WATER SERVICE DELIVERY IN HARARE:

A WILLINGNESS TO PAY (WTP) ANALYSIS

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ABSTRACT

In 2008-2009, Harare (Zimbabwe) was the centre of the worst cholera outbreak in Africa in the past fifteen years. A key reason cited was the lack of adequate water service delivery by the Harare City Council (HCC). Harare requires an optimum supply of 1 400 mega litres (ML) of water daily but the HCC has capacity to produce 650ML and after leakages and theft, only 400ML reaches consumers. This inadequacy compromised the hygiene of residents and forced them to resort to unsafe water sources. Coupled with a failing healthcare system, the outbreak resulted in over 4 000 deaths and further affected 100 000 people. The HCC attributes its poor service delivery to the lack of funds rendering them unable to adequately increase capacity and refurbish existing infrastructure (treatment plants and pipelines).

This thesis serves to explore whether the residents of Harare (and surrounding satellite towns) would be willing to pay monthly contributions towards the USD$2.5 billion needed for various water capacity and infrastructure projects to ease the water crisis in Harare. The study analyses the water problem using a framework on the typical stages of water provision. The research also places an emphasis on the key social, economic and political factors that are contributing to the problem in Harare.

Upon closer inspection, it was seen that the financial problems that the HCC is having are not only due to the economy, but poor management and transparency structures are also to blame. For various reasons, the government has largely lost its credibility with its citizens, leading some to conclude that the government's actions reflect those of a predatory state.

The contingent valuation method (willingness to pay-WTP) was used in conjunction with the dichotomous choice referendum. The binary probit model was used to help assess the degree to which different variables influenced the respondent's decision to contribute to the needed funds. In spite of the seeming lack of trust, it was found that approximately 66.19% of the respondents were willing to pay. Amongst those willing, the mean willingness to pay amount was approximately USD$7 monthly per household.

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LIST OF ABBREVIATIONS

AGI-	African Growth Institute
CV-	Contingent Valuation
DC-	Dichotomous Choice
DO-	Dissolved Oxygen
EMA-	Environmental Management Authority
HCC-	Harare City Council
HDI-	Human Development Index
IBR-	Increasing Block Rate
MDG-	Millennium Development Goals
MES-	Minimum Efficient Scale
ML-	Mega Litres
NOAA-	National Oceanic and Atmospheric Administration
NRW-	Non Revenue Water
NRZ-	National Railways of Zimbabwe
OECD-	Organisation for Economic Co-operation and Development
SDG-	Sustainable Development Goals
SLRS-	Sri Lankan Rupees
TC-	Total Cost
TFC-	Total Fixed Costs
TVC-	Total Variable costs
UNDP-	United Nations Development Programme
USD-	United States Dollars
WBCSD-	World Business Council for Sustainable Development
WH-	Water Hyacinth
WHO-	World Health Organisation
WTA-	Willing(ness) to Accept
WTP-	Willing(ness) to Pay
ZAR-	South African Rand

ZIMRA- Zimbabwe Revenue Authority

ZIMSTAT- Zimbabwe Statistics

ZINWA- Zimbabwe National Water Authority

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CHAPTER 1

1.1. Introduction

> *There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly… We have threatened our water resources with bad institutions, bad governance, bad incentives, and bad allocations of resources. In all this, we have a choice. We can continue with business as usual, and widen and deepen the crisis tomorrow. Or we can launch a movement to move from Vision to Action - by making water everybody's business* (Cosgrove & Rijsberman, 2014: xix,xxvii).

Water is one of the most abundant resources on earth with over 70% of the earth's surface being covered in water. However, 95% of this is salt water and of the remaining freshwater only 2.6% is readily accessible for use (Shiklomanov, 1993). Access to potable water is vital to the survival of all people around the world, but over a billion people lack access to safe drinking water and the figure for those without adequate access to proper sanitation stands at over two and a half billion (European Union, 2011). Water scarcity is both quantitative and qualitative, the latter being influenced by increases in urban settlements, industrial sectors and commercialized agriculture (Saleth & Dinar, 2004:1). An estimated 46% of the population in sub-Saharan Africa lacks access to potable water and the target of servicing this region with safe water is hoped to be achieved by 2040 (Manzungu *et al*., 2012: 454).

Numerous consequences are associated with the insufficient provision of water, particularly in urban regions which are characterised by relatively high population densities. Population control is seen as one of the steps in a bid to avert the anticipated wide-spread water crisis in the world (Shiklomanov, 1993). This is however something that can only be attained in the long-term. What is more readily feasible is adopting water management techniques that increase accessibility (supply management) and promote more efficient use of water (demand management) (Falkenmark & Widstrand, 1992).

The rate of urbanisation in the developing world is often much higher than the rate at which existing water infrastructure and capabilities of management can be upgraded (Manzungu *et al*., 2012: 454). Such trends have given rise to some urban areas becoming a hub of waterborne diseases - 'bacteriological cities'. This term can be applied to the cities of Lagos (Nigeria) and

Nairobi (Kenya), and since 2008 the capital city of Zimbabwe - Harare, has joined these ranks.

1.2. Background: Water Service Delivery to Harare

Harare (formerly Salisbury) was renamed after independence in 1980 and is surrounded by the satellite towns of Chitungwiza, Epworth, Norton and Ruwa. During the 2008-2009 period, Harare was struck by a massive cholera outbreak which was labelled as being the worst in Africa in the past fifteen years. This outbreak was further aggravated by a failing healthcare system and ultimately saw the death of thousands with even more people affected (Chenga, 2013). Inadequate provision of safe municipal drinking water was the main factor contributing to the cause of the endemic which started in the high density suburb of Budiriro (Mason, 2009). Cuts in water service provision are now prevalent throughout Harare and the neighbouring satellite towns.

It is important that water supply adapts to the changing physical and economic characteristics of a city (Livingston, 1994). This failed to happen in Harare as high population growth rates were not adequately matched by increases in infrastructure capacity - namely laying of new pipes and upgrading existing water treatment plants. ZIMSTAT (2012) estimates the population of Harare and its surrounding satellite towns to be over two million. Harare was also reported to have a population growth rate of 2% whilst that of the country as a whole is 1.1%, which has led to Harare having the highest population density in Zimbabwe with an estimated 2 500 people per square kilometre (ZIMSTAT, 2012).

Water shortages in a metropolis of a country not only have negative connotations for that city, but also reflect on the country's ability (or inability) to manage its urban areas (Manzungu *et al*., 2012). Typically water provision to an urban area involves five stages - namely abstraction, treatment, storage, distribution to consumers and the subsequent collection and processing of generated wastewater which then gets fed back into the system to be used again (Nhapi & Hoko, 2004). With the 'quality' of each stage being dependant on the preceding one, it is important to make sure that each stage is as efficient as possible so as to avoid compounding the problem.

Challenges in acquiring sufficient stocks of the water treatment chemicals aluminium phosphate and bauxite were cited as one of the reasons for the water shortages in Harare by the then Harare Mayor (Masunda, 2013). Another key problem is that almost 50-60% of the

treated water does not find its way to households as there are numerous leakages[1] due to old and worn pipes that need to be replaced. The worn out pipes also affect the water quality as in many areas tap water was reported to have a noticeably brown colour and contained rust particles (Karimakwenda, 2013).

Basic services in Zimbabwe are provided by the nine public enterprises in the country. With the exceptions of the telecommunications and air travel sectors where the private sector is highly visible, the remaining public enterprises face very little competition (Hove & Tirimboi, 2011). The Zimbabwe National Water Authority (ZINWA) and City Council have a clear monopoly in the management of (raw and clear) water in Harare. Table 1.1 highlights the changes in water management in Harare from independence (1980) to the present day.

Table 1.1: Water Management Dynamics in Harare

Period	**Managing entity**
1980-2005	Harare City Council
2005-2009	ZINWA
2009-present day	Harare City Council

(Source: Adapted from Hove & Tirimboi, 2011)

Under their (HCC and ZINWA) management, the quality of water service delivery has been decreasing as they have been facing challenges since the late 1990s (Jonga & Chirisa, 2009: 169; Musemwa, 2008). The situation reached dire levels in 2005 under the management of the ZINWA. Prior to 2005, as per the requirements of the 1998 Water Reform Act, water delivery was under the management of Urban Councils. In Harare, the Harare City Council (HCC) was the service provider. The Zimbabwean government ultimately responded by revoking the ZINWA management mandate and returned it back to the HCC in 2009 (Hove & Tirimboi, 2011). Such dynamics in the management of utilities are not uncommon in the developing world. This led Baietti *et al*. (2006) to describe the constant changing of utility management as being a vicious cycle that most governments are stuck in.

Water service in Harare is unpredictable and taps can be dry for anything from a few hours to several months. The longer dry periods are usually in high density and relatively new suburbs

[1] Appendix 4 shows a picture of a burst pipe in the Avenues in Harare. Such sights are common across Harare.

(Karimakwenda, 2013). In light of these shortages, the people of Harare and its surrounding areas have devised numerous coping techniques to avert and mitigate the effects of irregular water service delivery. From the researcher's observations these coping methods involve storing water, sinking private boreholes/wells, buying water, using public taps and collecting from friends and relatives. The water shortages have promoted the rise of opportunistic entrepreneurs as the business of bulk water selling is booming. From the researcher's general enquiries, in January of 2015 it costs an average of USD60 (approximately ZAR 775) for a 5 000 litre delivery of water - depending on factors such as location. This water is mostly obtained from underground sources and the ZINWA has mandated that such businesses register with the water authority in a bid to curb sporadic abstraction and help monitor the level of the water table (Horsfield, 2013).

The quality of water provided by the ZINWA is questionable and has been likened to 'filtered urine' mainly due to the condition of water in the reservoirs from which the water is sourced for purification (Zhangazha, 2012). Water for Harare comes from four key surface sources, namely Lake Chivero, Lake Manyame, Seke dam and Harava dam. All these sources are highly polluted and contain critical levels of nutrient enrichment mostly from untreated sewage flowing into their respective catchment areas (Nhapi *et al.,* 2002). Lake Chivero and Lake Manyame have the greatest capacity and supply 95% of Harare's population via the Morton Jaffray Water Works. The Morton Jaffray Water Works plant was constructed in 1954 and is in desperate need of intensive refurbishment. The Seke and Harava dams are smaller and are serviced by the Prince Edward Water Works (Nhapi & Hoko, 2004).

According to Zimbabwe's 2012 census data projections, the demand for water in Harare was estimated at 1 400 mega litres per day (ZIMSTAT, 2012). The Harare City Council (HCC) has capacity to produce approximately 620 mega litres daily. However, due to obsolete machinery this is reduced to 400 mega litres. The volumes that eventually reach consumers dwindle further to 140 mega litres because of theft and leakages (Chenga, 2013). Water lost through theft and leakages is called non-revenue water (NRW) and is essentially water that is produced but does not get sold to consumers. In Harare approximately 60% of the produced water becomes NRW. Such high NRW values are not limited to Harare only; New Delhi (India) was reported to be experiencing NRW values of up to 55%. In addition to theft and leakages, New Delhi also has an issue with NRW from water that is provided free through exemptions commonly extended to the poor (Gupta, 2011).

In an interview with the Harare town clerk, it was stated that the Harare City Council needed over USD40 million for refurbishment of pipes - some of which have been in place for over 40 years (The Herald, 2009). The total amount required including that for various capacity expansion projects is USD2.5 billion (Moyo, 2013). This comes at a time when the HCC is under the spotlight regarding its financial budget which failed to give adequate attention to the water problem. In 2011, three quarters of the council's budget was allocated to an exorbitant wage bill and at the time the Council claimed to be understaffed and proposed to add 3 500 more workers to their existing 9 800 (Chenga, 2013). The above factors suggest that the relevant authorities seem to place little urgency on rectifying the water problem.

In addition, securing revenue from water bill collection proves to be a challenging task. In the past, the government has cancelled[2] rates and water bills that were in arrears by the consumers (Chenga, 2013). Unfortunately such actions do not guarantee that residents will start paying new bills. Some government ministries and departments were also reported to be a major debtor owing over USD130 million in arrears (Masunda, 2013). It is such factors that beg the question of whether the public sector is the best option for provision of water in Harare or whether the private sector could do a better job (Bakker, 2013). Finances are clearly a problem. The research investigates whether or not consumers would consider providing the necessary funds for a more reliable water service.

This investigation overall analyses water service provision and pricing in an urban context. Pricing of any normal good or service ideally reflects the relative value of said good or service. This is not so easily the case for vital water service which is mostly provided through government subsidies using public funds. With increased poor management of water (coupled with economic circumstances), some governments are unable to maintain the increasing costs of providing subsidised water to their citizens. This inability is highlighted by reduced quality of service provision which in turn leads to a host of other problems.

[2] Outstanding bills for residential water consumers were cancelled shortly before the elections in July 2013 (Ruwende, 2014a).

1.3. Goal and Objectives of the Research

This study focuses on determining whether Harare residents are willing to pay more for improved water service provision. This would involve residents supplementing some of the public funds needed to provide a reasonable level of water service delivery. A reasonable level of water service delivery would be where the water service provided meets the relevant quantity and quality requirements. The study's main objectives are as follows:

- To discuss the pricing considerations for water service delivery.
- To investigate the main problems surrounding the supply of potable water to Harare.
- To determine the willingness to pay (WTP) of consumers for improvements in water service delivery.

1.4. Methodology

The study is interdisciplinary in nature and involves developmental, environmental and institutional aspects. The research makes use of a literature review and a questionnaire to highlight the various problems surrounding the inadequate provision of water in Harare. Part of the problem lies in the very nature of water as a life sustaining resource that has no substitutes. The fact that water is not perfectly divisible in its storage or transportation poses additional complications to the institutions responsible for its regulation.

Chapter 3 will discuss the economic theory of water provision by a natural monopoly as well as its regulation. Historically, to cater for increased demand of water, water authorities commonly made use of supply management techniques which sought to increase the supply of available water. Nowadays with global issues surrounding water security, it is no longer sustainable to use supply management techniques and authorities are now making use of demand management techniques which seek to reduce the water demanded by consumers. Chapter 3 will discuss water pricing methods as a form of demand management – more specifically how water should be priced to send the right signals to consumers regarding the full costs of provision and also taking into account factors such as consumer welfare and continuity of the natural monopoly.

The study takes a positivist approach and uses a questionnaire to elicit responses regarding the willingness-to-pay of consumers for improvements (inclusive of upgrading and refurbishing

existing infrastructure) in water service delivery. The questionnaire was to be administered to a sample of approximately 120-150 randomly selected households to represent the population of Harare and its immediate surrounding areas. The questionnaire was designed for self-completion by respondents and it was planned to be administered over a period of four weeks.

A dichotomous choice question was presented to respondents regarding whether or not they were WTP. Respondents that stated that they would be WTP were further asked to select a monetary amount. Various amounts were presented to respondents using a payment card and the respondents selected the amount closest to what they would be willing to pay. The payment vehicle would be a fixed monthly levy to be paid in excess of the rates and water bills of the consumers to the City Council. Under close supervision, the HCC would forward the money to a third-party body to coordinate the necessary water system upgrades. Finally, a binary probit model was used to analyse the probability of a respondent being willing to pay for improvements in water service delivery.

1.5. Outline

To address the objectives, the thesis is organised in six chapters as follows: Chapter 2 will discuss the water situation in Harare as well as the main issues behind the water problem. The theoretical economic aspects of water pricing and service provision are reviewed in Chapter 3 and this is followed by Chapter 4 which contains a discussion of the methods and procedures that were performed in conducting the WTP study. Chapter 5 presents the descriptive results from the questionnaire as well as the empirical results of the probit model. The thesis ends with Chapter 6 which gives the main conclusions of the research as well as recommendations for policy design.

CHAPTER 2

The Water Situation in Harare

2.1. Introduction

Water has numerous uses, from critical domestic uses for drinking and sanitation to uses that support the economy in industry and agriculture. Factors such as climatic conditions, technology, wealth and lifestyle influence the quantity required for these uses (Gleick, 1996). One could say that there are two main causes of water scarcity, those that are natural and beyond our control, for example, low precipitation and those that result from human actions, for example, the inability to secure adequate financial resources (Mehta, 2001). Ohlsson and Turton (1999) use the terms 'first-order scarcity' to refer to physical (natural) scarcity and 'second-order scarcity' to refer to economic (human action) water scarcity. The situation in Harare reflects the latter.

Water is also a key part of human life as it supports the various processes of the human body as well as the removal of waste. As a result, a minimum intake of water is required to sustain life; if this requirement is not met dehydration occurs (Kleiner, 1999). Regarding the life sustaining properties, questions such as 'how much water is "enough"?' spark some debate. According to the World Health Organisation (WHO) (1993) guidelines, an adult human needs to consume approximately two litres of water daily and a child requires one litre.

Domestic use of water can be classified into three main types - consumption (drinking and cooking), hygiene and amenities (such as car washing and watering plants). Uses for basic health protection (hygiene) are more water intensive than consumption and include washing food, laundry and bathing. Inadequate provision for these uses results in poor hygiene which is associated with for example diarrhoea and other diseases transmitted through the faecal-oral channel and those related to infestations (Howard & Bartram, 2003).

2.2.The Provision of Water

Internationally, there continues to be a focus on increasing water availability due to the numerous health benefits that stem from adequate and safe water provision. For

example, the millennium development goals (MDG) are eight goals that were devised as part of a United Nations initiative at the Millennium Summit and the World Summit on Sustainable Development in 2000 and 2002 respectively. Improving accessibility to water and sanitation is captured under the seventh goal which is to do with Ensuring Environmental Sustainability. To achieve this goal, certain targets must be met. Of particular relevance is target ten: to halve the "proportion of people without sustainable access to safe drinking water and basic sanitation" by 2015 (Target Ten) (UN, 2014). To reach this target, during the period 2002 to 2015 reliable water supply service for consumption must be expanded to an additional 1.3 billion people currently without water and to 1.9 billion people who currently lack sanitation. This works out to 100 million people annually for the former and 145 million annually for sanitation (Sanctuary & Berntell, 2012). The deadline for the MDGs has since lapsed and they have been revised into seventeen Sustainable Development Goals (SDGs) with 169 new SGD targets to be attained by 2030 (UNDP, 2015).

Increased access to water also significantly contributes to economic growth and poverty alleviation. It was seen in a study amongst low income countries that those that had better access to potable water and waterborne sanitation experienced an average economic growth of 3.7% whilst those that did not have such access had an average growth of only 0.1% per annum (Sanctuary & Berntell, 2012). It was also established that overall, the economic benefits from improved access to water were much greater than the costs associated with the relevant improvements. Depending on the region and technologies implemented, it was seen that benefits ranging from USD3 to USD34 could be realised for each USD1 invested (Sanctuary & Berntell, 2012). These benefits would be realised by the improvements in individual and household health as well as improvements in the industrial and agricultural sectors. In addition, areas where rainfall patterns are less reliable, increased water storage capacity can boost economic growth by making the economy more resilient to rainfall variability.

According to Sanctuary and Berntell (2012), investing in water is "good business" as various economic sectors stand to benefit from better water supply and management. Having access to clean, reliable and sufficient water services is critical to business development as it was seen to reduce business risk by offering a competitive advantage which ultimately attracts business opportunities. In 1992, water pollution in China eventually cost their economy a USD1.7 billion loss in income (Sanctuary & Berntell, 2012). If the MDGs are met

regarding sanitation and water supply, it is probable that significant gains in increased productivity could be potentially realised from reduced sick days from work. This was estimated to be 322 million days annually or worth USD750 million internationally (Howard & Bartram, 2003). At the household level, benefits can be realised from time saved due to more accessible water services (Young & Loomis, 2014).

2.3. The Case of Harare - Zimbabwe

Many countries in Africa (and in other continents) have experienced rapid rates of urbanisation in the past few decades. However unlike more developed countries, economic growth has failed to match the rates of urbanisation (Brown & Funk, 2010). The capital city of Zimbabwe, Harare is no exception.

Harare is home to 2 098 199 people[3] - approximately 17% of the Zimbabwean population, who are housed in approximately 530 000 households with an average of four people per household (ZIMSTAT, 2012). Population density is high, approximately 2 500 people per square kilometre. Such high population density has unfortunately not been matched with adequate provision of resources like water and this has resulted in a host of social problems.

Harare has been experiencing problems in the water service sector where service coverage is also low, covering less than 60% of the region. Poor service quality is evidenced in an inefficient billing and revenue collection system and significant volumes of water unaccounted for. Together with other issues such as low tariffs, these factors have contributed to poor municipal organisation, decrepit sanitation and water infrastructure and overall poor planning (Manzungu *et al.*, 2012).

2.3.1. Coping measures

Given the widespread shortage of water for basic activities, residents have adopted various coping measures to help alleviate the problem. Manzungu and Chioreso (2012) carried out a study to determine the residents' ability to 'internalise' the crisis and whether or not this could possibly lead to a partnership between the Harare City Council (HCC) and residents. Such a partnership could give rise to a new governance structure for water in Harare which

[3] According to the 2012 national census data.

could be a possible and sustainable solution. Residents' internalisation of the crisis has two aspects to it - a compensating mechanism and a coping strategy. Coping is for example when residents find short-term solutions to their water shortage such as sinking boreholes and in the process they are compensating for the shortfalls of the HCC (Manzungu & Chioreso, 2012).

Manzungu and Chioreso (2012) concluded that residents employed various short-term and long-term methods to cope with the water shortages. Regarding the possibility of a partnership, it was stated that there is need to take advantage of the fact that Harare residents are 'internalising' the crisis. Developing this further could prove to be beneficial to both parties. If for example, the HCC were to reimburse residents for their efforts, residents would be less disgruntled and would make more effort in securing private potable water. Given the current poor financial position of the HCC, this reimbursement could be in the form of a credit note which would be redeemable as possibly discounts on rates later on when the council is in a better financial position.

Residents have responded to the water shortage by adopting various coping measures such as using underground water, purchasing from vendors or going to queue at public sources. However, according to the Water Act of 1998, the digging of wells is illegal in the high density areas where there is a dense network of underground sewage pipes and the risk of contamination is very high.

2.3.2. Cholera

The failure by ZINWA to execute its mandate to supply water to Harare led to various challenges, an example of which was manifest in the massive cholera outbreak of 2008-2009. Zimbabwe had in the past experienced cholera outbreaks - in 1992, 1998, 2002 and again in 2003. These outbreaks had begun in communities residing along the border with other countries thus the endemic was most likely 'imported' from these neighbouring countries such as Mozambique and Zambia (Mason, 2009). The 2008-2009 outbreak quickly saw Zimbabwe change from being a country that used to suffer cholera outbreaks originating in other countries, to being at the heart of the worst outbreak Africa had experienced in fifteen years (Chenga, 2013).

Previous cholera outbreaks, although serious - were easier to contain due to an efficient

and effective healthcare system. Mason (2009), goes further to state that the main distinguishing factor of the outbreak of 2008 was that it coincided with the Zimbabwean health care system being in dire states as a result of a myriad of factors. These factors included poor infrastructure, critical shortage of finance and trained personnel - many of whom were going to work in other countries (mostly the UK, Australia and Canada) and those employees who remained were demotivated due to an inadequate supply of drugs and poor diagnostics and support systems. With many primary care facilities unable to provide the basic services for patient case management, the mortality rate increased significantly.

