FACTORS AFFECTING THE SUSTAINABILITY OF COMMUNITY-MANAGED PIPED WATER SUPPLY SCHEMES: A CASE OF MISEU FOLO AND EAST BANK IN CHIKWAWA DISTRICT, MALAWI

MSc (WATER RESOURCES AND SUPPLY MANAGEMENT) THESIS

BY

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BSc (Mechanical Engineering) - University of Malawi

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THE POLYTECHNIC

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A thesis submitted to the Faculty of Applied Sciences in partial fulfilment of the requirements of the degree of Master of Science (Water Resources and Supply Management)

University of Malawi

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DECLARATION

I, Arthur Hepeni, hereby declare that this research entitled "*Factors affecting the sustainability of community-managed piped water supply schemes: A case of Miseu Folo and East Bank in Chikwawa District*" is my own work and to the best of my knowledge has never been presented for the award of any other degree or diploma of the university or other institution of higher learning except where due acknowledgement has been made in text.

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CERTIFICATE OF APPROVAL

The undersigned certify that they have read and approved for acceptance by the University of Malawi, The Polytechnic this thesis entitled "*Factors affecting the sustainability of community-managed piped water supply schemes: A case of Miseu Folo and East Bank in Chikwawa District, Malawi".*

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DEDICATION

I dedicate this work to my dear wife, Eddah, my son Fraser and my daughters Pemphero and Chifuniro, for their moral support throughout the entire period of the study. I appreciate their motivation for the advancement of my studies.

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ABSTRACT

Developing countries especially those in the sub-Saharan Africa have the highest non-functional rate of community-managed water supply schemes. This happens after governments and other development partners have invested a considerable amount of funds in constructing and rehabilitating these water supply schemes. However, there are efforts by the Government of Malawi to reverse the situation through various interventions such as management of these water supply schemes under Water Users Association (WUA) model.

This study aimed at exploring factors affecting the sustainability of community-managed water supply schemes under WUA management model in Chikwawa District in the Southern Region of Malawi. The study employed descriptive design using both quantitative and qualitative methods. The target population consisted of both males and females who were water users and Board of Trustees (BOT) members of Miseu Folo and East Bank Water Supply Schemes in Chikwawa District. Data was collected from 148 respondents of whom 124 were water users and 24 were BOT members from the two selected water supply schemes.

The study found that the functionality of community-managed water supply schemes in Chikwawa District was staggering at 59.7%. The study revealed that Miseu Folo Water Supply Scheme (MFWSS), with boreholes operated by hydro-power had a higher functionality rate (100%) than East Bank Water Supply Scheme (EBWSS), a gravity-fed piped water supply scheme whose functionality rate was 26.5%.

The study revealed that the majority of BOT members acknowledged lack of capacity to manage water supply schemes sustainably and they could not elaborate clearly their roles and responsibilities in the WUA Board. The BOT members further acknowledged that engagement of a Local Utility Operator (LUO) to run a water supply scheme on their behalf could promote sustainability due to the LUO's vast skills in administration, operations and maintenance. However, the BOT members perceived that the LUOs were too expensive for Community Managed Water Supply Schemes thereby depleting the limited available funds on their remuneration.

The study further revealed that water users from EBWSS preferred borehole water to tap water which is currently supplied by their scheme because they were not satisfied with the services rendered by the East Bank Water Users Association (EBWUA). These findings were contrary to those found in MFWSS where water users were satisfied with the water supplied by the Miseu Folo Water Users Association (MFWUA). It was also found that user satisfaction, presence of alternative water sources, payment of water tariffs and cost recovery were some of the factors affecting the sustainability of community-managed water supply schemes in Chikwawa District.

Overall, the study revealed the need to revisit the WUA management model which is advanced by the Government of Malawi if the piped water supply schemes are to remain sustainable. Furthermore, both the WUA Board and General Assembly acknowledged the need for external support from other stakeholders. Therefore, involvement of the Central Government, District Councils and NGOs in the management of piped water supply schemes is critical to sustainability of the water supply schemes rather than leaving this enormous task to communities alone.

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ABBREVIATIONS AND ACRONYMS

BOT	Board of Trustees
DWDO	District Water Development Officer
EBWUA	East Bank Water Users Association
EBWSS	East Bank Water Supply Scheme
GoM	Government of Malawi
GVH	Group Village Headman
IRC	International Water and Sanitation Centre
LUO	Local Utility Operator
MBS	Malawi Bureau of Standards
MFWUA	Miseu Folo Water Users Association
MFWSS	Miseu Folo Water Supply Scheme
MGDS II	Second Malawi Growth and Development Strategy (2011-2016)
MK	Malawi Kwacha
MoAIWD	Ministry of Agriculture, Irrigation and Water Development
NSO	National Statistical Office
NWDP	National Water Development Programme
SRWB	Southern Region Water Board
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WSS	Water Supply Scheme
WUA	Water Users Association
WWAP	World Water Assessment Programme

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Globally, the provision of adequate and safe drinking water to communities has been emphasised as a critical water resource management issue particularly in rural areas of most sub-Saharan African countries (World Water Assessment Programme (WWAP), 2012). Water is an important natural resource that sustains life and vital for sustainable development (Nkambule & Peter, 2012). Water resources play a central and critical role in all aspects of life in terms of human survival and economic development. Inadequate access to safe drinking water coupled with poor sanitation and personal hygiene practices are the causes of water borne diseases in both rural and urban areas. Poor water supply, sanitation and hygiene conditions have given rise to 88% of the cases of diarrhoea which include diseases such as cholera, typhoid and dysentery. These diseases have exacerbated anaemia and malnutrition among children. Therefore, improving water, sanitation and hygiene (WASH) has the potential to prevent at least 9.1% of the disease burden (in disability-adjusted life years or DALYs, a weighted measure of deaths and disability) or 6.3% of all deaths (Prüss-Üstün et al., 2008).

Of the 748 million people which lack access to improved water sources in the world, over 90% live in rural areas and 43% in sub-Saharan Africa. While the implementation of the Millennium Development Goals (MDGs) had significantly improved access to safe drinking water, the countries in sub-Saharan Africa had made little or no progress in meeting the Millennium Development Goal (MDG) drinking water target (World Health Organisation (WHO)/United Nations Children's Fund (UNICEF), 2014). It is from these grounds that the Sustainable Development Goal (SDG) no. 6 promotes access to safe and affordable drinking water to everyone on earth. In order to realise MDGs and the recently established Sustainable Development Goals (SDGs), Governments continue to develop national policies and budgets that focus on key results and milestones on water supply services. For example, the National Water Policy articulates the Malawi Government's position on water resource management, infrastructure development and water and sanitation service delivery (Government of Malawi (GoM), 2005). The National Water Policy states the government's vision which is "*Water and Sanitation for All Always*." The vision encompasses availability and sustainable management of water and sanitation for all as stipulated in SDG no. 6. Therefore, in an effort

to improve the health and living standards of people, the Government of Malawi (GoM) had put in place a second Malawi Growth and Development Strategy (MGDS II) as a roadmap for creating wealth through sustainable economic growth and infrastructure development in the country. The GoM through the MGDS II identified several priority areas which would accelerate the economic growth of the country. The provision of potable water supply to both urban and rural communities is placed as one of the key priority areas (GoM, 2012). Furthermore, National Water Development Programme (NWDP), a project arm of the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) provides the platform for donor coordination within the Water and Sanitation Sector in Malawi. NWDP manages all donor supported water development projects and has invested in several water supply projects through drilling of boreholes, rehabilitation of gravity-fed water supply schemes predominantly serving the rural communities. Large investments from World Bank, the African Catalytic Growth Fund (ACGF), and the African Development Bank (AfDB) as well as grants from bilateral donors such as the Department for International Development (DFID) from United Kingdom and the Australian Government's Oversees Aid Program (AusAID) are managed centrally by the NWDP (Lockwood & Kang, 2012). The GoM also implemented gravity-fed piped water supplies from the late 1960s to the mid 1990s and with this effort Malawi has approximately 80 rural piped water schemes serving a design population of almost two million people (Zuzani et al., 2013).

The National Water Policy which the GoM put in place in 2005 embraces community ownership and management as an approach of realising MGDS as well as MDGs (GoM, 2005). In an effort to meet the MDGs, MoAIWD has piloted Water Users Association (WUA) management model in cooperation with African Development Bank and Water AID where the rural piped water supply schemes are now managed (Baumann & Danert, 2008). In many African countries, management of rural water supply schemes has been dominated by communities and community management has been embraced as the panacea for rural populations in sub-Saharan Africa (Harvey & Reed, 2003). However, community management is more suitable for small water supply schemes than for bigger water supply schemes (Kleemeier, 2000).

With such efforts by the GoM, it is not surprising to note that while many countries in the sub-Saharan Africa were poised not to halve the proportion of people without access to clean

water by 2015; Malawi on the other hand had already met the target. Despite this impressive progress, over 14% of the population of Malawi (2.2 million) living in rural areas had no access to safe drinking water sources by 2012 (WHO/UNICEF, 2014). Furthermore, the majority of rural piped water supply schemes in Malawi are not sustainable (Baumann & Danert, 2008; Zuzani et al., 2013) and sustainability of water supply schemes has been associated with functionality of water supply facilities (Nkambule et al., 2012; Salim, 2002; Zuzani et al., 2013). In developing countries, low functionality rate of water supply facilities is associated with inadequate resources to cover operations and maintenance costs (Baumann & Danert, 2008).

Therefore, functionality and utilisation of water supply facilities, quality of water service delivered, financial and management models practised are needed on these community-managed piped water supply schemes upon which to increase sustainability. Only knowing the level of sustainability is not enough but it is also necessary to understand the underlying factors that lead to non-functionality of community-managed piped water supply schemes.

1.1.1 Empirical Evidence on the Factors affecting Sustainability of Water Schemes

In a study conducted in Central Ethiopia by Tedesse et al. (2013) on rural water supply management and sustainability, a total of four schemes were selected for the study based on type of water sources and operational mechanisms. The water supply schemes comprised boreholes operated by diesel generators, gravity-fed water supply services, boreholes operated by hydro-power and water supply schemes consisting of ponds and hand pumps. They found that the functionality of the water supply schemes was affected by seasonal fluctuations of the water sources. This was due to the fact that the region under study is geographically located in the rift valley area where rainfall pattern is sporadic and has a corresponding effect on the groundwater recharge. Furthermore, the gravity-fed water supply scheme was affected with recurrent pipeline breakages and water shortage (Tadesse et al., 2013).

In another study in Kenya, income levels of consumers had a negative impact on sustainability of water supply schemes and quality of water supplied while adequate quantities enhanced sustainability of the water supply schemes (Mwnagi & Daniel, 2012). In the study conducted by Zuzani et al., (2013) on sustainability of piped water supply schemes

in Malawi, insufficient funding, ineffective community water committees, lack of training, age of system and political interference were major factors contributing to sustainability of rural piped water supply schemes. The reason behind this was that rural water supply schemes were basically community managed and people had to manage the operation and maintenance of these schemes without capacity building and support from the Government though they were resource constrained (Zuzani et al., 2013)

A study of functioning taps in the Southern Region of Malawi showed that 55% of the taps in the region were not functioning and Chikwawa District had 73% of its taps not functioning (GoM, 2012). Chikwawa District is one of the 28 districts in Malawi and is located in the Southern Region of Malawi as shown in Figure 1 below. From the study, Chikwawa District which is one of the districts in the Southern Region of Malawi has a non-functionality rate greater than that of the entire Southern Region of Malawi. Furthermore, Chikwawa District Council's water development sector annual report for 2014/15 financial year on gravity fed water supply schemes shows that the district has a functionality rate of 21% with 132 taps working out of 630 taps. This functionality translates to about 3% of the district's population accessing safe water through taps. However, the report on boreholes shows that the district has a functionality rate of 68% with 1,020 functioning out of 1,500 boreholes translating to 51% of the district's population accessing safe water through boreholes. (Chikwawa District Council, 2015).

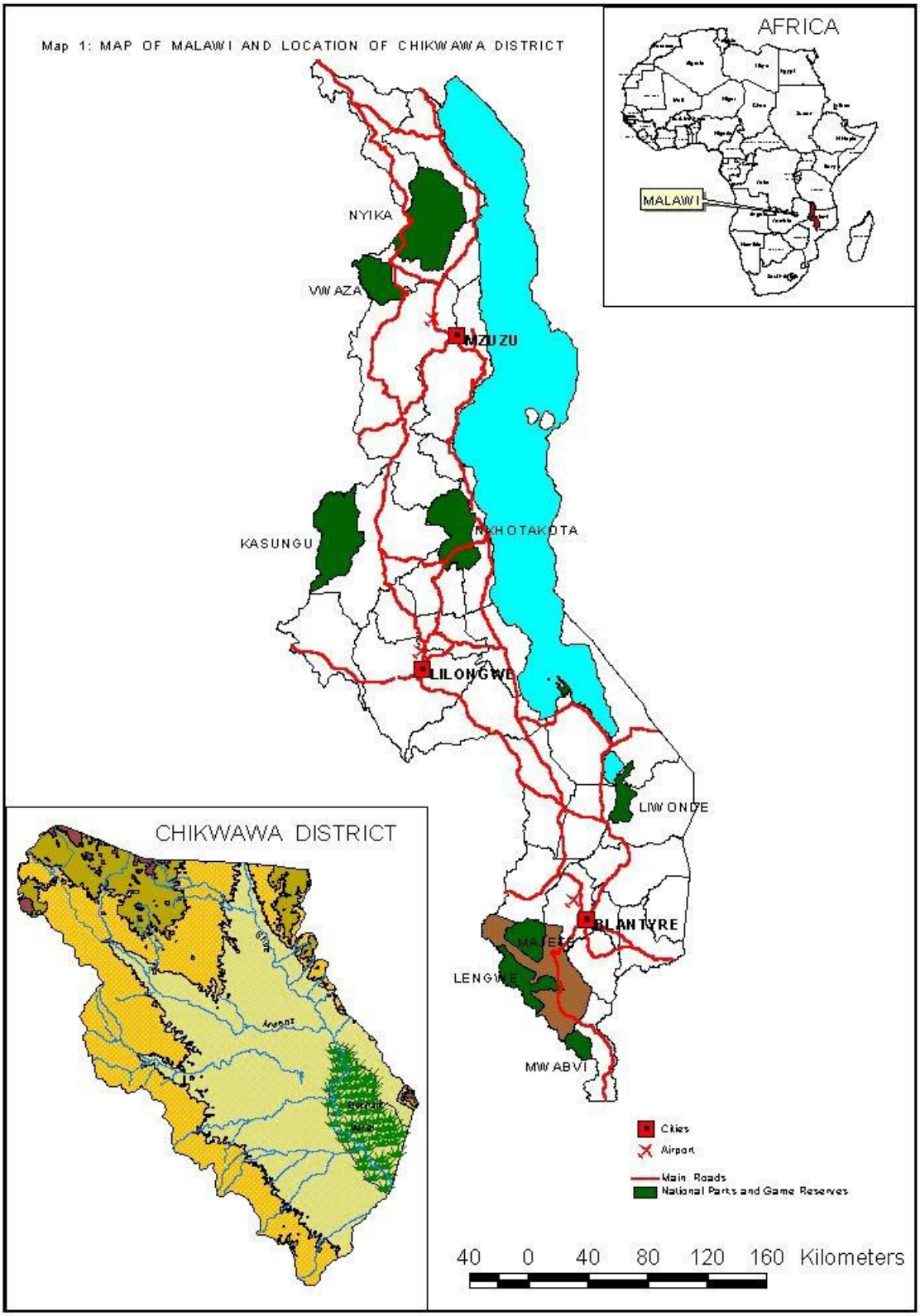

Figure 1: Map of Malawi showing Chikwawa District

Therefore, there was a gap in knowledge on the factors that influence the sustainability of community-managed piped water supply schemes in Chikwawa District utilising WUA management model. Various research studies that have been conducted on the sustainability of rural water supply at global, regional and national levels revealed varying factors affecting sustainability of water supply schemes. Furthermore the study setting varied from one study to another. For example, the study conducted in Ntcheu by Zuzani et al. (2013) utilised a sample from only gravity-fed water supply schemes operated by Central Region Water Board. However, this current study aimed to fill this gap utilised water supply schemes operating from both gravity-fed system as well as a system comprised boreholes equipped with electrical submersible pumps under WUA management model in both rural and market centre settings. Hence, the study examined Chikwawa East Bank and Miseu Folo water supply schemes operating in rural areas with gravity-fed system and market centre with boreholes equipped with electrical submersible pumps respectively. Furthermore, there is little literature on factors influencing sustainability of community-managed piped water supply schemes in Chikwawa District.

1.2 Statement of the Problem

In developing countries, the impact of water supply schemes on the beneficiary communities is insignificant because the water services and systems are inadequate, and are often under-utilised, broken down, or abandoned (Ademiluyi & Adugbesan, 2008). According to the 2014 update report from WHO/UNICEF joint monitoring programme for water supply and sanitation, 547 million people worldwide would remain without access to an improved drinking water source and 2.4 billion people would be without access to improved sanitation facilities by end of 2015. Owing to this situation, billions of people worldwide will remain at risk of water, sanitation and hygiene (WASH) related diseases such as diarrhoea, which in 2011 killed 2 million people and caused 4 billion episodes of illness (WHO, 2012).

Recent estimates on the status of water and sanitation indicate that Malawi has met the MDG drinking water target of ensuring environmental sustainability i.e. “halving the proportion of people without access to safe drinking and basic sanitation by 2015” (WHO/UNICEF, 2014). Although the WHO/UNICEF Joint Monitoring Programme suggests that Malawi has met the MDG water target eight years early (WHO/UNICEF, 2014), the data from the annual sector performance report on the performance of irrigation, water and sanitation in Malawi shows

that access to improved water sources for rural communities is not improving as revealed by high non-functionality rate of water facilities (GoM, 2012).

An analysis of the information from annual Sector Performance Report (SPR) which is a key source of information on the performance of the Irrigation, Water and Sanitation Sector (IWSS) in Malawi on the functionality of gravity piped water schemes in the Southern Region of Malawi reveals that there is high non-functional rate of taps in Chikwawa District (see Table 1 below).

Table 1: Functionality of Gravity Piped Water Schemes in Southern Region of Malawi - 2011

DISTRICT	NUMBER OF TAPS	FUNCTIONAL TAPS (NO.)	NON-FUNCTIONAL TAPS (NO.)	NON-FUNCTIONAL TAPS (%)
Balaka	1850	1625	225	12
Phalombe	1589	1192	397	25
Zomba	1384	726	658	48
Thyolo	338	167	171	51
Mwanza	534	165	369	69
Chikwawa	501	134	367	73
Mulanje	2218	442	1776	80
Mangochi	210	35	175	83
Machinga	1591	175	1416	89
TOTAL	**10215**	**4661**	**5554**	**54**

(GoM, 2012)

Table 1 shows that Chikwawa District has the fourth lowest functional taps in Southern Region of Malawi and such low functional rate of water taps threatens sustainability of community managed rural piped water supply schemes in the district (GoM, 2012). This low functional rate of rural water supply facilities undermines efforts to expand water service coverage and exerts immense pressure to the existing water supply systems especially when funds which could have been used to expand existing water supply system's coverage and capacity are used for maintenance in order to increase functionality.

However, the success made by the Government of Malawi in meeting the water drinking target will be meaningless if the community-managed piped water supply schemes remain unsustainable (Nkambule et al., 2012; Zuzani et al., 2013). Studies show that community

management has been a prevalent model for management of rural piped water supplies throughout sub-Saharan Africa (Bauman & Danert, 2008; Harvey & Reed, 2003). Despite community management being a dominant approach, water supply schemes fail after construction. It should be noted that despite this challenge of sustainability of community-managed piped water supply schemes where many piped water supply schemes fail after construction, there are also numerous piped water supply schemes that are sustainable (Schouten, Moriarty & Postma, 2013).

It is therefore in view of these observations that this research was set to explore why community-managed piped water supply schemes continue to fail after either construction or rehabilitation in spite of Government's effort in providing water supply to disadvantaged rural communities.

1.3 Objectives of the Study

1.3.1 Main Objective

The main objective of the study was to explore factors affecting the sustainability of community-managed rural piped water supply schemes in Chikwawa District.

1.3.2 Specific Objectives

The specific objectives of the research were:-

1. To establish the fraction of functional point of use units and their utilisation in Miseu Folo and Chikwawa East Bank water supply schemes.
2. To determine water user's perception on water service delivery in Miseu Folo and Chikwawa East Bank water supply schemes.
3. To identify the community management committees' perceived barriers to a sustainable water supply scheme.
4. To determine the influence of WUA management model practices on sustainability of community-managed piped water supply schemes.

1.4 Significance of the Study

The study mainly contributes to the debates on an important concept of sustainability specifically on community-managed piped water supply schemes under WUA management model. Several findings show that the majority of rural piped water supply schemes in sub-

Saharan Africa are not sustainable (Nkambule et al., 2012; Salim, 2002; Zuzani et al., 2013). However, there is a limited body of research findings that shows what causes these piped water supply schemes to be unsustainable and why such factors cause failure of the supply schemes. The unsustainable water supply schemes characterised by low functionality rate have cost implications on lost investment (GoM, 2012). Therefore, making water supply facilities sustainable would make the piped rural water supply more cost effective and would result in a positive return on investment. Consequently, the number of people having access to safe water would increase.

This study will assist Ministry of Agriculture, Irrigation and Water Development, Chikwawa District Development Team and WUA Boards in Chikwawa District to come up with measures and actions in the provision of water supply services to help the existing rural piped water supply schemes and those to be constructed in future to be sustainable.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Sustainability is a concept that has aroused so much debate in recent years and 'has become one of the most overused and abused word in development vocabulary' (Sugden, 2003). Despite this being the case, defining the concept has not been a matter of concern but determining how to achieve sustainability of water schemes has created substantial debate.

This chapter therefore, attempts to review literature related to the concept of sustainability and determine its influence on the functionality of rural piped water supply schemes in Chikwawa District. This chapter begins by reviewing existing definitions and basic conceptual frameworks on sustainability. This is then followed by rural water supplies in Malawi as well as WUA model of management in rural piped water supply schemes.

2.2 Sustainability Defined

Sustainability is a concept which has evolved from a debate from another concept of sustainable development which gained global importance until 1987 with the publication by the World Commission on Environment and Development (WCED) also known as Brundtland Commission Report of *Our Common Future* (Stewart & Gray, 2009). The concept of sustainable development is defined by the World Commission on Environment and Development as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs," (WCED, 1987 as cited in Stewart & Gray, 2009). From the Brundtland Commission's definition, the concept of sustainable development was employed in relation to natural resources and development for the present needs but without affecting the future.

