DETERMINANTS OF ADOPTION OF LIFESTRAW FAMILY WATER TREATMENT METHOD IN MATAYOS DIVISION, BUSIA COUNTY, KENYA.

BY

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DECLARATION

The research project is my original work and has not been presented for any degree in any other University

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This work is dedicated to my dear mother Alice Obara and my late father Cleophas Adhaya Obange.

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Abstract

Waterborne diseases remain a serious health crisis in many parts of the world particularly in the developing world where diarrhoeal diseases are major contributor to deaths especially for the children under the age of five years. The World Health Organization estimates that 1.7 million deaths attributed to diarrhoea globally could be prevented by improvements in the drinking water quality, sanitation and hygiene. In Kenya waterborne disease continue to be a major health problem with cases of cholera witnessed in different parts of the country over the years. LifeStraw family is a household based water treatment intervention that has been demonstrated as effective in removing microbiological organisms and particulate matter from water thereby providing quality drinking water. Large scale use of LifeStraw in Kenya was introduced in 2011 courtesy of Carbon-for-Water program; a private-public partnership between Vestergaard Africa Limited and the Kenyan Government. This study sought to establish the determinants of adoption of LifeStraw family water treatment method in Matayos division, Busia County, Kenya. The study was guided by the following objectives; 1) to determine the extent to which capacity building influences adoption of LifeStraw family water treatment method at household level, 2) to establish how water source determines adoption of LifeStraw family water treatment method at household level, 3) to assess the degree to which the cost of water treatment determines adoption of LifeStraw family water treatment method at household level and 4) to examine how the alternative water treatment methods affect adoption of LifeStraw family water treatment method at household level. The researcher employed descriptive survey study design, using quantitative and qualitative techniques of collecting information. Structured and key informant questionnaires were used to collate quantitative and qualitative data respectively. The researcher worked with a sample size of 384 households out of a target population of 13,101. Stratified random sampling based on the five locations of Matayos division and systematic sampling based on the household barcodes was employed to obtain the sample households. Data was analyzed using descriptive statistics and the results were recorded in the form of frequency tables, percentages, mean and standard deviation. Based on the analysis of data and the discussions, the following were the key findings of the study. For the case of objective 1) Capacity building influenced adoption of LifeStraw family water treatment method to a great extent. Similarly, household sensitization was an effective approach in disseminating LifeStraw information and its adoption in Matayos division. On objective 2) Quality of water at the source determined the adoption of LifeStraw family water treatment method. On objective 3) Cost of water treatment was a key factor in the choice and adoption of LifeStraw family water treatment method. 4) The alternative water treatment method affected the extent to which LifeStraw family water treatment method was adopted. From these findings the study recommends that; 1) Water, Sanitation and Hygiene stakeholders should develop appropriate health behaviour change messages with special focus on benefits of water treatment to increase uptake and sustained adoption of household water treatment methods. 2) The ministries of Health and Water should regularly undertake quality assessment on all water sources to ensure the safety of water at the source. 3) The ministry of water should explore ways and means of providing clean and safe water for all citizens in line with the UN convention on water. 4) Vestergaard Africa Limited should explore further improvements on LifeStraw family filter to enhance its capacity and efficiency. Suggestion for further studies: 1) Replication of the study in another sub county, 2) The sustainability of adoption of LifeStraw family water treatment method in Western part of Kenya, and 3) Correlation study on adoption of LifeStraw family water treatment method and the prevalence of waterborne diseases.

ABBREVIATIONS AND ACRONYMS

AIDS:	Acquired Immunodeficiency Syndrome.
BSF:	Bio sand Filter.
C4W:	Carbon-for-Water.
CAWST:	Centre for Affordable Water and sanitation Technology.
CDC:	Centre for Disease Control and Prevention
CHEWs:	Community Health Extension Workers.
CHVs:	Community Health Volunteers.
CRS:	Catholic Relief Services.
DBP:	Disinfection by-product.
DOI:	Diffusion of Innovation
EAWAG:	Swiss Federal Institute of Environmental Science and Technology
FAO:	Food and Agriculture Organization.
HBM:	Health Belief Model.
HRD:	Human Resource Development.
HWTS:	Household Water Treatment and Safe Storage.
IARC:	International Agency for Research on Cancer
ICROSS:	International Community for the of Starvation and suffering.
IFRC:	International Federation of Red Cross and Red Crescent Societies.
INRESA:	Integrated Rural Energy Systems Association.
JMP:	WHO/UNICEF Joint Monitoring Program.
KDHS:	Kenya Demographic and Health Survey.
KWAHO:	Kenya Water for Health Organization
LSF:	Lifestraw Family.
LVNWSB:	Lake Victoria North Water Services Board.
MDGs:	Millennium Development Goals.

MWCO:	Molecular weight Cut-off.
NF:	Nano-filtration.
NGO:	Non-Governmental Organization.
POU:	Point-of-use
RADWQ:	Rapid Assessment of Drinking Water Quality.
RO:	Reverse Osmosis.
SANDEC:	Swiss Department of Water and Sanitation in developing Countries.
SDGs:	Sustainable Development Goals.
SODIS:	Solar Disinfection.
SPSS:	Statistical Package for Social Sciences.
SSA:	Sub-Saharan Africa.
TTC:	Thermotolerant Coliforms.
UF:	Ultra filtration.
UN:	United Nations
UNDP:	United Nations Development Program.
UNGA:	United Nations General Assembly
UNICEF:	United Nations Children's Fund.
UNW-DPC):	United Nation Water Decade Program on Capacity Development.
EPA:	Environmental Protection Agency
UV:	Ultraviolet light
VAL:	Vestergaard Africa Limited.
WASH:	Water, Sanitation and Hygiene
WHO:	World Health Organization.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Safe drinking water is a basic entitlement to human life and is a key factor in determining quality of human health. Provision of quality drinking water is an effective strategy in the prevention and control of waterborne diseases and a valuable approach to reducing burden of diarrhoeal diseases resulting from poor quality drinking water (WHO, 2012). Throughout history quality water for domestic use and water for Livelihood have been among the major determinants of human development (UNDP, 2006)

The Millennium Development Goal 7c was a commitment by the world to reduce by half the number of peoples with limited access to safe water and sanitation. Although the Millenium target for water was achieved in 2010 well before the timeline of 2015, a towering 783 million people remained without access to safe water (UNICEF/WHO, 2010) while glaring differences were evident within and among countries (UNICEF/WHO, 2014).

Globally, poor quality drinking water is a major cause of escalating burden of diarrhoeal diseases, especially among the infants, the poor and people with low immunity. Annually, twenty percent of infant deaths are attributed to diarrhoea. This situation is dire in the less privileged regions of the world such as Sub-Saharan Africa where an estimated 40% of the population still relies on unimproved sources to meet their drinking water needs (UNICEF/WHO, 2012).

Provision of safe drinking water is a critical mandate of governments’ worldwide, failure of which results in massive use of labour, negative health impact and constraints in economic development (Gleick, 1995). The world Health Organization and United Nations Children

Fund (WHO/UNICEF, 2000), recognize investment in safe water supply and proper sanitation as key factors in poverty reduction and economic development.

Globally, safe water coverage varies from region to region. In the United States of America (USA) water quality is governed by state and federal laws which ensure that drinking water quality is in compliance with Environmental Protection (EPA) guidelines. Drinking water quality in the US is thus reliable and over Ninety percent of the water supply meet EPA criteria of quality.

In the European region, there exist glaring discrepancies between the east and the west. Whereas close to every household has got access to safe water supply in the western part, the situation in the eastern part although improving remained low (average 65%). WHO and UNICEF in a Joint Monitoring Program (JMP, 2012) reported disparities of 30-40% in the coverage between urban and rural areas. Some of the countries in this region like the United Kingdom are ranked among the best in the world in terms of drinking water quality as a result of its strict compliance with EU Drinking water Protocol (98/83/EC) and WHO standards.

Latin America which is considered to have the highest fresh water availability per person in the world is not spared as 77 million people constituting 15% of the population had no sustainable access to safe water and as is the case in other regions, variations existed between urban and rural populations with only 38% of the total rural population having access to safe drinking water within the homes, compared to 87% of the urban population (Soares *et al., 2002*)

Asian region has been on record for making tremendous achievement in providing its population with reliable access to safe water supply in only two decades (1990-2010), during which period a significant 758 million people were reported to have gained access (Watch, 2005). However there was evidence of contamination with feacal matter among some sources. The evidence of this is best elaborated in the case of India where 37.7 million are affected by water related diseases, approximately 1.5 million children die annually, 73 million working hours lost with a corresponding economic burden of Sterling pounds 600million per annum (Khurana & Sen, 2008).

Africa was categorized among regions that were unlikely to achieve the MDG water target as only 40% of its population had access to improved sources of drinking water (JMP, 2014). The crisis of safe water in Africa is more acute in the Sub-Saharan (SSA) region where only 64% of the population was reported to have achieved access. In the Northern and Southern parts of the continent, however, there were remarkable progresses represented by 92% and 94% safe water coverage respectively.

In Kenya 63% of households draw their drinking water from improved sources while only forty five (45%) of households treat their drinking water (boiling 27%, chlorination 17%, Filtration 1%). Differences, however, exist with more households in urban (57%) treating their water compared to (40%) in the rural (KDHS 2008-09).

While 81.6% of water points in Busia County fall under “improved source”, only 55% of the improved water sources supply safe water (LVNWSB 2012). Wright et al. (2004) observed that improved water source often does not guarantee safe water and emphasized on the need for safe handling and storage at Point-of-use, while Opisa *et al*, (2012) revealed that pit latrines were a major source of fecal contamination of the wells.

In Kenya large scale use of membrane technology as household water treatment method was introduced in 2011 courtesy of Lifestraw Carbon-for-water (C4W) program; a private-public partnership between Vestergaard Africa Ltd (VAL) and Kenyan government. Through this partnership approximately 900,000 households in the former western province of Kenya received LifeStraw Family filters. LifeStraw Family household based water filter that uses hollow fibres technology capable of removing virtually all (99.99%) of bacteria, protozoan parasites and viruses found in water and clears turbidity by filtering particles that exceed 0.02 microns. LSF is also effective against Cryptosporidium and Giardia the two protozoa parasites resistant to chlorination and recently found to be a major cause of mortality in infants and people with compromised immunity (Kotloff *et al*., 2013.)

1.2 Statement of the problem

Improvements in the quality of drinking water and sanitation alone could prevent up to 6.3% of annual deaths and contribute to lowering the global burden of disease by 10% (Pruss-Ustun., 2008). World Health Organization recognizes diarrhoea as a major contributor to the burden of disease emanating from poor quality drinking water, sanitation and hygiene and further attributes 1.9 million deaths of children under five annually to diarrhoea (Bosch-Pinto *et al*., 2008). Household water treatment interventions such as LifeStraw family have been demonstrated as effective in improving quality of drinking water and reducing the burden of diarrhoeal diseases in users and is one of the interventions adopted by UNICEF and WHO in 2009 for management of diarrhoea.

Although Kenya boast of having an elaborate health policies with a strong focus on provision of quality health care services, these policies have not significantly translated into transforming the health status of the citizens affected by poverty and ill health in Matayos Division of Busia County.

Matayos Sub-County Annual Health report (2014) indicated that diarrhoeal diseases were among the major causes of morbidity in the division. This situation prevailed against an entrenched public health “level one community strategy” spearheaded by grass root health providers namely; Community Health Extension Workers (CHEWs) and Community Health Volunteers (CHVs) who visit households regularly to deliver preventive health messages including safe water interventions. Supplementing government efforts are a number of NGOs both local and international implementing Water, Sanitation & Hygiene (WASH) programs.

Whereas HWTS has been established to substantially improve drinking water quality at the point of use (Ngai & Fenner, 2014), the use of LifeStraw family method in Matayos division has not significantly translated to reduction in morbidity and mortality attributed to waterborne diseases. From the foregoing it is clear that households are not correctly and effectively adopting the proposed interventions and that the approaches implemented by the safe water promoters are not effective.

1.3 Purpose of the study

This study sought to establish the determinants of adoption of LifeStraw family water treatment method at household level in Matayos division, Busia County, Kenya.

1.4 Objectives of the study

The study was guided by the following objectives;

1. To determine the extent to which capacity building influences adoption of LifeStraw family water treatment method at household level in Matayos division, Busia County, Kenya

2. To establish how water source determine adoption of LifeStraw family water treatment method at household level in Matayos division, Busia County, Kenya

3. To assess the degree to which the cost of water treatment determine adoption of LifeStraw family water treatment method at household level in Matayos division, Busia County, Kenya

4. To examine how the alternative water treatment methods determine adoption of LifeStraw family water treatment method at household level in Matayos division, Busia County, Kenya

1.5 Research Questions

1 To what extent does capacity building influence adoption of Lifestraw family water treatment method at household level in Matayos division, Busia County, Kenya?

2 How does the water source determine adoption of Lifestraw family water treatment method at household level in Matayos division, Busia County, Kenya?

3 To what degree does the cost of water treatment determine the adoption of Lifestraw family water treatment method at household level in Matayos division, Busia County, Kenya?

4 How do alternative water treatment methods affect adoption of Lifestraw family water treatment method at the household level in Matayos division?

1.6 Significance of the study

The results of this study will provide additional insight on how grass root WASH program providers can improve interventions and implementation approaches to scale up uptake and sustained use of LifeStraw family water treatment method.

The researcher anticipated that the findings will be relevant and appropriate to safe water stakeholders including Vestergaard Africa Limited (VAL), the manufacturers and promoters of Lifestraw Family Filters, in refining behavior change communication approaches and messaging to households.

The researcher envisaged that the outcome of this study will provide additional input to the policy and decision makers both at the National level and the County Government of Busia in further understanding the underlying factors of health behavior hence contribute towards developing appropriate and effective household water treatment interventions.

The study will contribute to the body of knowledge by either confirming or rejecting existing knowledge hence pave way for further studies on the subject of determinants of technology adoption.

1.7 Basic Assumptions of the study

The study was premised on the assumption that water from natural and improved sources in Matayos division is unsafe for human consumption and has to be treated in some way to make it safe for drinking. The study also assumed that the sample size chosen was representative of the target population and that household members who were interviewed provided honest, accurate and unbiased information. The study further assumed that the households that were provided with Lifestraw family filters would still be maintaining them in good working condition**.**

1.8 Limitation of the study

The study was carried out during the crop season when most families were away from home attending to their crops in the field. Since it was most convenient to administer the questionnaires to respondents at home, the researcher developed a “call back form” which the interviewers left behind to absent households indicating when they would return to carry out the interview. As was anticipated, wet weather was experienced during data collection constrained access due to muddy roads. The challenge was however, addressed by extending the time for data collection by one extra day.