The general political climate was also unstable which led to an economic crisis (Manzungu & Choreso, 2012). Furthermore, the population was vulnerable as a result of the economic instability at the time with an estimated 94% unemployment rate, hyperinflation at 489 billion per cent per annum and a life expectancy of less than 34 years (Makochekanwa, 2009). Such a situation led Makochekanwa to conclude that Zimbabwe had shifted from being the 'bread basket' of Africa to being the 'bread beggar' of Africa. In the end, the combination of these and other factors saw the loss of over 4 000 lives and an additional 100 000 affected, making it the largest and most extensive cholera outbreak to ever hit the nation (Chenga, 2013).

Some of the direct causes of the cholera outbreak included the bursting of sewage pipes, the lack of water for flushing toilets and inadequate access to clean water for consumptive purposes (drinking and cooking) (Jonga & Chirisa, 2009). Such a situation in the capital city impacts on the rest of the country as it reveals poor governance. Musemwa (2010) goes further and traces the problem of poor governance of water in Harare back to colonial times and concludes that the current features such as population increase and insufficient investment should rather be viewed as *symptoms* and not *drivers* of the crisis. This conclusion would imply that there are deeper issues that need to be addressed first before the water problem in Harare can be fully rectified. Some of these issues will be discussed in chapter 6.

Zimbabwe continues to lose people to water borne diseases. During the first half of 2014, over 300 people died from common diarrhoea and these cases have been linked to ingesting contaminated tap water (Kavhu, 2014). Furthermore, weekly reports by the Ministry of Health and Child Care Epidemic-Prone Diseases show that 55 deaths and almost 35 000 cases of waterborne diseases were recorded in January of 2014 alone - in both

instances approximately half of the cases were children under the age of five years.

2.3.3. What the Authorities say

In a 2013 interview with journalists, the then Harare Mayor - Muchadeyi Masunda revealed that the Harare City Council would need USD2.5 billion to put in place a programme to increase their water output capacity (Moyo, 2013). The municipality has plans to construct three additional water works which would produce 1 900 mega litres (ML). Some of the plans such as the construction of a water works at the Kunzvi dam were put forward over thirty years ago but have not yet materialised for various reasons.

In an interview with journalist Mapimhidze (2014), Leslie Gwindi (speaking on behalf of the HCC) stated that for 2014 the HCC had set aside USD108 million for their water budget. This amount is supposed to be distributed across the various tasks which include "the ongoing rehabilitation works and the operating expenses which include chemicals, power supply and repairs and maintenance." There is however a large discrepancy between the annual budgeted amount and the total required for ideal service provision - at this rate it could be decades before optimal (at least 1 400ML daily of good quality water) water service is restored to Harare.

During the same interview, Gwindi was asked why there were water shortages in Harare. The reply was that water demand had far exceeded (and continues to far exceed) supply capacity. Given the population dynamics of Harare, 1 400 ML of water are required daily but the HCC has capacity to produce 650ML. Existing water infrastructure is in a poor state which makes output volume susceptible to theft and leakages from burst pipes (Moyo, 2013). It was estimated by the Harare Water Director, Engineer (Eng.) Christopher Zvobgo that over 70 000 households in Harare were illegally connected to the water network (AllAfrica, 2013).

When asked why consumers were still having to pay for water when service is erratic and in some cases non-existant, the HCC apologised for the problems being experienced but mentioned that water is mostly charged based on meter readings. Even in areas where delivery was erratic, during the times that water is available people draw and store the water and this attracts a charge (Moyo, 2013). The water tariff structure in Harare is comprised of a fixed and a variable component to recover capital and operational costs respectively (see section 3.6), thus even if consumers do not make use of any water, there is still a fixed

monthly levy to be paid.

Given the shortages, the HCC has put in place a rotational water supply schedule in an attempt to make water distribution more equitable. The system addresses water management in the sense that different areas such as commercial, industrial and residential zones are assigned different service priorities (Mapimhidze, 2014). Mtistis (2008) also analysed the water situation from a legal perspective and concluded that because of poor enforcement and implementation of water quality regulation, the City Council was (and continues) infringing the basic right of residents to have access to clean, adequate and safe drinking water.

2.4. Water Provision in Harare

Typically water service provision can be summarized into five general stages namely:

1. Abstraction
2. Treatment
3. Storage
4. Distribution
5. Collection and Processing

In the case of Harare, there are challenges in all the stages but the study will be limited to stages where most of the problems are being experienced, namely abstraction, treatment and distribution.

2.4.1. Abstraction

The main source of water for Harare is Lake Chivero[4]. Lake Chivero (previously McIlwaine) is a lake located in sub-Saharan Africa and is the second largest of the Manyame lakes servicing the greater Harare region in Zimbabwe. During the mid-1960s. A few years after its construction, the lake was declared as being hypertrophic - an extreme case of eutrophication.

2.4.1.1. Eutrophication

The word eutrophication comes from the term 'eutrophe' which was first used in the beginning of the 20th century by a German botanist in an experiment using peat bogs to determine the

[4] Capacity ($m^3 * 10^6$)= 250; Catchment Area (km^2)= 2230; Surface Area (km^2)= 25.3; Average depth (m)= 9.5 (Marshall *et al.*, 1994)

nutrient conditions necessary for plant community development. Harper (1992), uses the term to describe the effects caused by an increase in the concentration of plant nutrients, particularly nitrogen and phosphorus. It was defined by Chislock *et al*. (2013: 10) as "the natural process by which a lake fills in over geologic time with erosional material carried in the tributary systems". They further recognise that it comes in four degrees of "trophic-ness"; oligotrophic, mesotrophic, eutrophic and hypertrophic in increasing order.

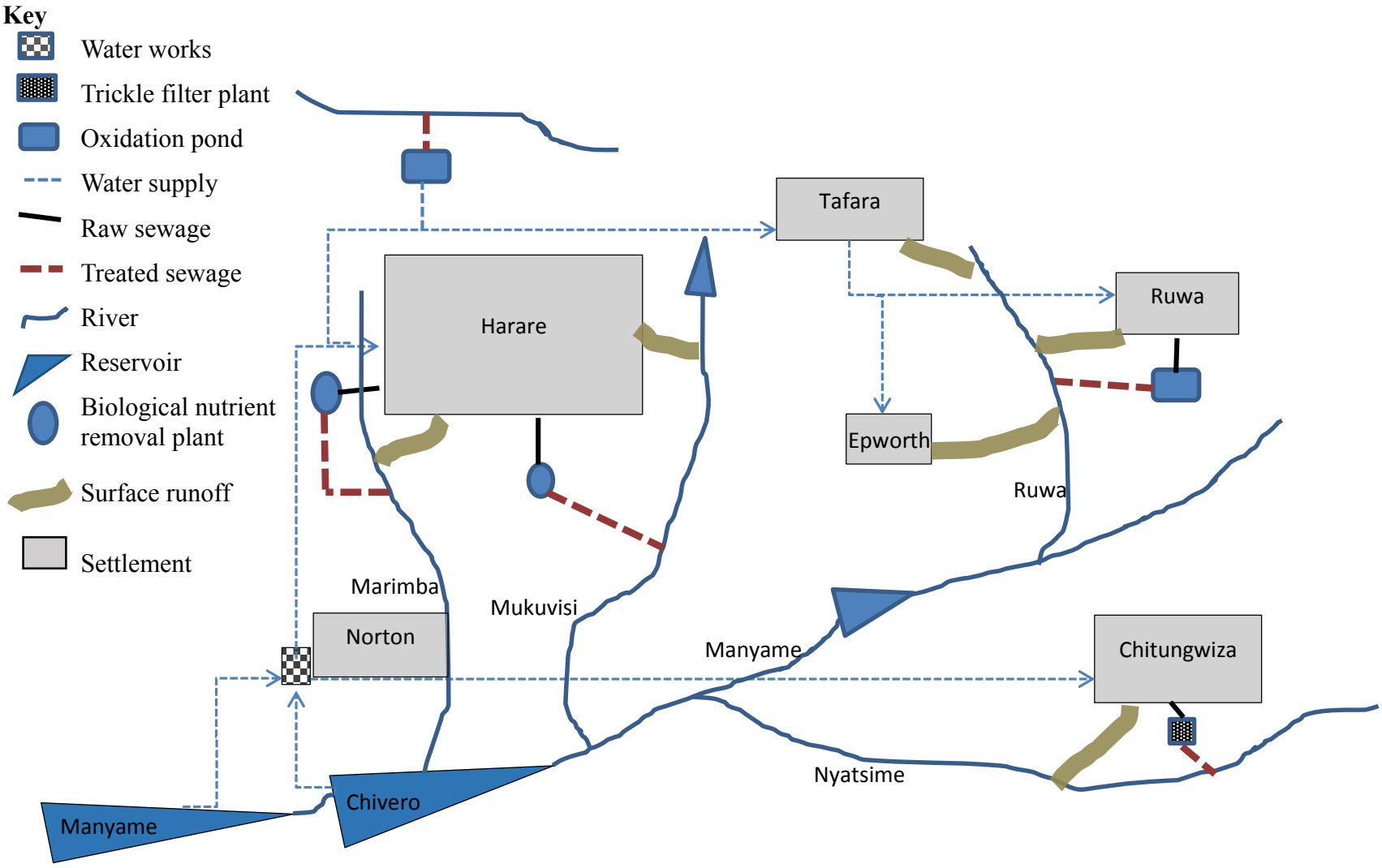
Eutrophication can be the result of the natural processes when a lake 'ages' (Spellman, 1996). There is also man-made (artificial) eutrophication where the activities of man directly or indirectly influence the biological state of water bodies. Harper (1992) further explained the challenges associated with deriving a specific definition because the degree of "trophic-ness" is usually made in comparison to the previous nutrient concentration of the water body in question.

Artificial enrichment of water bodies is an issue that has being going on for decades and man has benefitted from this as it has increased the yields of fishermen. With the onset of the 20th century, artificial eutrophication increased through urbanisation, industrialisation and agricultural use of fertilizers. There was also a general lack of control regarding the disposal of fertilisers which saw them leaching into water bodies (Harper, 1992). Pesticide deposits have been detected in samples of soil, fish, water and sediment from Lake Chivero. Water bodies are equipped with the ability to naturally self-purify but this has to be continuous to reduce the deterioration of water quality downstream (Spellman, 1996). This system is dependent on the extent of pollution because the purification system loses efficacy when the nutrient load is too high.

In the case of Lake Chivero, the chief source of water enrichment was found to be sewage effluent from a primary treatment facility. The Lake is located 35km downstream from the main catchment areas which is comprised of commercial and subsistence farming areas and most significantly, urban settlements primarily in Harare (including the dormitory towns of Chitungwiza and Norton) (Nhapi *et al*., 2004). ZIMSTAT (2012) gives the population of these towns to be a combined 2 154 532 and these are also the same areas which were cited by investigations as being the primary sources of sewage causing the eutrophication of the Lake. The main rivers that flow into the Lake are Manyame, Mukuvisi and Marimba; contributing 49%, 23% and 13% respectively to total inflow. The remaining 15% is comprised of direct rainfall and other small non-gauged rivers (Nhapi *et al*., 2004). To better illustrate the water

connections between Harare and the dormitory towns serviced by the HCC, Figure 2.1 gives a schematic presentation of the water networks.

Figure 2.1: Water supply, Waste Management and Settlements



(Source: Adapted from Magadza, 2003:70)

Ironically these towns, coupled with the town of Norton, rely on the lake to provide 77% of their potable water (Nhapi *et al.*, 2004). It was further revealed that the problem of pollution in the lake is being further aggravated by the poor enforcement of legislation as well as the bad state of existing sewage processing works (Nhapi *et al.*, 2004).

The battle with pollution in the lake has been on-going and a summary of the initial four decades of the lake is highlighted in Table 2.1.

Table 2.1: Eutrophication History of Lake Chivero

Year	**State of the Lake**
1952	Creation of lake
1960	Early signs of eutrophication detected, dramatic bloom in blue-green algae
1964	Algae bloom became a permanent feature creating problems for water purification.
1968	Dramatic drop in lake water level, critically changing the lakes ecological nature
1970	Massive fish deaths
1971	Lake declared hyper-eutrophic, teeming with algae and water hyacinth causing extensive de-oxygenation In response, the Harare City council was successful in instigating an intensive project where treated sewage effluent was used to irrigate pasture and lake recovered to a mesotrophic state.
1972	Successful use of chemicals to eliminate water hyacinth from the lake surface.
1973	Commissioning of replacement intake tower and tunnel after initial one was damaged by algae
1977	Almost 100% of municipal waste now being treated to tertiary standards.
1982-84	Gradual increase in nutrient load. This was followed by droughts which resulted in substantial outbreaks of water hyacinth.
1991	Fish deaths occurred
1996	Largest number fish deaths were observed.

(Source: Adapted from Gumbo, 1997)

During the initial stages (1960s), it was suggested that the municipality be more rigorous in its standards for effluent quality (Magadza, 2007). Official regulation was then put in place in 1968

where the maximum amount of phosphorus per litre of effluent was limited to one milligram. Unfortunately at that time, the municipality was ill-equipped to meet these standards. Instead they bought pasture land and irrigated it with the effluent, and at a later stage they made use of a biological system to remove the nutrients. Nevertheless, their efforts were rewarded and after a two year period the quality of water in the lake improved and this was evidenced by the level of water transparency[5] which improved from a visibility of less than 0.5 metres to over 2 metres in 1971. There was also a remarkable (94%) reduction in the level of phosphorus, from 685.6 tonnes per annum to 40 tonnes per annum (Nhapi *et al.,* 2004).

In 1992, the whole of Southern Africa was affected by a severe drought and inflows to Lake Chivero comprised almost completely of wastewater (Magadza, 2003). Additional findings in Magadza's (2003) study corroborated the notion of increased eutrophication in the lake namely, the low level of dissolved oxygen (DO) in the water. The study measured both the average DO and the lowest recorded level of DO each year and the results showed a consistent trend of declining DO levels. Such systems have a tendency of being ecologically volatile as they are characterised by highly productive water which precipitates rapid growth of algal blooms to levels where the blooms use up the DO in the water to unsustainable levels and the blooms collapse (Robarts, 1985).

As the water quality in the lake worsens, the purification process requires higher concentrations of treatment chemicals, for instance the use of lime to adjust pH levels. Magadza (2003) states that Lake Chivero has been amongst the top ten most studied reservoirs in Southern Africa with sizeable funding having gone towards finding optimal methods for its management and addressing the worsening condition of its water (Dlamini, 2012). Lake Chivero's hypertrophic state has promoted the growth of blue-green algae (particularly *Microcystis aeruginosa* and *Anabaena*) which causes an unpleasant odour as it decays.

Eutrophication is a problem that the world is familiar with and is not limited to certain countries. Despite numerous efforts that have been put in place to try and curb eutrophication of water

[5] To measure transparency, flat discs with alternating black and white quadrants (secchi discs) are used and the depth of visibility is monitored (Nhapi *et al.,* 2004).

reservoirs, Carpenter (2005) describes eutrophication as being a 'one-way trip' and a definitive solution has yet to be found.

The Lake has also been overrun by water plants - particularly the water hyacinth (*eichhornia crassipes*) and in the 1990s it was estimated that over 35% of the Lake's surface was covered by the weed (Luis *et al.*, 2000). These and other organic matter present an additional and serious problem to the extraction of raw water for treatment (Nhapi *et al.*, 2004).

2.4.1.2. Water Hyacinth and other Freshwater Plants

Water hyacinth (WH) is a floating freshwater plant that is identified by "large, pale-blue flowers, with purple and yellow spots on the petals and shiny, round green leaves" (Luis *et al.*, 2000:57). It originated in South America but now can be found in most countries and is regarded as being "the worlds' worst water weed". WH grows on the surface of water in groups called mats and in nutrient rich fresh water, the size of a mat can double every four to seven days (Luis *et al*., 2000).

A study performed on the reproduction patterns of water hyacinth revealed that the seeds of the plant can remain viable for over fifteen years. Thus every generation of flowering and seed-producing plants will add another potential fifteen years to the problem (Sullivan & Wood, 2012). Water hyacinth is a particularly resilient plant. It was observed during the dry seasons, that reservoirs in semi-arid regions would dry up and the water hyacinth infestation would disappear only to reappear once the rains begin (Dlamini, 2012). (Appendix 2 at the end of the thesis highlights how the Zimbabwean authorities have attempted to deal with the Water Hyacinth problem over the years.)

The overgrowth of water hyacinth creates a canopy over the water surface and when this and other organic materials decay, the decomposition process uses up the dissolved oxygen (DO) in the water. This can go on until the levels of DO drop to below critical levels that are necessary for sustaining "higher order" aquatic life forms such as phytoplankton[6] (Mathuthu *et al.*, 1997). Some of the aquatic plants that thrive in the nutrient rich water not only contribute to depleting DO levels, but are also commonly reported as being toxic to some fish and animals.

[6] Phytoplankton are microorganisms, many of which are not visible to the eye but with large enough numbers, they give a green hue to the water. This green discolouration is due to the presence of chlorophyll in their cells and they assist in the oxygenating of water by converting carbon dioxide into oxygen.

Chemical control of water hyacinth in Lake Chivero was conducted using herbicides, some of which are readily absorbed through human skin. Biological control using for example weevils to control WH, has not been as successful and this was attributed to the fact that such bio-control measures were implemented too late and the WH infestation would have already reached critical levels (Luis *et al.*, 2000).

One of the other plants, a common blue-green algae found in Lake Chivero is *Microcystis aeruginosa*, a type of cyanobacteria that has the ability to produce toxins which if ingested can negatively affect the nervous system. Ndebele and Magadza, (2006) studied the levels of a toxin called 'microcystin-LR' (produced by *Microcystis aeruginosa*) in Lake Chivero from March to April of 2003 and their investigation showed that the levels of microcystin-LR ranged between 18.02µgl^{-1} to 22.48 µgl^{-1}. These levels exceeded the maximum safe level for drinking water as set by the WHO (2001) of 13.9µgl^{-1}. These levels were also the highest to be recorded in the lake causing concern over the possible adverse effects that this could have on people drinking the water.

In order to manage the WH problem, Luis *et al.* (2000) emphasised the need for combined efforts and coordinated management of the entire catchment area - including upstream of the Manyame River. This needed to be supported by an awareness-raising campaign to keep all stakeholders up-to-date on the efforts and challenges faced in the attempts to control WH and other plants. It was also recommended that mechanisms facilitating the flow and acquisition of information regarding the control of WH be put in place as well as encouraging constant interaction between stakeholders.

2.4.1.3. Sources of Pollution in the Lake

In Zimbabwe, potable water is obtained from 'reusing' waste water as well as from surface runoff. However, in times of low rainfall, the reservoirs tend to have a higher proportion of effluent water to natural water. According to Gumbo (1997:8) during such periods the lake becomes a "100% sink of all the effluent flowing in to it", and this in turn presents additional challenges during the purification process.

Another factor that contributes to the level of pollution in the water is the storm water drainage that flows into the reservoirs without any form of prior treatment. With increased urbanisation, paving of the ground makes it less permeable to rainfall which increases surface runoff. Surface runoff water is not environmentally assimilated thus it contains many other materials and

substances to cause non-point pollution in the lake (Dlamini, 2012). It was concluded in a study by Thornton and Nduku (1982) that there was a clear positive relationship between urbanisation and nutrient loading of the lake. They further conclude that storm water runoff has the capacity to provide sufficient nutrients to maintain the level of eutrophication in Lake Chivero.

The rapid expansion of residential and commercial properties has also intensified the water problem. The high demand for land has led to construction over wetlands which serve a crucial role in the storage and purification of rainwater as well as preventing siltation of lakes (HerZimbabwe, 2015). In 2013 the 'Chinese Mall' Longcheng Plaza was opened in the Belvedere suburb of Harare. Its construction was controversial as it was constructed over the Marimba wetland. Initially construction of the mall was stopped by the Environmental Management Authority, however local government Minister Dr Ignatious Chombo was able to have this decision overturned and the USD200 million mall was constructed (HerZimbabwe, 2015). Plans are already underway for the construction of a second mall by the Chinese amidst protests from residents and environmental groups. Construction of the second mall is to be over the Borrowdale wetland which is already a construction zone with the construction of the upmarket Pokugara Residential estate currently underway (ZimbabweSituation, 2014). The economy in Zimbabwe provides Zimbabweans with limited options for investment, as a result many resort to investing in land and property. (Further discussion of this issue will continue in section 2.5.)

The climatology of Southern Africa was also seen by Magadza (2003) as a factor influencing the trophic condition of the lake. The study showed evidence that the water conditions of the lake had been in the form of a 'closed loop' where there was continuous cycling of abstracted water and returned effluent. Possible reasons given for this were an increase in the demand for water and a probable decrease in the catchment runoff.

2.4.1.4. Management challenges

Magadza (2003) suggests that additional issues are compounding the problem, for example the management of the lake. There are different institutional authorities responsible for certain elements and functions of the lake and with so many different influences, accountability becomes challenging.

For example, in the Lake's capacity as a recreational landmark, the Department of National Parks and Wildlife is responsible for managing the lake and surrounding areas. Issues regarding pollution are ideally left to the Ministry of Health. Furthermore, the Department of Agriculture put in place an act governing the management of nuisance weeds stating that the property holder - in the case of Lake Chivero, the Department of Parks and Wildlife - was responsible for the control of noxious weeds on the property. Other elements of the Lake include the dam wall which was constructed by the State and thus remains property of the State (Magadza, 2003).

The presence of different institutions playing a role in the management of the lake becomes problematic when it comes to actual accountability and assigning responsibility for upholding the standards of the lake. Unfortunately, state institutions fail to adequately provide consumers with a suitable accountability structure. According to Magadza (2003:80) it became a regular practice to use borrowed and donor funds for the provision of public services whilst the funds collected from ratepayers were (and still are) misused and used for "the personal aggrandisement of state officials". There was and continues to be a general lack of public concern over the quality of water that flows into the lake and this has also promoted an "institutional secrecy" over the quality of service sold to the ratepayers (Magadza, 2003).

2.4.2. Treatment

With regards to quality, Mr Gwindi states that water is regularly tested to make sure that it adheres to the strict standards that have been set to ensure water is potable. In the interview with Mapimhidze (2014), the HCC representative also stated that securing the adequate chemicals for treatment was of paramount importance in their provision of water and this requirement is always met. Furthermore, according to Mr Gwindi, the treatment works for Harare were constructed in accordance with world-class standards and thus have the ability to produce potable water. The treatment works purify water through the processes of coagulation, clarification and rapid sand filtration as well as the optimal doses of chemicals. However despite this exceptional design of the water works, many parts have not had any significant upgrading or replacement of obsolete parts. The resultant effect is constant breakdowns with long downtime periods which contributes to the overall reduced output of processed water (Mapimhidze, 2014).

2.4.3. Distribution

Regarding the issue of damage to the distribution pipelines, the HCC representative mentioned that the network is over 5 500km long. However in most places the pipeline system is failing due to its condition which is subject to corrosion, pressure and age. It is further reported that on average approximately 9 000 instances of burst pipes are reported annually in Harare- this is double the internationally accepted level (Mapimhidze, 2014). According to the HCC representative, the HCC has commissioned a Chinese company to manufacture pressure reducing valves that will attempt to reduce the pressure level in the pipelines and hopefully reduce the cases of burst pipes (Mapimhidze, 2014).

Other problems affecting the distribution of water include theft and leakages. During the first quarter of 2013, the Harare water authorities conducted a study to audit water meter connections. The sample size was taken across ten low density suburbs with 4 494 residential stands - 4 399 of which were fully developed and inhabited. Of all the stands, 4 448 had water meters and approximately 30% (1 360) of these meters were not functional (AllAfrica, 2013:1).