However, a variety of definitions have emerged pertaining to sustainability of water supply systems and most of the definitions centre on projects and service delivery of the water supply systems. Davis and Brikke (1995) defined a drinking water supply as sustainable if the water consumed is not exploited but naturally replenished, facilities are maintained in a condition which ensures a reliable and adequate water supply and the benefits of the supply continue to be realised over a prolonged period. Sustainability is further defined as the capacity of the project to continue to deliver its intended benefits over a long time

(Bamberger & Cheema, 1990 as cited in Sara & Katz, 1997). On the other hand, Sarah and Katz (1997) define sustainability as the capacity of project to deliver its intended benefits over the design period. The definitions by Bamberger and Cheema (1990), Davis and Brikke (1995), Sarah and Katz (1997) emphasise the continued flow of benefits after withdrawal of external support but the difference between the definitions is on the timeline which the communities will continue to enjoy the intended benefits after the completion of the project. While Sarah and Katz (1997) definition stipulates the design period as the appropriate duration for the intended benefits, Bamberger and Cheema (1990) and Davis and Brikke (1995) definitions have an indefinite timeline. Additionally, Davis and Brikke (1995) definition mentions the acceptable levels of water service delivery.

According to Abrams (1998) and Abrams et al. (2000), sustainability of water services is defined as the situation whereby water continues to be available for a long period of time in the same quantity and at the same quality as it was designed. Sara and Katz (1997) define sustainability as "the maintenance of an acceptable level of services throughout the design life of water supply system." In their contribution on the definition of sustainability based on service delivery, Sara and Katz (1997) in "Making Rural Water Supply Sustainable" stated that a sustainable system is one which is based on affordability, appropriate technology and continues to deliver a high level of water related benefits after completion of the project. In all fairness, a system is sustainable if all of the elements that are required for sustainability have been put in place (Sara & Katz, 2003). Carter et al. (1999) define sustainability of a water supply system as whether water continues to be abstracted at the same rate and quality as when the supply system was designed and build their definition from Abrams (1998) who defines sustainability as whether or not water services continue to work over time or last over time.

However, Brikke (2002) states that a water supply scheme is sustainable if:

1. It is functioning and being used;
2. It is able to deliver an appropriate level of benefits in terms of quality, quantity, convenience, continuity and health to all, including the poorest women and men;
3. It continues to function over a period of time (which goes beyond the lifespan of the original equipment);

4. Its management is institutionalised;
5. The management of the service involves the community (or the community itself manages the system)
6. It adopts a perception that is sensitive to gender issues;
7. It establishes partnership with local authorities;
8. It involves the private sector as required;
9. Its operation, maintenance, rehabilitation, replacement and administration costs are covered at local level through user fees or through alternative sustainable financial mechanisms;
10. It can be operated and maintained at local level with limited but feasible external support and
11. It does not affect the environment negatively.

Defining the concept of sustainability is vital because how we define the concept helps to set parameters which are used to measure it and in understanding the factors that influence it in water supply schemes. In this study, the following definition by Harvey and Reed (2004) is adopted:

> *"A water service is sustainable if the water sources are not over-exploited but naturally replenished, facilities are maintained in condition which ensures a reliable and adequate water supply, the benefits of the water supply continues to be realised by all the users indefinitely, and the service delivery process demonstrates a cost-effective use of resources that can be replenished"*.

In this definition by Harvey and Reed (2004), sustainability of rural piped water supply scheme is a multidimensional issue and encompassed all the recurring issues in the other definitions (Abrams, 1998; Bamberger & Cheema, 1990; Brikke, 2002; Carter et al., 1999; Davis & Brikke, 1995 and Sara & Katz, 1997). Therefore, sustainability of water supply system involves water sources which are not exploited, the quantity and quality of water supplied which is adequate and safe, the facilities which are operated and maintained for reliable water supply through the financing of regular operation and maintenance costs by water users and a continuity of benefits to all water users indefinitely.

2.3 Factors Affecting the Sustainability of Rural Piped Water Supply Schemes

A number of conceptual frameworks have been developed and identified from various studies in order to understand the factors that affect the sustainability of water supply systems. From the studies, multiple aspects related to rural water supply sustainability were also identified (Water and Environmental Health at London and Loughborough (WELL), 1998) which included institutional, social, technical, environmental and financial dimensions. The conceptual framework by (WELL, 1998) has been shared by many researchers including Abrams (1998).

According to Sugden (2003), the ability of the community to keep a water supply scheme functioning is dependent on a complex mix of managerial, environmental, social, financial, and technical issues as well as the institutions and infrastructure designed to support the community. Based on Abrams (1998), WELL (1998), and Harvey and Reed (2004) identify the following as critical factors to achieving sustainability of rural water supplies and include policy context, institutional arrangements, financial and economic issues, community and social issues, technological and the natural environment, spare parts supply, maintenance systems and monitoring. Therefore, sustainability cannot be attained by focussing on only one or any of the aspects in isolation because the aspects are interdependent on each other (Brikke, 2002; Harvey & Reed, 2004). It is also noted that the sustainability of water supply services is multifaceted and interdependent on the interaction of combined factors called the building blocks by Harvey and Reed (2004).

Lockwood et al., (2004) examined five studies (Hodgin, 1994; Sara and Katz, 1997; WaterAid, 2003; Water and Sanitation Programme (WSP)/International Water and Sanitation Centre (IRC) Methodology for Participatory Assessment (2003) and Water and Sanitation Programme (WSP) South Asia (1999) in order to gain insight into factors affecting sustainability and its relationship on project-related variables. The critical project-related issues affecting sustainability which they identify are classified into pre-project and post-project factors. The pre-project related issues are community participation, demand responsive approach, empowerment, technical design, construction quality, gender and equity, and training. On the other hand, post-project related issues are finance and tariff collection, user satisfaction, capacity of water committees, definition of roles and responsibility for system management and on-going training (Lockwood et al., 2004).

In a study on sustainability of drinking water schemes in rural communities of Nepal, Bhandari and Grant (2007) have concluded that user satisfaction on quality of service, trustworthiness of water committees, willingness to pay and affordability of water services are crucial factors affecting sustainability of water schemes.

2.3.1 The Context of Sub-Saharan Africa

Peter and Nkambule (2012) identify the following as being factors influencing sustainability of water schemes:

1. Functionality
2. Maintaining design flow
3. Water fetching time
4. Ability to meet additional demand
5. Use of the scheme by population
6. Gender equity
7. Participation in decision making on operation and maintenance
8. Existence of funds for operation and maintenance
9. Willingness of users to contribute money
10. Existence of a user's committee
11. Participation in the initial planning and design of water scheme
12. Coordination between the local leaders and user's committee

Peter and Nkambule (2012) further cite reliability of service, training and external support as other factors that affect the sustainability of water schemes.

A study done in Kenya by Mwnagi and Daniel (2004) found out that income level of consumers, poor quality and inadequate quantities of water supplied had a negative impact on the sustainability of water supply schemes. In another study conducted in Central Ethiopia in 2012, sustainability of piped water supply schemes was affected by functionality of the schemes caused by season fluctuation of water sources and recurrent pipeline breakage in the scheme's network (Tadesse et. al,. 2013).

2.3.2 The Context of Malawi

Kleemeir (2000) noted that a high percentage of dry taps in Malawian water supply schemes were caused by washed out pipes over river and gully crossings, vandalism, pipe breaks and blockages. She further noted that a management committee with the necessary capacity in the operations and maintenance was important in the performance of the schemes. Furthermore, the maintenance tasks assigned to the management committee were hindered by the size and complexity of the water supply schemes.

According to Zuzani et al. (2013), community-managed piped water supply schemes in Malawi are not sustainable because there are frequent wash-away of pipes at river crossings and gullies, prevalence of broken, leaking, stolen and vandalised pipes and non-functioning valves in the system. All the aforesaid problems are emanating from inefficient funding, inefficient community water committees, lack of training, age of system and political interference.

In a study by Ungwe & Morgan (2014), the following were identified as the six combined effects that affect sustainability of drinking services in Malawi:

1. Quantity of available water
2. Quality of available water
3. Capacity of infrastructure to provide and supply adequate water continually
4. Continuity of infrastructure to function as required at the design stage
5. Capacity to operate the infrastructure
6. Realisation of service provider expectations

Ungwe and Morgan (2014) further cite external support, supervision of subordinates, and safety of workers, clear management arrangements, adequate funding and supportive legislation/policies as other factors that influence sustainability of drinking water services in Malawi.

In the study by Magombo and Kosamu (2016) on water accessibility in Blantyre City, they conclude that poor governance, low tariffs, lack of financial support for maintenance and upgrading of reticulation system obstruct water availability in the city.

2.4 Community-Managed Piped Water Supply Schemes in Malawi – The WUA Management Model

2.4.1 Community Management

According to IRC (2003), involvement of communities in the construction of water supply systems began in the 1970s. In 1980s, the community involvement developed into community participation encompassing decision making processes and maintenance. Later in 1990s, the community participation led to communities managing the water supply systems on their own. Basically, this arrangement favoured communities and grassroots organisations which bypassed existing government structures (Lockwood & Smits, 2011).

In an attempt to improve water supply and sanitation provision, the GoM has traditionally focussed on increased supply based on infrastructure development but the challenges of such approaches are now recognised. Many systems constructed by the government are not functioning adequately due to broken pipelines, pumps and other factors. As a result, beneficiaries are left with limited option but to use unimproved water sources. Infrastructure development is indeed important but so are effective management of water supply systems by communities to circumvent lost investment. It is from this backdrop that community management has remained the management option of choice for Governments in the low-income countries including Malawi (GoM, 2005). This management option is considered to be a central prerequisite for the success of any developmental intervention within the communities and is one of the options for achieving sustainability. Community management has achieved widespread acceptance and is being applied by the majority of rural water supply systems in sub-Saharan Africa. In most cases, the users have the full control of their system (IRC, 2003). However, community management only runs smoothly within the first three years after commissioning of the water supply systems but later problems arise leading to the breakdown of management system (Harvey & Reed, 2007) and is the least preferred management option by water users (Hope, 2015). The problems identified to cause the breakdown of the management system include dependency on voluntary input, lack of incentives for community leaders, absence of appropriate replacement policy for committed members, lack of transparency and accountability and lack of regulation. Owing to the challenges faced by community management approach, it cannot ensure sustainability of water supply interventions although the approach is adopted unanimously in rural water supply systems of the sub-Saharan Africa (Harvey & Reed, 2007).

In Malawi, the National Decentralisation Policy instated in 1998 emphasises community empowerment through the transfer of power and responsibilities to local authorities. This was in view that in the past, the GoM took full responsibility of the operations and maintenance of rural water supply facilities. However, this arrangement was flawed by several inefficiencies making it unsustainable (GoM, 2015). Furthermore, National Water Policy puts emphasis on community management as the option of management of water supply and sanitation facilities with the expectation of communities owning and managing their water supply and sanitation systems sustainably. However, the water supply and sanitation systems still pose a lot of challenges despite government's arrangement for the systems to be managed at the lowest appropriate level (GoM, 2009a). Such arrangements were not legally recognised and the communities did not have the capacity to operate and maintain piped water supply schemes since they based their experience from managing point source supplies whose technology is less complex than the later. It is from this background that the GoM adopted the concept of Water Users Association (WUA) in order to improve the management of piped water supply systems in the market centres and rural areas. WUAs are an improvement to the traditional committee management which were based on voluntary support and were also not commercially viable. With the volunteer based community management of water supply systems, the community-led committee lose their interest or trained individuals moved away and the community never felt ownership of the new water supply system (Carter et al., 1999). Ownership is prerequisite for community management and key to sustainability of water supply systems. Ownership will lead to communities being responsible for the management of water supply systems which will in turn ensure that they contribute funds to cover for operation and maintenance costs.

Under the WUA arrangement, water users are expected to contribute user fees in order to cover fully operation and maintenance (O&M) costs with some savings being used for network expansion and service improvement. The O&M and other related costs incurred by the WUA ought to be met by applying a fixed charge tariff or metering to all water users within the water supply system. The WUAs operate the water supply scheme through a technically qualified Local Utility Operator (LUO) who is hired to manage the water supply scheme including collection of funds from consumer charges (GoM, 2009a). The WUA being a social organisation for the benefit of its members, WUA brings community cohesion and

empowerment in ways that can spread to other development activities within the water supply area.

2.4.2 Governance Structure

WUA is a mutual institution amongst water users as both owners and beneficiaries are usually incorporated under the Trustee Incorporation Act of 1998 or Cooperative Act of 1998 with a legal mandate to operate and maintain water supply system. Governance structure of WUA ensures a representation of water users in the management of the water supply system. Therefore, it constitutes Local Authority, General Assembly, WUA Board, a Local Utility Operator (LUO) as Secretariat and water users as primary stakeholders (GoM, 2009a). The structure is illustrated diagrammatically in Figure 2.

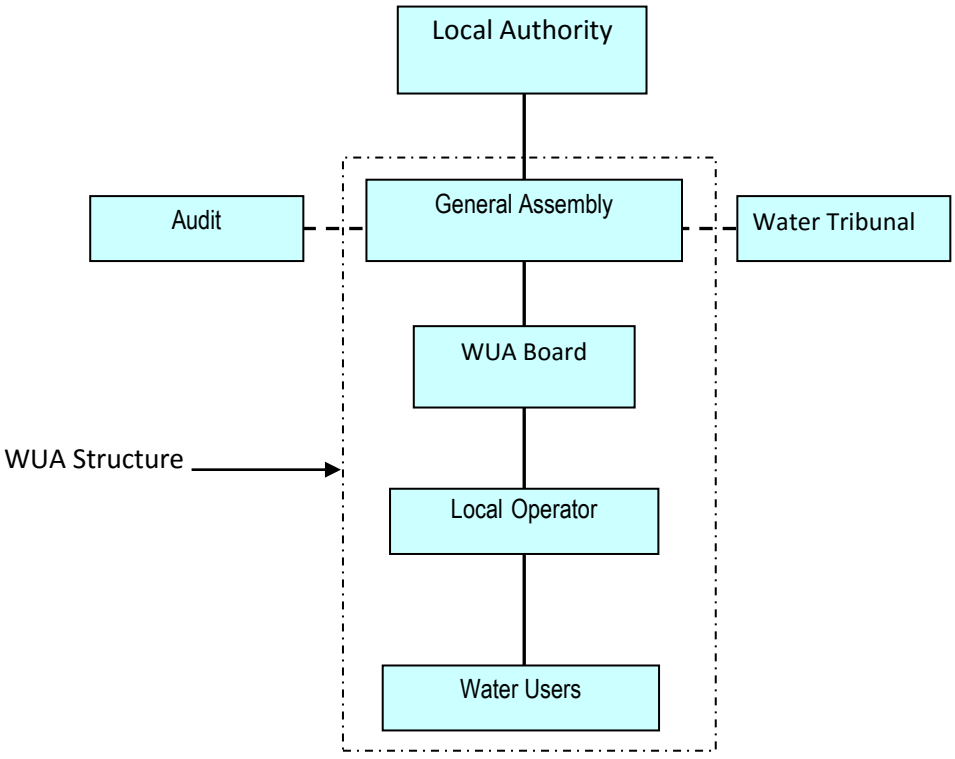

Figure 2: Governance Structure of WUA

The Local Authority (District Council) is the overall overseer of operations and maintenance of the water supply scheme and also the reporting agency at district level. Under the local authority is the General Assembly which is democratically elected from the water users most

especially from Village Development Committee (VDC), and comprises members representing water users from all customer categories within the catchment area of the water supply scheme. It also forms the ultimate body in creation of rules and policies governing the WUA.

The WUA Board plays a directorate role and supervises the day-to-day management of the water supply scheme. It comprises members drafted from General Assembly through democratic elections conducted by the General Assembly members themselves and independent members who do not have the right to vote. These independent members consist of the District Commissioner, the District Water Development Officer, Traditional Chiefs and other eligible persons such as the clergy, retired officers and prominent people (GoM, 2009a). Decision making is vested in the hands of WUA Board and fulfils corporate oversight role (Pilgrim et al., 2007).

The Local Utility Operator (LUO) is appointed by the WUA Board to undertake the day-to-day management of the water supply scheme and reports directly to the WUA Board. In the absence of a LUO, the WUA Board takes the day-to-day management of the water supply scheme on voluntary basis. The LUO collects user fees from water users (individuals, households or institutions who benefit from the services offered by the water supply scheme) which cater for operation and maintenance costs thereby increasing the sustainability of the water supply scheme. However, in certain circumstances user payments are generally insufficient to meet actual costs of operations and maintenance (Carter et al., 2010). In such scenario, the water services offered by the water supply scheme are generally poor affecting the water users' willingness to pay (Koehler et al., 2015).

2.5 Conceptual Framework of this Study

Consistent with Brikke (2002), Harvey and Reed (2004), Lockwood et al., (2004) and factors affecting the sustainability of water supply schemes in both sub Saharan Africa and Malawi, the emerging study can be categorised into five key concepts. Therefore, functionality and utilisation of the point of use units, perception of water users on the quality of services delivered, perceptions of WUA management committees on barriers to sustainable water supply scheme, practices of the WUA management model were considered when establishing factors affecting community-managed water supply schemes in Chikwawa District.

Furthermore, the physical conditions of the infrastructure and non-revenue water (NRW) were examined as a measure of maintenance of the water facilities being carried out by the community management.

The conceptual framework in Figure 3 demonstrates that sustainability of community-managed piped water supply schemes is dependent on independent variables which are categorised as functionality and utilisation of the point of use units, perception of water users on the quality of services delivered, perceptions of WUA management committees on barriers to sustainable water supply scheme, practices of the WUA management model. However, Government policies and legislation, water users' income and their level of education also come into play and they would also contribute to the sustainability of community-managed piped water supply schemes. Therefore, the conceptual framework attempts to represent important factors which contribute to the sustainability of community-managed piped water supply schemes as endorsed in the literature review section.

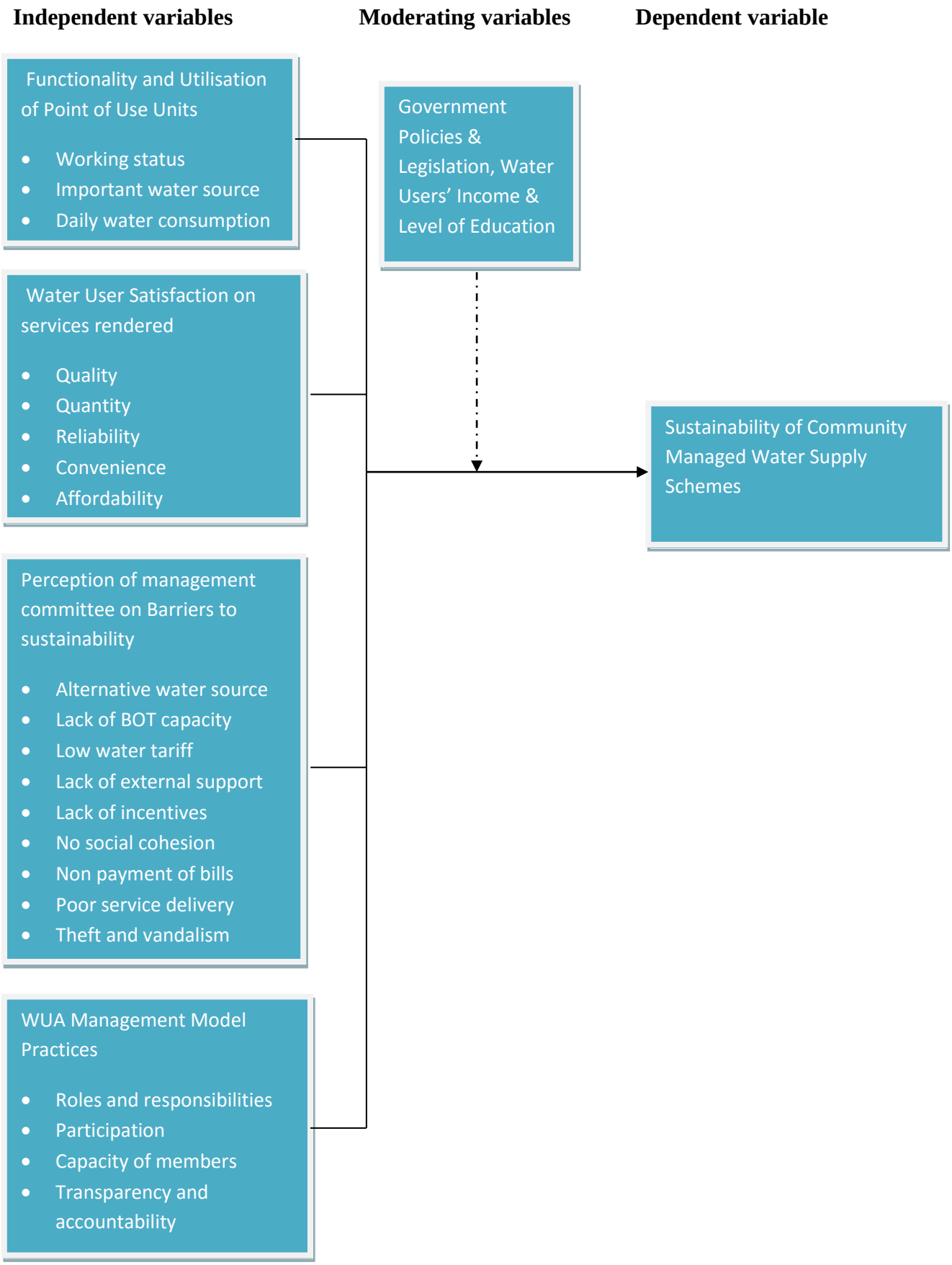

Figure 3: Conceptual Framework of the Study

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this chapter is to describe the methodology which was applied in the research in order to identify factors affecting the sustainability of rural piped water supply schemes in Chikwawa District. It describes the research design, sampling procedure, data collection methods, data analysis and presentation. These technical aspects of the study are discussed to justify the quality of procedure which was used. The chapter concludes with discussions on ethical considerations taken and limitations encountered during the course of conducting the research.