1.9 Delimitation of the study

The study was carried out in the five locations of Matayos division (Bukhayo West, Busibwabo, Nasewa, Lwanya and Nangoma) situated 4 – 24 km East of Busia town. Matayos was chosen because it is one of the divisions where households were provided with Lifestraw family filters in 2011 and that a greater part of the division is rural and majority of the households draw water from natural/improved sources. The study was also delimited to households that received Lifestraw family filters courtesy of Vestergaard Africa Limited. Finally, the study was confined only to household water treatment methods.

1.10 Definition of significant terms used in the study

Capacity building: Enhancing knowledge and skills base of an individual to enable him/her make informed decision and take appropriate action.

Household: Person (s) living together and sharing a common cooking point.

Adoption: Correct and consistent use of household water treatment method(s).

Lifestraw family filter: Microbiological water filter provided to households in the former Western Province by Vestergaard Africa Limited.

Alternative water treatment: Water treatment methods used by households in Matayos division other than Lifestraw family filter.

Cost of water treatment: Refers to amount of money or time spent by households in preparing safe water for drinking.

Water source: A water body or water point from where households collect water for use at home or at the household.

Household water treatment methods: Refers to processes employed to make water safe for drinking at household level.

1.11 Organization of the study

The research proposal was organized into five chapters. Chapter one highlights the background of the study, statement of the research problem, purpose of the study, objectives of the study, research questions, significance of the study, assumptions, limitation, delimitations and definitions of significant terms used in the study. Chapter two provides literature review related to the concept of Household Water Treatment and Safe Storage (HWTS); capacity building, water sources, cost of water treatment and alternative household water treatment methods. This chapter further reviews the theoretical and conceptual framework which highlights the interplay of the variables of the study and chapter three describes the methodology that was applied to collect, process and analyze data. This included the research design, target population, sample and sampling procedures, research instruments, validity and reliability of the instrument, data collection procedures and data analysis techniques. Chapter four provides the research findings which have been discussed under thematic sub-sections in line with the study objectives. Chapter five is a summary of key findings, conclusions, recommendations and contribution to body of knowledge.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed literature on past relevant research results on drinking water safety, efforts being employed to ensure access as well as the consequences of lack of it. The section begins by examining the concept of HWTS and its significance in improving drinking water quality at household level. The section further examines past literature on the various themes of the study namely; capacity building, water source, cost of water treatment and alternative water treatment methods and their influence on the choice of treatment intervention at household level. This section further explains the theoretical framework on which the study is anchored as well as the conceptual framework which presents the interplay between independent variables, dependent variable and intervening variable.

2.2 The concept of household water treatment method

Water related diseases continue to be a major health problem worldwide. Waterborne diseases emanating from poor drinking water quality, sanitation and hygiene cause an estimated 1.7 million deaths annually (Ashbolt, 2004; WHO, 2012), majority of whom are children under the age of five years in the developing countries (Kosek, *et al.*, 2003). Unsafe drinking water, sanitation and hygiene contribute to 88% of diarrhoeal diseases globally (WHO, 2003), a situation that exacerbates the already dire health conditions considering that 1.1 billion people worldwide still have no sustainable access to quality drinking water (Kindhauser, 2003).

The United Nations General Assembly (UNGA) and The United Nations Human Rights Council through resolutions RES/64/292/of 2010 and RES/A/HRC/15/L.14, respectively recognize the right to water as a fundamental human right and further acknowledges the entitlement of everyone to clean and safe water;, that is sufficient, accessible, affordable and acceptable, a position that is acknowledged by regional declarations notably; The Council of Europe, Asia-Pacific leaders (2007) and the first Africa South America Summit in Abuja (2006).

The achievement of MDG water target in 2012 well before the timeline of 2015 was commendable global effort. However, although this development represented an important breakthrough in the pursuit of the MGDs, an estimated 748 of the world population mostly the poor and marginalized still depended on unimproved sources for their domestic water. Recognizing the trend, WHO projected that there will be approximately 547 million people without access to improved water source beyond 2015 (WHO/UNICEF, 2014).

Commendable efforts have been made world over to improve water sources as a means of ensuring access to safe drinking water for communities particularly in the developing world. Contrary to the belief that improving water source is an assurance of drinking water quality, a growing body of research has shown that improved water source alone does not necessarily guarantee the quality of water (Lim, *et al*., 2012). Working on microbial quality of improved water source in South Eastern Asia, Godfrey, *et al*., (2011) and Bain, (2012), disapproved the assumption that improving the water source reliably results in water that is free from microbial organisms.

In another study Wright et al, (2003) demonstrated that microbial quality of water in buckets at the homes was lower than that at the source. Yet in another study Crampton (2005) found that the handling processes, subject water to contamination between collection and consumption. Based on these developments, (Trevett et al., 2005) in a study carried out in Honduras on post-supply water quality, demonstrated that use of hands, dipping of cups, containers used for water collection and storage as well as bio-film formation on the surfaces of water containers were major causes of contamination.

The above studies point to the fact that improving the water source on its own cannot be a reliable way of predicting the safety of water and points to the need of treating water at the household, also referred to as Point-of–use water treatment. HWTS has been demonstrated as more effective intervention in ensuring safe water at the household than the conventional improvement of the water sources (Sobsey, 2002).

HWTS eliminate contaminations associated with processes during collection and transportation of water as recontamination is considerably minimized considering that treatment is done at the point of use. This position has been affirmed by Fewtrell and colleagues (2005) who reported that HWTS was associated with 35% decrease in prevalence of diarrhoea compared to 11% for conventional interventions. A Cochrane review involving 53,000 people in 19 countries found HWTS twice as effective (47%) in controlling diarrhea that improved well (27%) (Clasen, 2006).

Effective implementation of HWTS together with scale-up have the potential of accelerating progress towards realizing universal access to quality drinking, consequently impacting positively on lowering global disease burden. While several HWTS interventions exist (chlorination, filtration, boiling, Solar disinfection, flocculation & disinfection), water filters such as LifeStraw have produced best results in prevention and control of diarrhoeal diseases (Clasen, *et al*., 2006). HWTS is not only effective in removing microbial organisms and reducing incidences of diarrhoea but also cost effective and an ideal option for the under privileged households.

Until every home is reached by pipe water supply, HWTS remains an essential alternative intervention for populations without access to safe drinking water. In spite of being lauded as effective in improving drinking water quality, the health benefits of any HWTS is depended on its acceptance and sustained use by the households. A study carried out in Kakamega (Kioko et al., 2012) noted that people's awareness of water treatment methods does not guarantee that they will use them. The study revealed serious misconception by the community about drinking water safety. Majority (42%) of the households used clarity as a measure of safety while the other 24%, 15%, 3%, 8% used taste, turbidity, temperature, information about the source, and smell respectively as measure of water safety.

LifeStraw Family 1.0 water purifier is a fairly modern water treatment intervention introduced in Kenya 2011. The filter uses hollow fibre technology which has the potential of eliminating virtually all microbial organisms (99.99%) and particulate matter larger than 0.02micron thereby ensuring access to clean and safe water at the point of use. According to the manufacture the filter has the potential of filtering up to 18,000 Litres of safe water enough to supply a family of 5 with clean drinking water for 3-5 years. Independent laboratory tests have confirmed that LifeStraw family filter meets criteria for "highly protective" category of safe water interventions by WHO (www.lifestraw.com)

2.3 Capacity building and adoption of LifeStraw family water treatment

Capacity building is a term widely used in development circles to mean different things to different people and has been lauded and maligned in equal measure. While some people have applauded it as the precursor of efficiency and effectiveness and the foundation of sustainable development, others have criticized it for ambiguity, and a drawback to self ambition and creativity.

To understand capacity building one needs to look at the word “capacity” on its own prior to collating it with building. While capacity refers to knowledge, skills and the confidence to undertake appropriate decisions and implement tasks satisfactorily, capacity building refer to the process of acquiring the knowledge and skills. The proverb “give a man fish and you feed him for today, teach a man to fish and you have fed him for a lifetime “is a statement widely used to emphasize the significance of capacity building.

The term capacity building has been conceived differently by different organization. The United Nations Development Program (UNDP) looks at capacity building as a continuous engagement and learning of stakeholders. Catholic Relief Services (CRS) on the other hand describe capacity building as ongoing undertaking that empowers individual or organisations to address their development needs. The Food and Agriculture Organization (FAO), considers capacity building as an essential component of development without which the success of projects is jeopardized.

Water education and capacity building are key elements in providing relevant competence required to meet prevailing water challenges, and as such are essential components of any meaningful strategy towards sustainable development. While technical solutions are of great importance for development and need to be further explored, United Nations Water Decade Program on Capacity Development (NW-DPC) observed that technical solutions alone in the absence of education and capacity development, have often failed to lead to lasting and sustainable changes (UNW-DPC 2015).

Working on Biosand water filters in Rural India (Ngai & Fenner, 2014) concluded that creating awareness to communities on the benefits’ of quality drinking water together with regular community outreaches contributed significantly to the effective use of the filters. In an independent study involving 1470 water sources in 570 communities in Ghana involving

World Vision Projects, the University of North Carolina Water Institute noted that approximately 80% of the wells sustained active operations after 20 years largely as a result of World Vision capacity building strategies and strong community involvement. In Tanzania World Vision capacity building intervention using “Appreciative Inquiry” approach has been credited for building community capacity upon the foundation of community own capability and aspiration and is considered one of the key factors in the success of community water projects (Booy & Seroney, 1998).

Similarly, the significance of capacity building is clearly demonstrated in the Kenyan Program interventions. During the period October 2012 to March 2013 alone World Vision Kenya Program; is reported to have established and trained 156 WASH Committees on facilities operation and Management, members of 124 communities on pump maintenance and repair, 535 schools and residents of 1,414 communities on safe water handling, storage, and use as well as establishing 232 school WASH clubs to spearhead school sanitation and hygiene programs. “These resulted in water that continues to flow long after our work” concludes World Vision.

Development Practitioners world over acknowledge that poor people are the most valuable asset in their development, and therefore shouldn’t be perceived as mere beneficiaries (Gillespie, 2004). Active involvement of a community in project planning and implementation is the foundation of success in community based development projects. Therefore, presenting ready-made programs to communities always do not yield sustainable results because communities tend to adopt initiatives that build on their knowledge and aspirations (Mansuri & Rao 2004).

Adoption of HWTS is a matter that requires understanding of the factors underlying health behaviour. Meierhofer and Landolt (2009) observed that several factors namely; social, economic and institutional influenced the adoption of HWTS. Other studies have shown that use of multimedia approach was much more effective in creating interest around water treatment and this could bring about greater awareness to the populace on matters water. Mobilizing community groups and institutions on water treatment enhances knowledge and confidence of the people on the intervention and helps clarify false impression.

Whereas HWTS has been demonstrated as effective in ensuring safe water at the household, no single intervention can be considered superior, but the suitability of any one method is depended on the consumer environment and preferences (Lantagne *et al*., 2009). Consequently, it is prudent that organizations involved in HWTS should understand the determinants of adoption behaviour of innovation and the interplay between them for better management of the programs.

2.4 Water source and adoption of LifeStraw family water treatment.

The amount of water available globally is estimated at 43,750 km^3/year with America owning the largest share of this water (45%) followed by Asia (28%) and Europe (15.5%). Africa with (9%) has the least share. Similarly, America at 24,000 m^3 fresh water availability per person per year leads the other continents followed by Europe 9,300 m^3, Africa 5,000 m^3 and Asia 3400 m. The bulk of world's water is saltwater represented by oceans, seas and some lakes. Fresh water constitute only 2.5% of all the world water out of which only 0.3% is available as surface water in form of lakes, swamps, rivers and streams (Gleick, 1996).

WHO and UNICEF categorize water sources as improved or unimproved. JMP report of 2008 defined improved water source as one that is free from external contamination especially from fecal matter and listed pipe water into home, communal tap, protected well, protected spring among others as improved sources while unimproved sources include surface water, unprotected well/spring, tanker-trunk and bottled water among others.

The declaration in 2012 by the UN that the world had met the MDG drinking water target before the stipulated timeline of 2015 was indeed commendable. While this undoubtedly represented a major achievement, the use of the term "improved source" rather than the "quality of the water" has been challenged as great discrepancy (Bain *et al*, 2012). As it would emerge later the UN figures as cited by JMP (2012) did not take into account the quality or safety of the water from the source. Recognizing the threat, WHO and UNICEF (2004) commissioned pilot Rapid Assessments of Drinking-Water Quality (RADWQ) to help JMP in monitoring access to safe drinking water globally.

The RADWQ was thus a deliberate effort to establish the effect of water source quality and progress towards attainment of MDG drinking water target using WHO protocol for drinking water quality namely; thermotolerant coliforms bacteria, arsenic, fluoride and nitrate as the parameters of quality. Accounting for compliance with the WHO Guidelines for drinking-Water Quality using these parameters, (Bain *et al.*, 2012), observed that the parameters substantially lowered estimates of 'safe' water across the study countries. Similarly in Indore Zone India, safe water coverage reduced by 17% when subjected to WHO parameters.

Several other studies have exhibited similar variations between improved water source and the provision of safe drinking water. In China, while 457 million people were reported to have gained access to improved water source between 1990 and 2010, only 330 million of this population had access to safe water (Yang, H., et al., 2012). As a result, the use of improved water source as the determinant of water safety has led to overestimation of the progress towards MDG drinking water target (Bain *et al.*, 2012). Consequently, the global perception that significant progress has been achieved in the situation of safe water supply and sanitation is a misplaced position (Tortajada et al., 2013).

Kenya, with surface water coverage of only 2%, and annual renewable fresh water supply of 647m3 per capita, is categorized as a water deficient country (KWAHO, 2009). The situation is made worst by contamination, over use, destruction of the environment, poor administration of water resources, escalating demand and week enforcement of land use policies. Growing demand for the scarce water resources is a major cause of competition and conflict among Kenyan communities specially the poor and the marginalized (GOK, 2006).

Kenya was a signatory to the MDG alongside other nations and remains an integral part of agenda 2030; the current Sustainable Development Goals (SDP). The nature of the water source is an indicator of the suitability of water for drinking. According to WHO & UNICEF, improved sources are considered to provide safe drinking water and include tap water, borehole, protected wells and springs among others (WHO/UNICEF 2008). However, collecting water from an improved source is not an assurance of safety as water can be contaminated at the time of collection, transportation and storage at the household. In this regard, HWTS is considered appropriate intervention in improving the quality of drinking water (KDHS, 2009).

In Kenya, an average 63% of the households have access to improved water source. However, access in urban areas is generally higher (91%) compared to rural areas (54%). Piped water into the plot account for the majority of the households in the urban areas while protected dug well & springs are more popular among the rural households. More than 30% of Kenyans still rely on unsafe water sources for their domestic use, among them streams, rivers, and Lakes,

In the rural western parts of the country springs are the major source of waters serving close to 43% of the households (KDHS, 2003). Kremer *et al* (2008) observed that springs were an important source of water in Western Kenya as they constitute 72% of the total collection trips. World Vision, one of the leading providers of clean water in the developing world works closely with the grass root communities in digging well, spring protection, rain water harvesting and maintenance as well as enhancing their capacities to take ownership and management of the water points.