To determine the extent of leakages, the water authorities observed where leaks occurred - before and after the meter. In the sample, 34 leaks occurred before the meter and 120 leaks occurred after the meter link (AllAfrica, 2013:1). These results are in line with the conclusions made by the visiting team from the eThekwini municipality (Durban - South Africa) that theft and leakages could be a larger contributing factor to Harare's water problems than output capacity. The study was however marred by residents who expressed their discontent of the audit as they complained that the City Council was not providing them with water thus why would they be concerned with auditing their meters.

2.4.4. Additional Considerations

Other than the above mentioned problems, there are also additional factors that should be considered in attempting to address the water problem in Harare.

2.4.4.1. Water Contamination Updates

Various legislation that was in place to promote conservation, protection and efficiency of water use has clearly failed to curb water pollution as evidenced by the 2008-2009 cholera outbreak. In

2014, six ministries came together and formed a Cabinet Committee headed by the Minister of Local Government, Dr Ignatius Chombo. The committee released part of the findings of a study on the various sources of water pollution in Harare. The blame was shared between "municipalities, food, beverage and oil companies, funeral and tannery businesses for discharging a variety of harmful industrial chemical waste and raw sewage that degrade under and above ground water or cause corrosion of water pipelines." (Gogo, 2014:1). The actual extent of the pollution from these sources was however not revealed.

In light of these results Dr Chombo threatened to shut down corporate polluters who failed to upgrade to technologies that reduce their water pollution by 30 June 2014. The Harare municipality was the main culprit cited in the report. Harare alone releases 3 885ML of raw sewage daily into the water system. This figure is almost 300 times as much as that released by the Bulawayo[7] municipality. What is further troubling about this figure is that Harare is only 3.2 times the size of Bulawayo (ZIMSTAT, 2012). Such high pollution levels also have further consequences on the amount of chemicals and effort required by Harare authorities to purify the water. Ideally, raw sewage needs to be treated to a reasonable level before being discharged into the water system (Gogo, 2014).

A researcher from the Cabinet Committee stated that the current chlorination method that the HCC is using to purify water is ineffective and it should be replaced by more modern water purification systems (The Standard, 2014). Investigations by the committee further revealed that only 10% to 20% of raw sewage was being treated at the relevant sewage treatment plants whilst the remaining raw sewage is leaking into the water systems. The main reason for this is that old pipes are compromising the process of safe sewage disposal. This is a problem not only in Harare but in most towns in Zimbabwe where sewer systems have well exceeded their lifespans. Leaking was confirmed by the Government Analyst laboratory which performed tests on the water and found evidence of microorganisms, rust and dust in the water. The report further found that the Harare service area is the worst affected city when it comes to quality of water.

[7] The second largest city in Zimbabwe.

Corporate polluters face the threat of being shut down should they fail to treat their waste prior to discharge. With currently very high unemployment rates, one needs to also consider the potential job losses that will ensue should the corporations be shut down.

The report however fails to single out any specific perpetrators thus an entire industry would be at risk. The food industry for example, discharges various organic solids and oils that block sewer systems. Without specifying which firms are polluting, everyone employed in the food industry could potentially lose their job (Gogo, 2014). Furthermore, one also needs to pose the question of who would pay the penalty fines if the corporations were shut down and not making a profit.

2.4.4.2. Pollution Penalties

Gogo (2014), recommends that authorities change their focus from using potential closure as a deterrent and rather start focusing their efforts more on penalising the perpetrators. Such an action would mean reviewing penalty fines because monetary fines are a more direct disincentive to polluters than the mere threat of closure. According to the spokesperson for the Zimbabwean Environmental Management Agency (EMA) - Mr Steady Kangata (in Gogo, 2014), environmental pollution penalties in Zimbabwe are classified by levels, with level 14 being the highest possible penalty. The highest penalty attracts only a USD5 000 fine whilst the lowest - level 1 attracts a USD5 fine. In 2001 the Chitungwiza and Harare municipalities were fined a combined USD10 000 for their role in degrading water sources in Harare.

These numbers are a far cry from the millions required to rehabilitate the polluted water sources. One can compare these fines (for pollution that can lead to the loss of human lives) to the billions of USD that various oil companies have been fined for oil spills that have resulted in the loss of animal and plant life. Closer to home, 2012 saw the deaths of over 80 elephants in Zimbabwe when poachers contaminated a watering hole in Hwange National Park with cyanide. The perpetrators were found to illegally be in possession of ivory as well as being in contravention of Section 73 (1) of the Environmental Management Act which "prohibits the possession and discharge of hazardous substances, chemicals, materials or oil into the environment." (Guvamombe, 2013:1). They were each given a sixteen year prison sentence and were further ordered to pay a combined USD600 000 in restitution (Guvamombe, 2013). In comparison, the million dollar Delta Corporation - the largest beverage producer in Zimbabwe was slapped with a USD5 000 fine for

its contribution to the water pollution problem. In addition, no company has yet been shut down as threatened (Gogo, 2014).

These fines are too low and prove ineffective as industries continue to discharge raw waste. This ineffectiveness has prompted the EMA to take action in calling for environmental courts to be established in Zimbabwe. It is their hope that once this happens, environmental issues will gain greater recognition - particularly those that have actually resulted in the loss of human life (Kangata, 2014). The committee is also vying for an official statutory instrument that would indorse the 'polluter must pay' principle.

To improve accountability Gogo (2014) further recommends that industries be grouped into clusters and each cluster will be collectively 'punished' for its pollution impact. Such an action would also push industries to monitor themselves within their respective clusters.

2.4.4.3. Poor Management and Accountability Structures

In 2013, the HCC acquired a USD144 million loan from the Chinese (EximBank) to try and curb the ongoing water woes (Magodyo, 2014). The HCC has unfortunately failed to adequately increase service capacity in many suburbs, particularly in the eastern and northern areas where water service is more constrained.

It was reported that the HCC purchased some equipment for the refurbishment of the Morton Jaffrey water works using part of the loan money. The whereabouts of this equipment could however not be established. There was talk that it was being allegedly held by the Zimbabwe Revenue Authority (ZIMRA) at Forbes Border post between Zimbabwe and Mozambique as collateral for the USD42 million that the HCC owes in tax arrears (The Herald, 2014a). The revenue authority has however denied these claims and Mr Gersham Pasi (ZIMRA Commissioner-General) stated that "no such equipment is being held by ZIMRA either at Forbes Border Post or at any other ZIMRA station. No clearance documentation has been submitted to ZIMRA by the importer or the importer's clearing agent" (The Herald, 2014a). The HCC spokesperson, Mr Gwindi has however stated that they have been having discussions with ZIMRA and the latter claimed that they would issue a tax certificate to clear the equipment.

It is further stated that the HCC should be blamed for misuse of public funds that should have been used to improve the water service system. The loan stirred further controversy as almost USD2 million of the amount was used by council officials to purchase 'luxury' vehicles (Ruwende, 2014b). Such spending is usually frowned upon when using borrowed funds especially considering that some low-level HCC employees have not been paid their salaries. It is generally recommended that borrowed funds be used for ventures that help generate more capital for instance, improving infrastructure. To add to the lack of clarity and accountability, the HCC failed to create project bank accounts for the loan, making any corruption allegations difficult to trace (Ruwende, 2014b).

An investigation as to how the loan money was used is yet to yield a satisfactory result as the HCC team tasked with the investigation is being sluggish in reporting its findings. It is such actions that lead Magodyo (2014) to conclude that the lack of financial transparency within the HCC causes consumers to withhold paying their rates which reduces revenue to an already financially strained HCC. (This specific problem will be referred to again in chapter 4 in the survey that was conducted in Harare.)

2.5. The Zimbabwean Situation

The Zimbabwean political situation has been under the global spotlight for various reasons over the years. The defining moment was spurred by the highly controversial stage of the Land Reform programme in 2000 after the general elections. The political challenges in Zimbabwe are said to be due to an 'inherited political culture' (Maundeni, 2002:113). Maundeni (2002) concluded this after analysing the Zimbabwean and Botswanan economies - particularly how both countries are similar in their non-political features, yet the Zimbabwean economy is failing whilst the Botswana economy is prospering. In fact, Botswana is identified as one of the fastest growing economies in Africa. Its citizens also have relatively higher living standards with a 2013 human development index (HDI) ranking more than fifty places higher than that of Zimbabwe (UNDP, 2014).

The 'inherited political culture' that Maundeni (2002:113) speaks of stems from the historical Shona (Zimbabwe) State which is described as having been a group of "loose, fragmented and undisciplined small states". This is in contrast to the Tswana (Botswana) culture that encouraged a centrally planned State. It is these diverse colonial differences that form the cornerstone of Maundeni's argument for the reasons behind the poor performance of Zimbabwe. It is argued that

the Tswana colonial powers largely opted not to interfere in State affairs whilst the Shona tribal states initially attempted to violently resist the colonialists. The Shona's who lost the fight and ultimately became victims of "excessive colonial exploitation" inherited a "loose and undisciplined" State culture (Maundeni, 2002: 122-123). As a result of this inherited culture, Maundeni (2002) concludes that the Shona people never gained the ability to have a coherent and centralised State and this still manifests in the current political climate.

Kovacs (2012) challenges part of Maundeni's analysis and states that the latter's analysis fails to consider the substantial decline in living standards in post-independence Zimbabwe. The economic decline can be traced back to the time when the Zimbabwean dollar crashed in November of 1997 (Makina, 2010). Furthermore, there is a strong positive correlation between the 1980 election of President Robert Mugabe, the subsequent formation of a one party State in 1987 and the economic decline of the country. Nevertheless, "to suggest that the complete dominance of one party has been detrimental to the country is oversimplifying matters, because Botswana has also had the same party in power since independence." (Kovacs, 2012: 3).

The question would then be why one regime has seemingly tolerated the economic decline of its country whilst the other was driven towards economic prosperity. A suggestion that Kovacs (2012) makes is that Zimbabwe has become a predatory State with each individual out to maximise their own benefits. It is well known that the Zimbabwean State is autonomous in its actions and as a result, the State authorities have the institutional capacity to choose their own goals and attain them at all costs (Przeworski, 1990).

> *If all state actions were aimed at maximising the general welfare, analysing government-business relations would be much simpler. If we could count on State actors to 'implement the logic of the capital', as structural Marxist theories… argued that they did, analysis would be simpler still. The theoretical premise of modern neo-utilitarian's also offers a seductively simplifying assumption: States are simply collections of individual maximizers, each intent on using his or her official power to gain wealth and informal power.* (Evans, 1997: 68).

The suggestion by Kovacs about Zimbabwe being a predatory State is also echoed by Moselle and Polak (2001) who stated that Zimbabwe is a case of political predation. The reason behind this is

that in Zimbabwe wealth emanates from political power. This is in contrast with the Marxist assumption that political power comes from wealth (Bayart, 1993). To illustrate this concept, Kovacs (2012) uses a key historical event - the Lancaster House signing in London in 1979. This agreement between the elites was summarised by Bratton and Masunungure (2011:8) as being an arrangement where "blacks would ascend to positions of political leadership while whites would continue to enjoy the ownership of the means of economic production." As a result, the majority of black people were excluded from the private sector and thus the State became the best way to acquire wealth. Those State officials that were currently in power were already dependant on the State for wealth thus maintaining their political status became a key objective for the regime. Bratton and Van de Walle (1997) also accuse the ZANU-PF of systematically exploiting State resources and power for their own private benefit. Corruption is rife in Zimbabwe and as a result State officials can *formally* acquire vast personal profits without significant repercussions.

The HCC recently came under fire for purchasing motor vehicles using USD1.3 million of borrowed funds that were part of a Water and Waste water Rehabilitation project. The council's Special Committee team conducted a probe into these purchases and it was found that a total of twenty-one luxury vehicles were purchased for a team that comprised of only fifteen members (NewZimbabwe, 2014). Their report further revealed that these purchases were made without a tendering process and that the purchases were "irreversible" (Matenga, 2014).

Local Government Minister, Ignatius Chombo spoke in defence of the purchase and stated that any similar project requires motor vehicles and the purchased number was actually less than the required number. The Special Committee team stated in their report that it was sheer recklessness to purchase vehicles for all team members. It is reported that the executive town clerk, Dr Tendai Mahachi failed to adhere to the necessary procedures and he went on to ask the team members which vehicle model they would prefer, and as such he has received most of the blame (Karimakwenda, 2014; Matenga, 2014).

Dr Mahachi was also the topic of controversy after he failed to comply with orders to disclose the salaries of the executive members of the council and this action led to his subsequent suspension. The salaries were eventually revealed and it was reported that the nineteen council executives had a combined salary totalling approximately half a million dollars each month, with Dr Mahachi grossing the highest amount of USD37 642 (approximately ZAR483 700) monthly (The Herald,

2014b). Such actions concur with the leadership culture of a predatory State and some State officials are realising their own personal agendas regardless of the repercussions. They award themselves with exorbitant salaries when lower order HCC employees can go for months without receiving their salaries and where the general economic climate has the average civil servant's salary at approximately USD500 per month. This is unfortunately not only limited to the public water sector, but was also cited as a key reason for the demise of the Zimbabwean national railway service (NRZ) (The Herald, 2014b). In other words, one has to question whether or not the HCC (and other State institutions in Zimbabwe) are trustworthy, a question which will be raised again in this analysis (see section 4.3)

Reputation models[8] classify governments as being either opportunistic or trustworthy and in situations where it is not possible to discern whether the government is being opportunistic or trustworthy, prudence principles suggest that the assumption of opportunism should be adopted (Williamson, 1975). Phelan (2006: 28) describes a trustworthy government as one where "the government is either unable to break explicit or implicit promises, or faces payoffs which directly punish it for doing so" and an opportunistic government is defined as one where "the government has a short-run incentive to break promises".

The relative trustworthiness (or lack thereof) of a government can spread from one sector to another. Once a government has failed to deliver on its promises in one sector, it is viewed as untrustworthy in other sectors leading to general distrust (Zak & Knack, 2001). Once this distrust has been reinforced, its effects can manifest by the reluctance of the citizens to pay for public projects – particularly if payment is through targeted taxes or donations. Citizens will also be hesitant to engage in public projects directed by the government and such projects become ineffective. The overall effect of citizens' distrust in the government will translate to poor economic outcomes (Algan & Cahuc, 2010; Beugelsdijk *et al*., 2004; Oh & Hong, 2012).

A study by Oguzhan and Uslaner (2010) on the relationship between trust and the level of economic growth found that for every 10% increase in trust, GDP increased by 0.5 percentage points. There was also growth in the manufacturing employment sector of 1.3 percentage points. It can thus be concluded that there is a positive relationship between the trustworthiness of a

[8] See Barro and Gordon (1983); Backus and Driffil (1985); Huynth *et al.*, (2006) and Phelan (2006).

government and economic prosperity. In other words, such a government would be seen as credible.

The Zimbabwean government - like several others, has been unable to benefit from improving their trustworthiness and potentially see much needed gains in GDP. Citizens harbour distrust not only in the public service sector but also from issues in other sectors such as the political unrest that has been ongoing for over a decade.

Apart from the above issues, the general economic conditions are not conducive for 'normal' economic activity. The housing market will be used to illustrate this point. Long-term mortgage lending facilities are a standard feature in many modern economies, however in Zimbabwe this facility had been suspended in 2008 during the hyperinflation period (mid to late 2000s). Landlords who relied on rental incomes would also increase their rental fees to keep up with the inflation rate[9] - and this was a dark time for lodgers. Long-term mortgage lending was recently reintroduced by banks in 2010 (Moyo, 2014).

Despite the economy being more stable now, interest rates are very high and getting a mortgage bond is therefore not a popular option. The Chartered Bank of Zimbabwe (CBZ) was offering personal mortgage finance of up to 60% of the purchase price at a rate of 18.5% payable over a maximum of ten years (CBZ, 2015). These conditions are similar across lenders. The Central African Building Society (CABS) and FBC Building society were reported to have lower rates of 15% however they further require an upfront cash deposit of 25% and 30% respectively of the purchase price (Moyo, 2014). In comparison, leading South African banks (Nedbank, FNB and Standard Bank) were granting home loans at a rate of 9.5% (Deposits, 2015). For the few that do manage to take out mortgage bonds, the rate of default is very high. In 2014, it was reported that default rates in the property sector had gone up to 60% from between 10%-20% in the previous year (The Sunday Mail, 2014).

The situation in Zimbabwe is coupled with a continuous property bubble that is being fuelled by people's preferences for financial security in property and fairly high rental amounts as people attempt to supplement their low incomes with rental revenue. The classifieds section of the Sunday Mail newspaper advertised residential land going for as high as USD40 (approximately ZAR514)

[9] Inflation had reached a peak of 489 billion per cent (Makochekanwa, 2009).

per square meter depending on location (The Herald classifieds, 2015). Such prices might be regarded as reasonable - or even low in other economies, however given the low income levels in Zimbabwe, the prices are beyond the reach of many.

The common practice when considering home ownership is to save up for the deposit on a plot of land and gradually pay if off and once that is complete, start building the house. The time this takes varies but can be anything from a year to decades depending on financial circumstances. It is a common occurrence to see extravagant houses being sold incomplete because the individual has run out of funds prior to completion.

2.6. Conclusion

This chapter set out to outline the issues surrounding the poor level of water service delivery in Harare. There were problems in all the stages of water service delivery but the most prominent were in the abstraction, treatment and distribution stages. Issues included the poor quality of water in the reservoirs where the City council was sourcing its water for treatment. This further affected the treatment stage as it meant that more chemicals would be needed to purify the water to acceptable standards. Poor maintenance of water distribution pipelines led to significant volumes of treated water being lost through theft and leakages.

Another factor compounding the problem was poor management by the relevant water authorities. There was evidence of mismanagement of funds which was not limited to water service delivery, but also in other public sectors. Such actions by the government authorities led Kovacs (2012) to conclude that the situation in Zimbabwe resembled that of a predatory State where authorities sought to satisfy their personal agendas regardless of the repercussions on the general public. The lack of trust in a government is one of the factors that can affect the WTP of consumers for public projects as consumers will have reservations regarding whether the authorities will use the money for its intended purpose (see section 4.3.3) (Oh & Hong, 2014).

At the very least, it is recommended that the HCC provide a reliable schedule for disruptions in water service. Such an action is in accordance with the constitution and its protection of human rights. In addition, this will contribute to a better relationship between the HCC and relevant stakeholders. This could even go further and extend to increased confidence amongst potential

regional and international funding partners who might wish to invest in infrastructure in Harare (Magodyo, 2014).

The following chapter will discuss the various production and pricing considerations for optimal water service provision. Water service is unique compared to other services as it involves the delivery of a good that is vital to human life. As such, some typical policies and theories are limited in their application to water service delivery.

CHAPTER 3

Water Provision

3.1. Introduction

Winpenny (1994), maintains that water scarcity has become one of the most universal problems facing all countries in the 21st century. Miller (2013), describe water scarcity as instances where the demand for water exceeds its supply and is generally measured by a ratio of water to population. Through estimating water requirements in the household, agricultural, industrial and energy sectors, a threshold requirement of this ratio is set. This is generally set at 1 700 cubic meters of water per person per annum, while availability of less than 1 000 cubic meters would indicate 'water scarcity' whilst that below 500 cubic meters would indicate 'absolute scarcity'. Water scarcity can also be identified in situations where the poor quality of water places a limit on its usability (Rijsberman, 2006). It is further estimated that 4.5 billion people in the world are currently living within 50km of a "spoiled" water source that is polluted or running dry (Harvey, 2013)

In regions where lack of water is less severe, there are also the problems of poor management, insufficient funds to maintain these sources as well as the public sector not having an in-depth understanding of the water situation locally and internationally (Famiglietti, 2013). These problems have led to increasing pressure on local authorities as they not only have to consider the issue of adequate supply of water but also that of proper disposal of waste water as this is another potential source of water once purified. The extent of the water problem further varies depending on the level of development of a country as it is more severe in the developing world where countries not only have to deal with the general scarcity of water but also with poor infrastructure to promote recycling of waste water (Harvey, 2013).

This chapter will initially describe the economic characteristics of goods and services, of particular interest being the nature of public water supply. This is followed by a discussion on the various considerations that must be made when providing this service. An analysis of the literature then ensues looking at various economic theories of water provision. Finally, there is an evaluation of different water pricing structures that policy makers have at their disposal.

3.2. Public Goods and Services

According to mainstream economic theory, a price that is determined through market interactions (market price) is regarded as an efficient mechanism. This is because a market allows consumers to compete for consumption of a good at the equilibrium price and when this happens, their welfare is maximised which leads to a socially optimal level of consumption (Parkin, 2010). This however is only applicable to private goods and attempts to apply this mechanism to pure public goods leads to market failure. With pure public goods, this quantity mechanism is no longer efficient as the stock of such public goods is not depleted with increased consumption (Black *et al.,* 2006).

3.2.1. Pure Public goods

A main feature of pure public goods (hereafter 'public goods') is that several individuals can consume the good without reducing its value or the quantity available for others. This is called non-rivalry and it is a key feature that distinguishes them from 'normal' private goods. Unlike public goods, private goods cannot be consumed by more than one person simultaneously (Powell, 2008). Pure public goods are also (normally) non-excludable because once a public good or service has been provided, the provider cannot prevent an individual from consuming that good regardless of whether the individual has paid for it or not (Black *et al.,* 2006). With modern technology, it is becoming possible for some public good providers to exclude those who do not pay. A common example is toll gates on public roads where only those who pay the fee can proceed and drive on the roads whilst those who do not pay are excluded from making use of the road.

Consumers can take advantage of this feature because for a given quantity, consumers will not automatically "self-select" their optimal price (Graves, 2009). Considering they cannot be excluded from consuming the good - they will seek to pay the lowest price possible (or nothing at all i.e. free riding). If this concept were to be represented graphically, then to derive the social demand curve of the good, the individual demand curves would be summed vertically unlike those of a private good which are summed horizontally (Parkin, 2010).

The non-excludability characteristic of public goods becomes an area of concern when the private sector attempts to produce such goods and this leads to 'market failure' as in some situations, the producer cannot exclude consumption. It is important to note that this element of public goods is not an absolute feature but is relative for most public goods as the costs associated with exclusion

from consumption can be very high. If private markets were to provide public goods, they would be inclined to under-provide because consumers have an incentive to avoid paying for the good they are consuming - i.e. free riding (Powell, 2008). Each consumer might decide to wait and not reveal their demand for the good in the hope that another will reveal their preferences (demand) and pay for provision of the good (Black *et al.,* 2006).

3.2.2. Impure Public goods

Impure public goods can be simply defined as anything with a positive consumption externality and the consumption by one individual allows others to also derive benefits without the latter paying for it (Black *et al.,* 2006). Examples include fire and police protection, and water and sewage services. A classic example of an impure public good is urban public water supply as it not only yields crucial life sustaining benefits, it also plays a role in overall social wellbeing such as good health and sanitation as well as economic activity (Graves, 2009).

Unlike rural inhabitants, urban consumers are more detached from the sources of the water that they consume. Urban dwellers usually get their water from public water systems - which can be privately or publically managed and water authorities draw water from underground and surface sources (McIntosh, 2003). Consumers who fail to pay for the service can be excluded from making use of it by the relevant water authorities.