3.2 Study Setting

The study was conducted in Chikwawa District, Malawi. Chikwawa District is one of the 28 districts in Malawi and is located in the Southern Region of Malawi. The district is bordered by four districts namely, Mwanza to the North, Blantyre to the North East, Thyolo to the East and Nsanje to the South. It also shares an international boundary with Mozambique to the West. The district is experiencing rapid population growth with a population of 438 895 in 2008, out of which 217 981 are male while 220 914 are female and an annual growth rate of 1.1% (National Statistical Office, 2008).

There are six piped water supply schemes in Chikwawa district. These are Chikwawa, Nchalo, Ngabu, Miseu Folo, Chapananga and Chikwawa East Bank Water Supply Schemes. Chikwawa, Nchalo and Ngabu water supply schemes are managed by Southern Region Water Board (SRWB) while the rest are managed by respective Water Users Associations (WUAs). Those managed by WUAs are classified as community-managed piped water supply in this study and these are Miseu Folo, Chapananga and Chikwawa East Bank Water Supply Schemes. Chikwawa District was specifically selected by the researcher with the expectation of collecting data from water users and water management committees while minimising costs of research process. This study purposively selected Miseu Folo and Chikwawa East Bank WUAs and excluded Chapananga WUA from the study because it was under rehabilitation during the study time. East Bank Water Supply Scheme covers Maseya and Makhuwira Traditional Authorities while Miseu Folo Water Supply Scheme covers part of Ngabu Traditional Authority as shown in Figure 4.

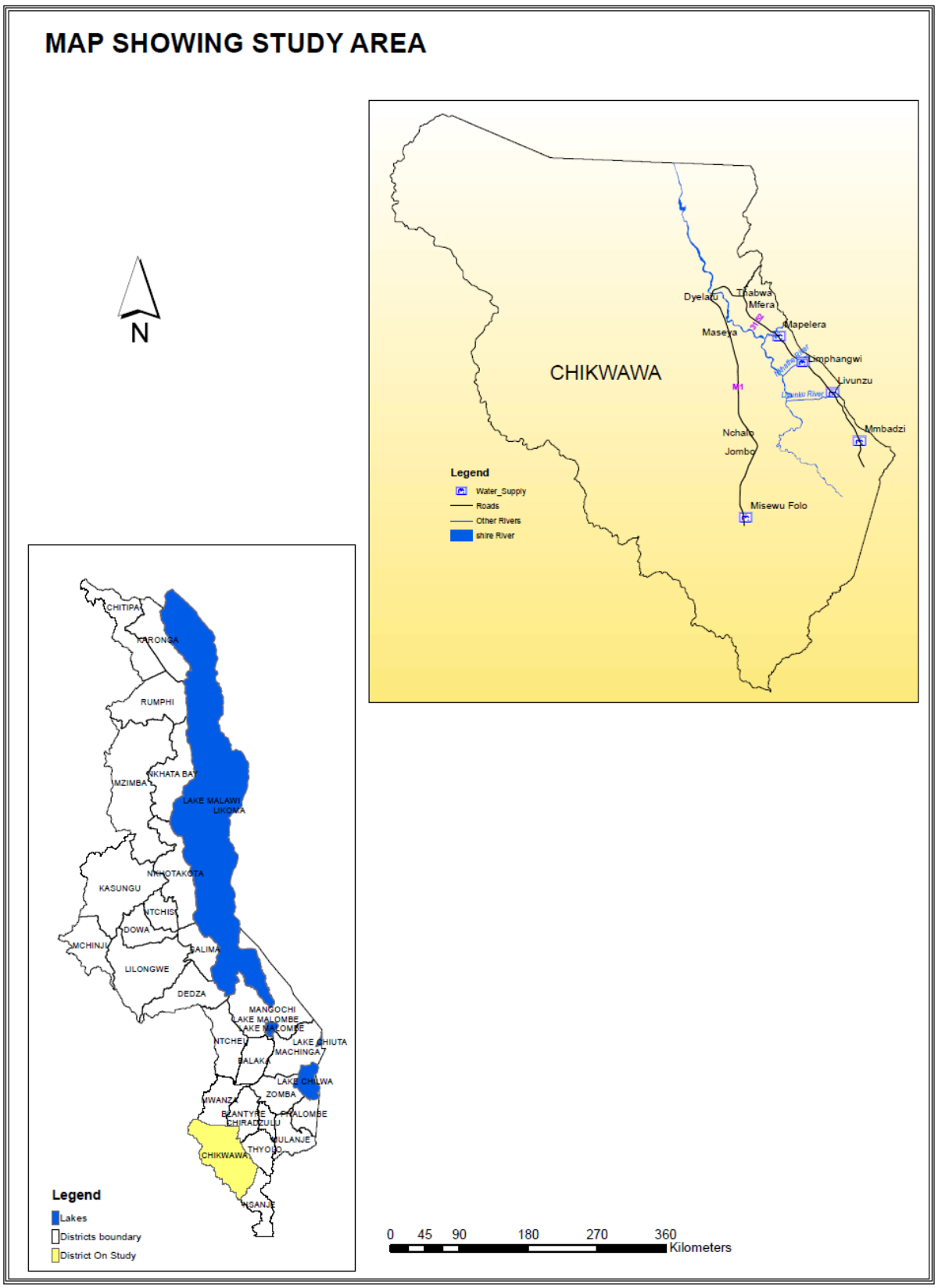

Figure 4: Map of Chikwawa District showing the Study Area

3.3 Research Design

This study used a descriptive research design. A descriptive design was chosen because the study aimed at obtaining a detailed description of factors which affect the sustainability of rural piped water supply schemes. Descriptive research designs seek to gain more information about the characteristics of certain groups within a particular field of study. They provide a picture of situations as they naturally happen. Furthermore, a descriptive study is concerned with determining the relationship between variables (Saunders et al., 2009).

There are many styles of research strategies and for this study; both case study and survey research designs were adopted. A Case study is "a strategy for doing a research which involves empirical investigation of a particular phenomenon within its real life context using multiple sources of evidence" (Robson, 2002 as cited in Saunders et al., 2009). The method of case study is vital in this study because it enables the final reader to appreciate and understand the situation as they are in their real sense. Furthermore, it has the ability to deal with a full range of evidence.

A mixed methods approach was applied in this research. This is where both quantitative and qualitative methods of data collection were employed to investigate the low levels of sustainability of supply schemes and address the specific objectives of the study. Creswell (2009) claims six major strategies in mixed method approach and are sequential explanatory, sequential exploratory, concurrent triangulation, concurrent embedded, sequential transformative and concurrent transformative strategies. One of the six major mixed methods strategies, concurrent triangulation strategy was employed in this research. The concurrent triangulation strategy involves collecting both quantitative and qualitative data concurrently to offset the weakness inherent within one method with the strengths of the other (Creswell, 2009). The multi-dimensional data source was used to negate the deficiency of a single data collection strategy. In concurrent triangulation strategy as utilised in this study, the researcher mixed quantitative and qualitative approaches to research throughout the study. From both forms of data collected and analysed, quantitative and qualitative interpretations were made. In this study, a reader finds the mixing of both approaches throughout the section of results and discussion.

3.4 Target Population

This study collected data from both male and female adults who were members of the communities of water users residing in Miseu Folo and East Bank water supply schemes and BOT members from the respective Miseu Folo and East Bank WUA boards involved in the management and operations of the schemes. Households were employed as appropriate units of analysis because they provided reliable information pertaining to the objectives of this study. This was based on the premise that households' water users are expected to have fresh recollections of the service delivery levels of their water supply schemes. This is the case because most water users are beneficiaries and also involved in the management of the water supply schemes.

3.5 Sampling and Sample Size

The researcher combined both systematic random and purposive sampling methods to select the research participants from piped water supply schemes in Chikwawa District in order to achieve maximum reliable responses for triangulation of themes. From all the existing piped water supply schemes in Chikwawa District, water supply schemes managed by communities under WUA management model were selected purposively. Out of the community managed rural piped water supply schemes in the district, water supply schemes were selected based on the type of technology and number of water sources used. Accordingly, Miseu Folo Water Supply Scheme (MFWSS) and East Bank Water Supply Scheme (EBWSS) were selected based on the criteria mentioned earlier on. MFWSS was selected based on the fact that it was the only water supply scheme getting its water from boreholes equipped with electrical submersible pumps in the district while EBWSS is gravity-flow system getting its water from 4 different springs supplying various villages. Each of the water supply schemes were under the jurisdiction of independent WUA Boards and the researcher established the sampling frame on the basis of inquiries with the water supply schemes.

Probability sampling was utilised to select research participants for a household survey which generated quantitative data. Sample size of 128 households was arrived at by utilising Decker (1997) and Leedy (1997) arguments that where elements of the population are similar, legitimate inferences about it can be drawn from its sample regardless of its size. Therefore, 20 percent of the total number of households from the points of use units in the water

schemes were drawn because they were under one water service provider and faced similar problems.

According to the inventory from the water supply schemes, MFWSS and EBWSS had 183 and 31 private taps at the time of study respectively. Additionally, MFWSS and EBWSS had 9 and 253 communal taps respectively. Those with private taps represented water users with taps within their households' yards and those on communal taps were water users who had to travel from their households to get water from the communal taps. In this study, households were categorised based on point of use units as private and communal taps.

Therefore utilising the argument by Decker (1997) and Leedy (1997), for private taps at MFWSS, the sample size was calculated as follows:

Sample size = 37 households (183 x 0.2)

For the private taps at EBWSS, all the 31 households were taken as the final sample size.

Due to unavailability of inventory for communal taps, it was difficult to estimate the number of households utilising a communal tap. Most communal taps in the water supply schemes had less than twenty households utilising a communal tap. Therefore, based on an argument by Decker (1997) and Leedy (1997), 1 household was selected from each communal tap from the water supply schemes. Looking at the number of communal taps in MFWSS, all the communal taps were taken as sample. Therefore, 9 households were taken as minimum sample from communal taps in MFWSS.

Similarly, utilising the argument by Decker (1997) and Leedy (1997) for communal taps at East Bank Water Supply Scheme, the sample size was calculated as follows:

Sample size = 51 communal taps (253 x 0.2)

Since, 1 household was selected from a final value of each communal tap in the water supply schemes, 51 households were utilised as minimum sample in EBWSS.

From the calculations above, the following was the total number of households from each water supply scheme as a sample:

1. MFWSS = 46 households (37 private taps + 9 communal taps)
2. EBWSS = 82 households (31private taps + 51 communal taps)

A total of 128 households participated in this study. These households were selected by employing systematic random sampling procedure as follows:

1. The 183 taps, total number of private taps at MFWSS was divided by 37 households which were selected for this study in order to get five as an interval number. Saunders et.al; (2009), explain that in systematic random sampling, any number between zero and the interval number can be selected as the first case, and subsequent cases are selected according to a particular interval. Therefore, in this study, *three* (the number between zero and five) was selected as a random number.
2. The third customer assigned by MFWSS on the customers list was used as the first household to be selected for this study. Thereafter, every fifth customer was selected.

Similarly, to get the number of households from 253 communal taps at EBWSS, systematic random sampling was used as follows:

1. The 253 taps, total number of communal taps at Chikwawa East Bank Water Supply Scheme was divided by 51 communal taps which were selected for this study in order to get five as an interval number. Three, a number between zero and five was selected as a random number.
2. The third communal tap as assigned by EBWSS on the communal tap list was used as the first communal tap to be selected for this study. Thereafter, every fifth communal tap was selected.

Purposive sampling was used to select research participants for focus group discussion and key informant interviews to obtain qualitative data. Purposive sampling is a non-probability sampling technique in which the researcher uses his judgment in choosing cases that make up a sample (Saunders et al., 2009). The researcher decides what needs to be known and sets out to find participants who can willingly provide information by virtue of knowledge and experience (Tangco, 2007). Purposive sampling can be more efficient than the popular probability sampling when used appropriately because random participants would not be as

knowledgeable as an expert informant. However, informants' competence and reliability is important because the quality of data gathered will be dependent on them.

Therefore, the researcher purposefully selected participants with an extensive experience and are knowledgeable to give detailed information relating to factors affecting sustainability of piped water supply schemes. The selection of District Water Development Officer and Local Utility Operators for the two water supply schemes as key informants was helpful in obtaining data on funding, management, water usage, operations and maintenance of water supply schemes. Furthermore, five members from General Assembly and one community leader from each of the water supply schemes were also selected as key informants. Only one focus group discussion was held with 8 BOT members of Miseu Folo Water Users Association.

During field visits and observations, the researcher purposefully selected and inspected each of the following water supply infrastructures i.e. the condition of intake structures, transmission pipelines, treatment plants (sedimentation tanks, slow sand filters and chlorination plant), reservoirs and distribution pipelines were studied in MFWSS and EBWSS. Furthermore, 10 functioning and 10 non-functioning point of use units in each water supply schemes were also inspected during field visits.

3.6 Research Instruments

This study used different methods to collect primary and secondary data in order to generate quantitative and qualitative data.

3.6.1 Desk Study

This involved collecting and analysing secondary data on sustainability of rural water supply systems as well as community management model of piped water supply systems in Malawi in order to find gaps which could be addressed by this study. The main sources of data for the desk study were existing documents, internet, journals, magazines, water supply schemes' reports, published and unpublished theses and other sources from institutions related to water and sanitation.

3.6.2 Field Visits and Observations

Field visits and observations were done in order to triangulate the information and get certain information which cannot be collected using the other methods. The researcher had direct contact with the actual situation and conducted tests on reliability of responses to the questionnaire. Field visits and observations were the powerful methods for collecting data on physical condition of the water supply infrastructure. A checklist on the condition of the infrastructure was used (see Appendix 4). The method provided necessary information on fencing of the intake (water source), leaking taps, exposed pipelines, cracks or leaking tanks and the type of pipes used on river crossing. Physical quality of the water supply infrastructure reflected the quality of construction and effectiveness of those carrying out maintenance and operations of the water supply schemes.

3.6.3 Questionnaires

Questionnaires were employed in this study to collect data in a household survey as well as from water management committees. The researcher with the help of two assistants conducted face to face interviews. This helped clarify certain questions especially when the questionnaire was being administered to persons with minimum literacy. The questionnaire had four sections namely: household profile, safe drinking water, access and its importance to health, water users' perceptions on service delivery, and sense of ownership and participation. Two questionnaires were administered in this study. The first questionnaire as seen in Appendix 1 catered for water users. All the responses from household survey were written down by the researcher and the research assistants especially on those who could not write or read English while the second questionnaire was filled by BOT members for the two water supply schemes (see appendix 2)

3.6.4 Questionnaire Pre-testing

A questionnaire pre-testing was conducted at Tengani Water Supply Scheme. This scheme is similar to both MFWSS and EBWSS because they are all water user associations managed by communities surrounding the schemes. The questionnaire was pre-tested in the preliminary field study before the main field study. The questionnaire pre-testing was conducted in order to test the validity and reliability of the questionnaires.

The LUO for Tengani Water Supply Scheme was approached for his permission for the researcher to conduct a questionnaire pretesting. The questionnaires were pretested on twenty water users as well as five BOT at Tengani Water Supply Scheme. Basing on the results from the questionnaire pretesting, modifications were made to some ambiguous questions and those repeated were removed.

3.6.5 Focus Group Discussions and Interviews

Qualitative methods were employed such as focus group discussion and individual interviews from key informants such as District Water Development Officer, LUO, General Assembly members, and community leaders. These enabled the researcher to cross-check and compare the findings from the other methods from which reliable conclusions were drawn (see Appendix 3). However, focus group discussions were done at the time when there were flash floods in the districts of Chikwawa and Nsanje making roads impassable. Therefore, only one focus group discussion was done at MFWSS because it was the only accessible scheme at the time of the field work. Nonetheless, individual interviews with both BOT and General Assembly for EBWUA minimised the impact of the limitation.

3.7 Data Analysis

The information gathered from this research included both quantitative and qualitative data since it adopted a mixed methods approach. Quantitative data collected from beneficiaries, water committee and technical staff using structured questionnaire interviews were entered and analysed in Microsoft Excel 2007 to determine descriptive statistics for the study. Descriptive statistics based on percentages and ratios was used to analyse data. Furthermore, Chi-square analysis provided descriptive statistics to determine probability of statistical association between nominal variables.

Qualitative data generated from focus group discussion and key informant interviews were analysed concurrently with data collection, making interpretations and writing reports (Creswell, 2009). Qualitative data was analysed by developing themes related to specific objectives. In the qualitative analysis four major themes emerged and were physical functioning of water supply schemes, capacity of water committee members and local utility operators, cost recovery strategies and transparency and accountability of water committee members and local utility operators. The quality of water supply infrastructure in MFWSS and EBWSS was done by rating various components of the water supply system. The rating

was done on a scale of 0 to 2, where 0 is a system which is not functioning and was categorised as poor, 1 is a system which is functioning and requires short to medium term intervention was categorised fair and 2 is a system which is in good condition and well functioning was categorised as good.

3.8 Ethical Considerations

Approval was sought from Chikwawa District Water Officer and the community leaders in the areas under study before commencing the study. Once permission was granted by both Chikwawa District Water Officer and community leaders, the researcher sought consent from the participants to participate in the study. The purpose and process of the study was explained to all potential respondents. All the participants were assured of their right to participate or decline or withdraw from the study at any time they feel uncomfortable. Participants were also assured of anonymity and confidentiality of their participation

3.9 Limitations of the Study

The research covered two community-managed water supply schemes out of the three water supply schemes existing in Chikwawa District, Malawi. Therefore, the findings are not likely to be applicable to all market centres and rural areas within Malawi and other developing countries because of a single case study which may offer poor basis for generalisation. Nevertheless, the impact of this limitation was minimised by purposively selecting community-managed water supply schemes with different technologies which were covering both market centres and rural areas which could fit other places with similar study setting.

Furthermore, the research was designed to explore factors affecting sustainability of community-managed water supply schemes in Chikwawa District and relied on the respondents' recollections of the events that took place within their water supply schemes which often occurred several months or even years prior to the study. As such, this might have affected the respondents' answers to some extent. In order to minimise this limitation, different methods of data collection were used such as household survey, focus group discussion, key informant interview and observation in a concurrent triangulation strategy.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results of the study that was conducted in Chikwawa District exploring the factors affecting the sustainability of Miseu Folo and East Bank community managed water supply schemes. The objectives of the study were to establish the fraction of functional point of use units and their utilisation, determine water user's perception on water service delivery, identify the community management committees' perceived barriers to sustainable water supply scheme and determine the influence of WUA management model on sustainability of rural piped water supply schemes. The data was obtained from both household respondents and BOT members through structured questionnaires. Therefore, this chapter presents analyses and discusses the results from the study in line with the objectives.

4.2 Response Rate

A total of 152 questionnaires were administered to both water users and management water committee members in MFWSS and EBWSS. Out of these, 128 were administered to sampled households and 24 to all water management committees' members under Board of Trustees (BOT) within the two water supply schemes.

Out of the 128 sampled households, 121 questionnaires were administered through face to face method while 7 questionnaires were distributed to those with tertiary education. Out of the 7 that got the questionnaires, 3 responded and returned the questionnaires. This represented a response rate of 96.9% of the households. Out of 24 BOT members, 22 questionnaires were administered through face to face method while 2 questionnaires were distributed to BOT members with tertiary education. Both the BOT members responded and returned the questionnaires. This represented a response rate of 100% of the BOT members. The response rate was as shown in the Table 2.

Table 2: Response Rate

Group	Sample size	Achieved	Response rate
Household	128	124	96.9%
BOT members	24	24	100%
Total	**152**	**148**	**97.4%**

The overall response rate of 97.4% was achieved in this study and those who did not respond to the questionnaires had various reasons of which the most predominant one was that they did not have the time for face to face interviews or to fill in the questionnaire. The researcher or his assistants did not go to collect the remaining questionnaires or have face to face interviews because of time limitations. However, a response rate of 97.4% was sufficient to proceed with data analysis.

4.3 Biographical Data of the Respondents

This section presents the biographical data of the respondents which included gender, age, status of respondent in the household, educational qualification, occupation, marital status, monthly household income and estimated monthly water bill.

4.3.1 Gender

The high percentage of female respondents at household level as depicted in Table 3 may be due to the fact that Chikwawa District has 98 males for every 100 females (National Statistical Office (NSO), 2009). Furthermore, the study finding shows that 80% of the respondents were married which is an indication that most of the women within the area under study are housewives such that are confined to household chores. Additionally, the higher rate of female respondents could be owing to the fact that traditionally and culturally in Malawi, the collection and storage of water at household level is predominantly the responsibility of women and girls. On the other hand, 58.3% of BOT members in the water management committees were male while the remaining 41.7% were women. Generally, women are main users and managers of water within the households and the data from Table 3 shows that the committees in community-managed water supply schemes in Chikwawa District are dominated by men. This is being the case in WUAs in Chikwawa District despite GoM's advocacy for a minimum of 50% representation of women in decision making. The numbers of women in the committees may look statistically insignificant but the WUAs in Chikwawa need a concerted effort on gender balance in order to complement women empowerment initiatives advocated by the GoM. When women are represented in such a way that they cannot influence decision making in a water committee, they miss an opportunity to gain management and leadership experience. As main users and managers of water at household level, lack of capacity to manage water supply systems could lead to unsustainable water supply schemes.

Table 3: Gender of Respondents

Gender	Household Respondents			BOT Members		
	Frequency	%	Cumulative %	Frequency	%	Cumulative %
Male	48	38.7	38.7	14	58.3	58.3
Female	76	61.3	100	10	41.7	100
Total	**124**	**100**		**24**	**100**	

4.3.2 Age of Respondents

The majority of the household respondents were aged between 21 and 30 years representing 34.7% and the mean age of 37. These were followed by those in the "31-40 years" age group representing 29.8%. 17.0% of the household respondents were aged between 41 and 50 years while the remaining 18.5% were aged above 50 years as depicted in Table 4. The high percentage of participants (34.7%) was aged between 21 and 30 years which may suggest that the area under study has a youthful population and was willing to undertake the study at a productive age. This claim is in line with the Malawi National Youth Policy of 2013 which defines a youth as all persons from age of 10 to 35 years and the significant proportion of the population in Malawi constitute the youth (NSO, 2008). The highest percentage of BOT respondents were between the age of 31 and 40 years representing 45.8% and mean age of 43. Those with the lowest percentage (4.2%) were aged between 20 and 30 years. There were more BOT respondents aged over 50 years representing 29.2% than those in the "41-50" age group representing 20.8%. The result implies that both young and old have equal representation in the management of water supply schemes in both MFWSS and EBWSS. This could help in enhancing sustainability of the water supply schemes because the youth have the opportunity to learn from the old persons in the management of the schemes.

