while adult population above 36 years comprised 69.2%. The results indicated that youth engagement in water management committees was low.

4.2 Water Management Committee Competencies

The study sought to establish if the management committees had requisite skills and competencies in running their water supply projects.

Table 2 below indicates the management committee members who received a salary from their respective water supply projects.

Table 2: Management Committee Members on Salary

Factor	Frequency	Percent	Cumulative Percent
No	39	75	75
Yes	13	25	100
Total	**52**	**100.0**	

The findings indicated in Table 4.17 show that only 13 (25%) out of 52 management committee members were paid a salary. This indicated that 75% of management committee members volunteered their services as water project's committee members.

The study sought to find out the salary brackets for the management committee members and the findings summarized in Table 3.

Table 3: Salary Bracket for Management Committee Members

Salary bracket for management committee members (Ksh)	Frequency	Percent	Cumulative Percent
Ksh 0.	39	75.0	75.0
Ksh 3000-5000	6	11.5	86.5
Ksh 5000-8000	1	1.9	88.5
Ksh 8000-12000	6	11.5	100.0
Total	**52**	**100.0**	

(Ksh) represents Kenya shillings

The findings in Table 3 indicated that 7 (13.4%) management committee members received a salary between Ksh 3000-8000 whereas 6 (11.5%) received a salary between Ksh 8000-12,000

The study sought to find out the category of staff employed by the sampled water projects and the results summarised in Table 4 below. The findings in Table 4 indicated that none of the water supply projects had employed managing directors, technical managers, engine mechanics and electricians. The category of staff that most water supply projects preferred employing included water supply operators/engine and pump attendants and plumbers that attend to pipe burst and leakages. The findings indicated that management committees in Merti Sub County had low levels of skilled and competent workers for water supply management and operations.

Table 4: Category of Staff Employed by Water Management Committees

Category of staff	Frequency	Percent	Cumulative Percent
Managing Directors	0	0.0	0.0
Technical Managers	0	0.0	0.0
Revenue Clerks	4	15.4	15.4
Meter Readers	3	11.5	26.9
Plumbers	7	26.9	53.8
Water supply Operators	9	34.6	88.5
Power plant Mechanics	0	0.0	88.5
Power Plant Electricians	0	0.0	88.5
Line patrollers	3	11.5	100.0
Total	**26**	**100**	

4.3 Water Management Committees Awareness of Water Regulatory Policy

The study sought to find out from the management committees the level of awareness of the water regulatory policy and its' application in the management of the rural water supply projects.

The results summarised in Table 5 indicated that two water supply projects (Bisan-Biliqo and Merti water supply projects) management committee members had the highest level of awareness of water regulatory policy whereas Makagalla and Yamicha water projects had the highest levels of unawareness of the water regulatory policy. On the overall 30 (57.7 %) out of 52 management committee members were aware of the water regulatory policy.

Table 5: Management Committees Aware of Water Regulatory Policy

Water Supply project	Management committee responses on awareness of water regulatory policy		Total
	No	Yes	
Bisan Biliqo	0	9	**9**
Bulesa	1	7	**8**
Korbesa	4	4	**8**
Makagalla	8	1	**9**
Merti	1	8	**9**
Yamicha	8	1	**9**
Total	**22**	**30**	**52**

4.4 Water Projects Licensed to Operate

The study sought to find out from the management committees if they had a license to operate as a water service provider in their area. The results were as indicated in Table 6

Table 6: Management Committees with License to Operate

Water supply project	Management Committee Members Responses on Availability of License to Operate		Total
	No	Yes	
Bisan Biliqo	0	9	9
Bulesa	0	8	8
Korbesa	6	2	8

Makagalla	9	0	9
Merti	1	8	9
Yamicha	8	1	9
Total	**24**	**28**	**52**

The findings from Table 6 indicated that 28(53.8%) out of 52 management committee respondents that indicated they had licences to operate produced certificates of registrations as water users associations as opposed to licences from the regulator**.**

4.5 Water Projects Applying Approved Tariffs in Their Billing Consumers

The study sought to find out if the water management committees applied approved water tariffs in billing their consumers / project beneficiaries and the findings summarised in Table 4.