3.3. The Theory Behind the Supply Of Water

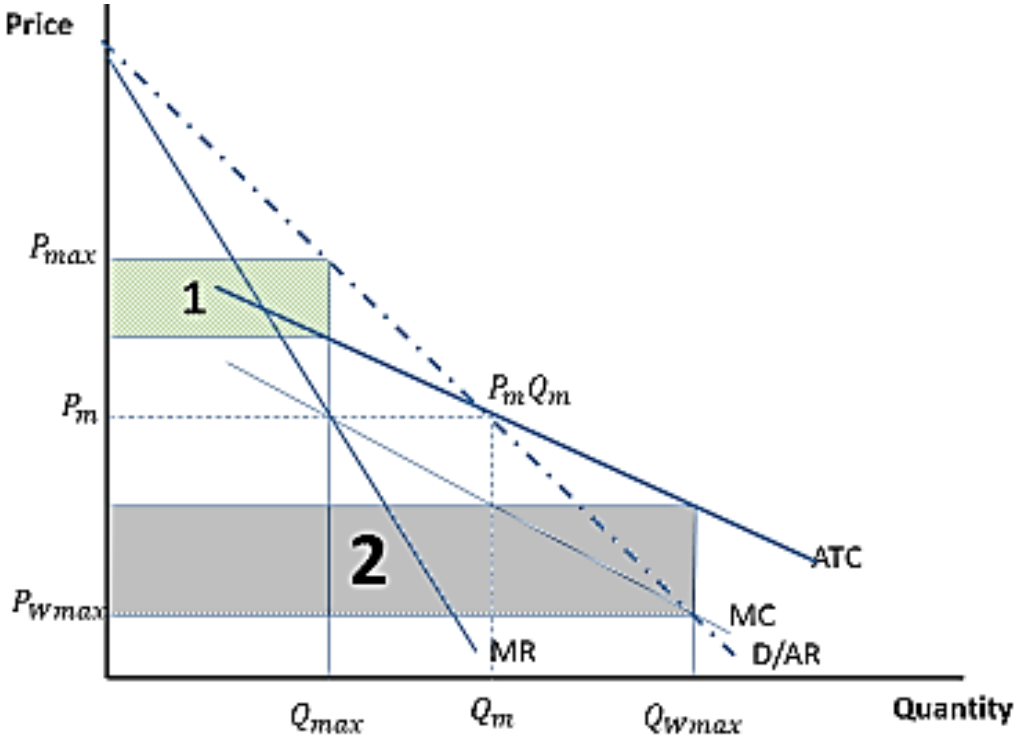
In order to best understand the arguments for and against the privatisation of public utilities, one needs to first understand the microeconomic theory behind natural monopolies. Standard microeconomic theory states that in the long run, a firm must - at a minimum, realise normal levels of profit in order to justify operating in that industry. This rule is however loosely applied when considering production in the short-run. For example, operational losses are common in some firms. However, in the short-run a firm can continue to produce on condition that total revenue received is sufficient to cover total *variable* costs. In other words, the price per unit of output must exceed (or at least be equal to) the average variable costs (Parkin, 2010). Nevertheless, any business faces fixed and variable costs in varying degrees and fixed costs must be paid regardless of output levels.

A naturally monopolistic industry is characterised by sub-additivity of cost functions, that is, production costs are lower if production is done by a single firm. In addition, entry by other firms into such an industry is not sustainable as there are barriers to entry such as high cost of capital. Sub-additivity can be attained through the presence of economies of scale[10] over the entire range of production (Train, 1991; Waterson, 1988). The economies of scale are due to the industry having high fixed costs and low variable costs. In such a case it is common for a natural monopoly firm to have excess capacity as it is able to produce below its minimum average cost (also known as the minimum efficient scale – MES) (Mosca, 2008).

The total cost (TC) of any firm is made up of total fixed costs (TFC) and total variable costs (TVC). TFC include the overhead costs of production such as rent that do not change with changes in production volume (Parkin, 2010). Provided the market is able to absorb increases in output, only the variable costs (and not fixed costs) will increase for a natural monopoly, thus no distinction is made between the long-term and short-term average cost curves. (Mosca, 2008). Figure 3.1 gives a representation of the pricing considerations of a natural monopoly.

[10] It is worth mentioning that the presence of economies of scale is purely a sufficient (not essential) condition for sub-additivity thus a decreasing AC function will always be sub-additive but the reverse will not be the case (Mosca, 2008).

Figure 3.1: Natural Monopoly Pricing



(Source: Calitz & Siebrits, 1999; Peacock & Rowley, 1972)

Like a 'normal' monopoly, the curves for revenue and costs are initially the same for a natural monopoly. The demand that the firm faces is depicted as 'D' which is also the average revenue (AR) curve. The exceptions to the 'normal' monopoly graph are the average total cost (ATC) and MC curves which remain negatively sloped throughout the range of output (the curves never intersect with the x-axis as their respective slopes become less steep with increased production). In other words, the demand curve intersects the ATC and MC curves when both the latter curves are downward sloping whilst for a 'normal' monopoly, this happens when the curves are upward sloping.

According to neoclassical theory of the firm, if this firm (in Figure 3.1) was unregulated, it would attempt to maximise profits by producing at a level where MC is equal to the revenue received from the sale of the next unit 'marginal revenue (MR)' i.e. the profit maximising position of MC=MR. The level of output and price where profits are maximised are shown in Figure 3.1 as Q_{max} and P_{max} respectively. The profit that the unregulated monopoly receives at this quantity level is found by multiplying the number of units sold (Q_{max}) by the profit received per unit

produced. The latter is determined by subtracting the average cost (ATC) from the AR per unit at Q_{max} (Peacock & Rowley, 1972). The overall profit made by the profit maximising unregulated firm is depicted by the shaded area '1' in Figure 3.1.

From a welfare perspective, Q_{max} is not optimal as the welfare maximising condition states that provision should be where price is equal to the cost of producing the next unit (marginal cost - MC). At Q_{max}, price (P_{max}) will be greater than MC and more importantly, the quantity of the good provided will not be able to meet the level of demand that is socially optimal. This creates a need for state intervention where the government assumes provision of the good at the welfare maximising quantity Q_{Wmax} where price (P_{Wmax}) is equal to MC. However, at production levels of Q_{Wmax} the firm faces an ATC which is higher than the AR, as a result the firm incurs a loss - an unstable situation. The total loss is depicted by the shaded area '2' in Figure 3.1.

Calitz and Siebrits (1999) go on to suggest ways to try and counter what amounts to a disincentive for production. Firstly, it is recommended that the government make use of the average pricing rule and equate P to ATC so that the firm breaks even. This option is shown on Figure 3.1 as the point where the ATC and AR curves intersect at $P_m Q_m$. At this point ($P_m Q_m$), the price will be higher and the quantity produced will be less than at the socially optimal point but this is a more favourable arrangement compared to that of an unregulated natural monopoly ($P_{max} Q_{max}$).

The second option suggested by Calitz and Siebrits (1999) is to use a combination of MC pricing with lump-sum taxes. The former will ensure that the level of production (Q_{wmax}) is efficient, whilst the tax will exactly offset the loss made by the supplier (shaded area 2). A lump-sum tax is regarded as the one tax that is most efficient as it does not distort the allocation of resources. There are some reservations when one considers the equity implications (fairness vs. justice) though. Such a situation would have a regressive effect as it would place a higher tax burden on those with lower incomes. Another problem that might arise would be complaints from tax payers who would not want to pay for the users of the service provided by the utility.

Lastly, a two-part tariff could be used and this would involve a fixed component as well as a variable one. The fixed charge would be levied on all users of the service and the variable charge would be equal to the marginal cost of each unit consumed. The overall revenue effect is the same as that of the lump-sum tax and has the equivalence of a non-distortionary tax that is charged

specifically on the users of the service. These positive factors have made the two-part tariff the preferred pricing rule of many utilities. Any such pricing structure will result in an output level that is inefficient; however it goes further to accommodate equity concerns unlike the case of an unregulated monopoly (Calitz & Siebrits, 1999). The two-part tariff is explained in more detail in section 3.6.

3.4. The Provision of Public Goods and Services by Public Utilities

Utilities are usually a type of 'hybrid' organisation which has features of both a private enterprise and a public entity. In the former capacity, a utility engages in production and selling of goods and services making it susceptible to typical organisational and market pressures. Whilst as a public entity it is under government ownership and/or regulation thus making it open to influences from politicians, administrators and the general public (Wallis, 1983).

The activities of utilities can be classified into three types - namely production, transmission and distribution. They "typically create a good or service at one location, and then distribute it over a 'network' where it is delivered to numerous customers for end use." (Geddes, 1999: 1163). Some regulated utilities - for example electricity, integrate all three processes into the firm whilst in others such as gas, some parts are open to competition. The production stage is the one that is innately competitive in most utilities with different firms engaged in this function (Crandall & Ellig, 1997). The three types of activities for a few different utilities are illustrated in Table 3.1.

Table 3.1: Activities of Four Utilities

Industry	**Production**	**Transmission**	**Distribution**
Airlines	Travel service	Air traffic control	Airports
Natural gas	Gas wells	Pipelines	Local distribution companies
Electricity	Generating plants	High-voltage lines	Local power lines
Water	Water treatment plants	Underground pipelines	Local Municipalities

Source: Adapted from Grandall and Ellig (1997:70)

In the case of the water industry, the product (processed water) is produced at the water treatment works in one (or more) location and then transmitted through a network of underground pipelines to be distributed under the management of local municipalities. A similar process can be traced for the natural gas industry where the gas is extracted/'produced' at the gas wells. The gas is then collected and transmitted through the gas pipeline network and is distributed by local gas distribution companies.

The services provided by utilities share common features which are summarised into distinctive characteristics. Such services are provided on a continuous basis through multiple activities across the economy. Usually, these services are not consumed directly but act as primary inputs in the production of other goods and services (Wallis, 1983). Using electricity as an example, it is not directly consumed by the consumer, it is however used to power various electrical appliances and equipment which are used to produce other goods.

Products of utilities normally cannot be stored for later use and they also face relatively consistent fluctuations in demand on an hourly, daily, seasonal or annual basis (Wallis, 1983). Due to their continuous provision and indirect consumption characteristics, public utilities tend to face demand that is relatively price and income inelastic[11]. This low price elasticity of demand affords utilities the ability to practice price discrimination and take part of the consumer surpluses of their clients. The inability to store their products and the demand fluctuations they face mean that utilities must have facilities with enough capacity to meet demand during peak periods (Grandall and Ellig, 1997).

3.4.1. Regulation of Public Utilities

The government exercises its economic control in varying degrees in the economy. The rationale for intervention falls into two general categories namely positive and normative.

Positive rationale

The positive rationale advocates that the ongoing activities of utilities need to be regulated to promote equity (fairness) and financial viability (cost recovery). Due to their nature, public utilities cannot be influenced the same way as private enterprises. The latter are indirectly controlled by

[11] Demand for the good/service is not significantly responsive to changes in the price of the good or the income of the consumers.

government through instruments such as taxes or policy changes. To achieve the above desired outcomes, utilities have historically been subject to a more direct level of government intervention through the use of 'rules' such as how pricing structures should be designed and also requiring that financial records be made available to the public (Wallis, 1983).

Normative rationale

The normative argument for regulation focuses on public-interest issues and the reasons for why the government *ought* to regulate utilities. There is a particular focus on market failures such as the existence of public goods and how the government could *theoretically* remedy these failures through regulation (Geddes, 1999). Utilities fall under industries that are naturally monopolistic and this is a common rationale for their regulation (Crew & Kleindorfer, 1979).

A naturally monopolistic industry is one in which a single firm is able to produce a single good or service at the lowest cost. This phenomenon occurs when the overall average cost of production for the firm is decreasing with increased output (as explained in section 3.3). Regulation can also affect pricing policy and is thus warranted to inhibit competition in order to maintain production (social) efficiency of the single firm (Moorhouse, 1995). The pricing and investment policies of utilities are constantly under scrutiny by government as monopolies can potentially restrict their output volume to try to make extra profits (Wallis, 1983:4).

Over the years, there has been increased dissatisfaction with the normative rationale. Reasons cited include how regulation was at odds with the empirical evidence and appeared unrelated to the observed features of a natural monopoly. Regulation, in its quest for public interest was said to reduce industry profits to avoid firms making excessive profits. It would thus be expected that firms would not be in favour of such regulation. Yet it was observed that many regulated utilities actually lobbied for regulation (Posner, 1974; Viscussi *et al.*, 1995). Another point made is that regulation was supposed to lower the prices of the utility, but a study by Stigler and Friedland (1962) using the electric utility prices from 1912 to 1937 showed that regulation had an insignificant effect on output prices. In addition, the normative approach fails to provide a

mechanism which shows how market failure translates into regulation which in turn leads to the desired outcomes.[12]

A further challenge to the rationale for utility regulation was headed by Demsetz (1968) who observed theoretical inconsistencies in natural monopoly theory and stated that the conventional view point of what a natural monopoly is was largely based on an 'incorrect' understanding of the idea of competition. It was shown that the existence of a single producer (due to scale economies) of a good need not necessarily lead to monopolistic pricing. There is a possibility that competitors can place bids for the right to serve the market and the mere threat of potential entry could be enough to discipline a firm against pursuing excessive profits. In addition, if the number of bidding firms was large enough - also assuming no collusion between them, the winning bid/price could be very close to the marginal cost of production. With this in mind, there would be no need for additional regulation in an attempt to make the winning firm use MC pricing (Demsetz, 1968).

This notion is further explored in the literature[13] on 'contestable markets'. A perfectly contestable market is seen as the 'benchmark' market and is defined as "…one in which entry and exit are easy and costless, which may or may not be characterised by economies of scale or scope, but which has no entry barriers." (Baumol *et al.*, 1982: xiii). A practical analysis of the theory of contestable markets was performed by Coursey *et al.*, (1984: 111) and in their conclusion;

> *The most significant result… is that the behavioural predictions of the contestable market hypothesis are fundamentally correct. It is simply not true that monopoly pricing is a 'natural' result of a market merely because firms in the market exhibit decreasing costs and demand is sufficient to support no more than a single firm.* (Coursey *et al.*, 1984:111)

In other words, assuming the presence of 'frictionless reversible entry' in a market dominated by a single firm, the firm can act competitively to disincentivise market entry by other firms (Brock, 1983: 1055). By acting competitively, the incumbent firm may choose not to use monopolistic pricing and rather opt for pricing similar to that under conditions of perfect competition. This will deter rival firms as there will be no significant profits to be made. Baumol *et al.* (1982: 347) regard

[12] These problems were later addressed and an alternative theory –'capture theory' was developed by Jordan 1972. Further literature was provided by Stigler, (1971), Posner, (1974) and a summary of the debate given by Priest, (1993).
[13] See Baumol *et al.*, (1977) and Bailey and Panzar, (1981).

market forces as being the "guardian" of general welfare which is far more effective and powerful than people presume. This notion places emphasis on the efficiency criterion and strengthens arguments for the privatisation of public water service delivery. The pricing implications of Calitz and Siebrits (1999) were also previously debated upon by Demsetz and Tesler in a series of papers.

A year after Demsetzs' pioneering work against regulating natural monopolies, Tesler (1969) published a paper criticising the formers work. Tesler argued that although bidding for contracts meant that the producer with the lowest price would most likely get the contract, there is no guarantee that this lowest price was necessarily equal to MC. Situations where MC is not equated to price are generally inefficient. In addition, Tesler (1969: 939) states that Demsetz is 'missing the point' by focusing on the rate of return of the firm, rather "the controversy concerns regulation to secure efficiency and to promote public welfare."

Demsetz (1971) responded to Tesler's criticisms by acknowledging that the winning bid price (point $P_m Q_m$ in Figure 3.1) would indeed fail to satisfy the requirements for Pareto efficiency (equating price to MC – $P_{wmax} Q_{wmax}$ in Figure 3.1). However, Demsetz adds that the bidding price is a better allocation than the pure monopoly alternative ($Q_{max} P_{max}$in Figure 3.1) where price would be higher and output lower. Furthermore, the inefficiency in this case (unregulated monopoly - $Q_{max} P_{max}$) would arise not from the lack of competition but from the challenges faced in trying to devise suitable contracts (without the bidding process). Peacock and Rowley (1972:230) conclude that Tesler would always[14] opt for regulation in the quest for efficient pricing, however he might admit that the predictions made by Demsetz regarding the bidding option were correct.

In their discussion against regulation, Peacock and Rowley (1972) also mention that one needs to think about the possibility of a shift in the MC curve (through x-inefficiency[15]) when considering regulating natural monopolies. When regulating natural monopolies there is the common assumption that in the presence of scale economies, there is no association between the production

[14] "I see no reason to embrace Q2 [Q_{wmax}], which Demsetz pronounces as his original contribution, merely because according to some vaguely described bidding process it yields no profit to the winning supplier. Marginal cost pricing is emphasised by most economists who study this subject….." (Tesler, 1971, in Peacock and Rowley, 1972: 230)

[15] When there is a difference between the theoretical and actual behaviour of a firm primarily due to a lack of technical efficiency caused by the respective firm not facing significant competition (Liebenstein, 1966)

function and regulatory intervention. Peacock and Rowley (1972) question this common assumption.

Without significant competition, a firm has reduced incentive to be technically efficient in its production activities. This could see the firm facing increasing unit costs of production which could exceed the costs under competitive pressures (Liebenstein, 1966). It can be assumed that something similar happened in the Harare case where initially provision for repairs and maintenance was made in the tariff design process however, a possible shift of the MC curve would mean higher costs than anticipated hence the need for additional funds.

This concept was presented in a study by Comanor and Liebenstein (1969) where they demonstrated that x-inefficiency induced by market power resulted in welfare losses. These welfare losses are similar to those put forward by Alfred Marshal's Marshallian triangle[16] (Helmers, 2012). Assuming the presence of x-inefficiency, the welfare losses will be in in the form of reductions in scale economies with increased production. Once this happens, "the cost saving case in the favour of the natural monopoly solution is correspondingly eroded, if not entirely destroyed." (Peacock & Liebenstein, 1972: 231).

One could argue that the 'pro-Tesler' regulatory authorities could take actions against potential x-inefficiency and possibly attain an x-efficient MC solution. An example of such actions could involve setting x-efficient output and price targets for the regulated monopoly. Peacock and Liebenstein (1972) are however quick to add that such a solution stems from a largely unrealistic view of how the regulatory process functions. In reality, regulatory authorities are not that well-informed and tend to rely heavily on cost information from other regulated sectors. Such a situation would give the natural monopolist reasonable incentive to produce under x-inefficient conditions and simply do away with the excess that the authorities are trying to eliminate in their quest of Pareto efficiency. This leads Peacock and Liebenstein (1972: 232) to ultimately conclude that "the marginal cost pricing solution imposed by regulation, therefore, is likely in practice to be based upon an x-inefficient cost platform."

Whether privatisation or public government control is better for natural resource allocation has been a hotly debated topic over the last three decades. The overriding factor has been efficiency

[16] Typical producer/consumer surplus 'triangle'.

although there are other considerations such as welfare implications as well as the political influence that comes with government control. Advocates of privatisation maintain that efficiency should be the superseding factor (Bakker, 2013). The other factor is whether or not the good in question is a public or private good.

3.4.2. Privatisation of a Natural Monopoly (Utility)

Utilities were initially established by governments so they could provide public goods and services to their citizens (Medema, 2007). Public utilities evolved from the need to provide public goods and they exist in a wide range of industries including telecommunications, oil, railroads and natural gas. The common feature of these industries is their use of a large-scale distribution 'network' structure which commonly spans over public rights-of-ways - for example streets and railway tracks. This also gives rise to the issue of utilities being a natural monopoly and warranting the involvement of the government. Such expansive infrastructure usually calls for substantial sunk costs in its establishment i.e. investment, as well as the potential to realise economies of scale over the entire range of output (Wallis, 1983).

In most instances, utilities have been granted the power to be regulated monopolies within their service areas. Utilities were traditionally publically managed due to their provision of public goods. In many countries these "natural monopolies" have since experienced changes in the way they are regulated, indeed many have been privatised. Calitz and Siebrits, (1999: 31) define privatisation as "the transfer or sale of certain activities or property from the public to the private sector". They go further to explain that privatisation can be in various degrees such as selling of a state enterprise or fixed assets, leasing or contracting out for various services.

In many developed countries, utilities such as electricity, energy and telecommunications have been privatised or restructured to include some elements of privatisation. This has not been as popular in the water and sanitation sector leaving some to call it 'the last monopoly'. Water utilities are perhaps the most monopolistic of industries, yet economic regulation is limited and mixed. Seppälä *et al.,* (2001:3) further explain that the water industry possesses a certain uniqueness in that it "…has not experienced major technological breakthroughs or come close to exploiting economies of scale in management and operations as other utilities did before restructuring", - making it difficult to restructure it in a way similar to the energy and telecommunications industry.

Privatisation involves essentially exposing the utility to competition and this can be achieved through removing all regulatory and legal barriers to entry in the industry and enabling conditions that promote exclusion - for instance, by controlling free-riding (Foster, 1992). The highly capital intensive nature of this industry means that the only sure way for a new player to enter the market in water provision would be through acquisition of a current utility and not necessarily building a new one altogether.

The privatisation notion is promoted by the increasing consensus that competition in an industry can achieve more extensive goals that are also more effective (Geddes, 1999). Privatisation of water supply has been advocated for decades by the World Bank and The World Trade Organisation and has been widely and successfully adopted in countries such as France and England (Prasad, 2006). On the other hand, there are examples such as Bolivia and Ghana where governments experimented with the privatisation of water schemes and were met with fervent civil outcry (PLOS Med, 2009; Tan, 2012)[17].

Those in favour of privatisation of water place an emphasis on the efficiency criterion that is synonymous with profit orientated private management. Public management unfortunately falls short when it comes to this efficiency component but it however takes into account social aspects such as welfare changes that are not prioritised by the private sector (Bakker, 2013; Shackleton, 2013).

With a particular focus on efficiency, it has been questioned whether privatisation of natural monopolies is particularly feasible. In response, three scenarios where this could be possible have been put forward in literature. Initially such monopolies could be privately owned and managed but this should be done in accordance with regulation set by a national utilities commission board - this is widely practiced in America. Another option could be to split the utility into its basic functions and services (Foster, 1992). These will then be individually analysed and allocated to the private or public sector depending on which is more efficient in performing the service (Calitz & Siebrits, 1999). For instance, with water service provision, chemical treatment of raw water can be privatised to ensure best quality at the lowest cost. The distribution of the water will be allocated to the public sector as they have the necessary pipeline network and they also have the incentive

[17] Also see Burke (2013) for water privatisation case studies in Guinea, Ghana and Senegal.

to increase coverage to harness the positive externalities associated with water service provision. Lastly, management of the utility could be given to the private sector on a contractual basis over a fixed period of time. Renewal of the contract for the next period would be performance based or tendered to other prospective contractors. This gives an incentive to the private contractor to not only be efficient but also incorporate welfare considerations (Calitz & Siebrits, 1999; Roland, 2013, Shackleton, 2013).

3.4.3. Anti-privatisation

Activists against privatisation cite various problems that can result from going this route. One can consider the workers that are employed by the 'pre-privatised' utility, there are inefficiencies in the public sector and many of these could be as a result of surplus labour. Upon privatisation, such workers will lose their jobs in a bid for efficiency (Bakker, 2013). A way of overcoming this is allocating shares to employees prior to privatisation of the utility. However, one can argue that from a macroeconomic perspective there are other factors that affect employment level- not just privatisation. One should also consider the potential job creation that can arise from the expansion possibilities of an efficiently managed firm (Calitz & Siebrits, 1999).