Table 4: Age of Respondents

Age	Household Respondents			BOT Members		
	Frequency	%	Cumulative %	Frequency	%	Cumulative %
21-30 years	43	34.7	34.7	1	4.2	4.2
31-40 years	37	29.8	64.5	11	45.8	50
41-50 years	21	16.9	81.4	5	20.8	70.8
Over 50 years	23	18.5	100	7	29.2	100
Total	**124**	**100**		**24**	**100**	

4.3.3 Household Headship among Respondents

In Malawi, 72.7% are male headed households while 27.3 are female headed households (NSO, 2008). The results presented in Figure 5 show that the majority of respondents 57.3% were household heads while the remaining 42.7% were relations to the household heads. Over half of the household heads were available to participate in the survey. This may have enhanced the respondents' ability to estimate household incomes without difficulties as shown in Figure 5 below which represents the household respondent's status in their respective households.

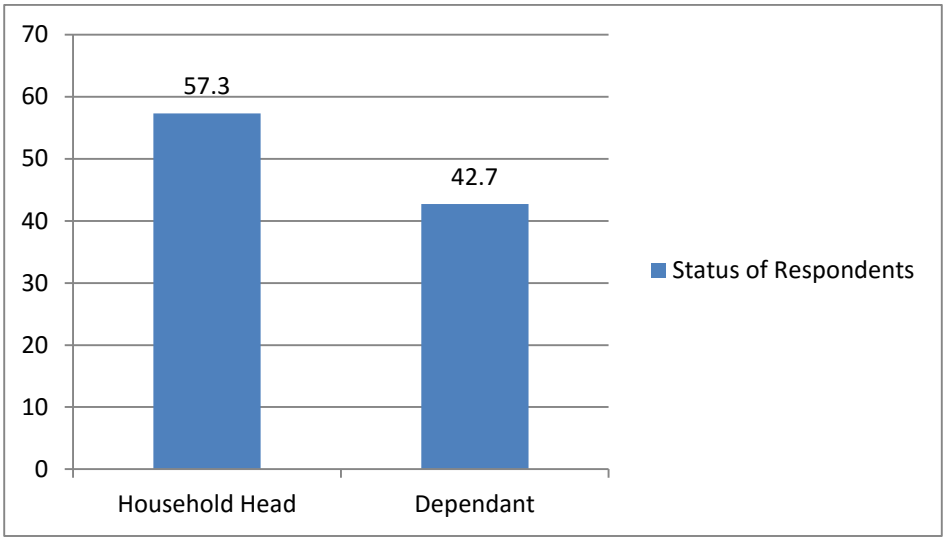

Figure 5: Status of Household Respondents

4.3.4 Education Levels of Respondents

Table 5 presents the summary of education levels of both household and BOT respondents. The study found that the majority of household respondents (67.7%) had primary school education (Standard 1 to 8) and 15.3% of the household respondents had never attended school. 13.7% of the household respondents had completed primary school education while 10.5% of the household respondents had completed secondary school education. 16% of the household respondents did not complete secondary education and 5.7% had professional certificates and diplomas. The education levels of the respondents indicate that the majority of the household respondents had at most a primary education which compelled the researcher and his assistants to conduct face to face interviews and fill some of the questionnaires on behalf of the respondents during data collection. This means that the majority of the respondents at household level had low levels of education. The majority of

the BOT respondents (62.5%) had at least a secondary school education while the remaining (37.5%) had at most a primary school education. The key functions in the WUA are performed by BOT members as such their levels of education could impact the WUA's quality of management based on their literacy levels. This may enhance the sustainability of water supply schemes.

Table 5: Education Levels of Respondents

Education Levels	Household Respondents			BOT Members		
	Frequency	%	Cumulative %	Frequency	%	Cumulative %
Never attended School	19	15.3	15.3	0	0	0
Primary School (Std 1 to 4)	48	38.7	54	4	16.7	16.7
Primary School (Std 5 to 8)	17	13.7	67.7	5	20.8	37.5
Secondary School (Form 1 to 2)	20	16.1	83.8	10	41.7	79.2
Secondary School (Form 3 to 4)	13	10.5	94.3	3	12.5	91.7
Tertiary Education	7	5.6	100	2	8.3	100
Total	**124**	**100**		**24**	**100**	

4.3.5 Size of Family

The study results showed that the majority of the household respondents (53%) had a family size ranging from 4 to 6. 30.6% of the respondents had a family size ranging from 7 to 10. The family size of the range of 1 to 3 as depicted in Table 6 accounted for 13.0% of the respondents. The remaining respondents (3.2%) had a family size above 10. The mean family size of household members was 6. This is slightly higher than the district's mean family size of 4.5 (NSO, 2008). These results could imply that those households with large family sizes could be utilising large quantities of water thereby affecting their ability to pay for water services rendered by the WUAs.

Table 6: Size of Family

Number of people in a household	Household Respondents		
	Frequency	%	Cumulative %
1 – 3	16	12.9	13.0
4 – 6	66	53.2	66.1
7 – 9	38	30.6	96.7
Above 9	4	3.2	100
Total	**124**	**100**	

4.3.6 Occupation of the Respondents

The study revealed that the majority of the household respondents (65.3%) were farmers while 22.6% of the household respondents were businesspersons. 9.7% of the household respondents were salaried workers while 1.6% of the household respondents were students and the remaining (0.9%) were housewives. The results are summarised and presented in Figure 6. This shows that the majority of the respondents were engaged in farming and family businesses as their major income generating activities. The business activities include baking, fish trading, barbershop, maize meals, radio and bicycle repairing and carpentry. Apart from farming and business activities, a number of people are employed in sugarcane plantation and government institutions. The dominant nature of the activities like farming and business activities gives a seasonal income that may impact on their cash flow for paying for water during lean periods.

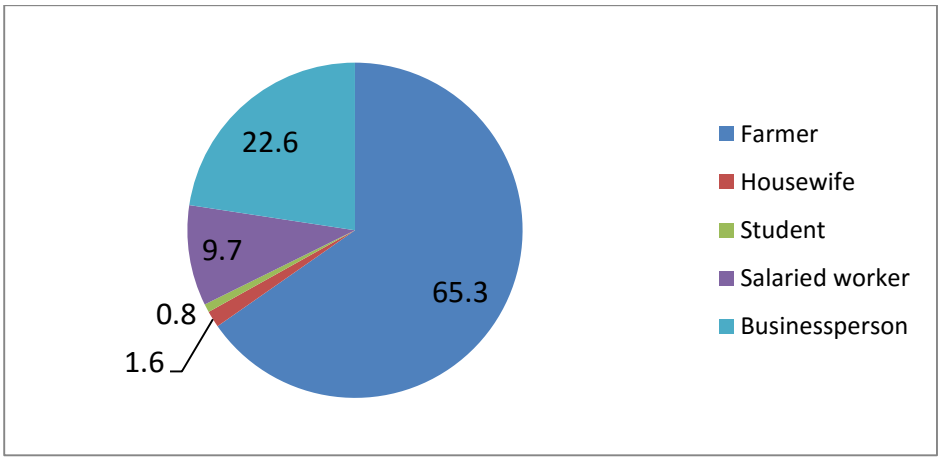

Figure 6: Occupation of Household Respondents

4.3.7 Marital Status of the Respondents

The study revealed that 79.8% were married while 5.6% were divorced. Furthermore, 11.3% of the household respondents were widows while 0.9% of the respondents were widowers. The remaining 2.4% of the household respondents were single. The study results imply that the water is supplied equitably amongst all members of the community regardless of their marital status.

Table 7: Marital Status of Household Respondents

Marital Status	**Household Respondents**		
	Frequency	%	Cumulative %
Married	99	79.8	79.8
Divorced	7	5.6	85.4
Widow	14	11.3	96.7
Widower	1	0.8	97.5
Single	3	2.4	100
Total	**124**	**100**	

4.3.8 Estimated Monthly Household Income and Water Tariff

4.3.8.1 Estimated Monthly Household Income

A large percentage (63.7%) of the respondents in both MFWSS and EBWSS earned up to MK10, 000.00 per month as shown in Table 8. Those that earned above MK10, 000.00 up to MK20, 000.00 accounted for 15.3% and those above K20, 000.00 were 21.0% of the respondents. The average monthly household income in both MFWSS and EBWSS was MK 10,524.69 equivalent to less than one US dollar earning a day (0.5 US$ per day using an exchange rate of MK700.00 per 1 US $).

Table 8: Estimated Monthly Household Income

Monthly Income	**Household Respondents**		
	Frequency	%	Cumulative %
Less than MK 5,000.00	33	26.6	26.6
MK 5,001.00 – MK 10,000.00	46	37.1	63.7
MK 10,001.00 – MK 15,000.00	8	6.5	70.2
MK 15,001.00 – MK 20,000.00	11	8.9	79.1
Above MK 20,000.00	26	21	100
Total	**124**	**100**	

4.3.8.2 Estimated Monthly Water User Charges

The monthly user charges incurred by the respondents, Table 9, depicts that 47.5% of the respondents had water user charges which ranged between K101.00 and K1, 000.00. 42.0% had water user charges above MK1, 000.00 but less than MK3, 000.00 while the remaining (10.5%) had water user charges above MK3, 000.00. The study results show that the respondents are living in extreme poverty earning less than one US dollar per day. With these low income levels, it would be difficult for the respondents to pay for water user charges from their hard earned income.

Table 9: Estimated Monthly Household Water User Charges

Monthly Water User Charges	**Household Respondents**		
	Frequency	%	Cumulative %
Less than MK 100.00	0	0	0
MK 101.00 – MK 500.00	54	43.5	43.5
MK 501.00 – MK 1,000.00	5	4.0	47.5
MK 1,001.00 – MK 3,000.00	52	41.9	89.4
Above MK 3,000.00	13	10.5	100
Total	**124**	**100**	

4.4 Physical Conditions of Miseu Folo and East Bank Water Supply Schemes

One of the research instruments used in this study was field observations. Before functionality and utilisation of point of use units were arrived at, the physical condition of the water supply schemes' infrastructures were assessed by the researcher to give the overall picture of the system condition. The level of maintenance of the water supply scheme's infrastructure and its water sources reflect the extent of the involvement of LUO and BOT members in the sustaining of the water supply system. In this section, the condition of intake structures, transmission pipelines, treatment plants (sedimentation tanks, slow sand filters and chlorination plant), reservoirs and distribution pipelines were studied through field observations in both MFWSS and EBWSS.

4.4.1 Miseu Folo Water Supply Scheme

MFWSS is located at Miseu Folo, a Market Centre in Chikwawa District situated south of Blantyre City along M1 Road to Nsanje District. The scheme's service area covers 1.5 km radius from the market centre and covers villages such as Mgujula, Robert, Mailosi, Paiva, Billie, Goma and Malikopo. The water treatment units for MFWSS are shown in Figure 7.

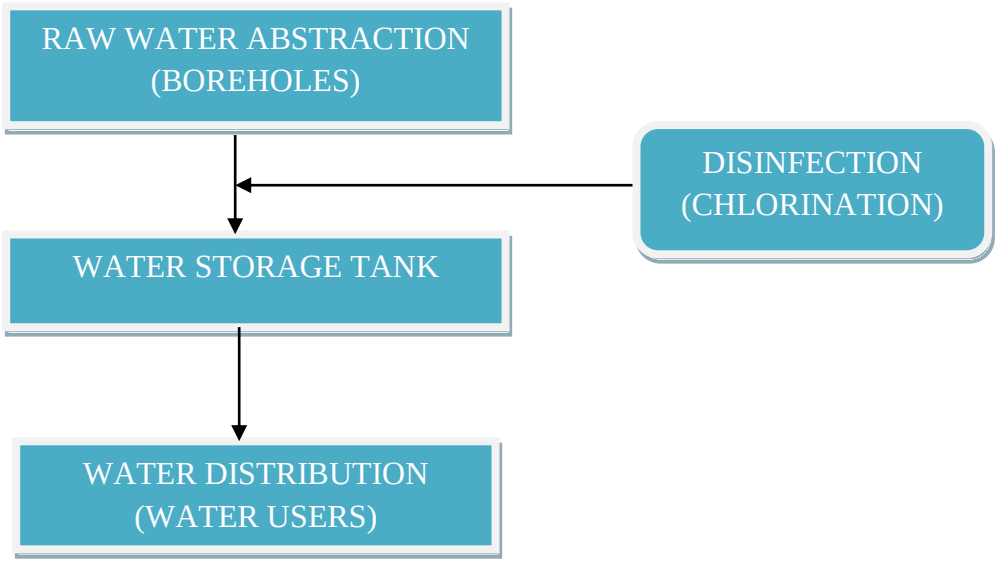

Figure 7: Conventional Treatment Units in MFWSS

4.4.1.1 Water Source

The scheme draws water from two boreholes located within the MFWSS premises. The boreholes are installed with electrical submersible pumps which pump water using ESCOM power from the boreholes to a storage tank. The boreholes are secured with wire fences to avoid human or animal contamination as shown in Figure 8.

Figure 8: Fenced Borehole at MFWSS

4.4.1.2 Water Treatment Plant

The water from the boreholes is disinfected before being conveyed to a storage tank. Chlorine dosing is done through an electronic liquid dispenser which pumps Calcium Hypochlorite into the water from a 200 litre plastic solution tank as shown in Figure 9.

Figure 9: Chlorine Dosing Equipment at MFWSS

4.4.1.3 Transmission System, Storage Tank and Distribution System

The treated water from boreholes is then transmitted to a 216 m^3 elevated steel storage tank located near MFWUA's office through a 100mm transmission pipeline as shown in Figure 10. Then the water gravitates from the storage tank to water users within the water supply system.

Figure 10: A Water Storage Tank at MFWSS

The operations reports in MFWSS revealed that the levels of NRW ranged from 10% to 15% and this was also confirmed by the LUO during interviews. It was observed during site visits that the water tank was not leaking and there were no exposed pipes.

4.4.1.4 Status, Size and Complexity of MFWSS

MFWSS is a fairly new water supply scheme such that its infrastructure is in good working condition. MFWSS is not complex as compared to gravity-flow systems because the water supply system covers a pipe network of 5.0 km. The treatment works is within the MFWUA's office and can be operated by one person thus reducing the number of employees working for the water supply scheme. Unlike EBWSS whose water treatment processes require sedimentation and filtration, MFWSS does not require such water treatment processes. Therefore, the proximity of the treatment works to MFWUA and its technical simplicity could be an opportunity for ease of management.

4.4.2 East Bank Water Supply Scheme

EBWSS is located to the north-eastern side of the Chikwawa District stretching from Thabwa to M'mbadzi extending to all areas under Traditional Authority (TA) Makhwira and parts of areas under TAs Maseya and Katunga. The scheme was originally constructed in 1991 and

was redesigned for a 10 year period during rehabilitation in 2008. The scheme covers a total pipe network of 36.3 km. Figure 11 shows the treatment units in EBWSS.

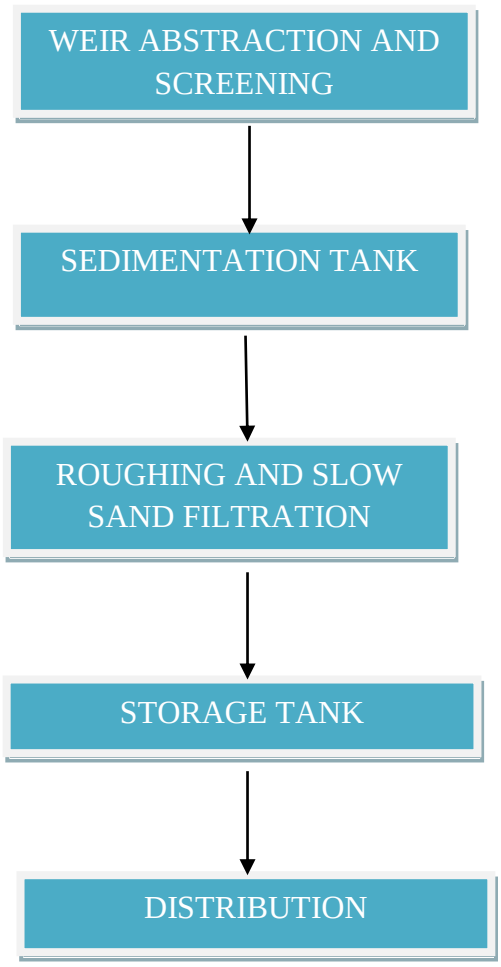

Figure 11: Convention Water Treatment Plant in EBWSS

4.4.2.1 Water Source

The scheme uses surface water from rivers within the scheme and has four intake points namely: Livunzu, Mapelera, Limphangwi and M'mbadzi. The rivers originate from Thyolo Mountain which has faced severe depletion of forest cover due to encroachment and illegal felling of trees as seen in Figure 12.

Figure 12: Water Intake on Limphangwi River in EBWSS

The catchment areas around the water sources for EBWSS are experiencing significant natural resources and environmental degradation which is having a negative impact on the water resource. This is affecting the quality and availability of water supplied to EBWSS.

4.4.2.2 Transmission System, Water Treatment Plant, Storage Tanks and Distribution System

The water from the rivers is screened at the intake structure to remove debris. The water is then transmitted through galvanised steel pipes as shown in Figure 13 to a sedimentation tank.

Figure 13: Transmission Pipelines in EBWSS

From the sedimentation tank, the water is then filtered through slow sand filtration which is an important part of the solid's separation treatment process. The process is often one of the last stages to reduce or eliminate hazard prior to final disinfection as shown in Figure 14.

Figure 14: Sedimentation Tank (on the left) and Slow Sand Filters (on the right) in EBWSS

The water gravitates through transmission pipelines to storage tanks and finally the water users as shown in Figure 15.

Figure 15: Water Storage Tank in EBWSS

4.4.2.3 Status, Size and Complexity of EBWSS

Overall, the condition of the infrastructure in EBWSS is fair. However, Livunzu and Mapelera are in a poor state requiring urgent attention. EBWSS is a little more complex than MFWSS because the water supply system covers a pipe network of 63.9km and the treatment works has several units. These units are all present in the four areas of supply namely: Livunzu, Mapelera, Limphangwi and M'mbadzi. Unlike MFWSS, EBWSS cannot be manned by one person because it has four water intakes with corresponding water treatment works thereby compelling the EBWUA to engage a considerable number of employees to work for the water supply scheme.

4.4.3 Participation and Sense of Ownership by Water Users

4.4.3.1 Participation of Water Users during Construction

To foster community participation during the construction of the water supply schemes, community members' contribution may take the form of cash, labour, materials and ideas. From the household survey carried out in MFWSS and EBWSS, the majority of water users (94%) in EBWSS indicated that they contributed labour during the construction of the water supply scheme and the remaining 6% were not involved as shown in Table 10. Only about 5% of the household respondents in MFWSS indicated that they contributed cash, labour, ideas whereas the remaining 95% of the respondents contributed nothing. This was owing to the fact that the nature of the project during construction phase in MFWSS was different from EBWSS. Unlike in EBWSS where community members contributed labour during construction phase, some community members from MFWSS were employed and paid by the contractor engaged to construct the water supply system. This arrangement could affect sense of ownership by the community members because of their focus on monetary returns rather than the outcome of the project. These findings were also supported by key informants during both interviews and focus group discussion. The involvement of the water users during construction in EBWSS implies that the water users were aware and committed to the success of the water supply project. On the other hand, the water users in MFWSS had limited involvement in the construction of the water supply scheme which could imply that they were not engaged during the construction phase of the project or the water supply project was conceived without their input during planning stage. There was significant involvement of water users at the early stages of the construction of water supply schemes in EBWSS than in MFWSS which is critical to sustainability of water supply schemes.

Table 10: Community Participation during Construction

Contribution of Water Users during Construction	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
Money	1	1.8	0	0
Labour	1	1.8	64	94.1
Materials	1	1.8	0	0
Ideas	0	0	0	0
None	54	94.6	4	5.9
Total	**56**	**100**	**68**	**100**

4.4.3.2 Sense of Ownership by Water Users

The data in Table 11 depict that the majority of respondents in both MFWSS (68%) and EBWSS (90%) indicated that none of them had sense of ownership for the water supply scheme. 7.1% and 10.3% of the respondents in MFWSS and EBWSS respectively thought that the GoM owned the water supply schemes. Despite the majority of water users getting involved in the construction of EBWSS, none of them indicated that they had sense of ownership for their water supply scheme. Regardless of their limited participation during construction of MFWSS, 23% of the water users thought that the community owned the water supply scheme. This may be as a result of lack of sensitisation during inception of the water supply project to the communities which could affect the sustainability of the water supply schemes.

Table 11: Sense of Ownership

Who owns the Water Supply Scheme?	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
Do not know	38	67.9	61	89.7
Government	4	7.1	7	10.3
Individual	1	1.8	0	0
Community	13	23.2	0	0
Total	**56**	**100**	**68**	**100**

4.5 Functionality and Utilisation of Point of Use Units

4.5.1 Functionality of Point of Use Unit

Functionality of point of use units was arrived at based on their present working condition at the time of survey. The number of functional and non-functional point of use units were recorded during data collection visits in order to establish the fraction of functional point of

use units in MFWSS and EBWSS. The number of functional point of use units was then expressed as a percentage of the total point of use units.

In response to the question as to whether the respondents' point of use units in their households were functioning or not in MFWSS and EBWSS, 56 respondents (100.0%) in MFWSS and 18 respondents (26.5%) in EBWSS answered "yes" while none of the respondents (0.0%) in MFWSS and 50 respondents (73.5%) in EBWSS answered "no". Thus the majority of the respondents were aware of the status of their point of use units within their water supply schemes as illustrated in the Table 12.

Table 12: Functionality of Point of Use Units

Water Supply Scheme	**Functionality**		**Functional**	**Non-Functional**
	Yes	No	%	%
Miseu Folo	56	0	100	0
East Bank	18	50	26.5	73.5
Total	**74**	**50**	**59.7**	**40.3**

The findings on the functionality of water supply schemes in Chikwawa District imply that there is an improvement on the functionality of community managed piped water supply schemes in the district staggering at 59.7% as compared to 27% in 2011 during a survey by Ministry of Irrigation and Water Development (GOM, 2012). However, the highest number of non-functional point of use units which were found in Chikwawa District was from East Bank which is a gravity fed system. This supports the findings by Zuzani et al., (2013) from Ntcheu District where gravity fed piped water supply schemes were not functioning well. The functionality rate of rural gravity fed water supply schemes in the district remains a challenge as it is below the district's functionality rate of 27%.