Table 7: Water Projects Applying Approved Regulator Water Tariffs

Water supply project	Approved WASREB Tariff Use		Total
	No	Yes	
Bisan Biliqo	0	9	9
Bulesa	0	8	8
Korbesa	8	0	8
Makagalla	7	2	9
Merti	0	9	9
Yamicha	8	1	9
Total	**23**	**29**	**52**

The findings in Table 4 indicated that 29 (55.8%) out of 52 management committee respondents reported that they used approved water tariffs. Bisan-Biliqo, Bulesa and Merti water supply projects led in application of approved water tariffs while Korbesa, Yamicha and Makagalla had a decimal application of tariffs.

4.6 Key Informant's Views on Water Regulatory Policy Influence on Rural Water Projects

Only one key informant (the Merti Sub County Water officer) was available during the study. The Water officer expressed that the community water projects lacked legal registration status,

water regulatory policy dissemination in the sub county was low and the county was yet to finalize a county water bill and a county water strategic plan.

4.7 Key Informant Interview Findings on Water Management Committee Competencies

The key informant available during the study was the Sub County Officer. The Water officer expressed that the management committees of rural water supply projects in Merti Sub County had inadequate skills and competencies to effectively manage water supplies sustainably.

4.8 Influence of Pastoralist Cultural Aspects on Management

The study sought to establish from the respondents if pastoralist cultural aspects influenced sustainability of community managed rural water supply projects and the findings shown in Table 8

Table 8: Culture Assists Water Management

Factor	Frequency	Percent	Cumulative Percent
No	45	86.5	86.5
Yes	7	13.5	100.0
Total	**52**	**100.0**	

The results in Table 8: Culture assists water management, indicated that 45(86.5%) out of 52 management committee respondents did not agree that cultural aspects assisted water supply management in Merti sub county. Some respondent thought it did assist in management with 13.5% of the management committee respondents reporting that there were instances when management committees called on elders to arbitrate management wrangles and deciding how clans and sub clans were represented in the management committees.

The study sought to establish if there were pastoralist cultural aspects that promoted free access and the results summarised in Table 9

Table 9: Management Committees' View on Culture Promoting Free Access to Water

Factor	Frequency	Percent	Cumulative Percent
No	45	86.5	86.5
Yes	7	13.5	100.0
Total	**52**	**100.0**	

The findings in Table 6 indicated that 45(86.5%) out of 52 management committee respondents did not agree that cultural practises in Merti promoted free access to water while 13.5% explained that though culture discouraged water wastage, it allowed free access of water to donkeys, during burials and during weddings.

4.9 Key Informant's Views on Pastoralists' Cultural Aspects in Rural Water Supplies

The key informant available during the study was the Sub County Officer. The Water officer reported that provision of free water for burials was an Islamic obligation but the provision of free water for donkeys and for wedding was cultural and this denied the water projects revenue.

4.10 Water Project Beneficiaries' Awareness of Water Regulatory Policy

The study sought to establish if the water project beneficiaries were aware of the water regulatory policy and its' application. The extent of water project beneficiaries' awareness of water regulatory policy were summarized in Table 10

Table 10: Water Project Beneficiaries' Awareness of Water Regulatory Policy

Factor	Frequency	Percent	Cumulative Percent
No	138	63.6	63.6
Yes	79	36.4	100.0
Total	**217**	**100.0**	

The findings in Table 7: Water project beneficiaries awareness of water regulatory policy indicated that 138 (63.6%) out of 217 project beneficiaries were not aware of the water regulatory policy. The 36.4% that were aware of the water regulatory policy explained that they knew about it in an Annual General meeting that had been attended by County water staff and during early stages of project inception.

The study sought to establish if the water project beneficiaries were aware of the procedure for licensing their water projects and the results summarized in Table 11

Table 11: Water Project Beneficiaries Aware of Procedure for Licensing Water Supply

Water Supply Project	Aware of procedure for licensing water supply project		Total
	No	Yes	
Bisan-Biliqo	4	16	20
Bulesa	18	10	28
Korbesa	23	5	28
Makagalla	24	1	25
Merti	62	29	91
Yamicha	24	1	25
Total	**155 (71.4%)**	**62 (28.6%)**	**217 (100.0%)**

The findings in Table 11 indicated that on the overall 155(71.4%) out of 217 beneficiaries were not aware of requirement for licensing their water projects. 80% of Bisan Biliqo water project beneficiaries (16 out of 20) beneficiaries were aware of the licensing procedures. Korbesa, Yamicha and Makagalla water projects had the least levels of awareness on licensing procedures. The water user beneficiaries explained that it was easier to register as a water users association with the social department because the procedure was less rigorous and did not require a lot of documentation unlike registering a water company.