When a firm is privatised, the government receives the proceeds mostly as a lump sum. However, there is the possibility that the government may be tempted to divert this revenue to financing its budget deficit for that year. Proceeds in lump-sum form should not be used for expenses such as salaries of government employees, such actions are comparable to "selling the family silver to buy groceries" and do not yield long-term advantages (Calitz & Siebrits, 1999). It is widely agreed that this money be first used towards reducing the public debt of the government. Alternatively, the government could use this privatisation revenue to increase its infrastructure or financial capital. When one analyses the sale of the firm, essentially the government has 'lost' an asset and this effect can be countered by investing in more capital and thus 'replacing' the lost asset with others. Such actions would ensure that the sale of the utility has led to obtaining something 'tangible' (Foster, 1992).

Much has been written about whether public or private provision is better for water service provision[18]; however a deeper analysis of this debate falls outside the scope of this study which is based on the city of Harare where the relevant water utility is publically owned.

With regards to a public monopoly that is managed by a municipality like in the case of Harare, the service will be provided by the city using revenue collected from general taxes. If the government is given the option to intervene in the market, local authorities could opt for either a public monopoly or one of the two types of 'private' monopoly (natural and regulated). With a private monopoly, the local government enters into a contract with a private firm and the latter will provide the public service. The contract is usually entered on the basis of a competitive bid and the chosen firm will be the sole provider of the service and will be paid by the city (Dubin & Navarro, 1988).

3.5. The Principles Behind Actual Water Pricing

In their quest to design the most ideal water pricing structure, water authorities have to take into account various aspects such as cost recovery which allows for the operation, maintenance and expansion of water systems. Authorities also use the price to capture elements related to "equity, public health, resource conservation, the recovery of costs inherent in the provision of the service, and the optimisation of administration costs" amongst others (Barberan & Arbues, 2008: 2104). Additionally, there could be microeconomic goals that they also need to be cognisant of. For example, if authorities are targeting redistributive goals, it is better to incorporate subsidised water provision as well as possibly using other pricing mechanisms which take into account income disparities

To facilitate efficient use, these charges must furthermore be designed in such a way that promotes rational consumption and increases the awareness of consumers regarding the scarcity of a resource based on its price (Parkin, 2010). The price will signal to consumers the real financial value of the resource thus promoting the allocation of scarce resources to more worthy uses (Borre *et al.,* 2001).

[18] See: Bakker, 2013; Barnekov and Raffel, 1990; Ghosh *at al.,* 1995; Ogden, 1997 and Wood, 2004.

It is difficult to design a tariff structure that fully captures all these factors as some of them are difficult to quantify and this poses further problems in including them in an economic model. An 'ideal' price system for all users is also difficult to develop as it depends on the preferences and characteristics of all the users as well as the particular objectives set by the local authority (Dinar *et al.,* 1997). The usual criterion used to analyse water rates design includes equity, simplicity, full cost recovery, efficiency and opportunity cost considerations (Barberan & Arbues, 2008; Gupta, 2011).

3.5.1. The Equity Principle

Equity considerations can be studied by looking at how a given price structure impacts on the distribution of income of users. This impact is determined by analysing users who benefit or lose as well as the extent of these gains or losses (Pashardes & Hajispyrou, 2002).

The concept of equity is usually reflected by taking into account distribution of income and/or welfare. Its social evaluation is a widely debated area in economic literature with no clear consensus emerging[19]. The key challenge stems from the concept of "fairness", which is unlike efficiency which can be stated as being where price is equated to marginal cost (IMF, 1999). The definition for fair distribution has philosophical and social underpinnings as well as subjective value perceptions. In order to achieve a more equitable distribution of public costs of service provision among tax payers, the ability-to-pay principle and the benefit principle are used (Black e*t al.,* 2006).

3.5.1.1. Ability-to-pay

The ability-to-pay principle states that each taxpayer should pay based on one's capacity to pay (Black e*t al.,* 2006). It is interpreted in the context of affordability, particularly in countries with high income inequality. In such situations, the ability-to-pay principle justifies the favourable bias towards relatively low income households in the provision of basic water needs.

[19] See: Young, 1994; IMF, 1999; Kolm, 2002 and Pant, 2011.

3.5.1.2. The Benefit Principle

When applied to the fiscal system, the benefit principle dictates that each taxpayer pays relative to the public service that they receive (Young, 1994). An example of this principle is shown in motorists having to pay a toll fee when using certain roads - only those who benefit from using the road must pay the toll, whilst those who do not are exempt. The benefit principle contributes to efficiency as it guarantees that consumers adjust their use of the public service based on the satisfaction they derive and price they pay. In the case of motorists, those who are satisfied with the quality of the tolled roads will make use of the roads and pay the fee whilst those that are not satisfied, might opt to use other roads that are not tolled.

When consumers consider purchasing goods, there is a maximum price that each consumer will be willing to pay given their perceptions of the value they will be receiving. This is called the 'reservation price' and it varies per consumer depending on factors such as disposable income and information about substitutes (Steedman, 1987). Attempting to find the reservation price of consumers so as to implement the benefit principle presents a challenge because the reservation price is subjective and varies between consumers. Thus the benefit principle is better suited for the financing of certain public services, for example libraries, national museums and highways (Oakland & Testa, 2000).

It however falls short in its application to finance *all* of public expenditure such as transfer payments. Applying the benefit principle to transfer payments would imply that only those receiving - for example, social welfare allowances should pay for this service. It is highly likely that those individuals receiving social welfare are already facing financial problems thus they would not be able to afford the 'benefit' of accessing the social welfare system. The benefit principle further fails to meet the redistributive objectives that many countries have in place due to large income inequalities (Oakland & Testa, 2000).

When comparing the benefit principle with the equity principle, the former would maintain that each individual pay for the volume of water that they consume, however water consumption for domestic use is measured per household and not individually. To resolve this problem, Barberan and Arbues (2008) recommend that a per capita charge be determined. This charge would be equal for all users and be derived from the recommended minimum water requirements - to meet basic

needs regardless of household size. Due to the direct impact that water services have on public health and quality of life, they are deemed an essential public service (i.e. a merit good) and governments have a constitutional obligation to guarantee the service to their citizens at affordable rates. In the case of provision for low income citizens - guaranteeing the service might involve the government subsidising the water prices to a level that meets basic water needs (Barberan & Arbues, 2008). Gupta (2011) states that a commercially viable service coupled with a rational tariff plan often brings about efficiency gains that prove to be more beneficial to consumers than the government subsidising the service. This is especially relevant to the Harare situation where the prevailing economic conditions coupled with a cash strapped government mean subsidies are not a viable route.

One way around the problems involved in trying to determine a fair price is to do a survey of what consumers will be willing to pay (WTP) for a public good or service. To determine the willingness-to-pay of users, tariffs are designed to target the different types of users such as agricultural, domestic and industrial. This serves as an alternative to the benefit principle as instead of deriving benefits for each user, users are grouped based on their needs and those users in the same group (assumed to receive similar 'benefits') pay a tariff designed for them (Barberan & Arbues, 2008).

In practice, it was observed that the benefit principle is more applicable for financing services that are typical private goods which exhibit excludability and rivalry in consumption. Methods to guarantee access and increase service provision should however not be confused with an income distributary function. Income redistribution goals should rather be accommodated in the relevant fiscal policies such as application of the ability-to-pay principle to general tax policy (Gupta, 2011).

3.5.2. Simplicity

To ensure that water authorities - and eventually users, face minimal management and administration costs in the provision of water service, the water rates structure should be simplistic. This involves presenting the rates to users in a clear way so that it is easy to understand the pricing structure and this will in turn promote acceptance of the rates by water service users (Barberan and Arbues, 2008).

Simplicity should not only be extended to water users but also in the administration of the service provider. Such administrative simplicity aids in efficiency of the service provider. A more efficient service provider is able to maximise the social returns from water rates which are obtained from the difference between benefits received (improved efficiency, equity, revenues) and administration and compliance costs.

3.5.3. Full cost recovery

Basic economic theory dictates that a market should clear at the point where demand equals supply. The price and quantity where this happens is the equilibrium price and equilibrium quantity respectively. Theory further states that in situations where a good (or resource) is scarce, price must increase so as to curb demand and allow the market to clear (Parkin, 2010). At this point, the cost of producing the next unit of the good is equal to the benefit derived from it. There is also a negative relationship between demand and price as consumers will demand less of a good as its price increases. The opposite is true for supply which has a positive relationship with price and as the price increases, producers will increase production so as to maximise profits (Pindyck & Rubinfeld, 1998).

This market mechanism is not being fully applied to water as prices remain generally low and this is creating problems in areas where revenues are lower than the associated costs of water supply (Winpenny, 1994). If the mechanism were being applied, then the prices charged for water would be significantly higher to reflect not only the scarcity of water but also the full costs of its provision.

If capital and operational costs are fully covered by the revenue collected, then there is operational cost recovery - also called budget self-sufficiency (Dalhuisen & Nijkamp, 2002). If the revenue is enough to cover environmental and external costs associated with provision (i.e. social costs), then full water cost recovery is attained. Gupta (2011) further identifies a third form of cost recovery called full service cost recovery. Full service cost recovery is attained when the revenue collected is not only enough to cover operational costs but is also sufficient to cover maintenance of existing capital.

Gupta (2011) also identifies an indicator for measuring operating efficiency called the operating ratio. The operating ratio is expressed by dividing the total operating expenses of the utility by the

revenue collected. An operating ration less than 1 would indicate that the utility is making a 'surplus' whilst a ration greater than 1 would indicate that the utility is operating at a loss.

3.5.4. Efficiency

Efficiency can be perceived in a number of ways, one definition when used in economic theory relates to Pareto efficiency where an individual cannot be made better off at the cost of another (Parkin, 2010). Another standard definition looks at the quantity of goods and services that a consumer receives per unit cost. Dinar *et al*. (2002) apply the concept of efficiency to water allocation and define it as when the marginal benefit from consumption is equalized across consumers - eventually maximising net benefits and social welfare.

When considering issues of efficient water pricing, economists have debated about whether to price water based on its marginal costs (MC) of provision - first-best pricing or based on its average costs (AC) of provision - second-best pricing (Vedula and Mujumdar, 2005) (see sections 3.3 and 3.4). The AC is defined as the cost per unit of output over the entire range of production and the MC as the cost of producing the next unit of the good. AC pricing (point $P_m Q_m$on figure 3.1) would be in line with the anti-regulation views of Demsetz whilst MC pricing (point $P_{wmax} Q_{wmax}$ on figure 3.1) follows Tesler's pro-regulation approach as discussed in section 3.4.2.

Deciding between the two depends on the policy outcomes that the authorities are pursuing. MC pricing is preferable if the prime consideration is that of efficient resource use and consumer welfare, whilst AC pricing is more in line with the financial argument for full cost recovery (Gupta, 2011). In other words with AC pricing, "only in the event that society is willing to pay the cost of producing, distributing and treating the last cubic meter of water, should it be produced" Chambouleyron (2004: 305-306). AC and MC pricing will now be analysed in their application to water service delivery.

3.5.4.1. Average cost pricing

When the revenue-recovery principle is central, utilities will set price equal to average cost - this is called "second-best" pricing. Referring to Figure 3.1 in section 3.3, a utility that is using this pricing structure would be producing Q_m volume of water at a price P_m. This relationship is depicted in the equation below where

β= Percentage change
P= Price
C=Consumption
Q= Volume of water produced

$$P = \frac{\beta C\ (Q)}{\beta Q}$$

(Source: Barberan & Arbues, 2008)

The price charged is equal to the percentage change in consumption multiplied by the volume of water produced and this will be divided by the percentage change in the volume of water produced[20]. Adopting AC pricing means that monopolies should realise normal profits rather than making economic profits[21] (Spulber, 1986). This action will further benefit consumers as there will be higher levels of production at lower prices compared to the situation of monopoly pricing (See section 3.3).

3.5.4.2. Marginal cost (MC) pricing and the two-part tariff

Water supply costs are comprised of numerous elements and the definition by Chambouleyron (2004: 306) best sums the associated marginal opportunity costs of provision;

> *…marginal opportunity cost of water is the sum of marginal water production costs (including extraction, transport, distribution, effluent treatment and disposal), marginal user costs (opportunity cost of resource depletion) and marginal environment costs (i.e. positive or negative environmental and health externalities created by water consumption).*

Using the case of public provision of water services, the numerous costs incurred include significant capital outlays, treatment, sewage collection and processing and recurring maintenance costs. In this case, the market dictates that the tariff structure should be based on the costs incurred per additional unit supplied (i.e. MC) (Gupta, 2011). Marginal cost pricing is part of the efficiency criteria of resource allocation. This pricing mechanism optimises the use of water to the extent that

[20] In a situation where second-best pricing is used and it is required that the budget of the utility balance, an alternative to second-best pricing can be used. This alternative is called "Ramsey-Boiteux" pricing and is further discussed in Garcia and Reynaud (2004).
[21] Derived from the difference between the revenue that the firm generates and the costs (implicit and explicit) faced.

the benefit received from the last unit of water supplied should equal the MC of supplying it (Barberan & Arbues, 2008).

A Pareto efficient allocation of water gives the highest return for the water resource thus equating price to the MC of producing the next unit plus the opportunity cost (the alternative uses that have been forgone) of the resource (Johansson, 2000). By using this pricing structure, a public utility is able to maximise social welfare and this maximising of net surplus leads to the law of equating social marginal cost to price.

This equating of price to MC is shown in Figure 3.1 (section 3.3) as point $P_{Wmax}Q_{Wmax}$ and is depicted in the equation below.

$$P = \frac{\beta C(Q)}{\beta Q} + \mu$$

The difference between MC pricing and AC pricing is that MC pricing includes the 'shadow price' of water (μ), which is used to give monetary value to those costs that are difficult to quantify - for example externalities. This inclusion gives an overall better estimate of the true opportunity cost per unit of the product.

To ensure an efficient allocation of resources, the benefit received from consumption of the next unit of a resource (private marginal benefit - MB) must be equalised for all users. When this happens, social welfare will also be maximised. An efficient water distribution system is one which maximises the overall net benefits from its consumption (Easter *et al.,* 1997).

An advantage of MC pricing is that it is theoretically efficient and is supported by most prominent economic literature as being central for efficiency (Monteiro, 2005; Tesler, 1971). From an economic perspective, resource use is considered as being efficient (socially) if the cost of receiving the resource (taking into account the opportunity cost of forgone alternatives) is equal to the social benefit from consuming the last unit produced. With this signalling from the price, the consumer is able to compare costs incurred against benefits received and can alter consumption accordingly. Relative to the socially optimal consumption level, if the price is greater than marginal costs then consumption levels will be too low and vice versa (Parkin, 2010).

Despite these positive elements, public utilities are prioritising revenue recovery in their design of a pricing structure. The reasons for this are the criticisms against first-best/ MC pricing (from a social perspective) which will be discussed below (Garcia & Reynaud, 2004).

A potential challenge associated with MC pricing would be particularly evident in times when water availability changes. For instance, in the rainy season the MC of supply will be less than during the dry seasons. There might also be complications arising from regional differences in supply within a country (Coase, 1946). For example, the cost of water provision might be cheaper for some regions that are serviced by nearby water bodies than for those far away from water bodies. The case of urban areas where significant economies of scale are realised and average costs of supplying water decrease with increased provision also presents another dynamic. Such situations create conflict between the full cost recovery criteria and the efficiency criteria. Making use of a two-part water rate schedule allows both objectives to be reached simultaneously (see section 3.6).

Monteiro, (2005) further cites some 'definitial' problems of using MC pricing. Firstly, the concept of MC - when applied to water becomes multidimensional as it becomes dependent on factors such as the volume, location and quality of the water. Due to the effect of fixed and variable costs, MC also changes depending on whether an increase in demand is permanent or temporary. There are also variations in MC based on the period in which it is measured - short run (SR) or long run (LR).

The SR would be the case for instance when the capacity of a reservoir exceeds current needs thus the only costs associated with an increase in demand for the service will be related to maintenance and operations. On the other hand, LR marginal costs take into account some of the SR marginal costs as well as those associated with increasing capacity (Warford, 1997). Furthermore, MC tends to disregard equity considerations. For instance, in periods of scarcity the price will increase based on need and this could have adverse effects on lower income groups (Spulber & Sabbaghi, 1994). While the application of pure MC pricing implies a financial fairness, it might not be ideal from a welfare perspective as it places an undue burden on those individuals on the negative end of the income scale (Monteiro, 2005).

In light of the problems identified when attempting to choose between MC and AC pricing (e.g. the predominance of fixed costs) a more practical approach was developed. This latter approach looks at the introduction of incentives for water conservation measures (Gupta, 2011). These incentives are associated with water saving measures and can be introduced by "calculating the volumetric charge with a multi-block tariff with increasing price blocks, where the price of the first block is closer to the marginal cost of providing the service and the prices of the following blocks increase according to the relative scarceness of the environmental resource and the environmental costs in each city." (Barberan & Arbues, 2008: 2108). This is explained in more detail in section 3.6.

3.5.5. Opportunity cost

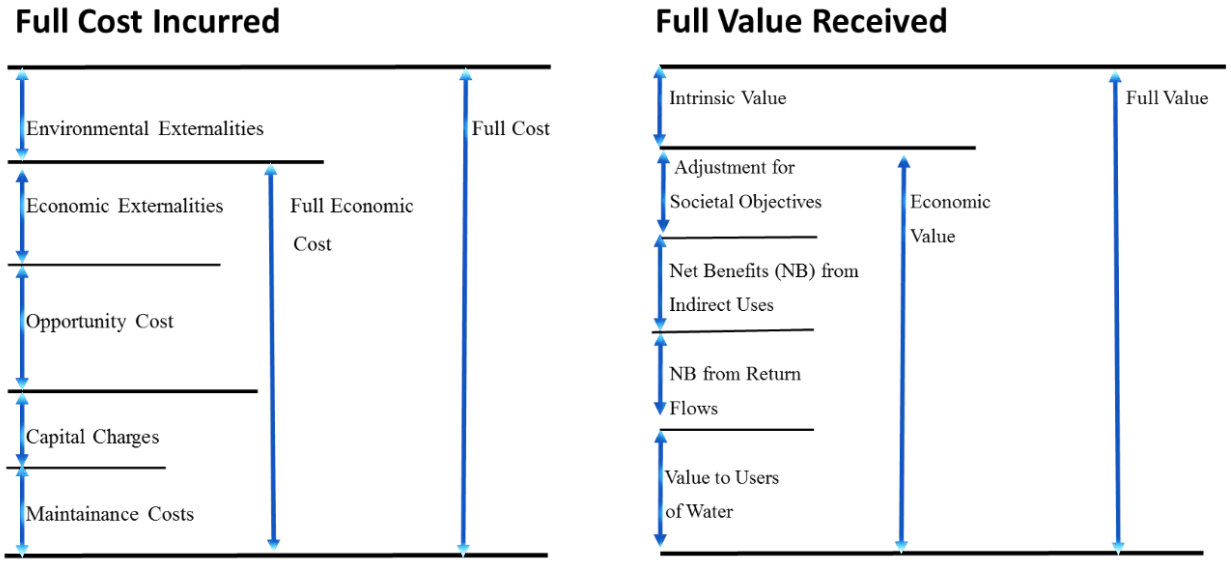
Each of the various functions of water such as drinking or irrigation attracts an opportunity cost (the highest valued alternative forgone) reflecting the other uses of a specific unit of water. As a result, there is continual conflict between the individuals in charge of the different functions. In addition, water service is an impure public good and it lacks the same features as other 'normal' goods. Thus determining its price from only the analysis of market demand is inadequate. Functional water markets are in fact a rare occurrence in the world economy (Dalhuisen & Nijkamp, 2002).

Incorporating the opportunity cost into the standard cost would be impractical as this OC value would be based on variable values perceived by users, some of which can be seasonal as is the case of agricultural uses. Therefore Winpenny (1994) suggests that the price charged should at least be greater than the economic cost of provision. One could also consider lowering the general costs of water provision through optimising the current system. By optimising the system, it is made more efficient and there will be lower costs from issues such as repairs or downtime. Nevertheless, the fact still remains that according to Winpenny (1994), the price consumers pay for water is too low compared to the benefits received from its provision as well as relative to the actual costs of provision.

It is widely recommended that pricing that captures all the costs of water provision be considered to guarantee continuity of water service provision. In Figure 3.2 below, an adaptation of Rogers *et*

al.'s (2002) general schematic representation of the relationship between cost value and price of water[22] is given.

Figure 3.2: General Principles of Cost and Value of water



(Source: Rogers *et al.*, 2002)

Rogers *et al.*, (2002) considers full costs incurred to include not only those costs that the provider faces such as maintenance and capital costs. There are also opportunity costs as well as social costs such as economic externalities. Economic externalities include both those that can be internalised as well as those that do not have a direct monetary value such as environmental externalities.

Value in this case is used to denote benefits that consumers receive. The full value is comprised of the economic value and the intrinsic value. The former can be expressed in monetary terms (for example - benefits to users and from indirect uses) whilst the latter does not have a direct monetary value attached (intrinsic benefits).

The final price of water that is set by the social and political system is meant to ensure equity, sustainability and cost recovery. Therefore, in the determination of the price of water, authorities not only consider cost but also other social elements (Rogers *et al.*, 2002). These water pricing mechanisms need to more accurately reflect the various costs and benefits associated with water

[22] See Rogers *et al*. (1998) for the relationships between full economic cost, full supply cost and full cost.

provision thus making the water price a better instrument for management of water consumption (Barberan & Arbues, 2008).

Before water scarcity concerns took shape, supply-side adjustments to increase water supply were common) analysed such a model which was able to incorporate the price of capacity increases into the price the consumer pays. Their analysis combined techniques of combined use management and second-best pricing. They extended the model to situations where financial restrictions hindered attempts to increase capacity to meet increases in demand. They further simulated the effects of their pricing policy on energy, water and land use and they concluded that using supply-based water management policies resulted in a decrease in water and energy demand. Nowadays, society has become more aware of water scarcity issues and there is the realisation that supply-side responses to increased water demand are not sustainable, thus there is a stronger focus on methods that curb demand for water.

3.5.6. Other water pricing models

Apart from MC and AC pricing explained above, there are also other pricing models that have been put forward in response to varying situations and limitations.

3.5.6.1. Constrained water pricing

A model devised by Dandy *et al.* (2010) attempts to derive the optimum water pricing model in the presence of constraints which limit the degree to which prices can change. They state that many models for capacity expansion and urban water pricing are inclined to overlook political and administrative influences. Such influences tend to limit the feasibility of decisions that are made.

Their model attempted to identify the timeline for water pricing and use it to try and maximise the present value of net benefits from water. Upon its application to a hypothetical urban water system, it was concluded that their model for capacity expansion and water pricing was "likely to achieve some increase in economic benefits when compared to average cost pricing" (Dandy *et al.*, 2010:511). Under the influence of political and administrative actions which tend to reduce the net benefits from water, it was concluded that the overall benefits received exceeded those from the use of AC pricing - making their model superior to AC pricing.

3.5.6.2. Multi-stage MC pricing

To address the challenge of determining the sizes and timing of capacity increases to urban water systems, Riordan (2010) makes use of a general model of investment pricing. The model uses typical demand and supply curves and empirical data to make various assumptions regarding the discount rate, growth in demand and the time horizon. It is important that the sequencing of the different stages of a capacity expansion project be done appropriately over time. Each stage is usually part of a sequence of planned subprojects to increase expansion over time and deciding on the size of each of these subprojects will impact on how long it will be until the next subproject is started (Howe, 1971).