4.5.1.1 Reasons for Non Functionality of Point of Use Units

In answering the question regarding the kinds of challenges affecting constant supply of water to households, 8 respondents indicated that they did not know the reasons for non-functionality of point of use unit, 53 respondents indicated that it was because of breakage of pipes either on river crossings or at the water intake, only 2 respondents indicated that it was because of vandalism whereas 8 respondents indicated that it was because of blockage of pipes. Furthermore, 53 respondents indicated that they do not face any challenge with water supply as summarised in Table 13.

Table 13: Challenges Affecting Constant Water Supply to Households

Challenges affecting Constant Water Supply to your household	Households					
	Frequency			%		
	MFWSS	EBWSS	Total	MFWSS	EBWSS	Total
Do not know	2	6	8	3.6	8.8	6.5
Breakage of pipes	0	53	53	0	77.9	42.7
Vandalism	1	1	2	1.8	1.5	1.6
Blockage of pipes	0	8	8	0	11.8	6.5
Breakdown of pumps	0	0	0	0	0	0
None	53	0	53	94.6	0	42.7
Total	**56**	**68**	**124**	**100**	**100**	**100**

The findings further reveal that the majority of respondents (77.9%) in East Bank Water Supply Scheme were convinced that the intermittent or no water supply at their point of use units was due to breakage of pipes at river crossings. 11.8% and 1.5% perceived that blockage of pipes and vandalism affected constant water supply respectively. 8.8% of the respondents did not know the cause of intermittent water supply. The majority of respondents (94.6%) in MFWSS had continuous water supply at their point of use units and 1.8% thought that vandalism affected constant water supply. The respondent explained that such vandalism is caused by kids who enjoy seeing water gushing out from a deliberate broken pipe. Through interviews, key informants stated that the breakage of pipes at river crossings could be a result of river flooding which was experienced in January, 2015 particularly in EBWSS. On the other hand, the key informants in MFWSS revealed that they did not encounter any problems relating to water supply since its construction completion in 2012. The revelations by key informants strongly support Zuzani et al., (2013) findings expressed in Chapter Two (Section 2.4.2)

4.5.2 Utilisation of Point of Use Units

Once the functionality of the point of use units was established, it was imperative to further ascertain the utilisation of such facilities by the beneficiaries. In this study, utilisation of point of use unit basically covered two areas i.e. most important source of water in respondent's household and household's daily water consumption.

4.5.2.1 Household's Main Source of Water

A question on the most important household's source of water was asked. While the majority of respondents (100%) in MFWSS preferred tap water as their most important source of

water, 72.1% of the respondents in EBWSS preferred borehole water to tap water as their most important source of water for their households. The remaining respondents (27.9%) in EBWSS preferred tap water to borehole water as illustrated graphically in Figure 16.

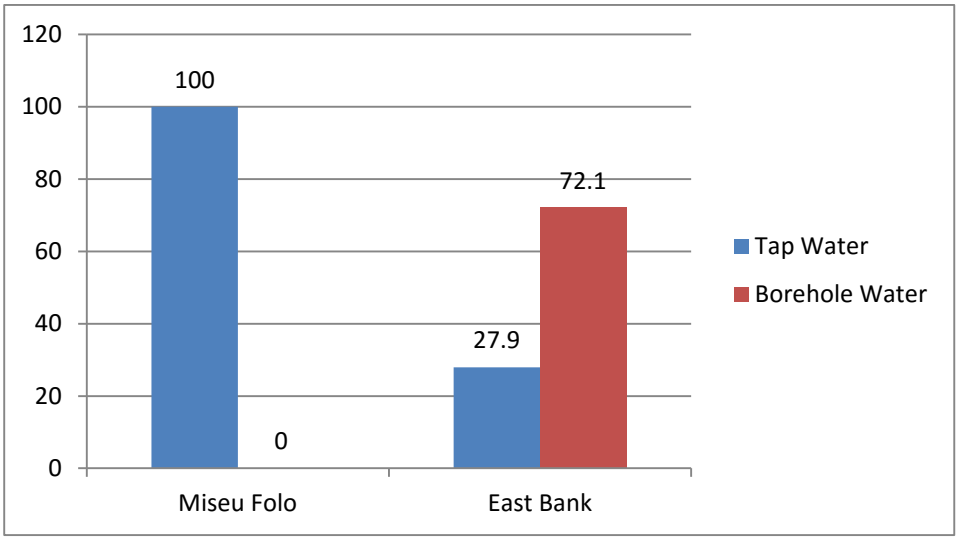

Figure 16: Household Respondents' Main Source of Water

The study findings indicate that a significant number of respondents (56) in MFWSS prefer tap water to borehole water where as those in EBWSS prefer borehole water to tap water. The water users believe that water supplied by EBWSS is not safe for drinking because it comes out with suspended solids, hence shunning away from tap water and preferring borehole water.

4.5.2.2 Household's Daily Water Consumptions

The majority of the respondents (76.3%) whose water supply to their households was metered in MFWSS had monthly water consumption in the range of 1,000 litres and 10,000 litres. The mean monthly water consumption of these respondents was 8,660 litres giving a mean daily water consumption of 287 litres with a mean per capita daily water consumption of 48 litres (Table 14).

Table 14: Estimated Daily Metered Household Consumption

Monthly Consumption	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
1 kilolitre – 10 kilolitres	29	76.3	0	0
11 kilolitres – 20 kilolitres	6	15.8	0	0
21 kilolitres – 30 kilolitres	3	7.9	0	0
Above 30 kilolitres	0	0	0	0
Total	**38**	**100**	**0**	**0**

On the other hand, the majority of the respondents (72.2%) whose water supply to their households was unmetered in MFWSS had daily water consumption in the range of 1 litre and 100 litres as shown in Table 15. The mean household's daily water consumption was 84 litres with a mean per capita daily consumption of 14 litres. In EBWSS, all the 68 respondents had water supply to their households not metered. The majority of the respondents (51.5%) had the same daily water consumption in the range of 1 litre and 100 litres as MFWSS. The mean household's daily water consumption was 108 litres with a mean per capita daily consumption of 18 litres.

Table 15: Estimated Daily Unmetered Household Consumption

Daily Consumption	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
1litre – 100 litres	13	72.2	35	51.5
101 litres – 200 litres	4	22.2	30	44.1
201 litres – 300 litres	1	5.6	0	0
301 litres – 400 litres	0	0	3	4.4
Above 400 litres	0	0	0	0
Total	**18**	**100**	**68**	**100**

4.5.3 Relationship between Functionality, Utilisation of Point of Use and Users' Perception of Sustainability of WSS

The water users in both MFWSS and EBWSS were requested to indicate their opinion on the sustainability of their water supply schemes based on the definition of sustainability adopted in this study. In their response, 62.5% of household respondents from MFWSS perceived that their water supply scheme was sustainable while 37.5% of the respondents perceived it not sustainable. In EBWSS, 17.6% of the household respondents indicated "yes" while 82.4% of respondents indicated "no" as shown in Figure 17.

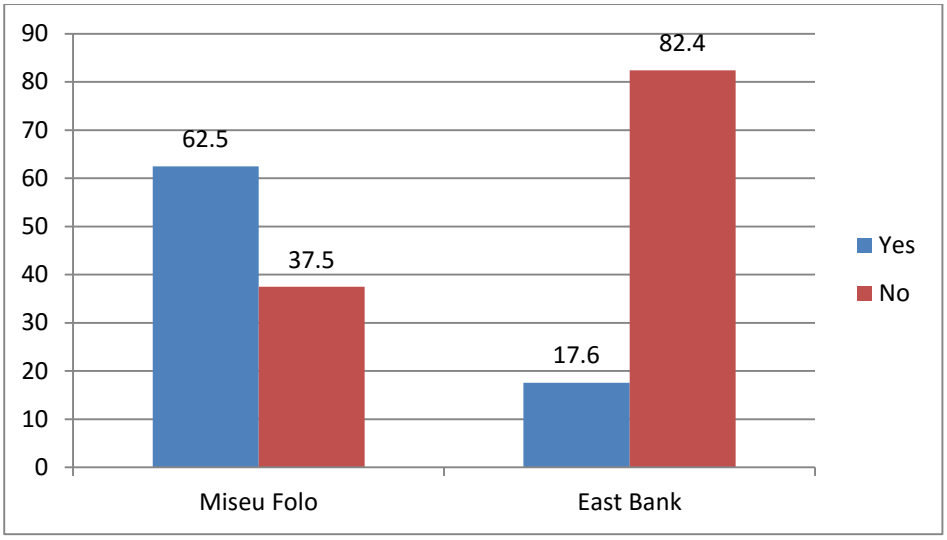

Figure 17: Household Responses on Perception to Sustainability of WSS

From the findings of the study, functionality of point of use unit was affected by several factors but the dominant one was frequent washout of transmission pipelines by natural disasters such as flash floods which occur annually at the water intakes of EBWSS in the Thyolo Mountain during rainy season. This emanates from poor designs of water supply systems which are complex and communities find it difficult to maintain or repair them when they breakdown. On the other hand, utilisation of point of use unit was influenced by the functionality as well as the quality of water service levels delivered in water supply scheme as noted by the preference of borehole water to tap water by water users in EBWSS. Therefore, the high non-functional rate of EBWSS implies that the water supply system is underutilised by the water users resulting into insufficient water supply to most areas within the scheme.

In terms of the relationship between functionality of point of use units and the perception of water users on sustainability of the water supply schemes, the findings of the study show that the scheme with a higher functionality of point of use units had the water users perceive it highly sustainable. MFWSS had high number of functional point of use units and the water users considered their water supply scheme sustainable. In EBWSS, the water users considered their water supply scheme unsustainable and they had low functionality rate of their point of use units. The findings of the study support the findings by Peter and Nkhambule (2012) that functionality and subsequent utilisation of facilities are associated with sustainability of water supply scheme.

4.6 Water User's Perception on Water Service Delivery

A water supply scheme is sustainable when it delivers the expected services to water users during the design period in terms of quality, quantity, accessibility, reliability and affordability (Harvey and Reed, 2004). In this study, five indicators namely water quality, water quantity, reliability of water, convenience of point of use unit and affordability of the water tariff were considered when determining water users' perceptions on water service delivery.

4.6.1 Water Quality

The majority of respondents (76.8%) in MFWSS felt that the quality of water was good, 19.6% of the respondents thought that the water quality was excellent while the remaining 3.6% felt that the quality of water was fair. In EBWSS, 25.0% of the respondents felt that the water quality was good, 29.4% thought that the water quality was fair, 33.8% felt that the water quality was poor and the remaining 11.8% felt that the water quality was bad as illustrated in the Table 16.

Table 16: Perception of Water Quality by Water Users

Water Quality Perception	**MFWSS Respondents**			**EBWSS Respondents**		
	Frequency	%	Cumulative %	Frequency	%	Cumulative %
Bad	0	0.0	0.0	8	11.8	11.8
Poor	0	0.0	0.0	23	33.8	45.6
Fair	2	3.6	3.6	20	29.4	75.0
Good	43	76.8	80.4	17	25.0	100.0
Excellent	11	19.6	100.0	0	0	100.0
Total	**56**	**100**		**68**	**100**	

The results show that the water users in MFWSS perceive the water quality as being satisfactory (96%) while in EBWSS as not satisfactory (75%).

4.6.1.1 Water Quality Challenges

4% of the respondents in MFWSS perceived that the water quality was fair while 75% of the respondents in EBWSS perceived the water quality from fair to bad. The respondents gave different reasons for perceiving the water quality being fair, poor and bad in the two schemes. The respondents in MFWSS indicated that the water tastes salty while those from EBWSS

indicated that the water was smelly. The water supplied in EBWSS sometimes comes out with debris accompanied with worms and is muddy especially during rainy season. The respondents further stated in one of the interviews that the water from EBWSS was not treated with chlorine hence questioning if really the water is safe for human consumption.

The WHO guidelines for drinking water recommend no total or faecal coliform for all water intended for drinking (WHO, 2004). In this study, the ratings by the water users on the perception of the water quality in both MFWSS and EBWSS were found to be in close agreement with the actual water quality through water quality tests. The bacteriological results of the borehole sampled at MFWSS revealed a faecal coliform contamination of 4 Count/100ml against the WHO and MBS recommended level of 0 Count/100ml (SRWB, 2011). Furthermore, the chemical analysis results showed that chlorides levels were 64.98 mg/l against the MBS drinking water specification (MS: 2013) recommended level of 250 mg/l (MS 214:2013). This was also confirmed during interviews with the LUO that water users complained about salty water when one of the boreholes situated to the western side of the scheme was operated. Due to the complaints, the scheme only operates the borehole situated to the eastern side as advised by LUO for MFWSS. The borehole chemical results show that it has low chloride levels (SRWB, 2011).

In a study on the water safety in EBWSS, similar taste complaints were reported by Phiri (2016). The study found out that there was presence of faecal coliforms at the point of use units. The results indicated that the bacteriological water quality is a concern in EBWSS. Apart from the microbiological water quality status, the study also found that the final water from water treatment plants had turbidity levels ranged between 0.11±0.01 and 1.43±0.51 NTU during dry season and between 3.70±2.86 and 19.33±12.66 NTU during rainy season. The turbidity levels were above the permissible limit of WHO Water Quality Guidelines especially during wet seasons.

Water quality supplied by water supply schemes is one of the important factors that affect service delivery and continuity of usage (Brikke, 2000; Schouten and Moriarty, 2003) Therefore, the water quality complaints from water users from both water supply schemes may lead to the rejection of the point of use units and eventually abandoning them. This development would affect the sustainability of the water supply schemes considering that

they solely depend on the water user charges for the operation and maintenance of the water supply systems.

4.6.2 Water Quantity

The quantity of water supplied by MFWSS and EBWSS ought to satisfy the daily water users' domestic needs. However, water service providers meet different challenges in carrying out their daily operations. Therefore, a question was asked to the respondents whether the water quantity supplied by the two water supply schemes satisfy their daily domestic needs. The respondents were required to answer "yes" or "no" to the question to find out their satisfaction on the quantity of water supplied by their water supply schemes. The respondents' results are presented in Figure 18.

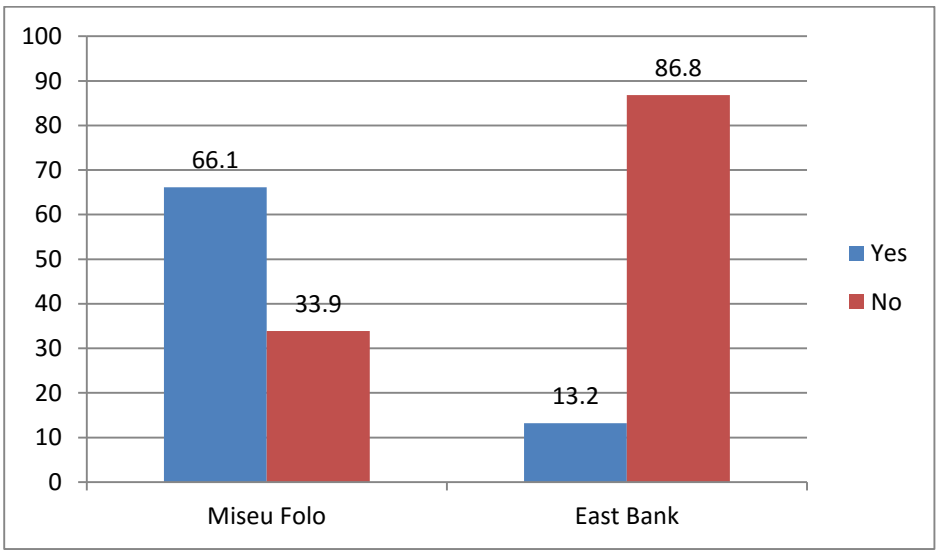

Figure 18: Household Respondents' Water Quantity Satisfaction

66.1% of the respondents in MFWSS are satisfied with the quantity of water supplied while the remaining 33.9% are not. In East Bank, the majority of respondents (86.8%) are not satisfied with the quantity of water supplied while 13.2% are satisfied. The Government of Malawi defines adequate water supply to mean at least 27 litres of water per person per day and accessible within a distance of less than 500 metres from the point of use unit. From section 4.4.2.2, MFWSS and EBWSS have a daily per capita consumption of 50 and 18 litres respectively. This finding agrees with perception of the water users in both MFWSS and EBWSS. The water supplied by MFWSS was more than the recommended minimum

quantity by GoM making the water users satisfied with water supplied. In EBWSS, the water supply was less than GoM's recommendation making water users dissatisfied with the water supplied.

4.6.2.1 Alternative Water Measures to Satisfy Demand

The results reveal that most of the respondents used alternative water sources when the water supplied by the water supply schemes could not meet their demand. While 68.4% of the respondents who were not satisfied with quantity of water supplied in MFWSS had to fetch water from alternative water sources to meet demand, 31.6% had to minimise domestic water usage. In EBWSS, those who were not satisfied with the quantity of water supplied, had to fetch water from alternative water sources as illustrated in Table 17.

Table 17: Alternative Measures to Satisfy Household Water Demand

Alternative Measures	**MFWSS Respondents**		**EBWSS Respondents**	
	Frequency	%	Frequency	%
Fetch water from Alternative water sources	13	68.4	59	100.0
Minimise domestic water usage	6	31.6	0	0.0
Total	**19**	**100.0**	**59**	**100.0**

The findings show that when the water supply schemes are unable to supply adequate water to meet household's requirement, the water users may depend on alternative water sources. In most cases, these alternative water sources are unsafe due to poor water quality which put the water users at high health risks.

4.6.3 Water Reliability

The responses for seasonal variation of water supply at the point of use units in MFWSS and EBWSS are presented in Table 18.

Table 18: Seasonal Variations of Water Supply at Point of Use Unit

Water Supply varies with Season	**MFWSS Respondents**		**EBWSS Respondents**	
	Frequency	%	Frequency	%
Yes	0	0.0	64	94.1
No	56	100.0	4	5.9
Total	**56**	**100.0**	**68**	**100.0**

The findings revealed that the water users in MFWSS were totally satisfied with the reliability of the water supply. All the respondents (100%) in MFWSS answered “no” in response to a question on whether there is seasonal variation at the point of use units. In EBWSS, the majority of the respondents (94.1%) answered “yes” while only 5.9% of the respondents answered “no” revealing that the water users are not satisfied with the reliability of water supply.

The 64 respondents indicated that the seasonal variation of water supply in EBWSS was caused by intake blockage (8%), reduced flow of water at the intake (2%) and pipe breakdowns owing to river flash floods which wash away supply pipelines during rainy season (90%)

4.6.3.1 Hours of Water Supply at Point of Use Units

The questionnaire further requested the respondents to indicate the hours of water supply during dry and wet seasons in MFWSS and EBWSS as summarised in Table 19.

Table 19: Hours of Water Supply at Point of Use Unit

Hours of Water Supply		**MFWSS Respondents**		**EBWSS Respondents**	
		Frequency	%	Frequency	%
Dry Season	1-6	0	0.0	14	20.6
	7-12	0	0.0	49	72.1
	13-18	2	3.6	3	4.4
	19-24	54	96.4	2	2.9
	Total	**56**	**100.0**	**68**	**100.0**
Wet Season	1-6	0	0.0	51	75.0
	7-12	0	0.0	15	22.0
	13-18	2	3.6	1	1.5
	19-24	54	96.4	1	1.5
	Total	**56**	**100.0**	**68**	**100.0**

The findings show that the majority of respondents (96.4%) in MFWSS receive water within the “19-24” hour band while the remaining (3.6%) receive water within the “13-18” hour band during both dry and wet seasons. In EBWSS, 92.7% of the respondents receive water in dry season within the hour band of “1-12” while the remaining (7.3%) receive water more than 12 hours daily. During wet season, the situation is even worse because the majority of

respondents (97.0%) receive water within the hour band of "1-12" while the remaining (3.0%) receive water for more than 12 hours.

4.6.4 Convenience of Point of Use Unit

All the respondents in MFWSS and EBWSS were required to indicate the distance between the point of use unit and their household. The responses are shown in Table 20.

Table 20: Distance from Household to Point of Use Unit

Distance to Point of Use Unit	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
Less than 10 metres	38	67.9	19	27.9
10m-50m	8	14.3	12	17.6
51m-100m	5	8.9	22	32.4
101m-500m	4	7.1	8	11.8
501m-1000m	0	0.0	5	7.4
Over 1000m	1	1.8	2	2.9
Total	**56**	**100.0**	**68**	**100.0**

The majority of the respondents (98.2%) in MFWSS were fetching water from a distance of up to 500 metres while the remaining (1.8%) were fetching water from a distance more than 500 metres. 89.7% of the respondents in EBWSS were collecting water from a distance of not more than 500 metres while the remaining (10.3%) were collecting water from a distance of more than 500 metres. The findings reveal that the point of use units in both MFWSS and EBWSS were located within the recommended distance of 500 metres as stipulated in the Second Malawi Growth and Development Strategy (MGDS II). Furthermore a household is said to have access to water if the distance to a point of use unit is at a distance less than 500 metres (Bauman & Danert, 2008).

4.6.5 Affordability of Water User Charges

Water is not only an economic good but also a social good (Savenije & Zaag, 2002), hence equity of supply should be considered. Research has found that many water users with low income levels continue to pay for their water user charges even when their earning power decreases and the water tariff remains the same. According to Butler and Memon (2006), good tariff policies should incorporate commercial and social welfare concerns thereby making water affordable to all. Similarly, when respondents were asked to indicate whether

they were able to pay their water user charges based on the current tariff, all the respondents (100%) in MFWSS answered “yes” while none answered “no”. The majority of respondents (98.5%) in East Bank answered “yes” while 1.5% answered “no” as illustrated in Figure 19. Usually, water users tend to conserve water in their households by minimising usage or use unsafe alternative water source for washing clothes and kitchen utensils as explained in Section 4.6.2.1 in order to ensure that the water user charge is paid for. However, payment for water user charges does not suggest that the water is affordable as it will be noted in the next section.