The foregoing indicates that improving the water source is not a guarantee that water from it will be safe. Water related illnesses have been observed among communities that depend on improved sources thereby necessitating water treatment at the household. LifeStraw family water filter is an effective intervention in removing microbial organisms found it water thus ensuring clear safe drinking water for the households. The provision of the filters to households in Matatyos division enabled the residents to take charge of their drinking water security by filtering water at home. This method is ideal in ensuring quality drinking water because chances of recontamination are considerably reduced as water is filtered at the point of use.

2.5 Cost of water treatment and adoption of LifeStraw family water treatment.

Studies have shown that HWTS interventions are more cost effective in quality water supply than the conventional improvements on water points. Effective implementation of low cost HWTS results in savings in cost leading to economic gain. While the cost of treating water per person per year varies with individual method, (UNICEF 2008), studies done in Africa have shown that the cost of implementing HWTS is relatively cheaper compared to installing and maintaining wells, boreholes and communal stand taps. Among the HWTS, chlorination is considered the most popular due to its relatively low cost and greater effectiveness with cost effective ratio of USS53 per disability-adjusted life year (DALY) compared toUSS123 for conventional source based interventions.

WHO in her recent analysis acknowledged that household based treatment such as use of chlorine were more cost beneficial and their use could actually accelerate progress towards the realization of the MDG water target (Hutton, 2007). In Zambia (Ashraf *et al*, 2007) found a great relief on public funds and donor funding when the target community were capable of meeting the cost household based water treatment products.

The impact of point-of-use water treatment is not only confined to household. In Kenya the integration of Point-of-use water treatment and hand-washing reduced by 26% the rate of absenteeism in primary schools (Blanton et al 2010). By investing in HWTS, authorities could actually benefit from savings of reduced healthcare costs in relation to diarrhoea diseases (WHO, 2008)

Based on the foregoing, it is evident that the introduction of LifeStraw family in Matayos division not only provided opportunities for households to improve drinking water quality but also contributed to reduction of the cost of water treatment.

2.6 Alternative HWTS methods and adoption of LifeStraw family water treatment

The many people in the world who still lack access to safe drinking water are a pointer to the continuing poverty especially in the developing world. Although reasonable progress is being realized in the expansion of improved water sources, these efforts have not translated significantly to addressing the problem of water among the poor. Studies have shown that house based interventions result in enhanced health benefits especially when focused directly to those in great need of safe water. Despite the merits of HWTS, greater emphasis by water sector institutions is still evident in the conventional source based interventions (Mintz *et al*., 2001).

Several studies have demonstrated not only the low cost of HWTS but also their effectiveness in the prevention and control of diarrhoea. These include chemical treatment commonly by chlorination or flocculation & disinfection (Reller *et al*., 2003), Solar disinfection (Conroy et al., 1999), ceramic filters and membrane filters (Clasen *et al*., 2005, Brown *et a*l., 2009), Biosand filters (Stauber *et al*., 2006) as well as boiling (Clasen, 2009).

The effectiveness of household based interventions has been shown in the work of several scholars; Clasen concluded that household based interventions were more effective than the source based. Graft *et al*., 2010 and Enger *et al*., 2012 concurred with Clasen but further asserted that the benefits of household based systems could only be realized with sustained adoption of the interventions.

2.6.1 Water boiling

Boiling is the oldest and the most widely used household based water treatment method. Globally, an estimated 1.2 billion use it for treating water at home (Rosa & Clasen., 2010). It is recommended that for effective disinfection, a rolling boil should be maintained for at least ten minutes (WHO, 2004). When appropriately applied boiling is effective in eradicating pathogens found in water including some bacteria spores and protozoan cysts resistant to chemical treatment as well as removing viruses some of which are too tiny to be removed by most filtration processes (Block, 2001).

Boiling can be used effectively across wide range of water characteristics and is considered ideal intervention in situations where filtration and chemical disinfection are challenged by physical (turbidity) and chemical (dissolved matter) water characteristics.

A study in Guatemala involving households that boiled water consistently (Rosa et al 2010) reported 86.2% reduction in geometric mean of thermotolerant coliforms in their drinking water. A similar study in India involving self reported boilers collecting water from unprotected sources recorded 99% reduction in geometric mean thermotolerant coliforms in their drinking water, while in a related study in Vietnam (Clasen *et al*., 2008), a reduction of 97% was reported further confirming the efficacy of boiling.

Despite its long history of effectiveness and simplicity, the scaling up of boiling as HWTs of choice is constrained by challenges. Increasing body of evidence indicate that boiling as routinely applied in several households does not necessarily yield water that is free from microbes. In the case of Cambodia, a study of the quality of household water from "improved" sources, reported significantly higher arithmetic mean of E. coli in stored household water than those in samples taken directly from the source, indicating substantial contamination of drinking water during storage (Wright *et al*, 2004 & Brick *et al*., 2004).

Furthermore, the scarcity and escalating cost of fuel are among the factors that render boiling out of reach of several households. From India, cost analysis of the common fuel both laboratory and field studies showed that that the cost of treating water by boiling using Liquefied Petroleum Gas to be higher (US$ 2.11) than using wood (US$1.66). A similar study in Vietnam reported an annual cost of fuel per person of US$ 0.65 for wood collectors and US$ 4.03 for wood purchasers (Clasen et al, 2008). Comparatively the annual cost of boiling water whether using gas or wood is much higher than treating equal volume of water using Sodium Hypochlorite (US$0.98) or solar disinfection (US$ 1.20) (Clasen T, Haller L, 2007).

While over fifty percent of the world population use wood, charcoal and other Biomas as source of energy for boiling water, the process of accessing these fuel is time consuming and cumbersome and deprive women time for engaging in productive and potentially health promoting activities. Furthermore boiling contribute to poor indoor ventilation considering that wood, charcoal and other biomass used are high in carbon emission (Ruhfuess, Mehta & Pruss-Ustun, 2006).

Notwithstanding the challenges, boiling has remained the benchmark by which the other methods are measured due to its combined effect of effectiveness in improving microbiological quality of water under wide range of conditions. A comparison of boiling and LifeStraw family method show contrasting qualities. While boiling has a continuous cost, LifeStraw has only the initial purchase cost. Whereas boiling contributes to indoor pollution which is a health risk to human, LifeStraw is environmentally friendly. The filter is chemical free and does not require energy to operate. As opposed to boiling, LifeStraw removes turbidity thereby producing completely clear and safe water for drinking and does not impart any smell to the water as is the case with boiling.

2.6.2 Chemical disinfection

Some of the organisms found in water are known to be harmful to human health and can be transmitted through drinking water. Today, chemical disinfection is broadly acknowledged as safe and effective water treatment method. The most preferred and widely used chemical disinfection intervention all over the world is chlorination i.e. use of free chlorine, chlorine dioxide, chloramines, sodium hypochlorite among others. Discovered in Sweden in 1744, chlorine was initially used to rid water of bad smell but later was found to be effective in eradicating pathogens from water resulting into safe drinking water.

Environmental Protection Agency of the USA recognizes chlorination as effective in disinfecting water by killing germs. While the chemical chlorine is harmful to human in high concentration, when added to water it quickly dissolve and disperse in water resulting into low concentrations that kills germs but safe to human. Chlorine deactivates pathogen by destroying the cell membrane and gaining access to the nucleus where it disrupts cell respiration leading to death of the organism (CDC, 2014).

Major benefits of chlorination include protective residual effect against recontamination, inexpensive yet effective against bacteria, protozoa, viruses, simple to use and convenient in water emergency situations compared to other water treatment methods. However, recent research has shown evidence of resistance to chlorination by some protozoan cysts namely Cryptosporidium and Giardia. Cryptosporidium outbreak in North Battleford in 2001 and Milwaukee in April 1993 was a clear evidence of inability of chlorination to disinfect water contaminated with the protozoa (WHO, 2004).

In an evaluation of household water treatment interventions, WHO observed that the risk of Cryptosporidium especially for people living with HIV persisted with the use of chlorine due to the parasites resistance to chlorination and recommended an integrated approach for protection of those at risk.

Chlorine is known to be reactive to a number of compounds found in water, results of which may be desirable or harmful. For instance, the reaction of chlorine with high natural organic matter can lead to formation of disinfection-by-products (DBPs) which are potentially harmful. On the other hand the reaction of chlorine with other matter in water may enhance the quality of water by eliminating undesired elements. However the risk posed by the DBPs are minimal compared to the danger attributed to waterborne diseases and therefore chlorination should not be compromised for control of DBPs (WHO, 2006).

An evaluation of carcinogenic potential of chlorinated drinking water by International Agency for Research on Cancer (IARC) in 1991, found inadequate evidence for carcinogenicity of chlorinated drinking water in human. However IARC recommended use of pre-filtration for water containing large quantity of organic matter.

Nevertheless chlorine is widely accepted among the general public for water purification mainly due to convenience in its use, cost effectiveness as well as its ability to eliminate microbial organisms in drinking water and is generally preferred for water purification at times of emergency (IFRC, 2008), (Lantagne *et al*., 2008). However, for a sustained health benefits to be realized, a constant supply of chlorine must be obtained.

In Kenya following a study on HWTS, Makutsa and colleagues (2001) observed that higher adoption of chlorination among communities in the study area were as a result of its ease of access and use.

2.6.3 Solar disinfection and Pasteurization.

Heating water to 65°C (149°F) for six minutes or to a higher temperature for a shorter time will kill all germs and make water safe for drinking contrary to the belief that water must boil or attain temperature of 100°C. The sunlight energy can be harnessed for the purpose of water disinfection through a process known as solar disinfection (McGigan *et al*., 2012). Solar water disinfection (SODIS) is an easy, environmentally sound, cost effective option for drinking water treatment at the point-of-use for households exposed to pathogen contaminated raw water. SODIS uses a combination of solar UV radiation and elevated solar temperature while solar pasteurization uses solar thermal energy only (EAWAG/SANDEC 2002).

Professor Aftim Acra of the American University of Beirut is credited as the father of SODIS research. His work inspired a number of organizations including Integrated Rural Energy systems Association (INRESA) and Brace Research Institute, Montreal leading to a launch of a network in 1985 followed by a series of workshops to review results of field research.

The dual effect of sunlight radiation and increased water temperature create greater synergy resulting into enhanced mortality of microbial organisms (Jadhav et al., 2008). Compared to the conventional boiling of water, pasteurization reduces the energy required by up to 50%. However, the effectiveness of pasteurization is achieved only when water is protected from recontamination during storage (WHO, 2011).

Pasteurization has proven an ideal water treatment intervention at household level rather than for producing large quantities of drinking water due to its low cost effectiveness. However, together with boiling, the two also referred to as thermo heat technology are used world over for disinfection of beverages such as milk, fruits juice, beer and wine on industrial scale.

According to Kenya Water for Health Organization, 6,000 user families in Kibera slums, Nairobi, Kenya reported health improvements and savings on medication by combining SODIS and proper hygiene practices (KWAHO 2004), while a similar study in Kajiado by International Community for Relief of Starvation and Suffering (ICROSS), together with Royal College of Surgeons Ireland concurred that SODIS of water can reduce morbidity among communities lacking other water treatment options especially at times of disaster (http://www.icrossinternational.org/downloads/solardisinfection of drinking water.pdf).

Contrasting results were however reported from Bolivia where a study to evaluate impact of SODIS in diarrhoea control among the under-fives only gave weak indication of reduction suggesting the need for further research on this intervention to establish its effectiveness (Mausezahl, et al (2009)

The Solar pasteurization method though effective in the removal of pathogens from raw fresh water, is ineffective in disinfecting water unclear raw water and water with high concentration of minerals. One of the major challenges with SODIS is its dependence on sunshine.

2.7 Household water filters

Household filters exist in many parts of the world. In the developing world the most popular models include Ceramic, Biosand and recently introduced Membrane filters.

2.7.1 Ceramic Filters

Ceramic filters can be made at low cost, considering that they do not require electricity or any form of energy to operate and the materials used are largely sourced locally. Ceramic filters have been demonstrated as effective particularly in removing turbidity but recent innovation integrating with Silver lining has made ceramic filters effective in disinfecting contaminated water. Among the ceramic filters, Pot-style and candle models have shown great promise as household based water treatment intervention (Laursen, 2007).

The recognition of Ceramic water filters as potential household water treatment intervention has led to some NGOs exploring their use in emergency response (Caens, 2005). In a randomized control trial in Zimbabwe and South Africa, in which 60 of 115 households received ceramic filters, Perez et al. (2008), observed reduced Escherichia coli counts and zero E. coli drinking water in 56.9% of intervention households with a corresponding lower diarrhoea incidences among filter users.

A similar study in the Dominican Republic, recorded lower feacal contamination (2.9 per 100 ml) among households that used ceramic filters compared to (32.9 per 100 ml) for households that did not use the filters. Further results indicated 70.6% compliance with WHO drinking water quality guidelines of zero thermotolerant coliforms per 100 ml against 31.8% per 100 ml for the control households. In Haiti ceramic filters were highly accepted and acknowledged as effective in improving microbiological quality of drinking water in flood stricken areas. However, unpublished results from Cambodia and Indonesia were in contrast. Minimal reduction of microbes was observed when the filters were deployed in a post flood setting in Cambodia, while in Indonesia the filter were found to be ineffective in providing quality drinking water for the displaced people (Clasen *et al*., 2006)

A performance study of ceramic candle filters in Kenya (Franz 2005) concluded that although the filters were not 100% effective in the removal of coliforms, they are an integral step in the attainment of a sufficient volume of clean, safe drinking water and recommended that water be treated post-filtration to remove any residual microbial contamination.

In view of the contradicting results, there is need for further research on ceramic filters to establish their effectiveness in removing microbes found in water. Although the effectiveness of the filters has not been conclusively researched and concluded, scholars have indicated that with proper use and maintenance, good results have been observed. The challenge with Ceramic filters is that there are several models of different qualities in the market and generally cleaning of the filters tend to erode and reduce wall thickness eventually compromising the purifier effectiveness (Clasen, 2007)

2.7.2 Biosand Filter

The Biosand filter (BSF) is a simple household water treatment device, which is an innovation on traditional slow sand water filters that have been used for community water treatment for hundreds of years, specifically designed for intermittent or household use. Like ceramic filters Biosand can be produced in many parts of the world using locally available materials (CAWST, 2009)

The cost of the filter is thus determined by labour and raw materials which often are readily available hence low cost. The filter is made of concrete or plastic container filled with successive layers of concrete and sand which through physical straining remove pathogens and turbidity. BSF eventually develop Bio-film which is a layer or network of microorganisms atop the sand layer. Bio-film aids in the removal of pathogens through a combination of biological (predation and competition for food) and physical processes (restraining, trapping) of the pathogens found in water (CAWST, 2009).