4.11 Project Beneficiaries Views on Requirement for Sustainability

The views on project beneficiaries' requirement for sustainability of their water projects were summarized in Table 12. The findings indicated that 129 (59.4%) out of 217 project beneficiaries considered capacity building for management committees as necessary for improvement of water project sustainability while 87 (40.1%) considered both technology improvement and skilled personnel recruitment as key to improving sustainability.

Table 12: Project Beneficiaries View on Requirements for Sustainability

Ways to Improve Sustainability	Frequency	Percent	Cumulative Percent
Capacity building trainings for management	129	59.4	59.4
Involvement of the community in water project planning and implementation	1	0.5	59.9
Technology improvement and skilled personnel recruitment	87	40.1	100.0
Total	**217**	**100.0**	

4.12 Linear Regression (Step Wise Method) Model for Rural Water Supplies Sustainability

The researcher carried out regression analysis to establish the statistical significance relationship between the dependent variable and all the independent variables. The computation used the stepwise method in order to get the best predictor variables for the model. Using Statistical Package for Social Sciences (SPSS V 20) to code, enter and compute the measurements of the linear regression model, the output equation expected was in the form

$$\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e}\ .$$

In which **Y** depicted the dependent variable while $\mathbf{X_1}$, $\mathbf{X_2}$, $\mathbf{X_3}$. $\mathbf{X_4}$ represented the four independent variables as follows;

Y = Sustainability of community managed rural water supply projects

$\mathbf{X_1}$ = Water regulatory policy

$\mathbf{X_2}$ = Management committee competencies

$\mathbf{X_3}$ = Pastoralist cultural aspects

X_4 = Technology adoption
β_0 = Intercept/Constant
β_1 = Coefficient of Water regulatory policy
β_2 = Coefficient of Management committee competencies
β_3 = Coefficient of Pastoralist cultural aspects
β_4 = Coefficient of technology adopted
e = Standard error of estimate

The regression model summary output from SPSS V20 was shown in Table 13

Table 13: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.452[a]	0.205	0.202	1.109
2	0.494[b]	0.244	0.238	1.083

a. Predictors: (Constant), Technology adoption
b. Predictors: (Constant), Technology adoption, Management committee competencies

The Regression model summary in Table 10 indicated that 24% (R square = 0.244) of variability in the dependent variable (Sustainability) was accounted for by both technology adoption and management committee competencies.

The analysis of variance output from the SPSS V 20 computation was as indicated in Table 14

Table 14: Analysis of Variance (ANOVA)

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	84.540	1	84.540	68.721	0.000[b]
	Residual	328.464	267	1.230		
	Total	413.004	268			
2	Regression	100.825	4	50.413	42.955	0.000[c]
	Residual	312.179	264	1.174		
	Total	413.004	268			

a. Dependent Variable: Sustainability of community managed rural water supplies

b. Predictors: (Constant), Technology adoption

c. Predictors: (Constants), Technology adoption, Management committee competencies

The results in Table 14 indicated if the model was a good fit for the data and this was determined by the F-test. According to the results, the p- values in the table were less than 0.01 significance level. This indicated that the model was s a good fit for the data.

The regression coefficients for the regression equation were summarised in Table 15

Table 15: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.277	0.141		9.042	0.000
	Technology adoption	0.431	0.052	0.452	8.290	0.000
2	Constant	1.009	0.156		6.481	0.000
	Technology adoption	0.352	0.055	0.369	6.391	0.000
	Management committee	0.220	0.059	0.215	3.725	0.000

a. Dependent Variable: Sustainability of community managed rural water supplies

The Regression coefficients in Table 4.75 indicated that the constant $\boldsymbol{\beta_0}$for the equation was 1.009, the coefficient $\boldsymbol{\beta_4}$ for technology adoption was 0.352 and the coefficient for management committee competencies $\boldsymbol{\beta_2}$ was 0.220. Substituting these coefficients in the equation

$$\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e}\ ,$$

$$\boldsymbol{Y = 1.009 + 0.220 X_2 + 0.352 X_4}$$

where $\boldsymbol{X_2}$ represented management committee competencies and $\boldsymbol{X_4}$ represented technology adoption. The effect of standard error $(\boldsymbol{e})$ was assumed to be negligible therefore e = 0. The regression model indicated that both the management committee competencies and technology adoption positively influenced sustainability of community managed rural water supplies in Merti Sub County. The finding indicated that any positive unit change in technology adoption improved sustainability of community managed rural water supply projects by 0.352 units whereas a positive change in management committee competencies positively improved sustainability by 0.220 units. Influence of water regulatory policy and pastoralist cultural aspects on sustainability were insignificant in the equation.