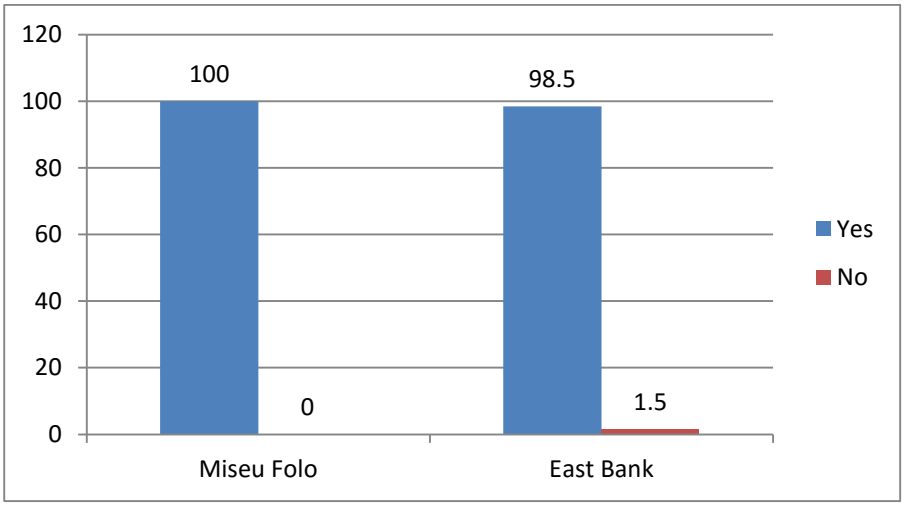

Figure 19: Payment of Current Water User Charges

4.6.5.1 Water Tariff Rating by Respondents

From the findings showed in Figure 19, the respondents were further asked to rate the water tariff with regard to their monthly water user charges. In answering the question on water tariff rating, 38.2% of the respondents in MFWSS felt that the water tariff was not fair while 39.3% felt that the tariff was fair. Furthermore, 16.1% and 7.1% of the respondents in MFWSS felt that the water tariff was somewhat fair and very fair respectively, In East Bank, 38.2% and 60.3% of the respondents felt that the water tariff was not fair and fair respectively. Only 1.5% of the respondents in East Bank felt that the water tariff was very fair as shown in Table 21.

Table 21: Water Tariff Ratings by Household Respondents

Rating of Water Tariff	MFWSS Respondents		EBWSS Respondents	
	Frequency	Percent	Frequency	Percent
Not Fair	21	37.5	26	38.2
Fair	22	39.3	41	60.3
Somewhat Fair	9	16.1	0	0.0
Very Fair	4	7.1	1	1.5
Total	**56**	**100.0**	**68**	**100.0**

From Table 8 and Table 9, the monthly income of water users and the monthly water charges were compared to find out the percentage of income that covers for water charges. Basing on the average monthly income of MK 10,524.69 and average monthly tariff of MK 1,340.82, water users in both MFWSS and EBWSS pay 12.7% of their monthly income to water tariff. However, water users in MFWSS spend 19.5% of their income on water. This is higher payment on water as compared to 6.5% by their counterparts in EBWSS. Generally, the water tariff being paid by water users in community managed water supply schemes under study was higher than the 3.5% of their monthly income which the WHO (2004) states that households should not be asked to pay for basic water supply service.

4.6.6 Relationship between User Satisfaction and Perceived Sustainability of WSS

In this study, five variables were considered when dealing with user satisfaction on quality of service in MFWSS and EBWSS. The five variables were water quality, water quantity, water reliability, convenience of point of use unit and affordability of water supply service. The findings of this study show that water users in MFWSS had a high user satisfaction and the majority of water users (62.5%) considered their water supply sustainable. In EBWSS, the majority of water users (82.4%) considered their water supply scheme unsustainable and they were not satisfied with the services delivered. This finding suggests that when water users are satisfied with the service levels of their water supply schemes, they are more willing to pay for such services thereby contributing enough revenue for O&M and expansion of their water supply network hence perceiving their schemes highly sustainable. The finding of this study agrees with those found by Bhandari and Grant (2007) and Koehler et al. (2015) that water users are generally reluctant to pay for water if the service levels are poor thereby affecting sustainability.

4.7 BOT Perceived Barriers to Sustainability of Piped Water Supply Schemes

The third objective of the study was to determine the water committee members' perceived barriers to sustainable water supply scheme. In order to understand perceptions of water management committee members on sustainability of water supply schemes, respondents were requested to indicate their opinion whether they considered their water supply scheme sustainable. In their response, one-third of the BOT respondents said their water supply scheme was sustainable while two-thirds said it was not. Their responses are shown in Table 22.

Table 22: Responses on Sustainability of Water Supply Schemes

Do you consider your scheme sustainable?	MFWSS Respondents		EBWSS Respondents		Total	
	Frequency	%	Frequency	%	Frequency	%
Yes	7	53.8	1	9.1	8	33.3
No	6	46.2	10	90.9	16	66.7
Total	**13**	**100.0**	**68**	**100.0**	**24**	**100.0**

The findings on the perception on sustainability of water supply schemes show that there are significant differences in opinions between BOT members and water users. Whereas 53.8% of the BOT members perceived that MFWSS was sustainable, 62.5% of the water users had similar observation. In EBWSS, 9.1% and 17.6% of the BOT members and water users perceived that their water supply scheme was sustainable respectively. The findings suggest that BOT members and water users define sustainability of water supply schemes differently. The water users may perceive a water supply scheme being sustainable when there is safe, adequate and reliable water supply (Harvey & Reed, 2004) while the BOT members may look at the indefinite realisation of the benefits of the water supply scheme by the water users. The different elements of sustainability could influence the way they responded on their perception to sustainability of their water supply schemes.

Following their opinion on the sustainability of water supply schemes, the BOT were further requested to indicate whether they were aware of issues which could affect sustainability of their respective schemes by mentioning at least three perceived barriers to their piped water supply schemes. Therefore, this section presents findings on the perceived barriers to sustainability from a questionnaire administered to BOT. The BOT highlighted critical

barriers that hinder sustainability of community managed water supply schemes. The barriers are shown in Table 23.

Table 23: BOT Perceived Barriers to Sustainable Water Supply Scheme

Variable	MFWSS		EBWSS		TOTAL	
	Freq.	%	Freq.	%	Freq.	%
Presence of alternative source to tapped water	2	5.1	0	0	2	2.8
Lack of capacity of BOT to manage water supply schemes	13	33.3	5	15.2	18	25
Low tariff charged to water users (No cost recovery mechanism)	2	5.1	2	6.1	4	5.6
Lack of external support	5	12.8	1	3.0	6	8.3
Lack of incentive	0	0	1	3.0	1	1.4
No social cohesion amongst water users	7	17.9	0	0	7	9.7
Non payment of water bills	10	25.6	8	24.2	18	25
Low Quality of Service	0	0	11	33.3	11	15.3
Theft and Vandalism	0	0	5	15.2	5	6.9
Total	**39**	**100**	**33**	**100**	**72**	**100**

The BOT were able to perceive some barriers that could affect the sustainability of their water supply schemes. The perceived barriers include presence of alternative source to tapped water, lack of capacity of water management committees, low tariff charged to water users, lack of external support, lack of incentive, no social cohesion amongst communities, non payment of water bills, unreliable water supply, theft and vandalism. The fact that BOT were able to mention management barrier as one of the barriers means that they were able to perceive the consequences of managing a system without necessary skills and knowledge. Still such knowledge did not influence the BOT to get the required skills and knowledge as will be noted in Section 4.8.1.2. Apart from management barrier, financial barrier was another equally important barrier as 25% of the BOT indicated that non payment of water bills was hindering water supply operations and maintenance.

4.7.1 Presence of Alternative Source to Tapped Water

Presence of alternative source to tapped water was one of the barriers which BOT members from MFWUA indicated that affects sustainability of water supply schemes. This was also

noted during field observations where water users in MFWSS were seen drawing water from boreholes within the supply designated area as shown in Figure 20.

Figure 20: Alternative Source to Tapped Water in MFWSS

Despite BOT members from EBWUA not indicating that alternative water sources like boreholes affect sustainability of water supply schemes, water users in EBWSS preferred borehole water to tap water. During informal interviews with those using the borehole water, most of those interviewed mentioned that high water tariff at MFWUA and low water quality at EBWSS compelled them to use alternative water sources existing in close proximity to their households.

4.7.2 Lack of Capacity of BOT members to Manage Water Supply Schemes

All over the developing countries including Malawi, most rural water supply systems are managed by communities itself. However, piped water supply system is a complicated option which cannot be effectively managed by communities (Kamruzzaman et al., 2013). Chowns (2015) argues that community management is not an efficient or effective framework for public service delivery and communities rarely have the capacity to sustainably manage their own infrastructure. Therefore, lack of capacity of BOT members to manage water supply schemes was one of the themes employed in this study. BOT members from both MFWUA and EBWUA revealed from focus group discussion and interviews that they lack capacity to

manage water supply schemes. This finding was supported by Ademiluyi and Adugbesan (2008) who concluded that communities have limited capacities to manage their water supply schemes sustainably.

4.7.3 Low Water Tariff Charged to Water Users

Both BOT members from MFWUA and EBWUA mentioned that the water user fees being paid by water users was not adequate to meet operations and maintenance costs incurred by the water supply schemes. This implies that the WUAs in Chikwawa District developed their water tariff structure without considering the actual costs of operating and maintaining their water supply system. Therefore, the water tariff should be reviewed and adjusted routinely to ensure that it is covering operations and maintenance costs thereby enhancing the sustainability of the water supply schemes.

4.7.4 Lack of External Support

Lack of external support dominates in literature as one of the factors affecting sustainability of water supply schemes (Peter & Nkambule, 2012; Zuzani et al, 2013; Ungwe & Morson, 2014). BOT members from both MFWUA and EBWUA cited lack of external support as one of the barriers to sustainable management of water supply schemes. The members mentioned that their monthly revenue collections were not adequate to maintain their water supply infrastructure because of low tariffs which could not meet even operation and maintenance costs. This was also evidenced during field visits to the water sources in EBWSS by the researcher. The intake structures at Livunzu and Mapelera are in a dilapidated state requiring huge investment which the communities cannot do alone. These challenges could be minimised if the policy of community management model being advanced by the GoM is reviewed against other models of water supply management like public private partnership.

4.7.5 Lack of Incentives

Community management requires that managerial decisions about levels of service, location of services, cost recovery, incentives, operations and maintenance should be made at the lowest level. However, circumstances may compel WUA leadership to make decisions in the best interest of their water supply schemes as well as beneficiaries. For example, EBWSS does not refund transport or meal expenses to its committee members during meetings because of cash flow challenges. It is against this premise that only one BOT member from

EBWUA indicated that lack of incentives affected sustainability of water supply schemes. The member mentioned that EBWSS has BOT members across the four sub schemes namely Livunzu, Mapelera, Liphangwi and M'mbadzi requiring refunds of transport and lunch expended on attendance of BOT meetings. The BOT member further explained that the roles and responsibilities undertaken by them consume much of their time which could have been used to earn them income for their households. The BOT members are involved in the management of water supply schemes on voluntary basis which does not become attractive to poor rural communities. Therefore, this implies that working by volunteering could be one of the reasons contributing to lack of commitment by some of the members to carry out their roles and responsibilities hence affecting water supply scheme sustainability.

4.7.6 No Social Cohesion amongst Water Users

MFWSS is located at a market centre close to Illovo Sugar Company at Nchalo which has attracted people of different ethnic groups to get employment. These people live within the areas around the sugarcane plantations and Miseu Folo is one of them. On the contrary, EBWSS covers a long stretch from Thabwa to M'mbadzi and marks boundary with Thyolo and Nsanje Districts. These dynamics have influenced MFWSS and EBWSS to have water users from different ethnic groups with different levels of education and income. In MFWSS, some of the water users disagreed with the proposal by the WUA Board to have their water tariff adjusted upwards despite others supporting the proposal. The disgruntled water users protested the upward tariff adjustment by refusing to pay bills based on the new tariff and the WUA Board reversed its decision to adjust the water tariff. This created a conflict between the WUA Board and the General Assembly (GA) because the WUA Board thought the GA was sabotaging the operations of MFWSS. This suggests that the GA, as a representative of water users should strive to know the social diversity of water users in their water supply scheme. This may help the GA to accommodate those water users with dissenting views when making decisions in relation to tariff adjustment.

4.7.7 Non Payment of Water Bills

Most of the BOT members from both MFWUA and EBWUA believed that non payment of water bills (user fees) hindered the sustainability of water supply schemes. Community-managed piped water supply schemes depend on funds collected from water users for services rendered. Some of the water users explained that they were unable to pay water bills

because the WUA Board is not transparent and they were not sure how the money collected was used. The water users could have lost trust and confidence in the WUA Board. This was revealed during face to face interviews that the General Assembly does not hold meeting with water users explaining how money collected is handled in the water supply schemes.

4.7.8 Low Quality of Service Delivery

Unlike in MFWSS where water users were satisfied with the quality of service delivery, EBWSS had challenges impeding their service delivery. Water users in EBWSS were not satisfied with the quality and quantity of water supplied. The water supplies were unreliable both in dry and wet seasons. During field visits, it was observed that deforestation and cultivation along the river banks have adverse effect on the water quality and quantity supplied. The fact that BOT members from EBWUA concurred with the water users on the quality of service delivery signifies the magnitude of the water challenges faced by the management of EBWSS. This implies that the EBWUA Board cannot improve the water service delivery independently unless an external support from either GoM or NGOs is provided.

4.7.9 Theft and Vandalism

It was only BOT members from EBWUA who indicated that theft and vandalism deterred the sustainability of their water supply scheme. This was also observed during field visits to the scheme as shown in Figure 21.

Figure 21: Theft and Vandalism of Transmission Pipelines in EBWSS

This implies that theft and vandalism is rampant in EBWSS and could be one of the barriers to sustainable water supply in EBWSS. This is so because the money which could have been used for expansion of the network is used for replacement of stolen or vandalised pipes.

4.8 Influence of WUA Management Model Practices on Sustainability of Community-Managed Water Supply Schemes

The fourth objective of the study was to examine the influence of WUA Management Model practices on the sustainability of community-managed piped water supply schemes in Miseu Folo and East Bank Water Supply Schemes. This section presents findings on the effects of WUA Management Model practices on the sustainability of community-managed piped water supply schemes. The practices considered under this study were firstly the roles and responsibilities of BOT members which covered knowledge of roles and responsibilities by BOT members and Training carried out by BOT members in relation to their roles and responsibilities. Secondly, participation of BOT members in the management of community-managed piped water supply schemes was considered which covered the attendance of meetings by BOT members, frequency of meetings, influence of BOT members in decision making during meetings, existence of conflicts amongst BOT members and their resolution and a follow up on agreed actions. Thirdly, the study considered the capacity of current BOT members in management of water services (technical, financial and management skills) in terms of management of water services and financial Policies (Preparation of budgets, tariff setting, revenue collection and penalties for non payment). Fourthly, transparency and accountability was considered covering auditing of accounts and record keeping.

4.8.1 Roles and Responsibilities of BOT Members

4.8.1.1 Knowledge of roles and responsibilities

A Water Management Committee in this case the WUA Board or BOT is appointed to administer the affairs of a water supply scheme on behalf of the communities (water users). The BOT members were asked to indicate their roles and responsibilities in the WUA Board in the water supply scheme. From Table 24, most of the committee members had limited knowledge of their roles and responsibilities in the water supply scheme because the roles and responsibilities indicated by the committee members were mostly related to those assigned to LUO on their behalf such as operating and maintaining of water supply facilities. This could be attributed to the fact that most of the committee members believe that their

responsibility is the day to day running of the water supply schemes despite having a LUO in place.

Table 24: Knowledge of Roles and Responsibilities by BOT members

Roles and responsibilities indicated	MFWSS Respondents		EBWSS Respondents	
	Frequency	%	Frequency	%
1. Operating water supply facilities	3	23.1	4	36.4
1. Operating water supply facilities 2. Maintaining water supply facilities	8	61.5	7	66.6
1. Operating water supply facilities 2. Maintaining water supply facilities 3. Hiring of LUO	1	7.7	0	0.0
1. Operating water supply facilities 2. Maintaining water supply facilities 3. Hiring of LUO 4. Calling for GA meeting	1	7.7	0	0.0
Total	**13**	**100.0**	**11**	**100.0**

4.8.1.2 Training of BOT Members

The water management committee members in the WUA Board were requested to indicate whether they were ever trained in relation to their roles and responsibilities. From Figure 22 below, the results show that the majority (72.7%) of the water committee members in EBWSS had training in relation to their roles and responsibilities while the remaining (27.3%) are carrying out their roles and responsibilities without any training. In MFWSS, the situation is even worse because only 53.8% of the water committee members had training while 46.2% had never gone for training in relation to their roles and responsibilities.

The findings of this study may imply that some of BOT members could be carrying out their roles and responsible without prior training on the management of the water supply schemes. This could mean that a few BOT members with the knowledge of managing water supply schemes may dominate in the decisions made for the success of the water supply schemes.

Just like in Section 4.6.1.1 above, the findings also suggest that the water management committee members have limited knowledge of their roles and responsibilities in the management of water supply schemes.

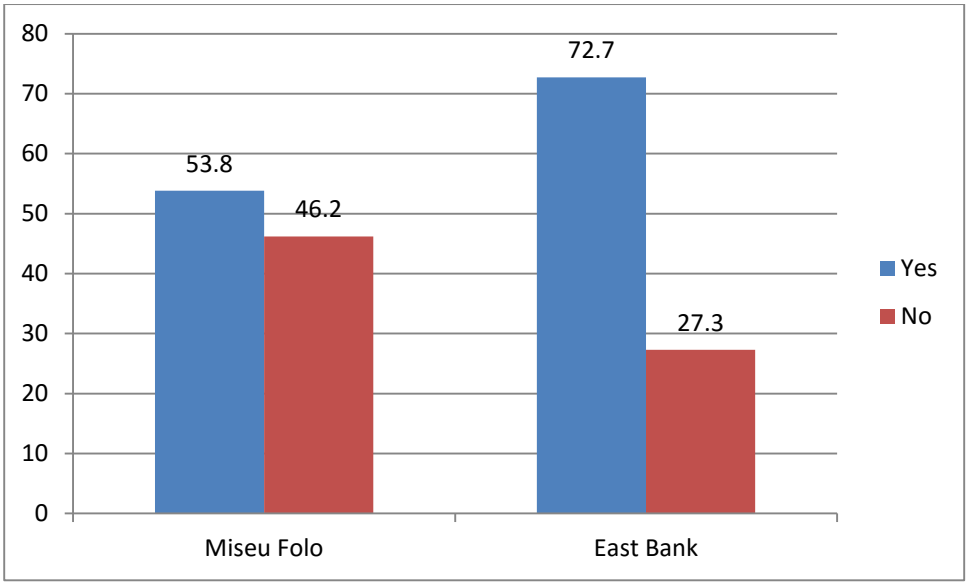

Figure 22: Training of BOT members

From the questionnaire, the BOT members were further requested to list the trainings undertaken before the commissioning of the water supply schemes. The BOT members indicated that financial management, procurement, ownership of scheme, leadership skills, operations and maintenance, business plan formulation, funds sourcing were undertaken among others trainings. Despite the majority (80%) of BOT members indicating the aforementioned trainings which they undertook prior to commissioning of water supply system, the remaining (20%) could not indicate any training undertaken which implies that they had forgotten the content of the trainings when years passed by.

4.8.2 Participation of BOT members in the Management of Community-Managed Water Supply Schemes

4.8.2.1 Attendance of Meetings by BOT Members

Attendance of meetings by the BOT members was one of the elements in the study showing that BOT members were participating in the management of water supply schemes. The study found that all the committee members in both MFWSS and EBWSS do attend meetings.

Table 25: Response of BOT members on Attendance of Meetings

Rate of attendance of meetings	MFWSS Respondents		EBWSS Respondents	
	Frequency	Percent	Frequency	Percent
Regularly	6	46.2	7	63.6
Occasionally	7	53.8	4	36.4
Never	0	0.0	0	0.0
Total	**13**	**100.0**	**11**	**100.0**

However, the attendance of meetings by the BOT members was not consistent as shown in Table 25. From the findings, 46.2% of BOT members in MFWSS indicated that they attended meetings regularly while in EBWSS was 63.6%. In MFWSS and EBWSS, 53.8% and 36.4% indicated that they attended meetings occasionally respectively. This is a significant finding as it indicates that the BOT members have lost interest in undertaking their roles and responsibilities in their respective water supply schemes. However, a further analysis of those who attended meetings occasionally, the finding shows that the majority of them were women. During focus group discussion, one of the women explained that they attended meetings occasionally because they are hampered by lack of time. Limited number of women during meetings could mean that decision making in the WUAs being a men's affair even on issues which women have special knowledge and interest thereby affecting the sustainability of water supply schemes. Conversely, several women in a meeting can one another mutual support thereby enhancing sustainability of the water supply schemes.

4.8.2.2 Frequency of Meetings

As per the constitution of the water supply schemes, meetings for WUA Board were supposed to be held quarterly. The study found that all BOT members indicated that meetings were held quarterly which is in tandem with their constitution.

Table 26: Response of BOT members on Frequency of Meetings

Frequency of meetings	MFWSS Respondents		EBWSS Respondents	
	Frequency	Percent	Frequency	Percent
Monthly	0	0.0	4	36.4
Quarterly	13	100.0	7	63.6
Total	**13**	**100.0**	**11**	**100.0**

However, it was also found that meetings were held on monthly basis in EBWSS contrary to their constitution. Four (4) BOT respondents representing 36.4% of the BOT members

indicated that their meetings were held every month as shown in Table 26. This indicates that WUA Board meetings held in EBWSS were unsatisfactory because some of BOT members could not attend monthly meetings citing logistical challenges. This could be a sign of poor communication tools for decision making in operation and maintenance of water supply schemes. The LUO for EBWSS further explained that the BOT members use their own money for transport costs and meals during meeting which they are not refunded. This lack of incentive initiative in EBWSS discourages the BOT members from attending meetings thereby being ignorant of actual dates of meetings.

4.8.2.3 Influence of BOT Members in Decision Making During Meetings

The BOT members were requested to indicate whether they influenced decisions during meetings. All the BOT members in both MFWSS indicated "yes" that they influenced decisions in meetings such that their contributions during meetings are taken on board. In East Bank, only one (1) respondent indicated that she has never influenced any decision during meetings because could not follow the proceedings. Despite the majority of BOT members indicating that they had influenced certain decisions in one way or another during meetings, the DWDO disagreed with their sentiments. During one of the interviews, the DWDO explained that the same BOT members especially men dominate deliberations in each and every meeting. The BOT members were further requested to indicate on the type of issues that they influenced and Table 27 shows the results of the study.