BSF has been shown to be effective in the removal bacteria, protozoa, helminthes as well as the mineral Iron and particulates that cause turbidity. However, BSF is ineffective against several dissolved mineral and arsenic substances. Water treated by BSF generally is clear, has good taste and acceptable odour (CAWST, 2009). Health impact studies have shown 30%-47% reduction in incidences of diarrhoea across ages particularly among the under five years of age who are known to be more vulnerable (Brown et al., (2008); Stauber, (2007).

Commercial distribution of BSF filters have largely been unsuccessful, a situation that has left the issue of filters exclusively in the domains of Non-Governmental Organizations. Laboratory and field trials have shown an average of 95% coliforms removal, 99& Cryptosporidium and Guardia removal but less that 90% Viruses removal. Other similar trials have also shown that BSF remain effective (deliver 1-2 log pathogen reduction) more than five years of use (Clasen, 2007).

2.7.3 Membrane Filtration

Widely recognized as the technology of choice for superior water and waste water treatment, a membrane or semi-permeable membrane, is a thin layer of material capable of separating substances when a driving force is applied across it. Once considered a viable technology only for desalination, membrane processes are increasingly being employed for removing of bacteria and other microorganisms, particulate material, and natural organic matter, which can impart colour, tastes, and odours to the water and react with disinfectants to form disinfection by-product (DBP).

Membrane filtration can be efficient and economical way of separating components that are suspended or dissolved in a liquid. Recent advances in technology have significantly reduced the cost of membrane based systems since today’s membranes produce more water and remove more impurities while using less energy (Munir, 2006).

In a US National Research Council report of 1997, most experts acknowledged membrane processes capability and potential in meeting the current and future drinking water quality standards. The experts further predicted greater frequency use of membrane technology in small systems such as the household as the complexity of conventional treatment processes for small systems increases.

Membrane interventions come in a variety of models and configurations each with unique features for meeting specific process needs. The four major membrane separation processes employed today for all Liquid filtration and liquid-solid filtration are Ultra-filtration, (UF), Reverse Osmosis (RO), Nano-filtration (NF) and Microfiltration (MF). The classification is based on pore size, molecular weight cut-off (MWCO) and applied pressure needed to push water through the membrane. MWCO is a measure of membrane pore dimension, a specification used by membrane suppliers to describe membrane’s retention capabilities (Lahlou, 1999).

UF refers to a separation of minerals from water using a membrane with spore size in the range of 0.002 to 0.1 microns, a MWCO in the range of 10,000 to 100,000 Daltons and an operating pressure in the range of 200 to 700 kPa. UF is capable of removing all species of microbial organisms, a range of viruses and organic matter.

Reverse Osmosis (RO) comprise membrane with the smallest pores and the process involves reversal of the osmotic process of a solution in order to drive water away from the dissolved molecules. RO relies on ionic diffusion to effect separation. Micro-filtration on the other hand involves separation membrane with pore size in the range of 0.03 to 10 microns, a MWCO in excess of 100,000 Daltons, and a relatively low operating pressure in the range of 100 to 400 kPa. MF is effective in the removal of sand, silt, clay, Giardia and

Cryptosporidium but is not absolute barrier to viruses. Common limiting factors of all membrane processes are fouling and blockage; phenomenon responsible for most difficulties encountered in membrane technology for water treatment. However, both fouling and blockage can be controlled by backwashing; a process designed to remove contaminants accumulated on the membrane. Backwashing entails reversing the direction of flow for 30 seconds to 3 minutes. The force and direction of the flow dislodge the contaminants at the membrane surface and wash accumulated solids out through the discharge line.

In the United States, regulations such as the Safe Drinking Water Act and the Long Term Enhanced Surface Water Treatment Rule and stringent wastewater discharge regulations, have promoted dramatic growth in the implementation of membrane technology. In Kenya large scale use of membrane technology as a method of household water treatment was introduced in 2011 courtesy of Lifestraw Carbon-for-water (C4W) program, a private public partnership between Vestergaard Africa (VAL) Company and Kenyan government. Through this partnership VF delivered close to 900,000 of Lifestraw Family water filters free-of-charge to households in the former Western Province of Kenya. By providing households with Lifestraw Family water filters and complimentary health and hygiene education, VF has enabled households to treat their water within the home, cutting down on the risk of contamination and subsequent illnesses.

Lifestraw Family (LSF) water purifier is one of the HWTS interventions available in Matayos Sub-county of Busia County. LSF is a high-volume water purifier for use in homes without access to clean and safe water

LSF uses hollow fibres with pore size of 0.02 microns capable of eliminating virtually all (99.99%) of bacteria, protozoa, viruses and particulate matter larger than 0.02 microns and meets WHO guidelines for quality drinking water standards (WHO, 2011). The filter can purify up to 18,000 litres of clean and safe drinking water enough to sustain a family of five people for 3-5 years. .LSF also eliminates Cryptosporidium; a protozoan parasite recently found to be a leading cause of diarrhoeal illness and mortality of children under five and People Living with HIV (Kotloff *et al*., 2013).

2.8 Theoretical framework

This study was anchored on the Health Belief Model (HBM) theory. The HBM theory was propounded by the US Public Health Service in the 1950s to investigate why medical screening programs offered particularly for tuberculosis were not very successful (Hochbaum, 1958). The HBM theory suggests that a person's belief in a personal threat of an illness or disease together with a person's belief in the effectiveness of the recommended health behavior or action will predict the likelihood the person will adopt the behaviour.

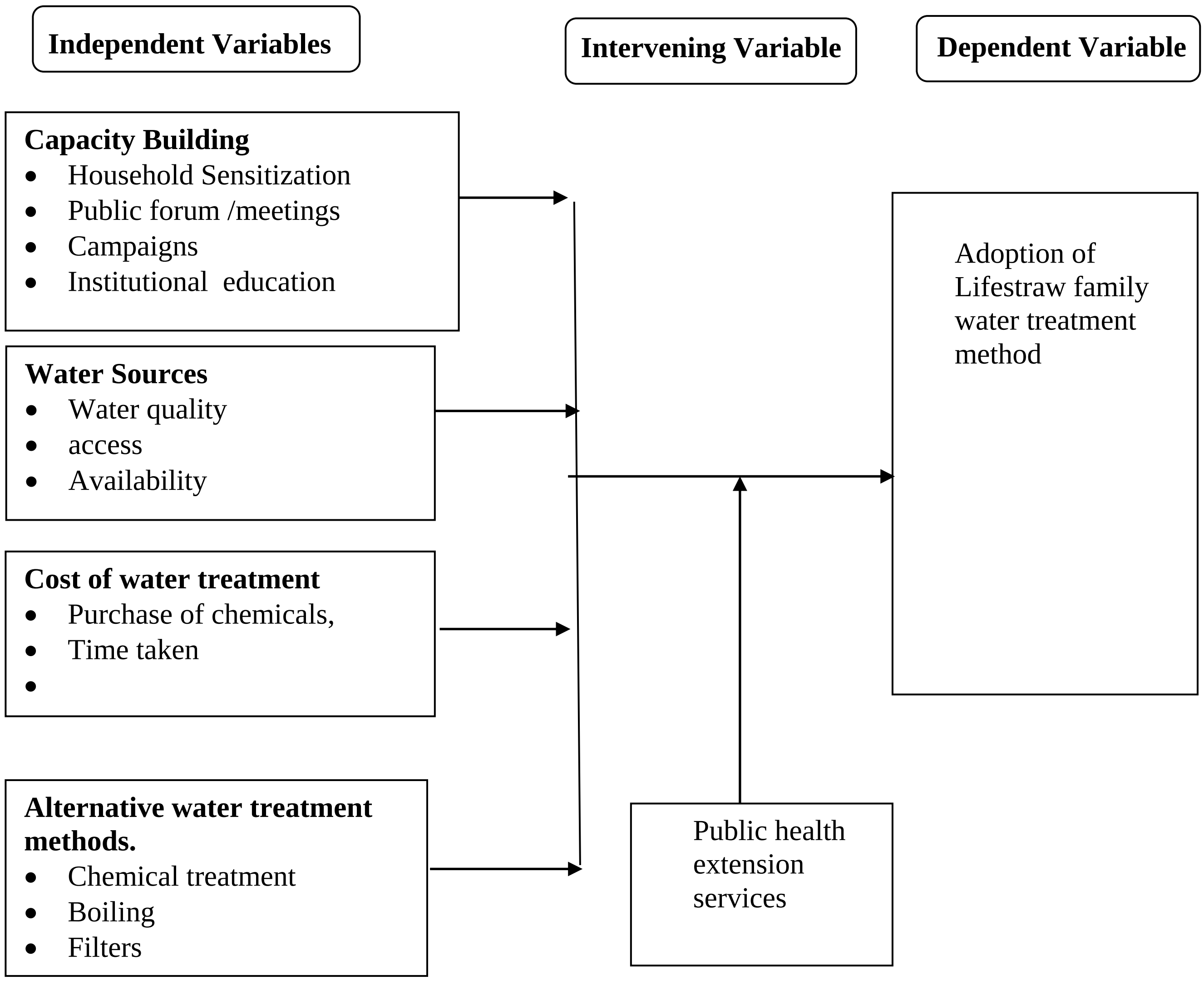
The theory recognizes that an individual’s decision to undertake a particular health behaviour is influenced by six perceived variables including; perceived susceptibility, perceived severity, perceived benefit, perceived barrier, cue to action and self efficacy.

The HBM theory suggests that when a person believes that his/her health is in jeopardy; the person perceives the potential seriousness of the condition in terms of pain or discomfort, time lost from work, economic difficulties and other outcomes; on assessing the circumstances, the person believes benefits stemming from the recommended behaviour outweigh the cost and inconveniences and that they are indeed possible and within his grasp; and the person receives a cues to action or a precipitating force that makes a person to feel the need to take action (Glanz, Rimer & Lewis, 2002).

The HBM has however been critiqued for low predictive capability of the determinants, insufficient size of effect and weak relationship between the variables. Despite, the inadequacies, HBM has been successfully applied in the design of health programs and have been found to be ideal on behaviours that are of health nature (Orji et al., 2012).

2.9 The Conceptual framework

This section describes the perceived conceptual framework used in guiding the study.



The conceptual framework represents the interplay between the independent variables and dependent variable with the Public Health Extension Services in play as intervening variable. The factors which have been conceptualized as independent variables include capacity building, water source, cost of water treatment and alternative water treatment methods. The independent variables are perceived to influence the dependent variable which is the adoption of Lifestraw family water treatment methods.

Capacity building in the context of this study is considered as a process of empowering individual(s) with knowledge, skills and ability to make and execute decisions that achieve effective and efficient results. In this study four community outreach approaches perceived to influence adoption were; household visits & sensitization, public meetings/forums, campaigns and institutional education at health facilities and schools. Capacity building creates awareness and therefore ability of a person to understand and assimilate concepts and adopt new technologies.

The World Health Organization, categorizes water sources as “improved” when the source is protected from external contamination such as piped water supply, protected spring, borehole with pump, protected dug well among others and “unimproved” when the source is exposed to external contamination such as unprotected spring, unprotected dug well, surface water (river, stream, dam). Individual(s) perception of the quality of water from a particular source may influence his/her decision to treat water at the point-of-use or not. Other factors that may influence source selection include access and availability of water at the source.

The cost of water treatment in this study is viewed in terms of amount of money spent (monetary) as well as in terms of effort and time spent (non-monetary) in treating water at household level. The cost of water treatment is perceived to be positively correlated to choice of method of water treatment. Generally, one would expect that the cheaper the cost the higher the chances of adoption but variations have been observed where people are willing to pay more due other underlying factors such as quality, efficiency and time.

The study looked at the use of LifeStraw family not in isolation but in view of the availability of other household water treatment methods and how this affected its adoption. The other water treatment methods (chemical, boiling, filtration) were perceived to provide alternatives from which to compare and contrast LifeStraw family. Attributes of the interventions considered to influence choice of the method include; ease of use, duration of the process, quality and cost among others.

Public Health Extension Services play significant role in sensitizing grass root communities about new health innovations and technologies and therefore a key factor in their acceptance and adoption. Community Health Extension Workers (CHEWs) together with Community Health Volunteers (CHVs) are the frontline level one community health providers in the villages and are considered key in the promotion and dissemination of health information. It is thus expected that when CHEWs/CHVs are adequately enlightened about an intervention, they can influence its adoption and sustained use in the community.

2.10 Knowledge gap

Several studies have been undertaken relating to LifeStraw water purifiers. A study of the use and impacts of LifeStraw have shown high compliance rates during the period of the study when it was provided free-of-charge. A challenge with LifeStraw and other point-of-use interventions has been pointed out as their continued use post the study period (Sobsey 2002). Globally achieving the potential of household water treatment methods such as LifeStraw family has depended not on availability of the intervention to the target community but to its being used correctly and consistently on sustained basis (adoption). This is the knowledge gap this study sought to investigate. This research study sought to provide further insight on the determinants of adoption of LifeStraw family water treatment intervention.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed the research methodology that was used in conducting the study. This included research design, target population, sample size, sampling techniques, research instruments; piloting, validity and reliability of the instruments, data collection procedure, data analysis techniques and ethical considerations.

3.2 Research Design

This study employed a descriptive survey design which involved both qualitative and quantitative approaches. Descriptive survey design was appropriate for this study as it is an efficient way of collecting information from a large number of respondents and appropriate for a wide range of information. This study sought to establish the determinants of adoption of Lifestraw family water treatment method and used questionnaire-based survey approach. Merits associated with the survey design include ease of establishment of association between variables and comparison, possibility of administration to many people and anonymous completion of questionnaires while shortcomings include possibility of response biases.

3.3 Target Population

Target population is the collection of elements that possesses information sought for the study by the researcher (Oso and Onen, 2005). The study targeted 13,101 households in Matayos division provided with Lifestraw Family Filters by Vestergaard Africa Limited (VAL). The households were identified from the records of beneficiary households held by

VAL. The list of registered households from VAL records formed the sampling frame from which a sample was drawn and interviewed. The study was conducted in all the 5 locations of Matayos division. The division was purposely selected for this study because it is one of the divisions where households were provided with Lifestraw Family Filters accompanied by Behaviour Change Campaigns by VAL.