The Table 16 indicated the variables that were excluded from the regression model equation in step 1 and step 2 using SPSS V20 stepwise computation method.

Table 16: Variables Excluded from the Equation (Step Wise) Regression Model Method

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Water regulatory policy	0.089[b]	1.568	0.118	0.096	0.910
	Management committee competencies	0.215[b]	3.725	0.000	0.223	0.851
	Pastoralist cultural aspects	0.067[b]	1.224	0.222	0.075	0.998
2	Water regulatory policy	0.035[c]	0.603	0.547	0.037	0.842
	Pastoralist cultural aspects	0.075[c]	1.409	0.160	0.086	0.996

a. Dependent Variable: Sustainability of community managed rural water supply projects

b. Predictors in the Model: (Constant), Technology adoption

c. Predictors in the Model: (Constant), Technology adoption , Management committee

The results in Table 16 indicated that in step 1, Water regulatory policy, Management committee competencies and Pastoralist cultural aspects were excluded and only technology adoption entered during computation.

5.0 SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

5.1.1 Water Regulatory Policy and Sustainability of Community Rural Water Supply Projects

The study also found out that water regulatory policy on it owns had a low positive correlation with sustainability of rural water supplies and therefore had low influence on sustainability. This low influence was attributed to low water regulatory policy dissemination, awareness creation and application in the community managed rural water supply projects. These findings were also collaborated by findings from key informant interview.

5.1.2 Management Committee Competencies and Sustainability of Rural Water Supplies

The findings indicated that a third of the management committees' members had a form-four level of education and above. Low education levels coupled with less availability of skilled and competent workers in the management committees contributed to low sustainability of water projects. None of the water supply management committees had employed managing directors, technical managers, engine mechanics and electricians. The highest percentage of category of staff employed was nine water supply operators and seven plumbers.

5.1.3 Pastoralist Cultural Aspects and Sustainability of Rural Water Supply Projects

The study found that customary methods on rare instances were pivotal in deciding how sub clans representation would be in the management committees and elders at times were arbiters in management wrangles. The customary management practices mainly applied at the water pans to regulate water access during droughts. It also applied for orderly water access frequency for livestock and for control of influx of livestock to the community's boreholes. In representation of women in water management committees, the male gender dominated the water management committees and although women were involved in water management decision making, they were rarely in key positions in management committees such as being chairpersons. The role of paying for domestic and livestock water was the preserve of men at the household level.

Technology Adoption and Sustainability of Community Managed Rural Water Projects

The study established that the dominant technology in community managed rural water supply projects in Merti Sub County were diesel powered engines and generators systems. Only three water projects thus Bulesa, Bisan – Biliqo and Merti water projects had integrated solar system technologies in their water projects. Over eighty percent of project beneficiaries were not involved in technology choice with an explanation that Government departments and NGOs chose the technology for them.

5.2 Discussions on Findings

5.2.1 Water Regulatory Policy Influence on Sustainability of Rural Water Supplies

According to the findings water regulatory policy awareness and application in community managed rural water supply projects in Merti Sub County was low and therefore its influence on sustainability was minimal. This led to non-compliance to requirements such as legal registration status of the water projects, licensing requirements for a service provider, use of approved gazetted water tariffs and requirement for water abstraction. The findings echo Lockwood and Smits (2011) that unclear policy and regulation, and lack of structured support are a cause of low rural water supply sustainability. They also echo Leclert et al. (2016) findings that water sector policy reforms have not penetrated rural water services in Kenya hence community groups in the country do not have legal status and do not conform to requirements to operate sustainably. The findings also reinforced Water Aid (2009) establishment that communities did not exhibit voluntary regulation as required and for sustainability to take root in rural water schemes there was need for better regulatory environment. Therefore, water regulatory policy influences sustainability of community managed rural water supply projects positively only if communities are made aware of its contents and requirements, otherwise lack of knowledge about it negatively influences sustainability because community water projects end up operating in an un-regulated environment without set benchmarks to perform sustainably.