Table 27: Responses on Issues Influenced by BOT members during Meetings

Issues influenced during meetings	MFWSS Respondents		EBWSS Respondents	
	Frequency	Percent	Frequency	Percent
Technical issue	4	30.8	3	27.3
Administrative issue	5	38.4	2	18.2
Financial issue	4	30.8	5	45.5
Not Applicable	0	0	1	9.1
Total	**13**	**100.0**	**11**	**100.0**

From the findings of the study, BOT members in MFWSS contributed more administrative issues (38.4%) than financial (30.8%) and technical (30.8%) issues during meetings. In EBWSS, BOT members contributed more on financial (45.5%) issue than technical (27.3%) and administrative (18.2%) issues. The findings may imply that BOT members in MFWSS could be actively involved in the resolution of conflicts arising between BOT and GA or

water users due to the disagreements on the tariff adjustment which the some members of the BOT and GA confirmed in separate interviews. The findings in EBWSS may suggest that BOT members could be participating on revenue collection and water tariff setting in order to have enough funds for maintenance and operation of their water supply scheme which was partially functioning at the time of this study. On the contrary, it could mean that the BOT members were not knowledgeable on issues which they failed to influence during meetings.

4.8.2.4 Existence of Conflicts among BOT Members

The study found that both MFWSS and EBWSS have rules and regulations governing their schemes. In view of this, the BOT members were requested to indicate whether conflicts existed amongst the BOT members. In their response to the questionnaire, ten (10) BOT respondents in MFWSS answered "yes" representing 76.9% while three (3) BOT respondents answered "no" representing 23.1% in relation to existence of conflicts among BOT members. In EBWSS, 63.6% of the BOT members responded that there was no existence of conflicts among BOT members while 36.4% noted existence of conflicts as shown in Figure 23.

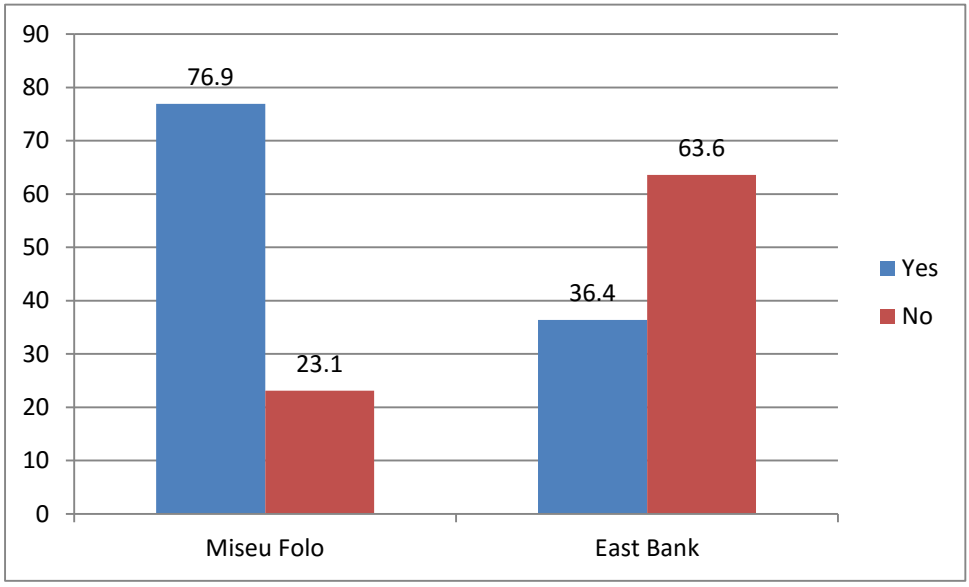

Figure 23: Existence of Conflicts among BOT members

During a focus group discussion, the water management committee attributed the conflicts to disagreement between the MFWUA's General Assembly and BOT members on the upward adjustment of water tariff by the MFWUA. In EBWUA, interviews from most of the General

Assembly members attributed the conflicts from lack of transparency and accountability by the WUA Board. The General Assembly suspected misuse of funds by BOT members which was affecting the operation and maintenance of their water supply scheme.

4.8.2.5 Follow up Meetings on Agreed Actions

In both MFWSS and EBWSS, the study found that there were no any follow up meetings on agreed actions. From interviews conducted, it was noted that the only time the WUA Board were tasked to explain their actions pertaining to the management of water supply schemes was during annual general meetings. Other than the said meetings, there were no any other forums for following up actions by the committee members.

4.8.3 Capacity of BOT Members in Management of Water Services (Technical, Financial and Administrative Skills)

This section presents findings on the management of water services (operations and maintenance), adequacy of technical, financial and administrative skills by both committee members and LUO, financial policies in place (preparation of budgets, revenue collection and penalties for non-payment)

4.8.3.1 Management of Water Services (BOT members and LUO)

According to the constitution of MFWUA and EBWUA, BOT or the WUA Board is appointed by the GA and play a directorate function. The GA is elected by water users and forms the ultimate body in the creation of rules and policies to govern the WUA. However, it was found that some of the BOT members were not water users in their respective water supply schemes. In view of this, the BOT members were requested to indicate whether they were water users in their respective water supply schemes. In their response, six (6) respondents in MFWSS representing 46.2% of the BOT members indicated that they were water users while seven (7) respondents representing 53.8% indicated that they were not. In EBWSS, the majority (72.7%) of the BOT respondents indicated that they were water users while the remaining (27.3%) respondents indicated that they were not as shown in the Table 28.

Table 28: Response by BOT members as being Water Users

Are you a water user?	MFWSS Respondents		EBWSS Respondents	
	Frequency	Percent	Frequency	Percent
Yes	6	46.2	8	72.7
No	7	53.8	3	27.3
Total	**13**	**100.0**	**11**	**100.0**

The findings could have an implication on governance and sense of ownership of the water supply schemes. The WUA leaders who are not water users cannot contribute objectively on issues surrounding their water supply schemes. In such cases, they could expect monetary benefits from the WUA in form of incentives.

Upon establishing the BOT members who were water users in both MFWSS and EBWSS, a question was asked on the functionality of the point of use units. The findings of this study indicate that all the six (6) BOT members in MFWSS who were water users had their point of use units functioning. In EBWSS, only one (1) BOT member representing 12.5% of the BOT members who were water users had the point of use unit functioning while 87.5% had their point of use units not functioning as shown in Figure 24 below:

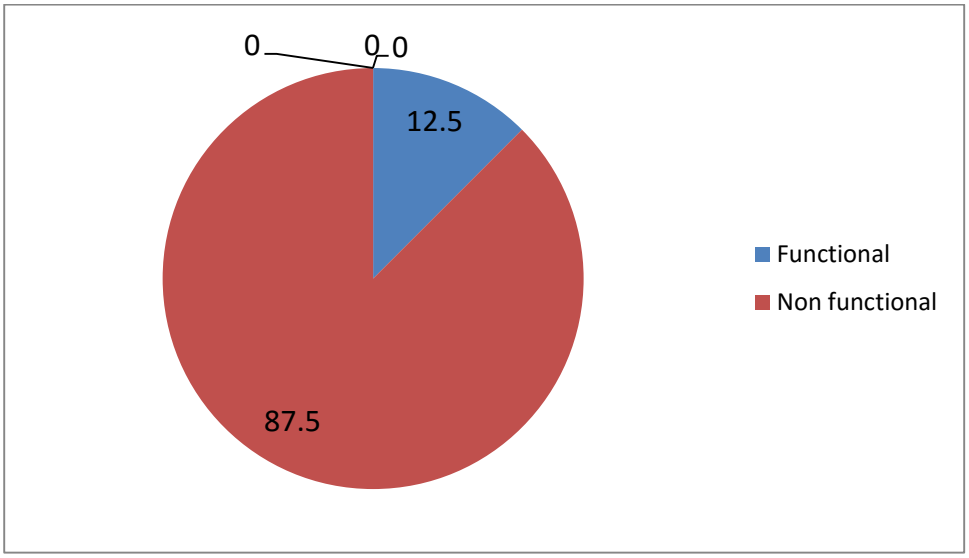

Figure 24: Functionality of Point of Use Units among BOT members

The findings of this study on percentage of BOT water users with functional point of use units agree with the findings in Section 4.4.1. However, the functionality of point of use units in this section for EBWSS (12.5%) was lower than the one found in Section 4.4.1 (26.5%).

The findings indicate that the majority of BOT members were not water users at the time of this study and for those who were water users had their point of use units not functioning. This could lead to a management lapse in cases where issues relating to water service delivery like water tariff and quality of service are directly managed by those members who are not water users of the water supply scheme.

It is expected that water supply schemes with a well functioning system to have its WUA leadership to be part of the water users. Surprisingly, MFWSS with a functionality rate of 100% had the highest percentage (53.8%) of BOT members who were not water users whereas EBWSS with a functionality rate of 26.5% had a lower percentage (27.3%) of BOT members who were not water users. The findings suggest that the majority of BOT members who were not water users at the time of the study were well aware of the need for the water supply scheme to operate efficiently in order to collect adequate revenue. With such revenue collection, the scheme would have additional funds to expand the water supply system to areas where the BOT members reside. On the contrary, those schemes with higher number of BOT members being water users would relax on the expansion of the system and concentrate on operation and maintenance.

The BOT members were further requested to state how long it took for a water supply breakdown to be repaired. In their response, six (6) BOT members from MFWSS who were water users at the time of this study stated that it took less than 24 hours for a breakdown in water supply to be repaired. In EBWSS, the situation was different because all the seven (7) committee members who were water users at the study time stated that it took more than six (6) months to repair a water supply problem. It was further revealed through interviews that in certain areas like at Group Village Headman (GVH) Mpokonyola in East Bank Water Supply Scheme, the period without water supply had gone beyond two (2) years. This has forced the water users within this community of GVH Mpokonyola to use alternative water sources which are not safe. The BOT members either raised the issue pertaining to water supply at a committee meeting when a water supply breakdown takes a long time to repair or did nothing when they were pretty sure that the breakdown would be repaired in less than 24 hours.

4.8.3.1.1 Inadequacy of BOT Members to Manage Water Supply Scheme

Lack of community management skills was one of the factors singled out that contributes to the low functionality rate of water supply schemes. The factor was also supported by Ungwe and Morson (2014) when they argued that capacity to operate a drinking water infrastructure affect sustainability of the water services. Therefore, a questionnaire had attempted to test the perceptions of the BOT members on their inadequacy of technical, financial and administrative skills to manage water supply schemes. The test results are shown in Table 29.

Table 29: Responses by BOT members on their Inadequacy to Manage Water Supply Schemes

Response (n=24)	MFWSS Respondents		EBWSS Respondents		TOTAL	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Agree	8	61.5	6	54.5	14	58.3
Disagree	4	30.8	4	36.4	8	33.3
Neutral	1	7.7	1	9.1	2	8.3
Total	**13**	**100.0**	**11**	**100.0**	**24**	**100.0**

The test results presented in Table 29 show that 61.5% of the respondents in MFWSS felt that water committee members do not have the technical, financial and administrative skills to manage water supply schemes while 30.8% felt that they have the skills and 7.7% of the respondents were not sure. In EBWSS, 36.4% felt that they have the technical, financial and administrative skills to manage water supply schemes whereas 54.5% felt that they do not have the skills and the remaining 9.1% were not sure.

It was hypothesised that inadequacy of BOT members affects effective management of water supply schemes. The study required to analyse Chi Square results to ascertain the significance of the results.

Table 30: Inadequacy of BOT members to Manage WSS

Response (n=24)	Inadequacy of BOT members to Manage Water Supply Scheme		
	MFWSS	EBWSS	TOTAL
Chi Square	5.692	3.455	9.000
Df	2	2	2
P	0.058	0.178	0.011

A Pearson chi-square test was conducted to examine results as presented in Table 30 above. The results revealed that there was a strong evidence of relationship between adequacy of water committee members and effective community management of WSS ($X^2(2) = 9.00$, $p < 0.05$).

4.8.3.1.2 Capacity of LUO to manage Water Supply Scheme

At the time of this study, the secretariat of both MFWSS and EBWSS was in the hands of LUOs who were responsible for the day- to- day running of the water supply operations in their respective schemes. Therefore, a questionnaire had attempted to test the perceptions of the management committee members on the capacity of the LUO to handle operations and maintenance of a water supply scheme. Their responses are shown in the Table 31.

Table 31: Responses by BOT members on the Capacity of a LUO to Manage WSS

Response (n=24)	MFWSS Respondents		EBWSS Respondents		TOTAL	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Agree	10	76.9	8	72.7	18	75.0
Disagree	1	7.7	3	27.3	4	16.7
Neutral	2	15.4	0	0	2	8.3
Total	**13**	**100.0**	**11**	**100.0**	**24**	**100.0**

More than half of BOT respondents (75%) indicated that the LUOs are well qualified and skilled to handle technical, financial and management issues of their respective water supply schemes, 16.7% indicated that the LUOs have no capacity to manage water supply schemes while 8.3% were not sure.

It was also hypothesised that the capacity of LUO to manage water supply schemes enhances effective management of water supply schemes. The study required to analyse Chi Square results to ascertain the significance of the results

Table 32: Capacity of LUO to Manage Water Supply Scheme

Response (n=24)	Capacity of LUO to Manage Water Supply Scheme		
	MFWSS	EBWSS	TOTAL
Chi Square	11.231	2.273	19.00
Df	2	1	2
P	0.004	0.132	0.000

A Pearson chi-square test was conducted to examine results as presented in Table 32 above. The results revealed that there was a strong evidence of relationship between capacity of a LUO to manage a WSS and effective community management of WSS ($X^2(2) = 19.00$, $p < 0.01$).

After ascertaining the influence of the capacity of a LUO on the sustainability of WSS, BOT members were further requested to indicate whether well qualified and skilled LUOs are too expensive for community-managed water supply schemes.

Table 33: Responses by BOT members on Well Qualified and Skilled LUOs being too Expensive for Community Managed WSS

Response (n=24)	MFWSS Respondents		EBWSS Respondents		TOTAL	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Agree	12	92.3	10	90.9	22	91.7
Disagree	0	0	0	0	0	0
Neutral	1	7.7	1	9.1	2	8.3
Total	**13**	**100.0**	**11**	**100.0**	**24**	**100.0**

In their responses as depicted in Table 33, 91.7% agreed that well qualified and skilled LUOs are too expensive for a community-managed water supply scheme while only 8.3% of the respondents were not sure.

Table 34: LUOs are too Expensive for Community Managed WSS

Response (n=24)	LUOs too expensive for Community Managed Water Supply Scheme		
	MFWSS	EBWSS	TOTAL
Chi Square	9.308	7.364	16.667
Df	1	1	1
P	0.002	0.007	0.000

A Pearson chi-square test was conducted to examine the results as presented in Table 34 which revealed that there was a strong evidence of relationship between remuneration of LUO and sustainability of community managed water supply schemes ($X^2(1) = 16.667$, $p < 0.01$).

4.8.3.2 Financial Policies in MFWUA and EBWUA

The BOT members have the responsibility to manage and disburse funds of the water supply scheme on behalf of communities (water users) in accordance to the constitution of the respective water users association. The study considered preparation of annual budgets, tariff setting, revenue collection and penalties on non payment as the financial policies in the study areas.

4.8.3.2.1 Preparation of Annual Budgets

One of the financial policies which the study sought to establish was whether the BOT members prepared annual budgets for their water supply schemes. From their responses, it was revealed that only MFWSS prepared annual budgets while EBWSS did not. This implies that MFWSS is the only scheme in Chikwawa District which is able to monitor performance by comparing actual performance with annual plans.

4.8.3.2.2 Tariff Setting

Water tariff is a rate at which water users are charged for water used. The main source of funds from the community-managed water supply schemes under study came from the revenue generated from the water sales. Therefore, the study sought to establish whether BOT respondents had special criteria for tariff setting. In their response, all the BOT respondents from both MFWSS and EBWSS agreed that they had a criterion for setting tariff. During interviews, the LUOs further explained that their WUAs have their own tariff structure which is prepared based on expected expenditure to operate and maintain the water supply schemes. Both the LUOs and BOTs narrated that would know that the tariff is appropriate when it is able to meet administrative, operation and maintenance costs.

MFWUA uses volumetric tariff which enables good cost recovery because tariff adjusts automatically with a change in consumption by water users. On the other hand, EBWUA uses fixed tariff because its water supply system does not have water meters which discourages water users to efficiently use or conserve water. Furthermore, households in EBWSS with connections can supply water to other water users without incurring any additional water tariff. Therefore, the water tariffs for EBWSS do not reflect the actual costs of rendering the water services.

4.8.3.2.3 Revenue Collection

The BOT members were further required to indicate how long it takes to collect monthly contribution fee. The findings indicate that 7.7% of the BOT respondents in MFWSS thought that the water users paid their monthly contribution fee when it was due while 92.3% thought that the water users paid their monthly contribution after 30 days of the payment being due. In EBWSS, all the BOT members thought that the water users paid their monthly contribution fee after 60 days of the payment being due. This implies that water users from MFWSS are able to pay their monthly contribution fee timely while those from East Bank pay their fees very late.

4.8.3.2.4 Penalties for Non Payment

The BOT respondents were asked to indicate whether the water users have penalties for late or non-payment of monthly contribution fee. In their response, all the BOT members from MFWUA indicated that they disconnect water supply when a water user default monthly payment. In EBWUA, 63.6% of the BOT respondents indicated that there were penalties for non-payment while only 36.4% disagreed with their colleagues. The disagreements in the response of the question on penalties for non-payment show that the system is not in place in EBWUA which also was collaborated by LUO managing the water supply scheme.

From interviews with the LUO, the EBWUA has no debtor follow up system in place to ensure that those who do not pay their monthly user fees are requested to do so. However, those water users who do not pay their monthly user fees, the payment is considered written off.

4.8.4 Transparency and Accountability of the BOT members

4.8.4.1 Auditing of Financial Accounts

The BOT members were required to indicate whether their financial accounts are audited. Their responses were as shown in the Table 35.

Table 35: Responses by BOT members on the Auditing of Financial Accounts

Auditing of Financial accounts	Frequency	Percent
Yes	0	0.0
No	24	100.0
No Response	0	0.0
Total	**24**	**100.0**

Majority of the BOT respondents (100%) from both MFWSS and EBWSS indicated that they did not audit their financial accounts. This finding implies that financial accounts had not been audited since inception of the water supply schemes giving room to fraud and corruption. The water users could lose trust and confidence in the water management committee due to lack of auditing of financial accounts.

4.8.4.2 Record Keeping

For an audit to be carried out on financial accounts there is need for proper record keeping of funds by an institution, In view of this, the BOT members were further requested to indicate whether they keep records for money collected and expended. Table 36 shows the responses of BOT members on record keeping.

Table 36: Response by BOT members on Record Keeping

Record Keeping	Frequency	Percent
Yes	24	100.0
No	0	0.0
No Response	0	0.0
Total	**24**	**100.0**

(Source: Research data)

Majority of the respondents (100%) indicated that their water supply schemes kept records for all the financial accounts. It was further indicated during discussions that they have a bank account which they use to keep their funds and some of the financial records they kept were bank statements and cash books. This implies that any member could request the financial records at any time for scrutiny. However, when the researcher requested to appreciate the type of financial records kept by the water supply schemes, the record keepers were unable to show such records to the researcher.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions and recommendations drawn from the results and discussion in the previous chapter. The focus of the study was to explore factors that affect the sustainability of community-managed piped water supply scheme in Chikwawa District. The study originated after considering the investment that the Government of Malawi was putting in construction and rehabilitation of piped water supply schemes in market centres and rural areas. After such huge investment in water supply schemes, they became non-functional after a few years of operation.

The setting of the study was such that the findings would assist Government which loses much of donor funds to construct and rehabilitate water facilities which eventually fail after either construction or rehabilitation. Therefore, if the findings are applied, the Government of Malawi could save lost investment and invest in other equally important areas. The study had literature review which was used to define sustainability and identify the factors affecting sustainability of community-managed water supply schemes in the context of sub-Saharan Africa and Malawi.

After the identification of the factors, a study was conducted through observations, questionnaires, focus group discussions and interviews in order to find out if the identified factors are at play in Chikwawa District. The research was narrowed down to Miseu Folo and East Bank as they were the only community-managed water supply schemes which were functioning at the time of the study. Chapananga Water Supply Scheme, a community-managed scheme was not considered because it was under rehabilitation at the study time. The findings of this study were assessed and discussed meaningfully in relation to the objectives of the study. From the study findings, conclusions were drawn and recommendations made.

5.2 Conclusion

From the findings of this study, it was concluded that functionality and subsequent utilisation of point of use units, user satisfaction of services rendered, financial viability and

management practices affect sustainability of community-management of water supply schemes in Chikwawa District.

5.2.1 Functionality and Utilisation of Point of Use Units

Out of the community-managed piped water supply schemes studied in Chikwawa District, MFWSS had a high functionality rate (100%) as compared to EBWSS (26.5%) which is a gravity-fed water supply system. This finding reveals that there has been no improvement on the functionality of gravity-fed piped water supply schemes in Chikwawa District since the sector performance report was conducted in 2011. The gravity-fed piped water supply schemes continue to underperform despite the Government of Malawi adopting WUA management model replacing the traditional scheme management. Therefore, it is proper to question the management model in place rather than the technology used to attain high functionality rate of point of use units.

The findings illustrate that there are important connections between functionality of point of use units and sustainability of water supply schemes. The findings also show that due to increased functionality, water supply schemes tend to achieve higher service delivery levels. However, the study found that low functionality rate of water supply schemes was affected by pipeline breakage and blockage during rainy seasons and vandalism of water supply facilities.

The study found that water users in MFWSS preferred to use tap water for drinking and cooking purposes rather than other alternative sources. In EBWSS, water users preferred to use borehole water for drinking and cooking purposes rather than tap water. The utilisation of water supply schemes was affected by the by tariff where it was a volumetric tariff like in MFWSS and by low quality of service delivery where the tariff was a flat tariff like in EBWSS. The dynamics compelled water users to use alternative source to tap water. Therefore, it can be concluded that the degree to which water was used for drinking and cooking purposes promoted sustainability of water supply schemes in Chikwawa District.

5.2.2 Water Users' Perception to Water Service Delivery

The water supply schemes are operating in a district where the water users are poor earning on average less than 1.25 US$ a day. These poor water users are also paying more than 5% of their household income for water services in order for the water supply schemes to cover O&M costs. However, these water tariffs are not adequate enough to generate sufficient

revenue for infrastructure management especially maintenance leading to deteriorating services.