3.3.1 Sample Size

The sample size for this study was 384 Lifestraw households drawn from a target population of 13,101 Lifestraw households ‘in Matayos division. Fisher, Laing and Stoeckel as cited in Mugenda (2003), suggested a formula for estimating the desired sample size when the population is more than 10,000;

$$n = \frac{z^2 pq}{d^2}$$

That is $$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

Where:

n: desired sample size when population is more than 10,000

z : desired normal deviate at the required confidence level

p: estimated proportion in target population with characteristics being measured

$q = 1 - p$

$d =$ the level of statistical test

Fisher recommends 50% of the target population should be assumed to have characteristics of interest with a $z =$ statistic of 1.96 at 95% level of confidence.

3.3.2 Sampling Technique

Stratified random sampling was employed based on the five locations. Thereafter the researcher used systematic sampling technique based on the household barcodes in picking the households that were interviewed. The barcodes of the households were arranged in ascending order of magnitude with every 30th household included in the sample. Population-proportion sampling procedure was applied to distribute respondents to the 5 Locations in the division.

Proportional sampling (Van Dalen, 1979) is appropriate for this study because it provided the researcher with a means to achieve even greater representativeness by selecting individuals at random from the Locations in proportion to the actual size of the total population.

Table 3.1: Sample size distribution per location.

Location	Population with Lifestraw	Sample size
Bukhayo West	4190	123
Busibwabo	2679	79
Lwanya	2025	59
Nang'oma	2046	60
Nasewa	2161	63
Total	**13,101**	**384**

Source: Vestergaard (2014) Lifestraw program household mapping village based data.

3.4 Research Instruments

Research instruments are the tools used to collect data (Oso and Onen, 2009). The study employed questionnaires, and key informant interviews to obtain primary data. The questionnaires used in the study were divided into five sections addressing the study objectives; Section A (elicited information on socio-demographic characteristics of the household), section B (household capacity building), section C (Water sources), section D (cost of water treatment) and section E (alternative household water treatment methods).

The researcher conducted face to face interviews using questionnaires and interview guides. The instruments were both open and closed ended questions for generation of data. Both qualitative and quantitative data were principally collected through questionnaires and key informant interviews. Although Bourque and Fielder (2002) assert that questionnaires are used to collect data from people who complete the questionnaires themselves, the researcher opted to engage Community Health Volunteers (CHVs) to carry out interviews with households. The choice of CHVs was based on the fact that they were involved in the initial distribution of Lifestraw family filters in their respective villages and therefore would not have difficulty in identifying sampled households. In addition, CHVs are literate and have been trained on various community/household approaches and therefore would require only basic induction to interpret and administer the questionnaire. The questionnaire was strictly administered to household heads.

Unlike in a posted questionnaire, face to face interview process ensures direct communication with respondents, ensuring clarity whenever a question posed to the interviewee was not clear. An interview provides the platform to gain cooperation, hence there was minimal loss of information (Leedy and Ormrod, 2004). The method also ensured avoidance of spoilt or lost questionnaires. Using this method guaranteed timely response.

3.4.1 Pilot Testing of Instruments

Nachmias and Nachmias, (1996) noted that pilot testing is an important step in the research process because it reveals vague questions and unclear instructions in the instruments. It also captures important comments and suggestions from the respondents that enable the researcher to improve the efficiency of instruments, adjust strategies and approaches to maximize response rate.

To ensure reliability of data collection instruments, a pretesting and practical interviewing was conducted by the researcher. The sampled households for pre-testing were drawn from the neighboring division in order to avoid interviewing households who would later form part of the sample for the study. This Location was considered ideal for pilot testing because, being in the same environment (same Sub-county) as the target area of the study; respondent were expected to display similar characteristics as the actual study respondents.

In piloting the instruments, questionnaires were administered to 30 Lifestraw households sampled randomly from the neighbouring Busia township location. The findings were used to refine the instruments for increased reliability for use in Matayos division. During the piloting attention was focused on questions that make respondents uncomfortable with a view of reviewing ambiguity to reduce despondence fatigue during the administration of the questionnaire.

3.4.2 Validity of Instruments

According to Mugenda and Mugenda (2003), a valid instrument measures what it is supposed to measure. Validity of research instrument is a measure of the extent to which the instrument measures what they are intended to measure (Kathuri and Pals, 1993). The validity of the instruments was ascertained by conducting a pilot study using the instruments in the neighbouring township division. This ensured that the instructions were clear and all possible responses to a question were captured.

Content validity for the instrument is the extent to which the instrument provides adequate coverage of the investigative questions guiding the study. The instruments were reviewed by my supervisors who are research experts to assess the appropriateness of the questions in terms of their relevance in generating answers to the research questions.

3.4.3 Reliability of Instruments

Reliability is the extent to which results from an instrument is consistent and reliable (Amin, 2005; Kothari, 2004). A reliable instrument is that which yields consistent results after repeated measurements (Cooper and Schindler, 2008). The researcher adopted Split half technique of assessing reliability because it requires only one testing session. The researcher preferred this technique of the test because it eliminates errors due to the subjects ease in remembering responses from the first test. The Split half attempts to overcome this problem by developing one scale for each variable then dividing the scale into two halves (odd and Even) and then calculating the Pearson's correlation coefficient (r) between the two halves of the test. The split half procedure is based on correlation between scores obtained from both halves of the test needed to determine reliability of the entire test. The Spearman-Brown Prophesy formula was used to make correlation as follows;

$$R_e = \frac{2r}{1+r}$$

where r is Coefficient of correlation.

The instrument (especially the questionnaire) will be deemed to have high degree of reliability if the value of correlation coefficient falls within the range of 0.85 to 1.

3.5 Data Collection Procedure

Before commencement of data collection, this study was taken through approval procedures as required by the University of Nairobi. The researcher obtained a letter from the university which he used to obtain a research permit from the National Council of Science, Technology and Innovation. The researcher also sought permission from VAL to get secondary data from project documents as well as primary data from households that were provided with Lifestraw family filters.

The researcher engaged 26 Community Health Volunteers (CHVs) for the purpose of data collection. The CHVs were trained for two days on correct interpretation of the questions in the instruments, language of interviews and ethical considerations. The researcher also informed the local administration (area chief), Assistant County Commissioner (ACC) and the Sub-county Public Health Officer about the study before he proceeded to conduct the study in the division.

The researcher personally administered the Key informant questionnaire to key informants. The CHVs interviewed individual household members using structured questionnaires and respondents were assured of strict confidentiality. To ensure high response rate the researcher and CHVs conducted the interviews with households in their homes. The researcher collected all completed questionnaires every evening and held daily review sessions with research assistant to evaluate the progress and address emerging issues.

3.6 Data Analysis Techniques

Data analysis means the computation of certain indices or measure along with search patterns that exist among data sets. Data analysis sought to fulfill research objectives and provide answers to research questions. Quantitative data analysis began in the field where data was sorted and checked for correct completion and consistency. This was followed by coding the open ended data, data entry, data cleaning, transformation, analysis and interpretation. Qualitative data was collected using discussion guides and the responses were grouped into themes corresponding to the objectives of the study.

Data was analyzed using descriptive statistics and the results were presented using frequency tables, percentages, modes, mean and standard deviation. For ease of analysis and accuracy the use of statistical software package especially statistical package for social sciences (SPSS) was employed. For cases of characteristic explanations, qualitative data analyses were employed by use of inferential statistics. To determine extent of relationships, correlation analysis was applied.

3.7 Ethical Issues

Ethical research practices were observed throughout the study. These included seeking consent from the interviewees before commencing data collection, assurance of confidentiality of information obtained from the interviewees as well as providing appropriate information regarding the purpose and significance of the study. Information obtained from other sources or from other authors to support the relevance of this research was adequately acknowledged in the form of references. The questionnaires used in data collection were kept under key and lock for purposes of confidentiality. The researcher obtained permit from the National Council for Science, Technology and Innovation as required.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRESENTATION

4.1 Introduction

This chapter presents findings of the study which have been discussed under the thematic areas and sub sections in line with the study objectives. The sub-sections include: return rate of the questionnaire, socio-demographic characteristics of respondents, the influence of capacity building on adoption of Lifestraw family water treatment method; how water source determine adoption of LifeStraw family water treatment method; extent to which the cost of water treatment determine adoption of LifeStraw family water treatment method; and how alternative water treatment methods affect adoption of LifeStraw family water treatment method. The results are summarized in the following sub-sections.

4.2 Questionnaire return rate

Poor response rates reduce sample size, and consequently the precision, and are a potential source of bias, lessening the confidence with which findings can be accepted and generalized. The study targeted 384 household heads for interviewing but only 380 household heads were interviewed giving a response return rate of 98%. The study managed to get this response rate due to a “call back form” which the interviewers left behind to absent households indicating when they would return to carry out the interview. This return rate was acceptable since it was above the 70% return rate recommended by Mugenda & Mugenda (2003).

Qualitative data was sourced through administration of key informant questionnaires to Public Health Officers (location and divisional). 80% (8 out of 10) of the respondents provided comprehensive information on determinants of Lifestraw family water treatment methods.

4.3 Demographic characteristics of respondents

Demographic information was collected in relation to age, gender, marital status and level of education, major occupation of the household head, average monthly household income and the household size. The results are presented in the following sub-sections.

4.3.1 Distribution of respondents by age

The study sought information on the distribution of age of the respondents. The respondents were asked to state their ages, the ages of the respondents were necessary for the researcher as this could determine their experience with household water treatment methods and have a bearing on how they relate with Lifestraw family water treatment method. The results of age category of household heads are presented in Table 4.1:

Table 4.1 Age distribution of respondents.

Age	**Frequency**	**Percentage**
25-30	42	11.1
31-35	77	20.3
36-45	131	34.4
Above 45	130	34.2
Total	**380**	**100**

From Table 4.1, out of the 380 household heads who participated in the study, 42(11.1%) of household heads were aged between 25-30 years, 77(20.3%) of respondents were aged between 31-35 years, 131(34.4%) of household heads were aged between 36-45 years and 130 (34.2%) of respondents were aged 45 and above years. Majority of the respondents 261

(68.6%) involved in household water treatment were adults above the age of 35. This can be attributed to the fact that most of the youth (aged below 35 years of age) who are able bodied young men and women may have migrated to urban centres in search of salaried employment.

4.3.2 Distribution of respondents by gender

Gender implies socially constructed roles, behavior, activities and attributes that a particular society considers appropriate for men and women. The respondents were asked to state their gender. It was appropriate to determine the gender of the household heads because gender of the head of the household determines decisions making and may influence the choice of water treatment method adopted by the household. Gender of the respondents was recorded and summarized in Table 4.2: below.

Table 4.2: Gender distribution of respondents.

Gender	Frequency	Percentage
Male	38	10
Female	342	90
Total	**380**	**100**

From Table 4.2 above, out of the 380 respondents, 342 (90%) were females while 38 (10%) were males. The results indicate that more women are involved with household drinking water treatment than men. This can be attributed to women being majorly associated with household chores. These results imply that equitable distribution of gender roles at the household level is yet to be realized in this community. The findings of this study concur with Gleick (1996), who in his study on Basic water requirements for human activities asserted that failure by governments to finance satisfactory water and sanitation systems, result in enormous human costs evidenced by among other factors, excessive use of labour; particularly for women, who travel long distances to obtain water for their families.

4.3.3 Distribution of respondents by marital status

Establishing marital status of respondents was vital in understanding the socio-demographic characteristics relevant to water safety and usage. The respondents were therefore asked to state their marital status and their responses were summarized in Table 4.3 below.

Table 4.3: Distribution of respondents by marital status.

Marital Status	Frequency	Percentage
Married	318	83.7
Single	5	1.3
Divorced	3	0.8
Widowed	54	14.2
Total	**380**	**100**

From Table 4.3 above, out of the 380 respondents, 318 (83.7%) were married, 5 (1.3 %) were single, 3 (0.8%) were divorced and 54 (14.2) were widowed. The results indicate that majority of respondents (83%), involved with drinking water treatment were married as compared to 2.1% who were single or divorced. This can be attributed to the fact that majority of respondents were above 35 years of age and parents for that matter and therefore would not want to compromise the health of their families by failing to purify water. These findings imply that marital status influence participation in household drinking water treatment.

4.3.4 Distribution of respondents by level of education attained

It was necessary to determine the education level of the respondents as it is believed that level of education dictates the ability of a person to understand and assimilate concepts and adopt new technologies. Respondents were therefore asked to state the highest level of education attained and their responses were summarized in Table 4.4:

Table 4.4: Distribution of respondents by level of education attained.

Level of Education	**Frequency**	**Percentage**
Primary	263	69.2
Secondary	85	22.4
College and above	10	2.6
Never attended school	22	5.8
Total	**380**	**100**

From Table 4.4, out of the 380 respondents who participated in the study, 263(69.2%) of the respondents had primary education as the highest level attained, 85(22.4%) had secondary level of education, 10(2.6%) of the respondents had tertiary education and only 22(5.8%) of the respondents had no education. The finding show that majority of the respondents, 348(91.6%) had attained either primary or secondary education. This implies that the majority of the respondents were literate and therefore trainable on water treatment methods.

4.4 Capacity Building

The study sought to determine the extent to which capacity building influences adoption of LifeStraw water treatment method at household level. The respondents were asked to respond to questions on LifeStraw family water treatment method; whether or not they received training, what greatly influenced their choice of the method, their perception of safe drinking water and mode of access of LifeStraw information.

4.4.1 Training on Lifestraw family water treatment method

Training on LifeStraw water treatment was important in providing knowledge and skills on the intervention. To establish whether or not the households received training on LifeStraw method, respondents were asked to state “Yes” if they received LifeStraw training and “No” if they didn’t. The responses are tabulated in Table 4.5,

Table 4.5: Number of respondents that received training.

Lifestraw Training	Frequency	Percentage
Yes	355	93.4
No	25	6.6
Total	**380**	**100**

From Table 4.5, out of the 380 respondents, 355(93.4%) agreed that they received training and 25(6.6%) had not received any training. Therefore majority of the respondents 355 (93.4%) were enlightened on the use of LifeStraw family water treatment method. The high enlightenment of the respondents on LifeStraw method is attributed to campaigns and household visits and education that accompanied the introduction of LifeStraw technology by VAL. The high number is a demonstration of the high interest the community has on matters of safe drinking water.

4.4.2 Acceptance of LifeStraw family water treatment method

In order to establish the acceptance of LifeStraw as a water treatment method, the respondents were asked to state the extent to which they accepted LifeStraw water treatment method. The responses were captured in Table 4.6 below;

Table 4.6: Levels of acceptance of Lifestraw method.