Determining the size of each subproject is difficult due to three main conflicting issues. There is the initial fact that demand for the service will increase with time, thus from an economies of scale perspective, it is more profitable to increase capacity at a large scale. However, increases in capacity that are yet to be needed prove to be expensive when discounted to their present value. "It pays to defer investment as long as possible since future costs are more heavily discounted than present costs." (Howe, 1971: 90). Lastly, there is also need to maintain flexibility in their planning.

An example to illustrate these conflicting aspects would be the hypothetical construction of a very small plant. This small plant would have the advantage of being less expensive to construct but it however proves expensive when one considers the cost per unit of capacity (Howe, 1971). If a massive plant were constructed, there would be lower costs per unit capacity, however it would also involve substantial construction expenditure in the present-day in the form of fixed costs. There is also the problem of having to maintain excess capacity of a large plant for a long time - until demand catches up. A larger plant would also lack the flexibility of a small plant as the former retains fixed technology over a longer period (Howe, 1971).[23]

The results from Riordan's multi-stage model are compared with those that would be expected from standard AC pricing in terms of their efficiency and it was concluded that despite existing empirical shortfalls, multi-stage MC pricing is able to realise 10%-20% more in net benefits than the AC pricing model.

[23] A more detailed discussion of this model can be found in Riordan, (1971).

3.5.6.3. Spot-market pricing

This pricing system was developed by Zarnikau (1994) and is a form of short-run MC pricing. This model charges different prices depending on the location and time of day. The short-run MC would include costs associated with the scarcity of water, capacity restrictions and running costs. With this system in place, the amounts that consumers actually pay would signal how they value alterations such as capacity increases or system upgrades. Overall, this model was found to be more efficient than average cost pricing (Monteiro, 2002). This was because the model allows consumers to adjust water consumption to its highest value at the relevant time through altering consumption from times with higher charges to those with lower ones.

3.5.7. Other considerations

Apart from the above mentioned principles of water pricing, there are also other aspects that can be put under consideration. Water demand and the costs associated with its supply are prone to seasonal changes and some authorities accommodate this by charging different prices according to these seasonal changes. In the dry seasons water rates are higher to curb demand and in the wet seasons when supply is higher, the rates are lower (Gupta, 2011). In comparison to using a maximum rate throughout, this method was seen to be the most effective. "While various seasonal prices reflect seasonal change of parsimony costs, rates could be a strong motive for conservation, economical return and equity" (Mohayidin *et al.,* 2009: 1540).

3.6. Water Tariff Design

Previous sections have discussed water pricing from a theoretical standpoint. This section will discuss how these various theoretical aspects are applied in practice.

An accepted way of tariff design looks at the recovery of the full or partial costs of the service. This has been applied to pricing of various public utility rates (irrigation, gas, railway or electricity) and is called the cost-of-service method (i.e. AC pricing). This method makes use of the previously discussed second-best pricing and users are charged an amount that is only enough to cover the costs associated with provision of the service (Mohayidin *et al.,* 2009). Many utilities when designing their water tariffs incorporate a volumetric component and/or a flat rate component (two-part water rate schedule). The former is where the water is charged over a metered connection and

price changes with consumption whilst with the latter is a fixed charge that does not vary with consumption. Volumetric tariffs are a complex form of pricing methods and are used in various industries as they are suitable in meeting efficiency and equity concerns in demand and supply-side management (Pashardes & Hajispyrou, 2002).

3.6.1. The two-part water rate schedule

The two-part water rate schedule is a combination of a charge for each unit consumed through a metered connection calculated based on the marginal cost of providing the service. The second part is a fixed charge that does not vary with consumption but would take into account potential consumption. The fixed amount is derived by dividing the costs not recovered from using the metered usage charges and dividing the unrecovered costs amongst the users (Barberan & Arbues, 2008). The two-part water rate schedule can be in three forms. Initially there are decreasing block rates (DBR) where the tariff decreases with increased consumption of water. There are also linear block rates (LBR) where the amount of the tariff remains constant regardless of consumption. Finally, there are increasing block rates (IBRs) where the amount of the tariff increases with increased consumption. IBRs are the most commonly used pricing schedule and will be the main focus of this discussion.

3.6.1.1. Increasing block rates (IBRs)

IBRs are the most commonly used tariff structure as they are said to signal the increasing costs of water use in the price and thus promote conservation of water. Monthly water consumption is measured in blocks of predetermined volumes (for example, block 1: 0-50 cubic metres (Cm), Block 2: 51-100Cm, and Block 3: 101-200 Cm). The price increases as the consumers' consumption moves to higher levels of water usage reflected in the blocks. Guidelines for setting the blocks for residential consumption are given in Table 3.2.

Table 3.2: Guidelines for Increasing Block Rates

Block	Guideline
1	Based on efficient level of monthly indoor use
2	Set to represent the water requirements of an efficient landscape
3	Set to represent more water intensive landscape
4	Set to represent wasteful and inefficient use

(Source: WRA, 2013)

The initial block is usually set at a very low tariff in a bid to protect low income households (i.e. a progressive tariff in line with the equity principle). In South Africa, the first block is for consumption levels under 6Cm and is provided free of charge by the authorities. Overall household water usage varies between countries and tends to be lower in countries in colder climates with minimal outdoor water use than in those with warmer climates. Compared to other types of tariffs, IBRs were seen to be the most effective at communicating the true value of water. They are also able to provide utilities with a sufficient and consistent stream of income (WRA, 2013).

To maximise the benefits from this structure, certain requirements must be met in its implementation. Initially, the blocks must be the 'right size' - not too big or too small. Block differentials should also be large enough to send an effective price signal to consumers when their usage moves into the next block. It was seen that increases of approximately 50% were significant in attaining this goal (OECD, 2009). The slope of a consumer's average price curve can be used to evaluate the effect of the block differential - a positive slope after Block 1 would signal effectiveness. To test the effectiveness of IBR structures, Baerenklau *et al.* (2013) performed a study to test the effect of IBRs on residential water demand. The study was performed over 13 000 single-family households and involved introducing a fiscal-neutral IBR water budget rate structure. Compared to a flat-rate price structure, their results showed an estimated 18% decrease in residential water demand under the IBR structure. From this study, it can be concluded that IBRs are a potentially very effective tool for demand-side water management.

For those utilities that include a fixed charge as part of their tariff structure, if they set a very high charge they have a relatively stable revenue stream. This however comes at the cost of water

conservation incentives for consumers as they will be paying a high charge regardless of consumption. Thus it is important that the fixed charges are not too high (WRA, 2013).

A prime justification for using IBRs is that they promote equality. This rationale is however challenged by Pashardes and Hajispyrou (2002) who state that IBRs place lower income large families at a disadvantage as their utility is not maximised under such a system. It was also shown that in overcrowded areas, an IBR structure can have a largely regressive effect. This is especially applicable if the IBR system is structured in such a way that there is a small number of wide blocks with a small difference in price between them (Whittington, 1992). Another disadvantage that was cited by Baerenklau *et al*. (2013) was that it takes a substantial amount of time for the decreases in water demand to be realised.

3.6.1.2. Analysis of IBRs

Utilities intending to implement IBRs need to take into account factors such as the high degree of analytical capacity required to determine the volumes of water sold per block and anticipating possible demand changes as consumers respond to changes in price. IBRs are also suitable for a utility that wishes to send a more effective price signal and one that is willing to invest additional effort (American Water Works Association - AWWA, 2000).

IBRs are more complicated in their design and explanation than other types of rates as they require information on water sales per block of consumption. They do however offer more flexibility in rate design which is necessary in addressing the different definitions of the equity principle whilst allowing full cost recovery. If IBRs are poorly designed or made too simple, they run the risk of being inequitable (AWWA, 2000).

IBRs tend to attract more revenue volatility mostly because an IBR works on the anticipation of recovering a greater proportion of the consumer's revenue requirement at increased levels of consumption. These increased levels of consumption tend to be more dependent on seasonal variations of the weather and other factors and when coupled with a higher unit pricing, customers tend to curtail consumption in these higher consumption blocks (Pashardes & Hajispyrou, 2002). A utility implementing an IBR structure is thus advised to have a good understanding of the distribution of water demand by consumer class and of price elasticity of demand. Over the long term, IBRs can give utilities and rate analysts flexibility with which to achieve predictable cost

recovery. A utility that is concerned about adverse revenue effects from IBRs might consider developing a reserve, often referred to as a stabilisation fund. Such a fund allows a utility to draw on the fund during revenue shortfalls (WRA, 2013).

In addition, Pashardes and Hajispyrou (2002) emphasise that there are also other equally important factors apart from income level that affect water consumption. Such factors include the composition and size of the household and the types of water using appliances used by the households (e.g. dishwashers, washing machines and swimming pools).

3.6.2. Criticisms of the two-part water rate schedule

The two-part rate water schedule - though simple in theory, faces challenges in its inability to capture social costs of using water such as the opportunity costs forgone and the environmental costs - negative externalities (Hanemann, 2006). Another problem is the high costs associated with the type of technology used for water supply in urban areas which leads to the utility facing a higher proportion of fixed costs to variable costs.

The effect of these limitations is that the application of the P=MC rule will result in a very low price for the variable rates and this price will often be lower than the total marginal cost of the water consumed. Such a situation is not compatible with the widespread problem of scarce water availability as it favours 'careless' water consumption and does not promote more conscious consumption (Barberan & Arbues, 2008).

3.7. Water Tariffs in Practice

Uses of water are varied and numerous, stretching from basic domestic use to those uses that keep the economy running through industry and agriculture (Cosgrove & Rijsberman, 2014). Basic economic theory dictates that in situations where a good [resource] is scarce, its price must increase to curb demand and allow the market to clear (Parkin, 2010). This market mechanism is not being fully applied/utilised in the water service industry as prices remain generally low. There are also many instances where consumers face negligible costs for the water they use, examples include those who use naturally recharging aquifers or those who install water catchment mechanisms using their roofs. However, these 'private' uses attract costs that are minor and relatively trivial

when compared to societal costs of large scale provision which have a real cost of supply attached to them (Winpenny, 1994).

Many countries share this notion of maintaining viability with approximately 60% of the Organisation for Economic Co-operation and Development (OECD) countries having metred connections in single family households. Water authorities can further incorporate equity considerations in their tariff structures by using selective metering where certain connections are charged less per unit of water consumed or charged a low fixed amount regardless of consumption (Jones, 2003). For example, a distinction can be made between high density suburbs (associated with lower income residents) and low density suburbs (associated with more affluent residents) with the former paying lower rates than the latter.

Nevertheless, there is a certain level of revenue that any firm/entity must recover to maintain financial viability – their cost recovery threshold. A firm can operate in the short run whilst only recovering its variable costs but in the long run, the firm must be able to recover both fixed and variable costs (Parkin, 2010). If capital and operational costs are fully covered by the revenue collected, then there is full service recovery (Dalhuisen & Nijkamp, 2002). The average water tariff rates in sub-Saharan Africa are approximately USD0.67 per cubic meter (Cm) (with a cost recovery threshold of USD1 per Cm). In 2004 the average tariff rate for OECD countries was approximately USD1 per Cm and USD0.35 for middle income countries respectively (Dharmaratna & Parasnis, 2012). The average tariffs in sub-Saharan Africa are almost twice those of medium income economies.

Dharmaratna and Parasnis (2012) performed a study in Sri Lanka to investigate possible under-pricing of water. Their analysis concluded that the cost of producing an additional unit of water (marginal cost - MC) was between SLRS[24]16.50 (approximately USD0.13) per unit in the short run and SLRS47.25 (approximately USD0.36) per unit in the long run. The short run amount captures the associated costs that vary with output volume (variable costs) only whilst the long run estimate includes the necessary expenditure for capacity expansion. Given their results, they went further to recommend that these estimates be used as lower bound estimates of the 'real' cost of water which will thus incorporate factors such as marginal costs.

[24] Sri Lankan Rupees

Most households in Sri Lanka were found to consume within the first two water volume consumption blocks[25] which are priced at SLRS1.25 (approximately USD0.01) per Cm and SLRS2.50 (approximately USD0.02) respectively. These prices are much lower than the cost of providing the water (Dharmaratna & Parasnis, 2012: 311).

Foster and Briceño-Garmendia, (2010: 307) estimate that under-pricing of water means the international water service sector forgoes at least USD1.8 billion annually in revenues (approximately 0.3% of international GDP). Some of the utilities in Africa worst affected by under-pricing were those of Senegal, Madagascar and Cote d'Ivoire where they sometimes collect less than 40% of the required revenues for continued production. This results in an economic burden of between 0.7% - 0.9% of GDP. The economic burden from under-pricing is defined as "the difference between the average effective tariff and the full cost-recovery tariff multiplied by the total volume billed." (Foster & Briceño-Garmendia, 2010: 307).

The respective utilities would then be operating at a deficit which is "often concealed within a set of complex financial arrangements with the central government." (Foster & Briceño-Garmendia, 2010: 307). This further impedes on financial sustainability, optimal resource allocation and efficient water resource use.

> *As a result, the utility management postpones basic investment and rehabilitation decisions to 'make it through the day' financially. Thus, although these policies appear to be socially benign, by debilitating the financial position of the utility, they ultimately lead to delayed investment and hence hold back service expansion to reach the unserved population.* (Foster & Briceño-Garmendia, 2010: 307)

It is likely that under-pricing issues could be affecting the Harare City Council, and coupled with poor collection systems, the HCC is unable to meet its revenue targets to cover both fixed and variable costs. A firm is able to operate in the short run whilst only meeting its variable costs. However, when a firm can no longer meet both its fixed and variable costs, it affects its long term viability and it might have to shut down (Parkin, 2010). In most instances utilities that provide goods and services that have positive social externalities (merit goods) are subsidised by the government so that the good/service is adequately provided to the public at a low cost. The

[25] Block 1: 0-10 cubic metres and Block 2: 11-15 cubic metres.

Zimbabwean government was cited as being a major debtor of the HCC. If the government cannot even afford to pay off its debt to the HCC, it cannot be expected to maintain subsidising the industry.

The HCC recently brought in a team from the eThekwini Municipality (Durban - South Africa) to assist in the HCC's poor revenue collection systems. Where the HCC manages to collect only 60% of its water revenue, its eThekwini counterpart collects up to 96% from users (AllAfrica, 2013). The two authorities signed a cooperation agreement that would facilitate skills transfer and the exchange of employees. Once implemented, the programme was expected to automate the water and sanitation system allowing for better monitoring. Automation of the system would be a step up considering the Harare authorities currently rely on physically checking the sewage reticulation and water system (AllAfrica, 2013).

3.8. Conclusion

Economic theory predicts that in times of increased scarcity, use and consumption of a good should become more efficient. This is due to increased prices giving consumers an incentive for increased use efficiency (Parkin, 2010). Saleth and Dinar (2004) state that in practice, this does not occur in the water sector because of the framework in which water policies are formulated and implemented. The same approaches that were used in the water 'surplus' era (supply-side adjustments) continue to be used with minor changes in these times of scarcity. Previous frameworks focused on supply management and made use of engineering based solutions, bureaucratic management structures as well as treating water as a free good. These have since become incompatible with today's problems given the resource realities, development philosophy and socio-economic concerns.

Marginal cost (MC) pricing forms one of the cornerstones of economic efficiency particularly from a welfare perspective. "The general theory of marginal-cost pricing holds that under perfectly competitive conditions, setting the price of every commodity equal to its marginal costs is required for efficiency" (Crew & Kleindorfer, 1979: 14). Similarly put: if the price of a good does not reflect its marginal cost, then it would fail to give the appropriate signal to consumers of the additional cost incurred in additional (or curtailed) production of that unit. The lack of such signals would make it difficult for consumers to purchase the appropriate quantity of the good. For instance, if a

good is priced higher than its marginal cost of production, some consumers will not be able to afford while they would have been willing to pay the cost of production incurred for that unit. When it comes to the provision of an essential service like water, the final management structures that utilities choose will also depend on various social, economic and/or political elements.

Water Pricing in Harare seeks to maximise consumer welfare and is thus based on a MC pricing framework. As previously explained, this framework does not prioritise cost recovery and production continuity of the utility and this is evidenced by the financial challenges[26] that the HCC is facing (especially regarding refurbishment and maintenance). This notion leads to the third objective of the study: to determine the willingness to pay (WTP) of consumers for improvements in water service delivery. The HCC's current position is comparable to point $P_{Wmax}Q_{Wmax}$ in Figure 3.1 where the utility will be making a loss due to production being at a point where ATC is greater than MC/P.

To remedy this situation Calitz and Siebrits (1999) initially recommend a two-part tariff. The HCC is already using this tariff structure (see section 3.8) but it has been largely unsuccessful due to the fixed component being fairly low relative to the costs the utility is facing. It is further recommended that they use MC pricing together with a lump-sum tax – in spite of equity and regressive effects. Based on this second suggestion, the study seeks to conduct a willingness to pay (WTP) study to see if consumers are willing to raise money which will be used the same way as would be the lump-sum tax revenue. This would increase the revenue that the utility receives at production output $P_{Wmax}Q_{Wmax}$ and narrow the gap between the utility's ATC and MC/P.

The following chapter discusses the methods and procedures that were followed in conducting the WTP study on the water service sector in Harare.

[26] In conjunction with other issues such as poor management.

CHAPTER 4

Research Design and Methods

4.1. Introduction

Environmental resources are frequently mispriced by typical market systems due to their public good nature (Hanley *et al.*, 1997). As a result, policy makers are forced to devise alternative methods of valuing environmental resources. Certain environmental services also deserve special attention as they are not only highly valued by society, but also involve controversial trade-offs. For economies to function, various activities have to occur (e.g. manufacturing) and the by-products of some of these activities harm the environment (pollution externalities) (Torfs *et al.*, 2004). It is important that these economic activities are monitored and regulated so that they do not operate at a level that exceeds the rate at which the environment can assimilate their by-products (Gregory *et al.*, 1993). In the case of Harare where there was poor monitoring and regulation, the resultant environmental degradation led to further consequences. These consequences included environmental (e.g. fish deaths in Lake Chivero), financial (e.g. buying more chemicals to purify drinking water) and social (the 2008-2009 cholera outbreak) problems.

This chapter will give an overview of some of the methods used to value non-market services. Of particular interest is contingent valuation (willingness to pay - WTP), which was also the method used in this thesis. The CV study was conducted by means of a questionnaire (see Appendix 1) and the steps that were taken in conducting the study will be discussed. The descriptive results from the questionnaire will also be reviewed in this chapter. To further analyse the empirical data, the probit model was used and this chapter will conclude with a brief overview of this model and a brief description of the variables that were used in the regression.

4.2. Valuation of Non-Market Goods and Services

One goal of economic analysis is to weigh the costs against the benefits of a proposed action. This concept is easier to apply to ‘conventional’ goods and services which can easily have a monetary value attached to them using market based values. Such market based values incorporate various aspects of production and utility perceptions, such as factors of production, defensive expenditures

and producer and consumer surpluses (Carson, 2000). This is not easily the case when it comes to environmental resources which provide a complex set of services - most of which are not easily quantifiable.

It is this complex mix of services which presents challenges when attempting to apply standard economic valuation principles to the analysis of such goods. In response to this problem, economists have attempted to devise various ways to capture the value of these non-market goods.

4.2.1. Total Economic Value (TEV)

The total economic value (TEV) of a good can be captured by analysing three main value functions. This is shown as:

Total Economic Value = Use Value + Non-use value + Intrinsic value

4.2.2. Use Value

Use value (UV) is described in three main forms, namely direct, indirect and option use values. Direct UV is derived from explicit consumptive or non-consumptive use of the good by users (Perman *et al.*, 2011). Examples include the use of actual products such as food and services (e.g. medical and educational). Indirect UV refers to that value that is derived from indirect functional services such as the carbon storing function of trees or how vegetation also serves to promote soil retention. Lastly, option UV considers that value which is derived from the possibility of *future use* of the good or service. There is no direct use of the good currently, but there is value in maintaining the option to use the good in the future (Tietenberg & Lewis, 2014). Examples include habitat conservation and the potential pharmaceutical products that could be made from maintaining biodiversity.

4.2.3. Non-use Value

Non-use values are also called passive UVs and are based on the notion that a good has value regardless of its use. There are two types of non-use values: existence and warm glow values. Existence value is defined as "the value of mere existence of a resource, given that the individual has no plans ever to use it" (Hanley *et al.*, 1997: 373). The latter has an altruistic component attached which is based on ensuring the availability of the good for others - namely future generations. Such warm glow value will be derived from an individual believing that future

generations should also have access to the good thus there is value in preserving it (Gregory *et al.*, 1993; Bateman *et al.*, 2002).

4.2.4. Intrinsic value

The idea of intrinsic value originates from the principles of ethics and is based on the notion that an object has value "in itself" (de Gennaro, 2012: 138). This is in contrast to instrumental value where the object draws value in its use to derive something else (Perman *et al.*, 2011). With this in mind, a good should have an element of intrinsic value attached regardless of whether or not it contributes to the making of another good.

4.3. Non-Market Valuation Methods

The various methods used to value non-market goods and services can be generalised into two distinct groups, namely revealed preference and stated preference methods. Revealed preference techniques are based on observations of behaviours towards other goods that are closely related to the non-market service under investigation. Stated preferences rely on survey interactions with consumers regarding their value perceptions of the non-market good. They can both be further broken down into direct and indirect methods (Carson, 2000; Perman *et al.*, 2011; Tietenberg & Lewis, 2014).

The methods for valuing non-market goods and services are shown in Table 4.1.

Table 4.1: Techniques for Valuing Non-market Goods and Services

Methods	**Revealed Preference**	**Stated preference**
Direct	Market price Simulated Markets	Contingent Valuation (CV)
Indirect	Travel Cost Hedonic Property Values Hedonic Wage Values Avoidance Expenditures	Contingent Ranking Choice Experiments Attribute Based Models Conjoint Analysis

(Source: Tietenberg & Lewis, 2014:88)

4.3.1. Revealed preference methods

Under direct methods, there are market prices and simulated market methods. These methods derive a price/value through direct observation or imitation of the good/service in question. An example of this would involve simply asking retailers how much a certain good costs or staging (simulating) a market to analyse purchasing decisions of consumers (Parkin, 2010). With indirect methods, value will have to be realised by observing the value of *related* costs and expenses. Once this is done, inferences can be made to arrive at a value for the non-market good in question (Tietenberg & Lewis, 2014). For example, the travel cost method is popular in valuing outdoor recreational modelling for activities such as hunting, fishing and forest visits. The method uses the associated costs of consuming the service as a proxy for the price. These costs typically include things such as entry fees, travel costs and any onsite expenditure as well as on equipment needed for consumption such as fishing rods. Other indirect methods include hedonic valuations which attempt to find the relationship between the non-market good and the prices of market goods - usually property (Perman, 2011).

4.3.2. Stated preference

These methods do not rely on other prices but rather use individual respondents' statements regarding their preferences and these responses are used to estimate utility functions (Kroes & Sheldon, 1988). These are also further classified as being either indirect or direct. An example of the latter is market prices which give a clear price of the good/service. Indirect methods make use of hypothetical questions to illicit values whilst the latter uses a more explicit approach. An example of an indirect method is contingent ranking where the respondents are asked to rank different alternatives as per their preference. Provided at least one of the alternatives is a monetary equivalent, the responses can be used to calculate marginal willingness to pay (Tietenberg & Lewis, 2014).