Water users will generally not pay for water supply services if they perceive the service levels to be poor relative to costs. This study found that water users in MFWSS were satisfied with the levels of water service delivery and were willing to pay for water services. In EBWSS, water users were not satisfied with the levels of service delivery and were reluctant to pay for water supply services. When water users are unwilling to pay for water services which are poor, revenue collection is affected leading to system failure. This was noted in EBWSS where Limphangwi and M'mbadzi water intake structures were affected by floods in January, 2015 and were not operational. The WUA Board had no money to purchase materials for maintenance of the water intake structures. It had to take a prospective water user to pay for the materials for the system to get back in operation.

Furthermore, water users may be willing to get disconnected when the water services are poor. On the other hand, water users may be willing to pay for water delivered when the water services are of good quality. The findings show that excellent service delivered by water supply scheme and water user's satisfaction can influence collection of enough revenue to operate and maintain water supply infrastructure. Therefore, good quality of water supplied, sufficient and reliable supply of water enhance the sustainability of water supply schemes.

5.2.3 Perception of WUA Board on Barriers Affecting Sustainable WSS

This study found out that BOT members perceived management, social, economic and technical factors as barriers to sustainable water supply schemes in Chikwawa District. The majority of BOT members (50%) indicated lack of capacity of BOT members to manage water supply schemes and non payment of water bills as main barriers to sustainable water supply schemes in the study area. The rest of the BOT members indicated low quality of service delivered (15%), no social cohesion amongst water users (10%), lack of external support (8%), theft and vandalism (7%), low water tariff or lack of cost recovery strategy (6%), presence of alternative water sources to tap water (2%) and lack of incentive (1%).

The findings show that BOT members acknowledge their inadequacy to manage water supply schemes sustainably by requesting external support from either government or non-governmental organisations (NGOs). This is further evidenced by their indication of lack of capacity to collect enough revenue for operations and maintenance due to poor service delivery, lack of social cohesion and lack of cost recovery strategy. Despite their acknowledgement of shortfalls in management, the BOT members indicated other barriers which were beyond their control like presence of alternative sources to tap water such as boreholes, theft and vandalism. It can be concluded that economic and management barriers are significant amongst water supply schemes in Chikwawa District and ought to be addressed if the water supply schemes are to remain sustainable

5.2.4 Management Committees' Capabilities and Practices

The study found out that policies, strategies and guidelines that encourage sustainability were in place at both MFWUA and EBWUA which is a positive indicator for sustainability. However, management of water supply schemes in the study area is still a sustainability challenge. The study found that most BOT members were not aware of their roles and responsibilities in their respective water supply schemes, though about 63% of the BOT members indicated that they were trained and organised to perform their roles and responsibilities.

Effective participation of BOT members is a key for achieving sustainability but in this study it was identified that there was lack of participation of BOT members during meetings. The BOT members attended meetings occasionally and rarely contributed on important issues affecting their schemes. Lack of capacity came up in this study as one of the factors affecting water supply sustainability. The study found that the majority of BOT members (58%) agreed with the statement that they did not have the capacities to manage water supply schemes. On the contrary, the majority of BOT members (75%) indicated that LUOs have the capacities to manage water supply schemes. Furthermore, the WUAs are unable to collect enough revenue to cover O & M costs due to lack of effective cost recovery and revenue collection strategies. The study found out that there is existence of conflicts amongst WUA governance structure due to lack of transparency and accountability on the part of WUA Board which negatively affects the sustainability of water supply schemes.

Overall, the concept of WUA management model being rolled out wholesome to piped water supply schemes without considering the environmental dynamics within communities seems not to work in Chikwawa District. The challenges faced in MFWUA were quite different from EBWUA hence requiring different types of management to achieve sustainability.

5.3 Recommendations

In order to counter the challenges that deter the sustainability of community-managed piped water supply schemes as a result of the factors identified in this study, it is prudent that different stakeholders play a role in ensuring that these vulnerable water supply schemes are sustainable.

This section therefore has suggested a number of recommendations for considerations by a number of stakeholders. These recommendations have been derived from the literature review, research findings and best practices from countries within the sub-Saharan Region.

5.3.1 Recommendations for the Government of Malawi

- ✓ One of the factors affecting functionality of water supply schemes is the degradation of water resources attributed by increased pressure on environment around the catchment of the rivers supplying water to the water supply schemes in Chikwawa District. These rivers originate from Thyolo Mountain and the communities around the mountain do not directly benefit from the water supply schemes hence carrying out a lot of activities. These activities include farming on marginal lands, gathering of fuel wood and production of charcoal that affect water quality and availability. Therefore, the Government of Malawi should engage officials from both Thyolo and Chikwawa District Councils on the need to conserve environment for the sustainability of the water supply schemes. Therefore, government's understanding on catchment characteristics and activities potentially impacting on raw water quality and quantity is paramount to ensuring the sustainability of piped water supply schemes
- ✓ The size and complexity of water supply scheme affect sustainability of water supply scheme. The larger the water supply scheme, the more effort needed to ensure its sustainability. The Government of Malawi through Chikwawa District Council should split EBWUA into two other WUAs to ensure sustainability.

5.3.2 Recommendations for the District Council

- ✓ Lack of capacity by the BOT members to undertake the management of their water supply schemes dominated the factors affecting the sustainability. The District Council through DWDO should monitor and give guidance on the management of water supply schemes after commissioning and provide capacity building trainings to BOT members. This would improve both operational and financial management of the water supply schemes.
- ✓ From the findings of this study, it was noted that there was lack of ownership amongst water users. Therefore, the district council should take a leading role in ensuring that WUAs are monitored on their performance since the ownership of all the water supply scheme's assets are under the district councils on behalf of water users.

5.3.3 Recommendations for the WUA Board

- ✓ It has been noted that there is lack of transparency and accountability in the water supply schemes understudy. Therefore, there is need to establish an independent committee of the General assembly to audit accounts in the WUA as per the structure in section 2.5.2
- ✓ It was clear from this study that water users were reluctant to pay user fees because they were not satisfied with the services rendered. Therefore, it is recommended that WUA Board should set performance targets for LUOs and when setting water tariffs, consultations should be done with the General Assembly members who are the representatives of the water users. The tariff should be set equitably so that water users can afford paying for water supplied in line with cost recovery strategy.
- ✓ The study further showed that the WUA Board gave no attention to operations and maintenance of the water supply system preferring extension of pipeline to cater for new water users. Therefore, the WUA Board should prioritise preventive maintenance on the existing water supply infrastructure in order to improve on functionality of point of use units in the water supply schemes.
- ✓ Longer distances between where the committee members reside and where meetings are held affect the level of attendance of meetings. In this study, most of committee members attended meetings occasionally affecting the sustainability of water supply schemes. Therefore, incentives should be introduced covering transport and lunch expenses in order to encourage members to attend meetings regularly.

- ✓ Both LUOs from MFWSS and EBWSS resigned during the study period such that the WUAs were operating without LUOs. The study established that the adequacies of LUOs to manage water supply schemes enhance sustainability of water supply schemes. Therefore, the WUA Boards are encouraged to engage LUOs for the supply schemes to function effectively.

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APPENDICES

Appendix 1: Household Questionnaire

Title: Factors Affecting the Sustainability of Community Managed Piped Water Supply Schemes in Chikwawa District

I am a student at the University of Malawi currently pursuing a Masters Degree in Water Resources and Supply Management at the University of Malawi, and conducting a research project as part of my academic requirement as per the captioned title above,

You are randomly selected and requested to participate in the study by answering the questions overleaf as honestly as possible. This questionnaire attempts to collect information pertaining to factors affecting the sustainability of community managed rural piped water supply schemes in Chikwawa District.

Your cooperation in answering the questions to the best of your knowledge would be greatly appreciated.

Thanking you in advance.

Researcher: Arthur Hepeni

QUESTIONS

DATE OF ADMINISTRATION.....

SECTION A: HOUSEHOLD PROFILE

A1. What is your gender?

Male	1
Female	2

A2. What is your age group?

10 – 20 years	1
21 – 30	2
31 – 40	3
41 – 50	4
Over 50	5

A3. What is your status in the household?

Household Head	1
Spouse	2
Child	3
Other, Please specify.....	4

A4. Have you attended school? If No go to A6

Yes	1
No	2

A5. What is your highest level of education?

Some primary school	1
Completed primary school	2
Some secondary school	3
Completed Form 4	4
Tertiary.....	5

A6. How many people live in your household?

1 – 3	1
4 – 6	2
7 – 9	3
More than 9	4

A7. What is your main occupation?

Farmer	1
Housewife	2
Student	3
Salaried Worker	4
Businessperson	5
Other, Please specify.....	6

A8. What is your present marital status?

Married	1
Divorced	2
Widow	3
Widower	4
Single	5
Other, Please specify.....	6

A9. What is your estimated monthly household income?

Less than MK5,000.00	1
5,001.00 – 10,000.00	2
10,001.00 – 15,000.00	3
15,001.00 – 20,000.00	4
20,001.00 – 25,000.00	5
Above MK 25,000.00	6

A 10. What is your estimated monthly water tariff (bill)?

Less than MK100.00	1
100.00 – 500.00	2
501.00 – 1,000.00	3
1,001.00 – 3,000.00	4
3,001.00 – 5,000.00	5
Above MK 5,000.00	6

SECTION B: SAFE WATER SUPPLY, ACCESS AND ITS IMPORTANCE TO HOUSEHOLD HEALTH

B1. What is the name of water supply scheme in which you are a water user?

.....

B2. How many years have you lived in this community?

Less than 1 year	1
Between 1 and 5 Years	2
Between 5 and 10 Years	3
More than 10 years	4

B3. How many years have you been a water user?

Less than 1 year	1
Between 1 and 5 Years	2
Between 5 and 10 Years	3
More than 10 years	4

B4. What was your main source of water before commissioning of the water supply scheme?

Borehole/deep well	1
Shallow well	2
Protected spring	3
Unprotected source (open well, stream, irrigation canal, river)	4
Other, Please specify.....	5

B5. What is the main source of water that you use for your household?

In-house water connection	1
Yard tap	2
Communal tap	3

B6. Is the water supplied to your household metered?

Yes	1
No	2

B7. If the answer to question B6 is “yes” what is your monthly consumption in kilolitres?

1 – 10	1
11 – 20	2
21 – 30	3
Above 30 kilolitres	4

B8. If the answer to question B6 is “no” what is your daily water usage on average in terms of number of jerry cans (20 litres) in your household?

1 – 5	1
6 – 10	2
11 – 15	3
16 – 20	4
Above 20	5

B9. Is the point of use unit convenient in terms of location?

Yes	1
No	2

B10. If the answer to question B8 is “no” why not convenient?

.....

B11. How far is the point of water use unit from your household?

Less than 10 metres	1
10m – 50m	2
51m – 100m	3
101m – 500m	4
501m – 1000m	5
Over 1000m	6

B12. What major challenges do you encounter with the point of use unit for your household?

None	1
Congestion of users	2
Too far from household	3
Hard/salty water	4
Irregular flow	5
Other, Please specify.....	6

B13. What is the major alternative source of water for your household?

Borehole/deep well	1
Shallow well	2
Protected spring	3
Unprotected source (open well, stream, irrigation canal, river)	4
Other, Please specify.....	5

B14. What is the reason for using the alternative water source?

Close to household	1
Good quality water	2
Free	3
Reliable water supply	4
Minimum congestion	5
Other, Please specify.....	6

B15. Who fetches water most of the time in the household?

Mother	1
Father	2
Girls	3
Boys	4
Labourers	5
Other, Please specify.....	6

B16. What kind of challenges affects constant supply of the water to the households?

Do not know	1
Breakage of pipes	2
Vandalism	3
Blockages of pipes	4
Breakdown of pumps	5
Other, Please specify.....	6

B17. With regards to monthly water tariff (bill), does your household afford to pay the water bills?

Yes	1
No	2

B18. With regards to the monthly bills, how do you rate the charges?

Not fair	1
Fair	2
Somewhat fair	3
Very fair	4
Other, Please specify.....	5

B19. What diseases do you know that are caused by water which is not safe?

Do not know	1
Diarrhoea	2
Dysentry	3
Bilharzia	4
Cholera	5
Worms	6

B20. What type of toilet do you use at your household?

None	1
Flushing toilet	2
VIP latrine	3
Pit latrine	4
Other, Please specify.....	5

SECTION C: WATER USER'S PERCEPTION ON WATER SERVICE DELIVERY

C1. What do you consider as the most important source of water in your household?

Borehole	1
Tap water	2
Shallow well	3
Protected spring	4
Unprotected source (open well, stream, irrigation canal, river)	5

C2. Is the water quantity provided by water service provider satisfying your daily domestic needs?

Yes	1
No	2

C3. If the answer to question C1 is "no" what alternatives do you use to meet your demand?

Fetch water from traditional sources	1
Minimise domestic water usage	2
Other, Please specify.....	3

C4. If the answer to question C2 is "traditional sources" For what purpose do you use the water?

Drinking	1
Cooking	2
Laundry (Clothes and utensils)	3
Personal hygiene	4
Other, Please specify.....	5

C5. How do feel about the water quality from the water service provider?

Poor	1
Bad	2
Fair	3
Good	4
Excellent	5

C6. If the answer to question C4 is “poor, bad, fair” what is the problem with the water quality?

Odour (smell)	1
Taste (Salty)	2
Colour	3
Hard (using a lot of soap)	4
Other, Please specify.....	5

C7. Is there seasonal variation of water supply at the point of use unit?

Yes	1
No	2

C8. If the answer is “yes” to question C6, what is the cause of this variation?

Pump breakdowns	1
Intake blockage	2
Reduced water flow at intake	3
Pipe breakdowns (washed away)	4
Other, Please specify.....	5

C9. For how long (hours) do you receive water from water service provider during dry season on daily basis?

1 – 6	1
7 – 12	2
13 – 18	3
19 – 24	4

C10. For how long (hours) do you receive water from water service provider during wet season on daily basis?

1 – 6	1
7 – 12	2
13 – 18	3
19 – 24	4

SECTION D: SENSE OF OWNERSHIP, PARTICIPATION AND SUSTAINABILITY OF WATER SUPPLY SCHEME

D1. Who funded the construction of the water supply scheme?

Do not know	1
Government	2
NGO (Name.....)	3
Individual (Name.....)	4
Other, Please specify.....	5

D2. At what level were you involved in the construction of the water supply scheme?

Planning	1
Design	2
Construction	3
Management	4
Other, Please specify.....	5

D3. What contribution did you make in the construction of the water supply scheme?

Money	1
Labour	2
Materials	3
Ideas	4
Other, Please specify.....	5

D4. Does your water supply scheme have a water user association committee?

Do not know	1
Yes	2
No	3

D5. Does your point of use point have a Water Point Committee (applicable for communal tap households)?

Not Applicable	1
Yes	2
No	3

D6. If the answer to question D4 is “yes”, who makes decisions about the water point?

Do not know	1
Men	2
Women	3
Men and Women	4
Children	5
Other, Please specify.....	6

D7. Who owns the water supply scheme?

Do not know	1
Government	2
NGO (Name.....)	3
Individual (Name.....)	4
Community	5
Other, Please specify.....	6

D8. Who manages the water supply scheme?

Do not know	1
Government	2
NGO (Name.....)	3
Individual (Name.....)	4
Community	5
Other, Please specify.....	6

D9. If you see a water pipe leaking within the water supply system, do you report the water leakage to the water service provider?

Sometimes	1
Yes	2
No	3

D10. Is your point of use unit functioning?

Yes	
No	

D11 In your opinion, do you consider your water supply scheme sustainable?

Yes	
No	

Appendix 2: Board of Trustees (BOT) Questionnaire

Title: Factors Affecting the Sustainability of Community Managed Piped Water Supply Schemes in Chikwawa District

I am a student at the University of Malawi currently pursuing a Masters Degree in Water Resources and Supply Management, and conducting a research project as part of my academic requirement as per the captioned title above,

You are selected and requested to participate in the study by answering the questions overleaf as honestly as possible. This questionnaire attempts to collect information pertaining to factors affecting the sustainability of community managed rural piped water supply schemes in Chikwawa District.

Your cooperation in answering the questions to the best of your knowledge would be greatly appreciated.

Thanking you in advance.

Researcher: Arthur Hepeni

QUESTIONS

DATE OF ADMINISTRATION......

SECTION A: MEMBER PROFILE

A1. Name of WUA in which you are a member? (Tick the appropriate box)

Miseu Folo	
East Bank	

A2. What is your gender? (Tick the appropriate box)

Male	
Female	

A3. What is your age group? (Tick the appropriate box)

20–30 years	
31 – 40	
41 – 50	
51 – 60	
Over 60	

A4. What is your highest level of education? (Tick the appropriate box)

Never attended school	
Read and write simple English	
Some secondary school	
Completed Form 4	
Tertiary.....	

A5. How long have you been a member?

Less than 1 year	
1 – 2 years	
3 – 4 years	
Above 5 years	

SECTION B: WATER SUPPLY MANAGEMENT AND PLANT OPERATION

B1. Are you a water user? (Tick the appropriate box)

Yes	
No	

B2. If answer to B1 is yes, is your point of use unit functioning?

Yes	
No	

B3. If you have a breakdown in water supply, how long does it take to repair it?

Less than 24 hours	
1 – 7 days	
1 week – 4 weeks	
1 month – 6 months	
More than 6 months	

B4. What action do you take as a member when a breakdown takes a long time to repair?

Nothing	
Raise it at a committee meeting	
Report the issue to operator	
Other, specify.....	

B5. What is your opinion on these statements?

Statement	**Agree**	**Disagree**	**Neutral**
a. Committee members do not have adequate technical, financial and management skills			
b. Well qualified and skilled utility operators are too expensive for community managed water supply schemes			
c. Utility operators are well qualified and skilled to handle technical, financial and management issues			

B6. Does the scheme prepare annual budgets?

Yes	
No	

B7. Do you expect any financial reward for undertaking community water management responsibilities?

Yes	
No	

B8. If the answer to B7 is yes, why do you expect the financial rewards for voluntary responsibilities?

Reimbursement of transport fee	
Repayment for money used to have lunch	
Payment for attending meetings	
Other, specify.....	

B9. Do you have rules and regulations for your water supply scheme?

Yes	
No	

B10. Who enforces the rules and regulation in your water supply scheme?

Local Utility Operator	
Management committee	
Other, specify.....	

SECTION C: FINANCIAL MANAGEMENT AND TRANSPARENCY

C1. Do you have special criteria for tariff setting and how do you know if the tariff is appropriate?

.....

C2. How do the monthly contributions for water fee collected?

Water management committee	
Utility Operator	
Other, specify.....	

C3. Do those collecting monthly contributions issue receipts to the water user?

Yes	
No	

C4. Do you keep records for money collected and expended?

Yes	
No	

C5. What kind of financial records do you keep?

Bank statements	
Cash book	
Other, specify.....	

C6. How long does it take to collect monthly contribution upon being due?

When it is due	
30 days	
60 days	
Other, specify.....	

C7. Do you have incentives for timely payment and penalties for late payment of monthly contribution fee?

Yes	
No	

C8. Have you adjusted your tariff lately?

Yes	
No	

C9. When was the last time you revised your water tariff?

.....

C10. Do you audit your water supply scheme's financial accounts?

Yes	
No	

SECTION D: WATER SUPPLY SCHEME SUSTAINABILITY

D1. What are your roles and responsibilities as a management water committee member?

.....
.....
.....
.....

D2. In your opinion, what other roles and responsibilities do you indulge yourself as committee members which are not your roles or responsibilities?

.....
.....
.....

D3. Have you ever been trained in relation to your roles and responsibilities?

Yes	
No	

D4. If your answer to question D3 is yes, what did your training cover?

.....
.....
.....

D5. Do conflicts exist amongst committee members?

Yes	
No	

D6. Who resolves the conflicts amongst committee members?

Local Utility Operator	
Committee members	
District Council	
Other, specify.....	

D7. Is the committee functioning well with all the members active?

Yes	
No	

D8. How often do you attend meetings?

Regularly	
Occasionally	
Never attended	

D9. How often do meetings take place?

Monthly	
Quarterly	
Biannually	
Annually	

D10. Have you made suggestion or influenced any decision during your meetings?

Yes	
No	

D11. On what issue have you made suggestion or influenced decision?

Technical issue	
Administrative issue	
Financial issue	
Other, specify.....	

D12. Do you feel satisfied with the management of water services in the scheme by the current committee members?

Yes	
No	

D13. Is the current tariff setting meeting your expectations and if not why?

....

D14. In your opinion, do you consider your water supply scheme sustainable?

Yes	
No	

D15. In your opinion, what are the perceived barriers to achieving sustainability of your water supply scheme (Please, list them in order of their importance)?

.....
.....
.....
.....
.....
.....
.....
.....
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.....

Appendix 3: Question Guide for Local Utility Operator, General Assembly and Individual Interviews

1. Who chose you a water committee member for the water supply scheme?
2. Did you get training after being chosen?
3. For how long was the training and what was the aim of the training?
4. How many villages are within the water supply scheme and name them?
5. Do you have members of the committees whose villages are not within the supply scheme, if yes, name the villages?
6. Who chose the technology being used by the water supply scheme?
7. Are all members of either board of trustees or general assembly water users of the water supply scheme and if not, how many are water users of the water supply scheme?
8. How many members are in the general assembly and out of these how many are women?
9. How many members are in the board of trustees and out of these how many are women?
10. Do you have special criteria for tariff setting and how do you know if the tariff is appropriate?
11. How do the contribution of water fee per month collected?
12. Do you have a Bank Account?
13. Who are the bank signatories and who selected them?
14. What were the selection criteria?
15. What are the major problems faced by your water supply scheme?
16. Do you have rules and regulations for your water supply scheme?
17. Has your water supply scheme been registered as water users association and if not, why?
18. Have you been at the intake of the water supply scheme?
19. What activities are undertaken at the intake?
20. What are the benefits for improved water source?
21. Do you consider your water supply scheme sustainable?

Appendix 4: Checklist for Observation

- Intake (Source)
    - Cleanliness of the source
    - Evidence of deforestation
    - Quality of construction/maintenance
- Transmission
    - Type and quality of materials used
    - Exposed pipelines
    - Leakages
- Treatment
    - Quality of works and equipment installed
    - Presence of testing equipment
- Storage tanks
    - Leaking tanks
    - Quality of construction/maintenance
- Distribution
    - Type and quality of materials used
    - Exposed pipelines
    - Presence of air valves
    - Presence of line valves
    - Leakages
- Point of use
    - Leaking taps
    - Exposed service pipelines
    - Leaking service pipelines
    - Functionality of point of use