Acceptance	**Frequency**	**Percentage**
Low	28	7.4
Moderate	138	36.3
High	149	39.2
Very High	65	17.1
Total	**380**	**100**

From Table 4.6, 28(7.4%), 138(36.3%), 149(39.2%) and 65(17.1%) accepted Lifestraw water treatment method to a low, moderate, high and very high extent respectively. Majority, 214(56.3%) accepted the use of LifeStraw water treatment method to a high and very high extent. These findings were further subjected to cross tabulation analysis to establish how training on Lifestraw water treatment method determines adoption of Lifestraw method. The results are summarized in Table 4.7 below:

***Table 4.7**: cross tabulation of Lifestraw water treatment acceptance and training on Lifestraw water treatment method.*

		Received training on Lifestraw water treatment		
		Yes	No	Total
The extent of Lifestraw water treatment acceptance	Low	17	11	28
	Moderate	124	14	138
	High	149	0	149
	Very High	65	0	65
Total		355	25	380

From Table 4.7 out of the 355 respondents who received training on Lifestraw method, 17(4.8%) had low acceptance, 124(35%) had moderate acceptance, 149(42%) had high acceptance while 65(18.2%) had very high acceptance. The result indicate that majority of the respondents 214 (60.2%) accepted Lifestraw as a water treatment method to a great extent. On the other hand 100% of those who did not receive training had only moderate to low acceptance of Lifestraw method. This finding implies that training influenced the acceptance and use of LifeStraw method by the respondents. These results ratify the finding by Ngai & Fenner (2014), who working on Biosand water filters in Rural India, found that conducting education and awareness to villagers on the importance of drinking water safety and conducting household monitoring visits to reinforce health messages enhanced uptake and proper operation of the filters.

4.4.3 Mode of dissemination of Lifestraw family water treatment information

A variety of approaches exist for disseminating evidence from those who develop interventions to those who are expected to use them. It was important to establish the mode by which households accessed LifeStraw information and how this relates to adoption of LifeStraw family water treatment method. Respondents were asked to state the method used by the promoters to reach them with Lifestraw information. On a scale of 1,2,3,4, the respondents were required to state; not used, least used, used or most used. Responses on the methods of access are presented on Table 4.8;

Table 4.8:Methods of information access

	N	Minimum	Maximum	Mean	Std. Deviation
House hold visit with regard to information access	380	1	4	3.44	.607
Campaigns with regard to information access	380	1	4	1.83	.908
Barazas with regard to information access	380	1	4	2.08	.839
Dialogue days with regard to information access	380	1	4	1.83	.931
Health Centres with regard to information access	380	1	4	2.81	.883

From Table 4.8, household visits had a mean of 3.44 and standard deviation of 0.607, campaigns had a mean of 1.83 and standard deviation of 0.908, baraza had mean of 2.08 and standard deviation of 0.839, dialogue days had mean of 1.83 and standard deviation of 0.931 and health centres had mean of 2.81 and standard deviation of 0.883. These findings indicate that household visits had the highest mean (3.44) indicating that majority agreed household visit was an important approach in disseminating LifeStraw information. In the same vein, a mean of 2.81, approximately 3, also shows that a good proportion of the households received information from the health centres. It is therefore notable that the most commonly used methods of LifeStraw information dissemination were household visits and health centres outreaches. This could be attributed to Lifestraw provider's (VAL) door-to-door training approach and health talk sessions at the Health facilities during introduction of the program. On the other hand campaigns, Barazas and dialogue days were least used.

4.4.4 Choice of Lifestraw family as a water treatment method.

The study sought to establish factors that influenced individual choice of LifeStraw water treatment method over the other methods. Respondents were asked to state why they preferred LifeStraw as their water treatment method of choice. The responses were tabulated as in Table 4.9

Table 4.9: What greatly influenced choice of Lifestraw water treatment method

Lifestraw attribute	Frequency	Percentage
Sensitization	95	25.0
Water quality	244	64.2
Duration of the treatment process	27	7.1
Cost of treatment	14	3.7
Total	380	100.0

From table 4.9, out of 380 respondents, 95(25%) stated that their choice of LifeStraw method was greatly influenced by sensitization, 244(64.2%) stated that their choice was influenced by the quality of the water while 27(7.1%) and 14(3.7%) agreed that the choice of LifeStraw was influenced by duration of the treatment process and cost of treatment respectively. These findings show that quality of drinking water produced by Lifestraw method influenced the choice of majority, 244 (64.2%) of the households followed by sensitization 95(25%). Duration of treatment process 27(7.1%) and cost of treatment 14(3.7%) had least influence on the choice of LifeStraw water treatment by households. These findings indicate the high value the households attach to the safety of drinking water and that choice of LifeStraw water treatment method was greatly determined by the quality of water it produces.

4.4.5 Perceptions on drinking water safety

Understanding individual's perception of safe drinking water was important as this might influence ones preference on water treatment method. Respondents were asked to state how they would tell that water is safe for drinking. The responses were captured as in table 4.10;

Table 4.10: Perception of the respondents on what constitutes safe drinking water?

Perception	Frequency	Percent
Water clarity	157	41.3
Water taste	127	33.4
Water Source	81	21.3
Water odour	10	2.6
Others	5	1.3
Total	**380**	**100.0**

From Table 4.10, out of the 380 respondents, 157 (41.3%) considered that water is safe on the basis of its clarity, 127(33.4%) considered water to be safe on the basis of its taste, 81(21.3 %) considered water to be safe on the basis of the source, 10 (2.6%) based the decision on water odour while 5 (1.3%) considered water to be safe based on other factors. The majority 157(41.3%) of the respondents agreed that water clarity dictates their perception of water safety. This finding concurs with Kioko *et al.*, (2012) who in a study carried out in

Kakamega, observed serious misconception and belief by the community about drinking water safety where 42% of the respondents used water clarity as a measure of safety.

4.5 Water source and adoption of Lifestraw Family water treatment method

The study sought to establish how water source determine the adoption of Lifestraw water treatment method in Matayos division. To realize the objective respondents were asked to state the frequently used water source, safety of the water source, accessibility and availability of the water sources.

4.5.1 Water sources used by respondents.

The study sought to establish the various sources of drinking water for the households. Respondents were asked to state the main source of their drinking water. Table 4.11 presents the responses.

Table 4.11: Water source most frequently used

Source	Frequency	Percentage
Protected Spring	232	61.1
Unprotected Spring	37	9.7
Well	56	14.7
Pump	24	6.3
Tap	24	6.3
Stream	7	1.8
Total	**380**	**100.0**

From Table 4.11, out of the 380 respondents, 232(61.1%), 37(9.7%), 56(14.7%), 24(6.3%), 24(6.3%) and 7(1.8%) used protected springs, unprotected springs, well, pump, tap and stream respectively. Therefore, majority of the respondents 232 (61.1%) collected water from the protected springs. This result validates finding by Kremer *et al,* (2008), which posited that naturally occurring springs are important source of drinking water in rural western Kenya as they contribute to 72% of all water collection trips and supports KDHS (2003) report that

43% of rural western Kenyan households use springs for drinking water.

4.5.2 Safety of the water sources

The study sought to assess the perception of households on the safety of drinking water sources and how this determined adoption of household drinking water treatment methods. Respondents were asked to state if their source water was safe for drinking. The responses are presented in Table 4.12.

Table 4.12: The extent to which the water source is safe

Extent	Frequency	Percentage
Very low	16	4.2
Low	23	6.1
Moderate	132	34.7
High	168	44.2
Very high	41	10.8
Total	**380**	**100.0**

From Table 4.12, 16(4.2%) argued that their water source was safe to a very low extent, 23(6.1%) claimed it was safe to a low extent, 132(34.7%) said it was moderate, 168(44.2%) stated that their water source was safe to a high extent and 41(10.8%) stated that their water source was safe to a very high extent. The results show that as many respondents as 209(55%) accepted that their water source was safe to a high and very high extent while a good proportion of the respondents 171(45%) acknowledged that their water source was safe to a low and very low extent. The use of LifeStraw in this community can be attributed to the perception that the water at the source was not safe.

These results affirm the findings of Godfrey *et al*. (2011) and Bain, (2012), who working on the microbial quality of “improved” drinking-water sources in south-eastern Asia, observed that the current definition of “improved water source” does not reliably predict microbial safety of the water, a fact that is widely acknowledged in the water sector today. This result demonstrates that there is need for treating water at the point of use to make it safe for drinking.

4.5.3 Access to clean water a challenge?

It was necessary to establish whether access to clean water was a challenge in the community. The respondents were asked to answer “Yes” if access to clean water was a challenge and “No” if access to clean water was not a challenge. The responses were tabulated in Table 4.13,

Table 4.13: Access to clean water is a challenge?

	Frequency	**Percentage**
Yes	181	47.6
No	199	52.4
Total	**380**	**100.0**

From Table 4.13, 199(52.4%) refuted the claim that access to clean water is a challenge while 181(47.6%) alluded to the fact that access to clean water was a real challenge in the community.

While majority 199(52.4%) of the households considered that access to clean water is not a challenge, the proportion of households with dissenting views was significant 181(47.6%). It is therefore not clear if access to clean water is a challenge in this community. However, the high proportion (47.6%) of households that attested that access to clean water was a challenge is a demonstration of the need to treat water at the household level. These findings imply that lack of access to clean water influenced adoption of Lifestraw family water treatment method.

4.5.4 Water treatment methods used by respondents.

Information on the existence and use of other methods of water treatment was of paramount importance in this study. Respondents were therefore required to give information on the water treatment methods they use mostly. The Table 4.14 below shows the responses.

Table 4.14: Methods used to make water safe for drinking

	Frequency	Percentage
Lifestraw	224	58.9
Boiling	31	8.2
Water guard	27	7.1
Chlorination	94	24.7
Others	4	1.1
Total	**380**	**100.0**

From Table 4.14, out of the 380 respondents, 224(58.9%) used Lifestraw, 31(8.2%) used boiling, 27(7.1%) used water guard, 94(24.7%) used chlorination and a paltry 4(1.1%) used other methods. Majority 224(58.9%) of the households used Lifestraw followed by chemical treatment (chlorination) with 123(31.8%). This finding can be attributed to the positive attributes of Lifestraw family intervention outlined in the sensitization messages; clear and safe drinking water, cheaper water treatment method i.e. donated and serviced free-of-charge by VAL, does not require any form of energy to operate, and the filter's ability to remove Cryptosporidium and Giardia parasites known to be resistant to chlorination.

4.5.5 Source attributes

The study sought to establish respondents' opinion on their water sources and how this determined adoption of LifeStraw water treatment method based on the following attributes; most accessible, cheapest, safest, most popular and most reliable. On a scale of 1, 2, 3, 4, 5 and 6 representing stream, spring, pump, tap, well and rainwater respectively, the respondents were asked to state their views on the water sources. Table 4.15 illustrate the results

Table 4.15: Source attributes

	N	Minimum	Maximum	Mean	Std. Deviation
Most accessible source	380	1	6	2.64	1.247
Cheapest Source	380	1	6	2.89	1.414
Safest Source	380	1	6	3.09	1.113
Most Popular Source	380	1	6	2.64	1.245
Most reliable source	380	1	6	2.62	1.215

From Table 4.15, all the sources had mean between 2 and 3 and standard deviation between 1.113 and 1.414. This implies that springs and pumps were the most accessible, cheapest, safest, most popular and most reliable sources of water in this community.

This can be attributed to the fact that the area has high water table, hence endowed with natural springs as well as enhanced ease of sinking boreholes and erecting water pumps.

4.6 Cost of water treatment

The study sought to assess the extent to which cost of water treatment influence the adoption of Lifestraw family water treatment at household level in Matayos division. The researcher sought the views of respondents on the following four attributes of water treatment; water treatment is expensive, use of LifeStraw is safer, use of LifeStraw is cheaper and treated water is the best irrespective of the cost.

4.6.1. Water treatment is expensive

The researcher sought the views of the respondents on whether water treatment was expensive or not. The respondents were required to state; strongly disagree, disagree, neutral, agree, or strongly agree. Table 4.16 illustrates the results.

Table 4.16:Water treatment is expensive

Extent of agreement	Frequency	Percentage
Strongly disagree	55	14.5
Disagree	115	30.3
Neutral	18	4.7
Agree	141	37.1
Strongly agree	51	13.4
Total	**380**	**100.0**

From Table 4.16, out of the 380 respondents, 55(14.5%) strongly disagreed that water treatment was expensive, 115(30.3%) only disagreed, 18(4.7%) of the respondents were neutral while 141(37.1%) and 51(13.4%) agreed and strongly agreed respectively. In summary, 192(50.5%) of the respondents agreed that water treatment was expensive while 170(44.8%) were of the contrary opinion. Water treatment was perceived to be expensive in view of purchase of water treatment chemicals and fuel for boiling water as well as the cost of maintenance of the filters. These findings imply that cost of water treatment influence choice and adoption of household water treatment method. This finding is in support of the finding of Lantagne *et al*., (2008) that although chlorination was socially accepted by the public for purifying water because of its ease of handling, cost effectiveness and good removal of microbial organisms in drinking water, a constant supply of chlorine must be guaranteed.

4.6.2 Use of LifeStraw is safer

Information on the safety of Lifestraw treatment method was of paramount importance in its adoption. The researcher therefore sought information on the safety of LifeStraw method from the respondents. The respondents were asked to state**;** strongly disagree, disagree, neutral, agree or strongly agree on whether use of LifeStraw family was safer method compared to the others. Table 4.17 shows the responses.

Table 4.17 use of LifeStraw is safer

	Frequency	**Percentage**
Strongly disagree	25	6.6
Disagree	43	11.3
Neutral	28	7.4
Agree	177	46.6
Strongly agree	107	28.2
Total	380	100

From Table 4.17, 25 representing 6.6% of the respondents strongly disagreed, 43 representing 11.3% of the respondents disagreed, 28 representing 7.4% were neutral, 177 representing 46.6% of the respondents agreed and 107 representing 28.2% of the respondents strongly agreed that LifeStraw method was safer. From the table majority 284(74.8%) of the respondents agreed that Lifestraw family was a safer method of water treatment compared to the 17.9% of the respondents who disagreed. These findings imply that the adoption of LifeStraw family was influenced by the perception that it was a safer water treatment method.

4.6.3. Use of Lifestraw is cheaper

Information on the cost of Lifestraw family water treatment method was of relevance in its adoption. The researcher therefore sought respondent's perception on how cheap the method was. The respondents were required to state; strongly disagree, disagree, neutral, agree and strongly agree to the statement on whether the treatment method was cheaper than other methods or not. The responses were recorded and presented in Table 4.18.

Table 4.18 Use of LifeStraw is cheaper

	Frequency	**Percentage**
Strongly disagree	22	5.8
Disagree	77	20.3
Neutral	25	6.6
Agree	134	35.3
Strongly agree	122	32.1
Total	**380**	**100**

From Table 4.18, 22(5.8%) of the respondents strongly disagreed that LifeStraw method was cheaper, 77(20.3%) only disagreed while 25(6.6%) were neutral. Among the respondents who acknowledged that the use of LifeStraw family method was cheaper, 134(35.3%) only agreed while 122(32.1%) strongly agreed. In summary majority of the households, 256(67.4%) agreed that the use of Lifestraw family was a cheaper method of treating water compared to 99(26.1%) who disagreed. This can be attributed to the free distribution and servicing of Lifestraw filters courtesy of VAL and the fact that the filter does not require energy or any other additional input to operate. These findings suggest that the awareness that LifeStraw family method was cheaper influenced its adoption.