Another indirect method is choice experiments which break down a good into the individual attributes that the good offers and these are combined into a set. Individuals are then asked to make their choice of the given sets and this is done by making implicit trade-offs between the different levels of attributes in the alternative sets presented to them (Alpizar *et al.*, 2001). This discussion will largely be limited to contingent valuation (CV) which is not only the most popular of the methods, but also has numerous advantages. CV differs from additional stated preference methods

in that it *explicitly* asks the respondent for their willingness to pay (WTP)/willingness to accept (WTA) value whilst other methods make *inferences* about the WTP/WTA value from other information given by the respondent (Perman, 2011). Given the nature of the study and what the study plans to achieve, CV was deemed the most appropriate of the methods.

4.3.3. Contingent valuation

Contingent valuation (CV) is a direct stated preference method which makes use of surveys to determine the value an individual places on certain non-market goods or services (Hanemann, 1994; Perman *et al.*, 2011; Tian *et al.*, 2011). There has been increased use of the CV method primarily in response to there being a growing need for more comprehensive methods of assessing the costs and benefits associated with policies that have significant health or environmental impacts (Carson, 2011). In this case, CV is being used to better understand the value perceptions of water service delivery in Harare.

When using CV, the key approaches used to assess value are WTP and WTA. The former looks at how much an individual would be willing to pay to *gain* a specified good or service whilst the latter looks at how much one would want to be compensated to *give-up* a good. Unlike 'normal' services where value can be inferred from observations in regular market transactions, CV creates *hypothetical* markets for non-market goods. In such a hypothetical situation, no actual transactions occur which makes it particularly useful in getting responses to a proposal prior to its actual implementation (Perman, 2011). An example would be in the case of public goods like improvements in water service and air quality or private 'commodities' such as potential illness that could be avoided (Wedgwood & Sansom, 2003). Tian *et al.* (2011:3) explain that "it [CV] can be used to examine environmental goods and terms for providing them that is different from what has been observed now or in the past, and avoids many of the economic modelling problems that are common to most observational data".

CV became popular after it was used to assess the Exxon Valdez oil spill of March 1989 when the Alaskan state authorities sued the company responsible for the loss of passive-use values. These losses included the deaths of 2 000 sea otters, 300 seals, up to 250 000 sea birds and the contamination of almost 2 000km of shoreline (Graham, 2003:1). Fifteen years after the spill, it was reported that the effects of the oil spill were lasting longer than expected.

To make their case against Exxon, the general American public was asked how much they would be willing to pay to avoid another oil spill of a similar magnitude. The results of the study found that Americans were willing to pay a total of approximately USD3 billion and this amount was later settled in court (Carson, 2012). The oil industry responded by launching a campaign questioning the legitimacy of CV studies and various criticisms were discussed at a 1992 conference in Washington sponsored by the Exxon company. The arguments against CV focused on the notion that relying on CV in either policy decisions of the government or damage analyses, was largely 'misguided' (Hoyos & Mariel, 2010). A thorough investigation was performed in 1993 by the National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel where they reviewed all the empirical and theoretical underpinnings. According to the NOAA:

> *Defendants will argue that closer attention to substitute commodities would have yielded lower valuations. Trustees will argue that they have already leaned over backwards to ensure conservative responses. Judges and juries must decide as they do in other damage cases. The Panel's conclusion is that a well-conducted CV study provides an adequately reliable benchmark to begin such arguments. It contains information that judges and juries will wish to use, in combination with other evidence, including the testimony of expert witnesses* (Arrow *et al.*, 1993: 45).

Over the years, CV has been shown to be a reliable tool. It is however easy to get misleading information from biases[27], thus careful consideration must be taken in its design and use.

4.3.3.1. WTP vs. WTA

Overall CV aims to measure the 'compensation or equivalent variation' for the respective good or service. Compensating variation is applicable to a situation where the individual must purchase the good, such as environmental quality (WTP). In situations where the individual faces a potential loss of the good (e.g. deterioration on environmental quality), then equivalent variation would be appropriate (WTA) (Alberini & Cooper, 2000). WTP can also be defined in the context of utility as "the amount that must be taken away from a person's income while keeping his utility constant"

[27] When respondents base their WTP values relative to other values that were presented to them during the course of the study, for example the starting bid.

and WTA for the good is defined as "the amount of money that must be given to an individual experiencing a deterioration in environmental quality to keep his utility constant" (Alberini & Cooper, 2000:7). This is denoted as:

$$\text{WTP:} \quad U(y - WTP, p, q_1; Z) = U(y, p, q_o; Z) \tag{1}$$

$$\text{WTA:} \quad U(y + WTA, p, q_1; Z) = U(y, p, q_o; Z) \tag{2}$$

Where:

U= Indirect utility function

y= Income

p= Price vector that an individual faces

q_o and q_1 = Alternative quantity or quality levels of the service

Z= Normally distributed

Using this utility based approach to investigate the supply of and access to water, the assumption is made that utility is influenced by a vector of individual characteristics. These characteristics affect the trade-off between income and quality of water service provision that an individual is prepared to make (Alberini & Cooper, 2000; Yuying, 2000). The WTP (or WTA) as depicted by equations 1 and 2 is subject to the various socio-economic variables such as income of the respondent, all prices the respondent faces (including prices of substitutes), the initial and final (hypothesised) levels of the service (q_o and q_1) and other variables influencing the WTP of the respondent (Carmon & Ariely, 2000).

Neoclassical economic theory dictates that in situations where the WTP is a small portion of total income or where there are no income effects, then WTP and WTA results should be more or less equal. However, in practice it has been observed that the WTA tends to be significantly higher than WTP for the same good or service being investigated (Hanemann, 1991; Horowitz & Mcconnell, 2003). This phenomenon could be due to various reasons, such as the elasticity of substitution between private substitutes and the public good or service. Many public goods and services are produced by the public sector because they cannot be efficiently provided by the private sector. Due to this issue, stated WTA values tend to be much higher because the substitutes

produced by the private sector are limited and expensive (Carmon & Ariely, 2000; Tietenberg & Lewis, 2014).

Another explanation for the difference between WTP and WTA values is based on the 'theory of prospects' which states that individual people value losses more than potential gains. This perception forces individuals to select higher compensatory values than potential expenses (McDermott *et al.,* 2008). In other WTA situations, the proposed action might go against consumers' perceptions regarding who they think is entitled to the property rights for said service (Hanemann, 1991). For example, if consumers believe they are entitled to have access to a service (clean water), they would echo their rejection of the hypothetical proposal (which compromises their availability of clean water) by stating a very high WTA value. This action is in the hope that authorities will deem the compensatory figures too high and therefore halt plans for the hypothetical proposal. Any one or combination of these factors could be the reason(s) for the difference between the WTP and WTA values.

The choice between the two (WTP or WTA) for this study was made using guidelines from Carson (2000). Carson advises that WTP be used for studies where the consumer stands to make potential gains from the proposed plan. He goes further to state that the choice of whether to use WTP or WTA depends on who is the holder of the property rights of the service. In situations where the consumer does not have the legal right to the good, then WTP should be used. Should however the consumer be legally entitled to the good and is being asked to give-up that right, then WTA would be more applicable (Carson, 2000). In Harare, the users of the water service are not the holders of the property rights of the service, thus WTP is more applicable. Furthermore, they are not being asked to give-up any rights to the service – which would warrant compensation where WTA would apply. Instead, they stand to make various gains that stem from improved water service delivery (see section 2.1); therefore it was decided to use the WTP method.

Various biases can be identified when conducting a WTP study. The extent of many of these biases can however be reduced by a carefully designed questionnaire (the main biases are summarised in Appendix 3).

4.3.3.2. Advantages and disadvantages of using CV

Most of the criticisms surrounding CV arise from the fact that it primarily makes use of non-use values (or passive UVs). The use of non-use values allows for the estimation of WTP for proposals that are yet to happen (Alberini & Cooper, 2000). Since an estimation of WTP cannot be inferred from the existing situation, a scenario is presented and consumers can state their preferences.

The most prominent advantage of CV is its applicability. It is not only useful in valuing some market goods but more specifically, CV has become the most popular technique of valuing those unique environmental non-market goods - for instance the protection of endangered species (Portney, 1994). These non-market goods include those where there is insufficient data to support policy considerations that are being analysed and where previous market transactions do not show updated information regarding substitutes and potential hazards (Hoehn & Randall, 1987). Compared to other methods, CV allows for a greater degree of flexibility in its use as it does not rely on an existing data set. In other words, researchers can decide on details such as the "number of states of the goods and the conditions of its provision that lie outside present institutional arrangements or levels of provision" (Hoevenagel, 1994: 252). Table 4.2 gives a summary of the advantages and disadvantages of CV.

Table 4.2: Advantages and Disadvantages of CV

Advantages	**Disadvantages**
It can be applied to many environmental goods	It is based on respondents' *intentions* to pay
It can directly measure the various types of non-use benefits	It asks respondents to make an unfamiliar (budget) decision
It can directly estimate the correct Hicksian welfare measure	It is vulnerable to abuse
It can include specific reliability and validity checks	It depends on the creation of a scenario that must be understandable, plausible and meaningful
When results are well presented, the concept is easily understood by politicians, administrators and non-specialists	

(Source: Adapted from Hoevenagel, 1994; Portney, 1994; Wedgwood & Sansom, 2003)

Apart from the advantages discussed, CV also has its pitfalls such as the fact that it is based on the *intentions* of respondents. Intentions can change thus there is no guarantee that once the hypothetical scenario has been implemented, respondents will pay that actual amount which could result in a significant discrepancy between the hypothesised (intended) and received amount (Mugabi and Kayaga, 2010). Consumers are also not used to making financial decisions based on hypothetical situations and it might be difficult for some to fully comprehend. The hypothetical scenario presented to the respondents must also be realistic and structured in a way that respondents can easily understand and see as practical (Wedgwood & Sansom, 2003).

WTP is an especially useful method for researchers who are analysing households as it gives a reflection of the latter's economic situations as well as the costs that they face in acquiring substitutes. However, in situations where the good or service that is being investigated has very limited substitutes (e.g. water), reported WTP values tend to be overstated (Portney, 1994). For example, it has been observed that in developing countries women sometimes tend to have higher WTP amounts for in-house water connections (World Bank, 1993). A possible reason for this could be that women spend a lot of time collecting water for the home. Conducting CV studies in the developing world also presents additional and often unique challenges compared to developed economies. For instance, when administering a study in rural areas, community leaders may attempt to influence the respondents' responses (World Bank, 1993). The community leaders do this in hopes of influencing provision of the good or service in question (Alberini & Cooper, 2000).

Another challenge cited by Cuccia (2011) is that in some situations researchers are forced to make *ad hoc* assumptions about the respondents due to the former being unable to obtain full household records of the latter. In addition, respondents might have difficulties in understanding the idea behind 'maximum WTP'. It has been observed in some studies that respondents state very low WTP values compared to the costs of coping (i.e. aversion and mitigation expenditure) which are significantly higher (Hanemann, 1984). Such a situation is usually observed in studies involving public goods and services like electricity and water systems. The coping cost for the lack of these services (e.g. installing solar panels and sinking boreholes) will be much higher than their respective WTP to ensure sufficient public provision. Possible reasons for this could be an unwillingness to commit to regular cash payments to the public service provider because some

households can have irregular cash flows, particularly where the household heads are seasonal employees in sectors such as agriculture (Alberini and Cooper, 2000).

In some studies, describing the specifics of improvement technologies could be difficult given the hypothetical nature of the scenario, thus special consideration will have to be made in the drafting stages of the survey instrument (Arrow *et al.,* 1993). Other studies in Africa and Asia found that respondents blame their governments for the poor state of public services and infrastructure. Such populations do not trust their government and this is reflected in their low WTP values for various public service programmes at the regional level (Oh & Hong, 2014). In a study by Oh and Hong (2006) on WTP for improved indoor air quality in subway stations, it was concluded that the people's lack of trust in their government highly influenced their WTP. This was evidenced by the fact that despite 88.3% of respondents agreeing that there was a need to improve air quality, only 40.7% were willing to make a financial commitment.

4.3.4. Elicitation methods

There are four main elicitation methods to determine how much respondents would be WTP/WTA for a good or service. These are the dichotomous/binary choice approach (DC), an open-ended technique, a bidding game and payment cards (PC) (Carson, 2000).

4.3.4.1. Dichotomous choice approach

DC is the most popular method[28] and it comes recommended by the NOAA. DC can either be single bounded or double bounded. With single bounded DC respondents are simply presented with a price amount and asked whether they would be WTP/WTA the amount. With double-bounded DC, respondents are asked the same as with single-bounded but in addition they are asked a follow-up question(s) to improve the accuracy of their answers (Tian *et al.,* 2011). The simplicity of use with the DC approach adds to its popularity as it means answers are easy to populate. DC also presents a market condition that the respondents are familiar with as they are simply required to state 'yes' or 'no' to the given question (Ahmed & Gotoh, 2007). Despite its popularity, the DC

[28] Used in various case studies including Blum *et al.* (2014); Casey *et al.* (2006); Raje *et al.* (2002); Whittington *et al*. (2002).

referendum does have some problems which include inconsistency and being prone to starting point bias (Tian *et al.,* 2011).

4.3.4.2. An open ended technique

Respondents are explicitly asked to state their maximum WTP (or minimum WTA) for a good. Typically, respondents are asked a single question with no follow-up questions. A key advantage of this technique is that it provides a straightforward actual valuation of the good (Ahmed & Gotoh, 2006). The open ended technique is however criticised because it presents a format that respondents are unfamiliar with. That is to say respondents are normally *price takers* who respond to a given price rather than selecting a price themselves (Hanemann, 1991; Tietenberg & Lewis, 2014).

4.3.4.3. Bidding game

With bidding games, the respondents are asked whether they would be WTP a specific amount. If they say 'yes' then they are presented with a higher amount and again asked whether they would be WTP this higher amount. This continues until the respondent is presented with an amount whereby they say 'no'. The true WTP is estimated to lie between the value they said 'no' to and the one before it (Tietenberg & Lewis, 2014). Should the respondent say 'no' to the initial amount they are presented with, then they are presented with a lower amount until they say 'yes'. It is again assumed that their true WTP lies between the value they eventually said 'yes' to and the one preceding it. The bidding game method is also prone to starting point bias.

4.3.4.4. Payment cards (PC)

Respondents are presented with a card with different monetary values and are asked to choose the value that is closest to their maximum WTP (or minimum WTA). Similar to the bidding game, it is assumed that the true WTP value of the respondents is located above the indicated value and below the next higher one (Tian *et al.,* 2011). This is the method that was used in this study as there is the advantage that the WTP values can be obtained directly from the original data and are not inferred. Kerr (2001) states that precision of the PC approach can be improved by increasing the number of divisions on the card and this can be done by lowering the intervals between amounts. It is important, however, not to make intervals too small such that the PC becomes too

visually and cognitively complex to the respondents. Rowe *et al.* (1996:184) surmise that "maintaining the range of a payment card and increasing the number of entries to reduce the interval size may result in a presentation that is unwieldy for respondents and that assumes more precision than respondents have in the formation of their values."

These are the main elicitation methods but additional methods can be found, for instance ones that use a combination of the above methods. An example is a hybrid method that was used by Hu *et al.* (2006) by combining double bounded DC with the use of a PC in assessing the WTP of Chinese consumers for genetically modified soybean oil. Nevertheless, the method to be used in this study is the straight-forward PC method.

4.4. Conducting the CV study

The primary goal of this research is to determine whether the residents of Harare would be willing to pay towards improving municipal (public) water service delivery, specifically the refurbishing and possible expansion of existing infrastructure. As this water situation in Zimbabwe is largely a symptom of poor planning and management, the general perceptions of respondents regarding the situation are also awarded equal importance in the study.

The study makes use of a dichotomous choice referendum question (with follow-up) to the respondents - whether they would or would not be willing to pay for improved water service delivery. Should respondents be willing to pay, they are then presented with a payment card and they select an amount closest to their actual WTP amount. Dichotomous choice referendum was the elicitation method of choice because it presents less of a cognitive burden on respondents and it is also more reflective of the actual behaviour of respondents in a typical market setting (Loomis *et al.*, 1997; Alberini & Cooper, 2000). The use of follow-up questions further increases this model's accuracy because it allows one to determine whether respondents have strategically selected their WTP values. Such strategic choices should be revealed by the respondent changing their choice upon being presented with additional information.

Cuccia (2011) provided a basic structure for a CV study which comprised of three parts, namely selecting the sample, describing the hypothetical market and deciding on the choice of technique for eliciting WTP. These steps were expanded on by Perman (2011) and categorised into six steps:

1. Creating the survey instrument
2. Choosing an appropriate survey technique
3. Identifying the population of interest
4. Analysing the responses
5. Aggregating the WTP data
6. Evaluating ex post the success (or otherwise) of the CV study

This general sequence of steps for conducting a WTP study will be used in this thesis. Additional insight was also sourced from Arrow *et al*. (1993) and Wedgewood and Sansom (2003) - this will be integrated into the study.

4.5. Creating the Survey Instrument/Questionnaire

This first step can be broken down into smaller subsections. The initial section of a CV questionnaire typically comprises of a short explanation of the study and why it is being done. Depending on the nature of the study, there might be a need to include assurances of anonymity of the respondents as well as whether the information and data collected will be for private use or made available to the public (Perman, 2011). The questionnaire would go further to give a brief description of the problem being researched.

The questionnaire is included in Appendix 1. In the study, the respondents were asked to give their informed consent prior to taking the survey. Informed consent involved telling the respondents about the background and purpose of the study as well as the fact that this specific study was intended for personal research purposes and was not directly connected to the Harare City Council (HCC). Some respondents harboured resentment against the HCC and it was important to dissociate the interviewers from the HCC. Respondents were also informed that they could choose not to answer a question as well as withdraw from the interview at any point should they wish to do so. Respondents were further given details on the contents and procedure of the study as well as an estimate of how long it should take them to complete the questionnaire whilst being encouraged to ask questions should they have any.

Respondents were then asked questions about the various demographic characteristics of their respective households. Such questions try to get a better picture of the wealth, ability-to-pay and disposable income of the household. The wealth indicators in this case are household income, education level, rental expenditure, overall monthly expenses and whether the household received any other income from abroad.

Due to the precarious nature of the Zimbabwean economy, the informal sector has greatly expanded as people seek ways to supplement their income from any formal employment. Unemployment is also very high at an estimated 80% despite Zimbabwe having one of the highest literacy rates in Africa (Masekesa & Chibaya, 2014). For those who are fortunate enough to be formally employed, the income - though regular - is simply not sufficient for many. The avarage income for a civil servant is used as a proxy for average public sector income in the analysis and it currently stands at approximately USD419 (ZAR5 384) per month. The questionnaire thus distinguished between formal and informal income amounts (Africa Growth Institute, 2014).

Questions requiring an individual to disclose their income are highly sensitive and it would be expected that respondents would choose to skip this question if asked directly. To gather information on incomes whilst attempting to minimise the problem of respondents refusing to answer the income question, the study gave the respondents the option to choose between ranges of incomes. There were nine range options of increasing incomes and respondents were required to circle the range that best reflected the total income of their respective households[29].

Two pilot studies were conducted to test the created questionnaire. The initial pilot study was on a group of environmental economists who were familiar with the theoretical and practical aspects of WTP studies, but who were not from Harare and so did not have first-hand experience of the actual water problem. This group was able to give feedback on the construction of the questionnaire and its adherence to WTP principles. The second pilot study was done in Harare on a group of people who were directly affected by the water crisis but did not know about WTP studies. Responses from this group gave insight on how the questionnaire would be received by

[29] Respondents were required to give information on the total income for their household and not just the income of the head - that is, if there were other individuals in the household who were employed (formally or informally), then their incomes were also included in the estimate.

the average Harare resident. Relevant adjustments to the questionnaire were made based on the feedback from the pilot studies.

When asked about the number of people in their respective households, the respondents were required to distinguish between adults and children younger than twelve years. This was done to incorporate the notion of the various water volume requirements per household as different groups of people have different water needs. Groups with different water needs could include young children, the elderly, pregnant or lactating women, athletes and the terminally ill (Howard & Bartram, 2003). According to the World Health Organisation (WHO) (1993) guidelines, an average adult human needs to consume approximately two litres of water daily and a child requires one litre. Children are the most vulnerable when it comes to health issues from inadequate water and sanitation. The World Business Council for Sustainable Development (WBCSD) describes *reasonable* access to water as having access to a minimum of twenty litres daily from a source that is within a kilometre from where a person lives (WBCSD, 2006).

To gain a basic understanding of the current water situation that the residents are facing, the respondents were initially asked whether they had a municipal water connection at their place of residence. For those that responded 'yes' to this question, they would then be asked how many days per week water flowed from the taps.

Residents have adapted to there being days when there is no water and resort to getting water from alternative sources. Overall water sources were narrowed down to six possibilities (municipal connection, private well, private borehole, water vendor, river or stream, water from friends and relatives). Respondents were also given an 'other' option to include all other excluded sources such as public taps and boreholes. Initially, respondents were asked to rank these sources in order of use but after feedback from the first pilot study, this was found to be confusing and cognitively taxing for some respondents. This was then changed and respondents were required to select their top three sources from the given list.

A distinction was also made between sources for consumptive and non-consumptive uses. This distinction was necessary to accommodate those who for instance do not have access to a private well or borehole and have to resort to a water vendor. Such buying is usually limited to

consumptive uses where water has to be potable whilst for other non-consumptive uses, water does not have to be of drinking quality and can be sourced from unsafe sources such as rivers or streams.

Associated costs vary depending on the type of alternative water source used but digging a private well can be anything from USD300 to USD700 depending on factors such as depth and location. Private boreholes are even more expensive. A recent post in the classifieds section of the local Herald newspaper showed an advertisement for borehole installation with drilling costs at USD40 per metre and borehole pumps starting from USD600 (Zimbabwe Classifieds, 2014). For the average private borehole, the total costs for installation can easily exceed USD3 500 and given the average civil servant's (teacher) salary of approximately USD419 (approximately ZAR5 384), this is well beyond the reach of many (African Growth Institute (AGI), 2014).

The study did not however ask those respondents who had boreholes and wells for the costs as such installation costs are normally once off costs and some respondents would not be able to remember how much it cost them. Another reason this was not considered is that during the period when the water crisis was intensifying (2008-2009), the Zimbabwean economy had multiple currencies including the Zimbabwean dollar - ZWD, which was officially phased out by April of 2009 (Chishamba, 2014). For those residents who installed their wells and boreholes when the ZWD was still active in the economy, it is difficult to get a current USD estimate of the cost given that in 2008 Zimbabwe was experiencing hyperinflation of 231 million per cent and prices (in ZWD) were constantly changing (Berger, 2008).

A hypothetical scenario was given in the third and final section of the questionnaire and it forms the crux of a CV study. The scenario should involve feasible options that are realistic given the existing conditions (Carson, 2000). The respondents were therefore presented with a WTP scenario which was based on information gleaned from an interview with the then Harare City Mayor, Muchadei Masunda (Moyo, 2013). In the interview, Mr Masunda stated which various urban water delivery projects were being considered by the HCC as well as estimations of the associated costs. As previously stated, less than half the required water volume reaches consumers. Capacity boosting projects and their estimated costs included the construction of a water works at Kunzvi Dam (USD539 million estimated cost), Musami Dam (USD886 million) and Mazowe Dam (USD1.5 billion). There was also USD40 million needed to refurbish the existing underground

water pipeline network. The estimated total cost of these projects was USD2.5 billion (Moyo, 2013).