5.2.2 Management committee competencies influences on rural water supply sustainability

Management committee competencies influence on community managed rural water supply projects sustainability was significant and it ranked second best predictor of sustainability of community managed rural water supply projects in the Sub County. However, the findings indicated that management committees in Merti Sub County had inadequacy of skilled workers

and competencies for water supply management and operations hence could not operate their water supplies sustainably. Both community members and management committees ranked highly capacity building training as key for enhancing management capabilities. Inadequacy of skilled personnel caused community projects to be over-reliant on external assistance to fill the gap. These findings tend to reinforce Mesa et al. (2014) that for a community water supply management to improve there is need for communities to hire competent staff. They also echo Tadese et al. (2013) findings that community managed water supply projects rely heavily on the government and NGOs for sustainability. Therefore, management committees' competency is a factor that positively influences sustainability of community managed rural water supply projects.

5.2.3 Pastoralist cultural aspects influence on sustainability of rural water supplies

Even though there was no significant relationship between pastoralist cultural aspects and sustainability of rural water supplies in Merti Sub County, male gender dominance in water management was seen. Some aspects of culture considered normal such as use of elders to arbitrate management committee wrangles and discouragement of water wastage instilled were also vital in instilling responsiveness in water use and management. Male dominance in water management concurred with Magala (2014) assertion that water management was a socially endorsed role to women and a symbol of womanhood but with controlled male participation and engagement. This also collaborated Beyene (2012) and Pesonen (2016) that women participation in rural water supply management was low.

5.2.4 Technology adoption influence on sustainability of rural water supply projects

On findings for technology adoption, majority of the community members were not involved in technology selection. Diesel powered technology was dominant in the community water projects and had high frequency of breakdowns. The findings also indicated that communities were unable to operate the water technologies without external assistance, they had inadequacy of skilled persons to operate the technology and preferred solar technologies that were more economical in terms of operation and maintenance costs. These findings echoed Gleitsman et al. (2007) that communities preferred technologies that did not frequently breakdown. They also agree with Beyene (2012) that water supplies in which the communities were not involved in technology choice have high rates of non-functionality.

5.3 Conclusions

The study concluded that water regulatory policy influences positively the sustainability of community managed rural water supply projects only if the rural communities are aware of its contents, requirements and applicability. This is so because the study found that low penetration of water regulatory policy in rural water supply projects lead to decimal applicability and compliance in rural community water supply management. Water regulatory policy should be able to offer guide in setting regulations and standards for community managed rural water supply projects in pastoralist areas to operate sustainably.

Management committee competencies highly influenced sustainability of community managed rural water supply projects. The need for improved management committee competencies ranked

high within the community with majority reporting that more capacity building trainings were required to enhance management capabilities. Low levels of skilled personnel and low levels of education within the management committees caused them to be over-reliant on external help, led to provision of poor services and caused less financial prudence in water projects. Few management committee members received token remuneration while the rest volunteered their service hence being a disincentive for attracting qualified competent staff for water management.

Pastoralist cultural aspects did not influence sustainability of community managed rural water supply projects in Merti Sub County, however, men dominance in water management issues was evident.

Adoption of technology influenced to a great extent sustainability of community managed rural water supply projects in the study area. The rural communities preferred technologies that they could easily adopt such as solar powered pumping systems that had low rates of breakdowns and were less expensive to sustain. Technology skill requirement was inadequate and external help sought frequently. Therefore any water technology that is user friendly and is easily adopted by communities, requires low O&M costs and technology skill requirements is available enhances water supply functionality , ensures regular water services and increases user satisfaction with the level of service hence positively influencing sustainability of community managed rural water supply projects.

5.4 Recommendations

The following recommendations are put forth to enhance and improve sustainability of community managed rural water supply projects;

1. Since water service is a fully devolved function to the county governments, the water sector in the counties need to extensively raise awareness on water regulatory policies and produce abridged translated versions in the local dialects so that community members and management committees can apply it to effectively manage rural water supply projects,
2. Capacity building trainings to enhance management committee skills and competencies need to be periodically done by the county governments and a monitoring system instituted for tracking, assessing and reporting on progress in improvement of management capabilities. This should be followed by development of remuneration packages for a lean but competent professional staff that will ensure improvements in water collection and better customer service levels,
3. County governments and other partners implementing rural community water projects in the counties in pastoralist areas should develop user friendly technologies for water supplies such as solar powered systems owing to the long hours of sunshine in these areas. This should then be followed by sponsoring community youth to take up technicians course trainings in diagnostic, repair and maintenance of the applied water technologies,
4. Positive cultural practices such as the ones that discourage water wastages and encourage alternative dispute settlements using elders should be and embedded in formal county

water regulations and by –laws. The laws should also encourage women participation in water management committees by making it mandatory for reserved key positions to be allocated to women.

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