4.6.4 Treated water is the best irrespective of the cost.

The researcher sought the views of the respondents on the statement “treated water is the best regardless of the cost. The respondents were required to state; disagree, strongly disagree, agree, strongly agree. The responses were recorded and presented on Table 4.21.

Table 4.19, Treated water is the best irrespective of the cost.

	Frequency	**Percentage**
Strongly disagree	28	7.4
Disagree	102	26.8
Neutral	16	4.2
Agree	138	36.3
Strongly agree	96	25.3
Total	**380**	**100**

From Table 4.19, 28(7.4%) of the respondents strongly disagreed, while 102(26.8%) only disagreed. 16(4.2%) of the respondents were neutral. 138(36.3%) only agreed while 96(25.3%) strongly agreed that treated water is the best irrespective of the cost. The results show that majority 234(61.6%) of the respondents agreed that treated water is the best irrespective of the cost. This result can be attributed to the perception by the respondents that treating waterborne diseases is more expensive than treating water. This finding is congruent to a similar study in Zambia by Ashraf et al., (2007) who found considerable evidence that the target population was willing and able to pay for some or all of the cost of household based water treatment products, leveraging public sector and donor funding and allowing more focus on the base of the economic pyramid. These findings were further subjected to cross tabulation analysis to establish how cost of water treatment determines individual decision to treat water or not. Table 4.20 shows the result of the tabulation.

Table 4.20:Treated water is safer * Treated water is the best irrespective of the cost Cross tabulation

		Treated water is the best irrespective of the cost					
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Treated water is safer	Strongly disagree	2	15	0	8	0	25
	Disagree	16	16	0	0	11	43
	Neutral	0	11	4	4	9	28
	Agree	6	47	3	86	35	177
	Strongly agree	4	13	9	40	41	107
Total		28	102	16	138	96	380

From Table 4.20, 68(17.9%) of the respondents disagreed that treated water is safer. Similarly 130(34.2%) respondents disagreed that treated water is best irrespective of cost. 234 (61.6%) of respondents attested that treated water is best irrespective of cost and 284(74%) agreed that treated water is safer. 49(12.9%) of the respondents disagreed that treated water is safer and best irrespective of the cost while 234 respondents agreed that treated water was safer and best irrespective of cost. Out of 68 respondents who disagreed that treated water is safer, 19 agreed that treated water was the best irrespective of cost while out of 284 respondents who agreed that treated water is safer, 70 disagreed that treated water was best irrespective of the cost. Overall, the majority 202(53.1%) of the respondents alluded to both statements that treated water is safer and the best irrespective of cost compared to 49 (12.9%) who disagreed with both statements. The realization by the households that treated water is safer and best irrespective of the cost is clear evidence that households would go an extra mile to ensure safe drinking water for their families. This implies that households could employ point-of-use water treatment methods such as LifeStraw family at household level to make water safe for drinking.

This finding can be attributed to individual’s knowledge on transmission of diarrhoea and water-borne diseases together with perceived susceptibility and severity of contracting waterborne diseases. This result affirms the position of the World Health Organization that "quality of drinking-water is a powerful environmental determinant of health and assurance of drinking-water safety is a foundation for the prevention and control of waterborne diseases (WHO, 2012)".

4.6.5 Duration of treatment time

The researcher found it important to establish the amount of time spent to treat drinking water by the different water treatment methods. This was important due to the understanding that time is money, and therefore duration of water treatment has a financial implication considering that an equal amount of time could be used to perform another productive work. The respondents were asked to estimate the amount of time it would take to treat equal quantity of water by boiling, filtering using LifeStraw and by chemical treatment using chlorine. The respondents were required to state; very short, short, moderate, long or very long to estimate the length of time. The mean and standard deviation were computed and presented as illustrated in Table 4.21.

Table 4.21: Length of treatment time

	N	Minimum	Maximum	Mean	Std. Deviation
Lifestraw length of time in treating drinking water	380	1	5	3.03	1.210
Boling length of time in treating drinking water	380	1	5	3.95	.971
Chemical length of time in treating drinking water	380	1	5	2.61	1.244

From Table 4.21**,** LifeStraw had a mean of 3.03 and standard deviation of 1.210, boiling had a mean of 3.95 and standard deviation 0.971 while chemical treatment (chlorine) had a mean 2.61 and standard deviation of 1.244. The results show that Lifestraw takes a shorter time compared to boiling and moderately the same length of time compared to chemical method. These findings indicate that time taken to treat drinking water determines adoption of household drinking water treatment methods, and validates findings by Clasen *et al* (2005) on water quality improvement for prevention of diarrhoea in Colombia, which found that a significant number of households took untreated water because the ceramic water filters took long to filter water and could therefore not filter enough water for the household members.

4.6.6 Distribution of respondents by household monthly income.

In order to determine the income of the households, respondents were asked to state their average monthly income. Establishing the average monthly income of the households was important in finding out how this relates with adoption of Lifestraw family water treatment method. Table results are illustrated on Table 4.22.

Table 4.22:Average monthly house hold income

	Frequency	Percentage
Up to Kshs. 3000	259	68.2
Kshs. 3001-5000	77	20.2
Kshs. 5001-10000	38	10.0
Above 10 000	6	1.6
Total	380	100.0

From Table 4.22, out of the 380 households interviewed 259 (68.2%) earned an average monthly income of Kenya Shillings 3,000 and below, 77 (20.2%) earned KSh 3100 -5,000, 38 (10%) earned Ksh 5100 -10,000 and 6 (1.6%) earned above Ksh10,000. These findings show that majority 336(88.4%) of the households are low income earners with less than Kshs 10,000.monthly income. This can be attributed to the fact that a good proportion of the population are peasant farmers and also due to lack of industries that could provide employment opportunities. These results were further subjected to cross tabulation to establish how monthly income determines adoption of LifeStraw family water treatment method. Table 4.23 illustrates the results.

*Table 4.23: Average monthly house hold income * The extent of Lifestraw water treatment acceptance Cross tabulation*

		The extent of Lifestraw water treatment acceptance				
		Low	Moderate	High	Very High	Total
Average monthly house hold income	Up to Kshs. 3000	19	82	102	56	259
	Kshs. 3001-5000	9	42	19	7	77
	Kshs. 5001-10000	0	12	24	2	38
	Above 10 000	0	2	4	0	6
Total		28	138	149	65	380

From the cross tabulation, 101(39%) of households earning Ksh 3000 and below had low to moderate acceptance to LifeStraw water treatment method, 158(61%) had high to very high acceptance to LifeStraw method. In the category of households earning between Ksh 3100-5,000, 51(66%) had low to moderate acceptance while 26(34%) had high to very high acceptance. 12(32%) of households earning Ksh 5,100 - 10,000 had low to moderate acceptance to LifeStraw method while 26(68%) in the same category had high to very high acceptance. For households earning over Ksh 10,000, 2(33%) had low to moderate acceptance and 4(67%) had high to very high acceptance to LifeStraw water treatment method.

Overall, the findings indicate that majority 210(55.3%) of households that accepted LifeStraw water treatment method to high and very high extent had an average monthly income of below Ksh 10,000. The results further indicate that acceptance declined with increase in household monthly income among the households that showed very high acceptance. These findings imply that majority of households that accepted LifeStraw methods to a high extent were the poorest, earning below Ksh. 10,000, as compared to the relatively more economically endowed households (earning above Ksh. 10,000). The high acceptance by the poorest can be attributed to free distribution, follow ups and free servicing of the filters by VAL. The findings imply that household income levels determined adoption of LifeStraw water treatment method.

4.6.7 Distribution of the respondents by household size

The number of people living in a household determines the quantity of drinking water consumed and time taken to treat the water which might have a bearing on choice of water treatment method. The study sought to establish the household size of the respondents and thus investigate the extent to which household size determines adoption of LifeStraw water treatment method. Respondents were asked to state the number of persons that live and feed in their household. The results are illustrated in Table 4.24: below.

Table 4.24: Distribution of respondents by house hold size

Number in HH	Frequency	Percentage
1-3	55	14.5
4-6	162	42.6
7-8	123	32.4
9-12	38	10.0
Above 12	2	.5
Total	380	100.0

From table 4.24; 55 (14.5%) respondents had between 1 and 3 persons living in their households, 162 (42.6%) had between 4 and 6 persons, 123 (32.4%) had between 7 and 8 persons, 38 (10%) had between 9 and 12 persons while 2 (0.5%) had above 12 persons living in their households. This result indicate that the majority of respondents, i.e. 162 (42.6%), had between 4 and 6 persons living in their households followed by households that had 7-8 (32.4%) persons. Households with more than 9 persons were the least (10.5%). The finding was further subjected to cross tabulation analysis to establish how household size determine acceptance of Lifestraw water treatment method as in table 4.25

Table 4.25: Number in the house hold * The extent of Lifestraw water treatment acceptance Cross tabulation

		The extent of Lifestraw water treatment acceptance				
		Low	Moderate	High	Very High	Total
Number in the house hold	1-3	4	20	26	5	55
	4-6	7	60	67	28	162
	7-8	13	42	40	28	123
	9-12	4	16	14	4	38
	Above 12	0	2	0	0	2
Total		**28**	**140**	**147**	**65**	**380**

Table 4.25, shows that 24(43.6%) of households with between 1 and 3 members had low to moderate acceptance of LifeStraw water treatment method while 31(56.4%) had high to very high acceptance of the LifeStraw water treatment method. In the category of households that had 4-6 persons, 67(41.4%) had low to moderate acceptance and 95(58.6%) had high to very high acceptance. 55(44.7%) of households that had 7-8 persons showed low to moderate acceptance, 68(55.3%) showed high to very high acceptance. For households with 9-12 persons, 20(52.6%) had low to moderate acceptance while 18(47.4%) had high to very high acceptance. All households with above 12 members had only moderate acceptance. These findings indicate that the majority 194(91.5%) of the households that accepted LifeStraw family water treatment to a high and very high extent had 1 – 8 members.

The results further indicate that the category of households with more than 12 persons had the least acceptance (0.5%) of the LifeStraw family method. These findings could be attributable to the fact that the larger the household size, the less the likelihood for the household to treat drinking water, possibly because of the time and cost involved. This finding validates findings of an empirical study by Maeusezahl, Pacheco & Tellez (2009) on solar drinking water disinfection to reduce childhood diarrhoea in rural Bolivia, who found that use of solar disinfection was positively associated with family size.

4.7 Alternative water treatment methods

The study sought to examine how alternative water treatment methods affect adoption of Lifestraw water treatment method at household level in Matayos division. The respondents were therefore requested to indicate whether they used other water treatment methods besides Lifestraw and whether they were satisfied with Lifestraw method of water treatment.

4.7.1 Use of other methods besides Lifestraw family

Information on other water treatment methods available to the respondents was important in establishing individual preferences of water treatment methods and how this determined the adoption of LifeStraw water treatment method. Respondents were required to state "Yes" if they used other methods besides LifeStraw and "No" if they used only LifeStraw. The results were tabulated and presented on table 4.26;

Table 4.26: use of other methods besides Lifestraw to treat water

	Frequency	Percentage
Yes	293	77.1
No	87	22.9
Total	380	100.0

From Table 4.26, out of 380 respondents, 293(77.1%) assented to using other water treatment methods besides LifeStraw while 87(22.9%) stated that they strictly use Lifestraw method of water treatment. These results indicate that majority (77.1%) of the households use alternative methods of water treatment besides Lifestraw. This could be construed to mean that the availability of other methods of water treatment provide households with options from which to make choices based on individual preferences, merits and demerits of the methods. This finding implies that the alternative water treatment methods affected the extent to which LifeStraw water treatment method was adopted.

4.7.2 Satisfied with Lifestraw family water treatment method

Households use LifeStraw water treatment method for various reasons. The study sought to establish the reasons for satisfaction with LifeStraw water treatment method. To determine this, respondents were asked to state "Yes" if satisfied and "No" if not satisfied with LifeStraw water treatment method. Table 4.27 presents their responses.

Table 4.27: Satisfied with Lifestraw as a method of treating water

	Frequency	Percentage
Yes	348	91.6
No	32	8.4
Total	380	100.0

Table 4.27; shows that majority of the respondents; 91.6% were satisfied with the use of Lifestraw water treatment method, only 8.4% stated that they were not satisfied with the method. The study further sought to establish the reasons for dissatisfaction with LifeStraw method from those who stated that they were not satisfied with the method. The analysis is captured in table 4.28

Table 4.28; Reasons for dissatisfaction with LifeStraw

	Frequency	**Percentage**
Cumbersome to use	12	37.5
Slow/takes long	10	31.3
Difficult to backwash	8	25
Easily spoilt/blocked	2	6.3
Total	**32**	**100**

Table 4.28 shows the reasons why some households were dissatisfied with Lifestraw method. The study found that out of the 32 (8.4%) respondents who were dissatisfied with LifeStraw water treatment method, 12(37.5%) argued that it was cumbersome to use, 10(31.3%) argued that the process was slow, 8(25%) reported that it was difficult to backwash while 2(6.3%) stated that the filter easily got spoilt or blocked.

From these findings, it can be deduced that individual’s perception about LifeStraw method had influence on its acceptance. This finding concurs with a study by Ngai (2011) on how small non-governmental organizations can improve their program implementation strategies to increase the adoption and sustained use of household water treatment systems in the developing world , who identified; individual’s awareness that the technology exists, along with prevailing social norms, habits and extent of observable benefits, as the among the major themes influencing the adoption of innovations.

4.7.3 Lifestraw attributes

The study sought to establish the extent to which the respondent agreed or disagreed to the attributes of Lifestraw method of water treatment. On a scale of 1-5, the respondents were required to respond; strongly agree, agree, moderately agree, disagree or strongly disagree. Their responses were summarized in Table 4.31.

Table 4.29, LifeStraw attributes

Lifestraw positive attributes.	N	Minimum	Maximum	Mean	Std. Deviation
Cheaper than other methods.	380	1	5	2.11	1.137
Safer than other methods.	380	1	5	1.89	0.944
Most commonly used method.	380	1	5	2.85	1.293

From Table 4.29 all the 380 (100%) respondents agreed that LifeStraw was both the cheaper and safer water treatment method compared to the other methods in Matayos division. With regards to use, there was moderate agreement that Lifestraw was the most commonly used. The findings imply that although majority considered LifeStraw method to be cheaper and safer than the others, it was however, not the most commonly used method due to perceived demerits namely; cumbersome to use, slow, difficult to backwash and easily blocked.

This finding is congruent to finding by Makutsa *et al*, (2001) working on point-of-use water treatment interventions in Kenya, observed that the higher adoption rates of chlorination among the study communities was due in part to ease of access and use of the product.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMENDATIONS

5.1 Introduction

This chapter presents summary of findings, conclusions, recommendations, contribution to the body of knowledge and suggestions for further research.

5.2 Summary of findings

The objectives of this study were to; determine the extent to which capacity building influence adoption of LifeStraw family water treatment method, establish how water source determine adoption of LifeStraw family water treatment method, assess the degree to which the cost of water treatment determine adoption of LifeStraw family water treatment method and examine how the alternative water treatment methods affect adoption of LifeStraw family water treatment method in Matayos division, Busia County, Kenya.

The first objective sought to determine the extent to which capacity building influence adoption of LifeStraw family water treatment method. The study found that a vast majority (93.4%) of households were enlightened on the use of LifeStraw family water treatment method and that 60% of those who received the training accepted Lifestraw as a water treatment method to a great extent. On the other hand the study found that 100% of those who did not receive training had moderate to low acceptance of Lifestraw method. The study further established that 25% of the households that adopted Lifestraw family water treatment method did so as a result of the sensitization that came along with it and that household visits and sensitization was the most commonly used mode of information dissemination about Lifestraw family method. These findings demonstrate that capacity building influenced the acceptance and adoption of LifeStraw family water treatment method.

The second objective sought to establish how water source determine adoption of LifeStraw family water treatment method. The study finding was that majority (61.1%) of the households in Matayos division drew water from protected springs and that a good proportion of the households (45%) consider water from the source unsafe. Majority (58.9%) of the households that considered water unsafe at the source used LifeStraw family water treatment method at the household level. The findings demonstrate that majority of the households perceived that water from the local sources were not safe and therefore need for treatment. These findings demonstrate that the quality of water at the source was a key factor in determining adoption of LifeStraw family water treatment method.

The third objective sought to assess the degree to which the cost of water treatment determines adoption of LifeStraw family water treatment method. The study found that majority (67.4%) of the households that used Lifestraw method considered it as a cheaper intervention while 74.8% acknowledged that Lifestraw was a safer method of water treatment. With regards to income, the study found that 56% of the households that accepted LifeStraw water treatment method had an average monthly income of below Shillings 10,000 and that acceptance declined with increase in household monthly income. The study further found that households with 1 to 8 members (56.7%) had higher acceptance of LifeStraw water treatment method while households with more than 12 members had the least acceptance (0.5%) of the LifeStraw method. With regard to the treatment duration, the finding was that LifeStraw took shorter time (mean of 3.01) compared to boiling (3.95) and moderately the same length of time compared to chemical treatment (2.61). From these findings it can be deduced that the adoption of LifeStraw family was higher among households that perceived it as cheaper and relatively fast process as well as smaller (1-8 members) and low income households (less that 10,000) per month. The study therefore found that cost was a major factor in determining adoption of LifeStraw family water treatment method.

Finally, the study sought to examine how the alternative water treatment methods affect adoption of LifeStraw family water treatment method. The study found that although majority of households (91.6%) were satisfied with the use of Lifestraw as a water treatment method with 67.4% and 74.8% of the households approving the method as the cheapest and the safest respectively, a good proportion (77%) of the households that adopted Lifestraw method also used alternative water treatment methods. Reasons advanced for use of alternative methods were; slow process, cumbersome refilling and occasional blockage. These findings imply that alternative water treatment methods affected the extent to which households adopted LifeStraw family water treatment method.

5.3 Conclusion

Capacity building empowered households with knowledge and skills on LifeStraw family water treatment method and was a key factor in the adoption of the technology in Matayos division. Similarly, household visits and sensitization was an effective approach of disseminating LifeStraw information and its adoption in Matayos division.

Protected springs were the major source of water in Matayos division. However the perception by a good proportion (47%) of households that the water from the springs was not safe influenced treating of water at the household and was a key factor in the adoption of LifeStraw family water treatment method in Matayos division.

Cost of water treatment whether fiscal (monetary) or non-fiscal (length of time) had a bearing on the choice and adoption of water treatment method. It was evident that majority (67.4%)

of the households chose LifeStraw on the basis that it was the cheapest method while a good proportion (68.8%) of households that used other methods, did so on the basis that LifeStraw family was slow and cumbersome to refill, a manifestation that cost had significant effect on the adoption of LifeStraw family water treatment method in Matayos division.

The availability of alternative water treatment methods provided options from which households made choices based on the merits and demerits of the methods, and this affected the extent to which LifeStraw family water treatment method was adopted in Matayos division.

5.4 Recommendations

Based on the findings and the conclusions of the study, the researcher puts forward the following recommendations:

1. The Water, Sanitation and Hygiene stakeholders should develop appropriate health behaviour change messages with special focus on benefits of water treatment to increase uptake and adoption of household drinking water treatment methods.
2. Ministries of Health and Water should regularly undertake water quality assessments on all the water sources to establish their safety.
3. The ministry of water should explore ways and means of providing clean and safe water for all citizens in line with UN convention on safe water.
4. Vestergaard Africa Limited (VAL) should explore further improvements on LifeStraw family filter to enhance its capacity and efficiency.

5.5 Contribution to the body of knowledge

The findings of the study have generated additional contributions towards the body of knowledge as spell out in the figure below;

Objective	Contribution to the body of knowledge
To determine the extent to which capacity building influences adoption of Lifestraw family water treatment method at household level in Matayos division.	Training, household visits and sensitization influenced the adoption of LifeStraw family water treatment method to a great (60%) extent.
To establish how water source determine adoption of Lifestraw family water treatment method at household level in Matayos division.	The nature and quality of water at the source have a moderate effect (58.9%) on the adoption of LifeStraw family water treatment method.
To assess the degree to which the cost of water treatment determine adoption of Lifestraw Family water treatment method at household level in Matayos division.	The adoption of LifeStraw family water treatment method was highly (67.4%) influenced by the cost.
To examine how the alternative water treatment methods affect adoption of Lifestraw family water treatment method at the household level in Matayos division.	Availability and access to alternative water treatment methods have effect on the adoption of LifeStraw family water treatment method.

5.6 Suggestions for further research

In addition to this study, further research should be conducted in the following areas to understand the determinants of LifeStraw family water treatment method.

1. Replication of the study in another sub county.
2. The sustainability of adoption of LifeStraw family water treatment method in Western part of Kenya.
3. Correlation study on the adoption of LifeStraw water treatment method and the prevalence of waterborne diseases.

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APPENDICES

3.8 Appendix I Household Questionnaire

Questionnaire Number: ………………………………………………

Date: ……………………………………………………………………

Interviewer ID :………………………………………………………

3.9 QTH - Questionnaire to Households

I am Gerald Omolo Adhaya, a student at the University of Nairobi pursuing this research for the degree of Master of Arts in project planning and Management. For the purpose of fulfillment of my degree, I kindly request you to fill the questionnaire as required to the best of your knowledge with sincerity. The information given by you will be confidentially treated and only used for the said purpose.

Please put a tick (√) in the box next to the correct response.

A. Demographic Characteristics

1. Age in Years:

   25 – 30 □

   31 – 35 □

   36 – 45 □

   Above 45 □

2. Gender: Male □ Female □
3. Marital status: Married□ Single□Divorced □Widowed □
4. Highest level of education attained: Primary □ Secondary □ College and above □
5. Location: Bukhayo West □ Busibwabo □ Lwanya □ Nang'oma □ Nasewa □
6. Religion: Muslim □ Christian □ Other □

   Specify………………………………………….
7. What is the main occupation of the household head?

Farming □Family Business □Paid employment □ Other □

Specify…………………………………………………………………………………………
…..

8. What is the average monthly household income?

   Up to Ksh. 3 000 □Ksh. 3 001 – 5 000 □Ksh. 5 001-10 000 □Above Ksh. 10 000 □

9. How many are you in this household?

   1-3 □4-6 □ 7-8 □9 - 12 □Above 12 □

10. Does your religious belief accommodate Lifestraw method of water treatment? Yes□ No□

B. Capacity Building

11. Have you ever received any training on Lifestraw water treatment? Yes □ No □

12. Tick appropriately with regard to mode of access to information on Lifestraw water treatment method.

Mode	**Not used**	**Least used**	**Used**	**Mostly used**
Household	1	2	3	4
Campaigns	1	2	3	4
Barazas	1	2	3	4
Dialogue days	1	2	3	4
Health Centres	1	2	3	4

13. To what extent do you accept the use of Lifestraw water treatment?

Very Low□Low□Moderate□ High□Very High □

14. Which of the following would you say greatly influenced your choice of Lifestraw water treatment method?

    Sensitization □ Water quality□ Duration of the treatment process □ Cost of treatment □ 5. Other□; specify ---

15. How would you tell that water is safe for drinking?

    Water clarity□Water taste □Water source□ Water odour □other □specify --------------------
----

C. Water Sources

16. Which water source do you use most frequently for your household?

Protected Spring ☐ Unprotected Spring ☐ Well ☐ Pump ☐ Rain water ☐ Tap ☐Stream ☐

17. To what extent is the source in 16 above safe for drinking?

Very Low ☐ Low ☐ Moderate ☐ Great ☐ Very Great ☐

18. In your opinion is access to clean and safe water a problem in this region?

Yes ☐ No ☐

19. What method do you use to make water safe for drinking?

Lifestraw ☐ Boiling ☐ Water guard ☐ Chlorination ☐ Others☐ Specify

……………………………………………………………………………………..

20. What is your opinion on the sources of water below based on the given attributes;

Source of Water	**Stream**	**Spring**	**Pump**	**Tap**	**Wells**	**Rain water**
Most accessible Source	1	2	3	4	5	6
Cheapest Source	1	2	3	4	5	6
Safest Source	1	2	3	4	5	6
Mostly popular Source	1	2	3	4	5	6
Most reliable Source	1	2	3	4	5	6

D. Cost of water treatment

21. What is your view on the following?

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Water treatment is expensive	1	2	3	4	5
Treated water is safer	1	2	3	4	5
Use of Lifestraw is cheaper	1	2	3	4	5
Treated water is the best irrespective of the cost	1	2	3	4	5

22. How long do the following methods take in treating drinking water?

Treatment method	**Very Short**	**Short**	**Moderate**	**Long**	**Very Long**
Lifestraw	1	2	3	4	5
Boiling	1	2	3	4	5
Chemical	1	2	3	4	5
Others	1	2	3	4	5

E. Alternative water treatment methods

23. Other than Lifestraw, do you use other methods to treat water? Yes □ No □

If Yes Name them

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……

24. Are you satisfied with Lifestraw as a method of treating water? Yes □ No □

If No why

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………...

25. To what extent do you agree with the following in the scale 1-5

Treatment method	Strongly Agree	Agree	Moderate	Disagree	Strongly disagree
Lifestraw is cheaper than other treatment methods	1	3	3	4	5
Lifestraw is Safer than other treatment methods	1	3	3	4	5
Lifestraw is the most commonly used method.	1	3	3	4	5

Appendix II : Key Informant Questionnaire

1. What are some of the common water borne diseases in Matayos division?

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…………………………………………………………………………………………
…………………………………………………………………………………………
………………

2. Which methods do you use to access the households of Matayos division regarding water safety?

…………………………………………………………………………………………
…………………………………………………………………………………………
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3. What are the drinking water sources in Matayos Division? To what extent are they safe for drinking?

…………………………………………………………………………………………
…………………………………………………………………………………………
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……………………

4. What do you say about the cost of household water treatment in the division?

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…………………………………………………………………………………………
…………………………………………………………………………………………
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……………………

5. Are there alternative water treatment methods used by households in Matayos division? If yes rank them in order of frequency of use.

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
……………………

APPENDIX III: RESEARCH AUTHORIZATION

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
KISUMU CAMPUS

The Secretary
National Council for Science and Technology
P.O Box 30623-00100
NAIROBI, KENYA

28th April, 2017

Dear Sir/Madam,

RE: OMOLO GERALD ADHAYA - REG NO: L50/64550/2010

This is to inform you that **Omolo Gerald Adhaya** named above is a student in the University of Nairobi, College of Education and External Studies, School of Continuing and Distance Education, Kisumu Campus.

The purpose of this letter is to inform you that **Gerald** has successfully completed his **Masters** course work and Examinations in the programme, has developed Research Proposal and submitted before the School Board of Examiners which he successfully defended and made corrections as required by the School Board of Examiners.

The research title approved by the School Board of Examiners is: ***"Determinants of Adoption of Lifestraw Family Water Treatment Method in Matayos Division, Busia County, Kenya"***. The Project is part of the pre-requisite of the course and therefore, we would appreciate if the student is issued with a research permit to enable him collect data and write a report. Research project reflect integration of practice and demonstrate writing skills and publishing ability. It also demonstrates the learners' readiness to advance knowledge and practice in the world of business.

We hope to receive positive response so that the student can move to the field to collect data as soon as he gets the permit.

Yours Faithfully

CO-ORDINATOR
SCDE – KISUMU CAMPUS
28 APR 2017
P. O. Box 825 – 40100,
KISUMU

Dr. Raphael O. Nyonje, PhD
SENIOR LECTURER & RESIDENT LECTURER
DEPARTMENT OF EXTRA-MURAL STUDIES
KISUMU CAMPUS

APPENDIX IV: RESEARCH PERMIT

NATIONAL COMMISSION FORSCIENCE,
TECHNOLOGY ANDINNOVATION

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Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/17/78532/17321**

Date **3rd July, 2017**

Gerald Omolo Adhaya
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Determinants of adoption of Lifestraw Family Water Treatment method in Matayos Division, Busia County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Busia County** for the period ending **19th June, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Busia County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Busia County.

The County Director of Education
Busia County.

National Commission for Science, Technology and Innovation is ISO9001: 2008 Certified

Scanned by CamScanner

APPENDIX V: RESEARCH CLEARANCE PERMIT

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

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National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 14539

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. GERALD OMOLO ADHAYA
of UNIVERSITY OF NAIROBI, 0-40123
Kisumu, has been permitted to conduct research in *Busia County*

Permit No : NACOSTI/P/17/78532/17321
Date Of Issue : 3rd July,2017
Fee Recieved :Ksh 1000

on the topic: ***DETERMINANTS OF ADOPTION OF LIFESTRAW FAMILY WATER TREATMENT METHOD IN MATAYOS DIVISION, BUSIA COUNTY, KENYA.***

for the period ending:
19th June,2018

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

APPENDIX VI: PLAIARISM TEST REPORT

Turnitin Originality Report

- Processed on: 08-Dec-2017 09:38 EAT
- ID: 892507506
- Word Count: 20652
- Submitted: 1

Proposal *By Gerald Adhaya*

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APPENDIX VIII: MAP OF THE STUDY AREA (MATAYOS DIVISION)