The respondents were therefore asked if they were willing-to-pay and thereby contribute to this capital amount of USD2.5 billion plus refurbishing costs. Depending on the amount of money raised, one (or more) of the capacity boosting projects could be funded. Given factors such as the lack of trust in the government by citizens as well as the prevailing economic conditions, it would be idealistic to assume that USD2.5billion can be raised in a once off endeavour. It was thus put forward that money be raised for the various refurbishment and capacity boosting projects in *stages*.

In order to reinforce the viability of the programme, the smallest and lowest cost projects could be attempted in the first stage. Once this is successfully completed – and hopefully some trust regained from citizens, collection of money for the second stage could then ensue. The choice to have consumers pay over a three year period was based on a prior consult with Ms Shambare from the HCC (Marlborough office) regarding the duration of expansion projects. She stated that the ongoing refurbishment project of the Morton Jaffray water works was scheduled for four years. By the time the questionnaires would be administered, the project would be in its second year. From this information, the decision was made to limit collection of money to the three remaining years of the project. Collecting for less than this duration could lead to too little funds being raised whilst timelines exceeding this could present challenges in how the [potentially] excess funds are handled before the next stage of the projects begins.

Using the WTP amount from the study by Ndedzu *et al.* (2012) of USD8.58 per month and assuming 50% of the 530 000 households in the HCC's service area actually pay, then USD80 million could be raised to assist in completing the initial stage. As the projects become more capital intensive, this three year period would be extended.

If the respondent was willing to pay, they would then be asked how much they would be WTP from a payment card with various amounts ranging from USD0.50 to USD30. There was also another option for those respondents who were WTP amounts exceeding USD30 per month.

As part of the hypothetical scenario, the respondents were informed that this study was for a personal academic study and not affiliated with the HCC. Although the results could be given to

the HCC at a later date, this was not the purpose of the study. At the end of the questionnaire, there were a few lines left for additional remarks and if the respondent or interviewers had any other information they would like to include, they could write it in that space.

4.6. Choosing an Appropriate Survey Technique

The most popular elicitation techniques used in administering questionnaires involve the use of an electronic (computerised) medium, pencil and paper (face-to-face interviews or postal) or a telephone. They are used in varying degrees depending on the nature of the study. For example, studies that require the respondent to select an answer from a predefined list of answers are more likely to use an electronic medium whilst those that require more comprehensive information on the opinions of the respondent are more likely to use a face-to-face or telephonic medium.

The process of answering questionnaires places the following general cognitive tasks on respondents: "comprehension of the question, recall of requested information from memory, evaluation of the link between the retrieved information and the question, and communication of the response" (Bowling, 2005:281). Taking into account the level of cognitive burden that the questionnaire places on the respondents will allow the research to be conducted using the ideal elicitation method. Of the various methods, the one that places the least burden on the respondent is the face-to-face interview as it simply requires the respondent to speak (in the same language that the questions are being asked in) and to have basic listening and verbal skills (Bowling, 2005).

Phellas *et al.* (2011) list the main advantages and disadvantages associated with using face-to-face interviews as well as doing self-completion questionnaires. These are summarised in Table 4.3.

Table 4.3: Self-completion Questionnaires and Face-to-face interviews, a comparison

	Advantages	**Disadvantages**
Face-to-face interviews	Allows use of complex questions as interviewer can explain to respondent.	High administering costs can limit the sample size and geographical area.
	Interviews can be longer to get more comprehensive information unlike self-completion questionnaires where respondents can be put-off by length of questionnaire.	Interviewers can introduce biases in the responses. This can happen due to the way the interviewer asks some questions or in the respondents wishing to derive warm glow effects from the interview.

	Interviewer has greater control of context and environment in which interview takes place.	Large amounts of qualitative data can be difficult to analyse and contextualise.
	Interviewer can pick up on non-verbal cues of respondent	The art of interviewing can be difficult for some interviewers to master.
	Allows use of visual aids	More accommodating when interviewing multi-lingual samples.
	Increased scope for asking open questions as respondent does not need to write down own answers.	
Self-completion Questionnaires (using electronic mediums or the postal system)	Cheaper to administer with main associated costs being the design and printing of the questionnaires and their eventual electronic or postal distribution.	Conductors of the study have little control over who completes the questionnaire and can never be sure whether the questionnaire was completed by someone within their intended target group.
	Reduces biases related to the interviewer	Questionnaires must be simple and to the point thus it is not possible to probe further on responses. Longer and complicated questionnaires also tend to annoy respondent(s).
	Allows for increased coverage of geographical area at no additional travel costs.	They tend to receive low response rates and it is difficult to know the reasons and characteristics of those who did not respond.
	Without an interviewer being present, the respondent gets a greater degree of anonymity which is especially useful when conducting sensitive or personal research.	Potential respondents with poor access to internet or poor literacy levels are unlikely to complete the questionnaire and are excluded from the study.
		Strong reliance on the literacy levels of adults in the household and can exclude those with poor literacy levels from participating in the study.

(Source: Adapted from Phellas *et al.,* 2011: 183-185)

The study interview method took into account the analysis of the above methods (as well as time and budget restrictions) and the questionnaire was largely designed to be a self-completion questionnaire but instead of being sent to the respondents, the interviewer would be available during the completion of the questionnaires. In other words, the interviewer would be present to attend to any queries that the respondents might have. By having the interviewer present, it allowed the study to gain some of the benefits associated with face-to-face interviews, for example, being able to pick up on the non-verbal cues of respondents.

After the second pilot study, personal interviews were also included as an option to self-completing the questionnaires. During the second pilot study, it was observed that most respondents were generally not committed to the task of reading through the entire questionnaire and some would decline taking part in the study altogether. For those that appeared unwilling to take part in the survey, once the interviewer explained to them that they had the option of an interview, with the interviewer asking them the questions and filling in the answers on the questionnaire, the respondents became significantly more receptive to taking part. In one instance, upon the request of the respondents, copies of the questionnaire were left with the respondents in the morning for self-completion and collected at the end of the working day.

Another reason why face-to-face interviews were a better choice over the alternatives was due to time constraints of other options. For example, posting the questionnaires was not regarded as an option. Furthermore, there were uncertainties regarding how efficient the Zimbabwean postal service (ZIMPOST) would be at delivering the questionnaires. There were also information constraints regarding email addresses which eliminated the option of electronic media. Another interview technique is telephone interviews, but these are generally not recommended due to issues such as the researcher not knowing the opportune time to contact a potential respondent and contacting a respondent at an inappropriate time could lead to an unwillingness to take part in the study or half-hearted responses for those who do. In the context of this study, telephone interviews were not regarded as an option because they automatically exclude consumers who do not have access to a telephone from being part of the study and this does not adhere to the principles of random sampling. Furthermore, in Zimbabwe most people have mobile phones whilst the landlines have dwindled in popularity.

Indeed, the National Oceanic and Atmospheric Administration (NOAA) has put forward a set of recommended guidelines for conducting a WTP study to help reduce the main sources of bias. One of the initial recommendations is that personal interviews be used as opposed to other methods such as post, telephone and electronic media (Arrow *et al.*, 1993).

4.7. Identifying the Population of Interest

In an ideal situation, every Harare resident would have been sampled to get the most accurate value of the mean WTP. Due to various constraints, however, this was not possible and a small sample of people was selected to represent the greater Harare population. Regardless of the proportion of any sample to the rest of the population size, the sample must be carefully selected to ensure that it gives the best representation of the population. In other words, it should be a random sample, that is to say "every member of the population should have an equal chance of being selected" (Wedgwood & Sansom, 2003: 22).

The nature of the sampling strategy ideally depends on the nature of the subject being studied and the relevant group(s) being affected. In the case of this research, the subject of the study is a universal public service that everyone is entitled to, thus the sampling method was population-based and the sample selected was chosen to represent the entire population serviced by the Harare City Council (HCC).

Generally, the larger the sample, the more precise the estimates. However, there is a trade-off between the sample size and the budget required to conduct a survey as increasing sample sizes will also mean proportionally increasing associated costs of administering the survey (Arrow *et al.*, 1993; Carson, 2000). Given the limitations of the budget for the survey section of this thesis, four weeks were set aside for the questionnaires to be administered making use of four interviewers. Given the previous mentioned constraints, the study had a targeted sample size of between 120-150 interviews and in the end, 141 interviews were conducted.

A WTP survey typically requires input from the head of the household as they are in the best position to know the necessary information required by the questionnaire (e.g. household income, expenditure, current coping measures) and especially whether they would be willing to make the financial commitment for the WTP amount. As such, interviews were targeted at the respective

heads of the households and the interviews were conducted predominantly at places of employment. This was preferable during week days as opposed to going to people's homes where the heads would most likely be unavailable for the interview because they were at work. On non-working days (i.e. weekends), respondents were approached in their homes for interviews.

Once the questionnaire was ready, the researcher went to Harare to conduct the survey. The selection of assistant interviewers was done in Harare and due to the times that the interviews would be conducted, interviewers were selected from recent graduates from local universities who have more flexible schedules. During the initial meeting, it was ensured that they had a thorough understanding of the theory and the objectives behind conducting the WTP study. Being natives of Harare, they had first-hand experience of the water problems over the years as well as a good knowledge of the relevant local culture and language. Based on the expected sample size and other considerations, four interviewers were hired. They were then given an opportunity to familiarise themselves with the questionnaire coupled with some role-playing exercises. For their field training exercise, the assistant researchers were asked to assist in conducting the second pilot study.

4.8. Regression analysis

WTP responses are qualitative responses (dichotomous/binary choice referendum) where the response can only take one of two forms - yes or no. WTP will be analysed as a function of different explanatory variables. The logit and probit models are two of the popular models used for qualitative analysis. The cumulative distribution function of the logit model follows a logistic function whilst that of the probit follows a normal distribution (Ndedzu *et al*., 2012). Choosing between the two is a matter of preference as both models produce very similar results.

The probit model was selected for this study and the probability that a household would be willing to pay for improved water service delivery was modelled as follows (Source: Ndedzu *et al.*, 2012):

$$P(Y) = \Pr(Y = 1) = \Phi(-\beta' X_i) = \left(\int_{-\infty}^{\beta' X} \frac{1}{(2\pi)^{\frac{1}{2}}} e^{\frac{-t^2}{2}} dt\right)$$

Where:

X_i = vector of explanatory variables,

β = coefficients to be estimated,

Φ = standard normal cumulative distribution function,

t = the standardised normal variable (mean of zero and variance of one).

The dependant variable in the study is WTP and is assigned a value of '1' if the respondent is willing to pay for improvements in water service delivery, and '0' otherwise. For each of the respondents, the probability that they will be willing to pay for the improvements (Y=1) will depend on a number of the explanatory variables (X_i). This conditional relationship is represented as:

$$P_i = P(\boldsymbol{Y} = \mathbf{1} \mid X_i) = \Phi(\beta_0 + \beta_1 X_i)$$

The probit model to explain WTP for improvements in public water service delivery in Harare is:

$$P(\boldsymbol{WTP} = \mathbf{1} \mid X_i) = \Phi(\beta_0 + \beta_1 gender + \beta_2 formal\ income\ 2 + \beta_3 formal\ income\ 3 + \beta_4 formal\ income\ 4 + \beta_5 expenses + \beta_6\, municipal\ connection + \beta_7 household\ size + \beta_8 education\ 2 + \beta_9 education\ 3 + \varepsilon_i)$$

The selection of independent variables was based on a series of case studies that were conducted by the World Bank (1993) in selected regions of South Asia, Africa and Latin America. The studies aimed to identify the various socio-economic factors influencing WTP for improved water service. Their results showed that education, gender, formal employment, household size influenced WTP. Use of alternative sources of water was also included as a factor influencing WTP as well as information on consumers' use of alternative water sources. Information on use of alternative sources for this study is given in Table 5.3. Due to the overlap of use across sources, for example a household could make use of multiple alternative sources simultaneously, being connected to the HCC network was used as a proxy for this factor in the model.

In addition to the factors that were included in this study, the World Bank report also cited additional factors but these were not part of this study. These factors included the cost of the improved water source; if it would cost them more, then the households were less likely to be WTP. It was also concluded that households would be more likely to pay if the water from the improved source was reliable and less likely to be WTP if they believed that they were entitled to

the service (World Bank, 1993). Additional insight regarding selection of variables was also sourced from additional previous research (Arrow *et al.*, 1993; Ayanshola *et al.*, 2013; Casey *et al.*, 2006; Hensher *et al.*, 2005; Kayaga *et al.*, 2003; Sule and Okeola, 2010; Wang *et al.*, 2010) as well as the author's knowledge of the local context and environment.

A description of the variables is given in Table 4.4.

Table 4.4: Description of Variables

Variables	Description
Gender gender	Dummy variable indicating gender of the head of the household with 1=male and 0=female
Formal employment income[30] formal income 1 (base level) formal income 2 formal income 3 formal income 4	Dummy variable for monthly income ranges from formal employment with 1= USD0-USD349.99, 2= USD350-USD849.99, 3=USD850-USD1 499.99 and 4=USD1 500-USD2 500+
Expenses expenses	Estimated monthly expenditure per household in USD
Connection to network connection	Dummy variable indicating whether or not the household is connected to the HCC water network with 1=connected and 0=not connected
Household Size household size	The total number of individuals (adults and children) in the household
Education level education 1 (base level) education 2 education 3	Dummy variable indicating the highest educational level of any member of the household with 1= 11 years of formal education, 2= 14 years of formal education and level and 3= 17+ years of formal education.

(Source: Author's own computations)

The *a priori* expectations were as follows: more years of formal education and higher income from formal employment were expected to increase the likelihood of a respondent being WTP; a greater

[30] There was initially a total of nine monthly income ranges starting from "less than USD149.99" to "more than USD2 500". To allow for simplicity and greater distinction between income range groups in the probit regression, the nine initial groups were consolidated into four groups 1 = USD0-USD349.99, 2 = USD350-USD849.99, 3 = USD850-USD1 499.99 and 4 = USD1 500-USD2 500+.

household size was expected to reduce the probability of being WTP; females were expected to be more WTP than males; consumers who were connected to the HCC water were anticipated to be more likely to be WTP than those who were not connected, and increasing expenses that the consumers faced was expected to be associated with a lower probability of being WTP.

4.9.Conclusion

This chapter discussed the different valuation methods available for valuing non-market services. The research makes use of the CV method and the typical steps in conducting a CV study were discussed in the context of water service delivery. These steps were used as a guideline in the construction and administering of the questionnaire. With regards to elicitation formats, the second pilot study led to the observation that respondents were more responsive to face-to-face interviews rather than having to self-complete the questionnaires. The payment vehicle was a levy that respondents would pay together with their monthly water bill payments. Respondents made use of a payment card to show how much they would be willing to pay.

The probit model used in his study was specified, with a range of indicators employed as a function of the probability of being WTP. The key variables that were identified as influencing the decision of the respondent to be WTP for improved water service provision were gender, income from formal employment, monthly expenditure, education level, household size and being connected to the HCC network. Chapter 5 will discuss the descriptive statistics and probit regression results.

CHAPTER 5

Descriptive Statistics and Regression Results

5.1. Introduction

This chapter discusses the characteristics of the sample as well as the results of the WTP study. As previously stated in chapter 4, the study sample size was 141 observations and this chapter will initially give a preliminary analysis of the characteristics of the sample. A discussion of the survey responses will then ensue and this is followed by an analysis of the probit regression results.

5.2. Analysing the Responses

During the process of cleaning the data, it was observed that some of the respondents would give a ratings opinion regarding the frequency of running water (question 16) when they previously answered that they are not connected to the HCC water network (question 11). Such answers were disregarded and instead the 'days of flowing water' was used as a proxy regarding frequency perceptions. With the high degree of income inequality in Zimbabwe, some responses which seemed to reflect too high incomes, could actually not be regarded as outliers and thus the study included all the income data.

Household Demographics

Approximately 60% (n = 84) of the respondents were male and the remaining 40% (n = 57) were female. Out of all the interviewed respondents, almost 70% were the heads of their respective households. Thus, approaching people at their places of employment was a useful form of targeting. The average family size was approximately four individuals with each household having an average of 1.93 children.

Education

Education levels in Zimbabwe are fairly high and the 2011 adult literacy rate was reported by the World Bank to be 84% (World Bank, 2015). Other sources have reported the value to be as high as 91% (The African Economist, 2013; SABC, 2014).

Education levels were condensed into three groups; the first (level 1) included those who had gone through primary school and the first four years of high school up to O-Level (11 years of schooling). The second (level 2) encompassed those who had gone through all six years of high school up to A-Level and those who had some form of post high school diploma course (14+ years of schooling). The third (level 3) group included those who had furthered their studies to university level (undergraduate and post graduate) (17+ years of schooling). Approximately 20% of the sample had level 1 education and 37% and 42% had level 2 and 3, respectively (See Table 5.1).

Table 5.1: Education level

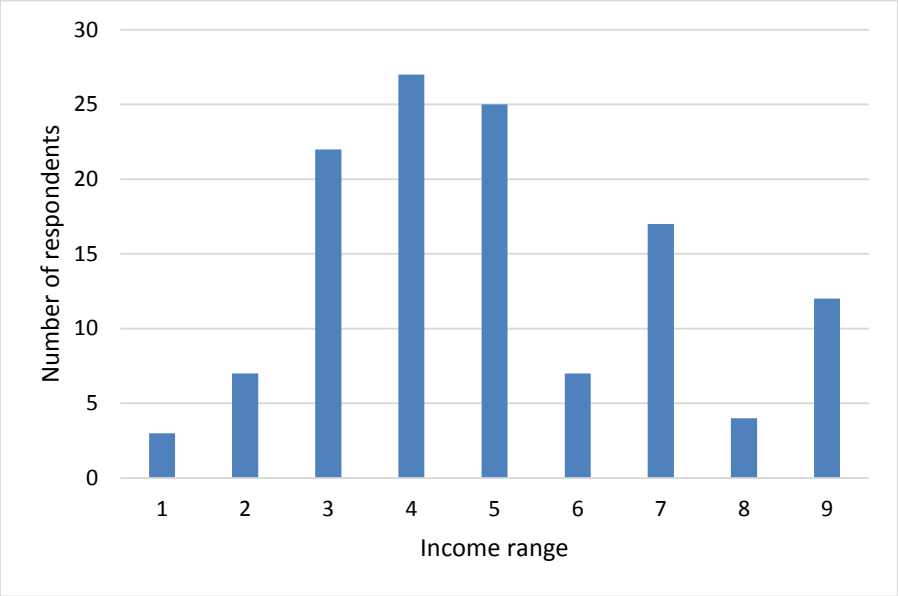
Education level	**Number of respondents**	**Percentage of sample**
1	28	19.72
2	52	36.62
3	59	41.55
No response	2	1.42

Source: Author's own data from WTP survey

Employment and income

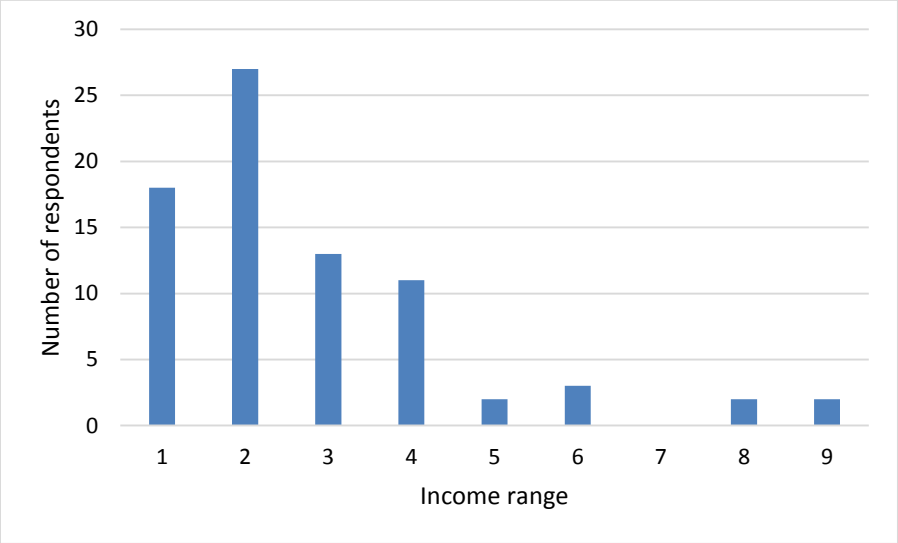
Regarding employment, 88% (n = 124) of the households had at least one member who was formally employed thus there was a regular source of income, while the remaining 12% (n = 17) of the households relied solely on income from informal employment. The monthly income ranges were plotted against the number of respondents receiving a monthly income within a specific range. The frequency graphs for formal and informal income are shown as Figure 5.1 and 5.2 respectively. Their corresponding data were combined into Table 5.2.

Figure 5.1: Frequency - Formal Income



(Source: Author's own data from WTP survey)

Figure 5.2: Frequency - Informal Income



(Source: Author's own data from WTP survey)

From Figure 5.1, formal income appears to be more normally distributed than the distribution for informal income (Figure 5.2), which is more positively skewed with the modal frequency being in the range of USD150-USD349 monthly. The modal frequency range for formal income is

USD500-USD849 monthly. This shows that most people engaged in some form of informal employment earn significantly less than those with income from formal employment[31].

Table 5.2: Formal and Informal Income Frequency Data

Income range group	**Monthly income range amount (USD)**	**Frequency Formal Income**	**Percentage Formal Income**	**Frequency Informal Income**	**Percentage Informal Income**
1	<149	3	2.42	18	23.07
2	150-349	7	5.65	27	34.61
3	350-499	22	17.74	13	16.67
4	500-849	27	21.77	11	14.10
5	850-1199	25	20.16	2	2.65
6	1200-1499	7	5.65	3	3.84
7	1500-1999	17	13.71	0	0
8	2000-2400	4	3.22	2	2.56
9	>2500	12	9.68	2	2.56

(Source: Author's own data from WTP survey)

Table 5.2 combines the data for both formal and informal income. Overall it is observed that income from informal employment was concentrated in the lower income ranges whilst that from formal income was concentrated in the middle to higher income ranges.

External income and housing

Due to the poor economic conditions in Zimbabwe, a significant number of Zimbabweans have fled to look for employment in other countries and it is a common occurrence that they send money back to their families and friends. When asked about whether their respective households received any money from abroad, 20% responded 'yes' and since for most people these remittances are not

[31] It is possible for individuals to be *both* formally and informally employed. For example, many individuals have small-scale side businesses such as poultry or potato farming and their formal jobs also serve as a market for their side businesses.

regularly received, the respondents were asked to give an annual estimate. These estimates range from USD500 to USD5 000 with an average of USD1 485 per annum (USD123.75 per month) between them. In 2014, these remittances from abroad amounted to USD1.4 billion (for both individuals and industrial organisations) and in an interview with Mataire (2014), a Reserve Bank official stated that this figure could be higher if it also included money received through informal channels. In 2012 and 2013 these remittances amounted to USD2.1 billion and USD1.8 billion respectively. Of these figures, approximately USD655 million (31%) and USD764 million (42%) were from individuals in 2012 and 2013, respectively (Mataire, 2014).

With regards to housing, Zimbabweans generally prefer the security of owning their own home. In the sampled population, approximately half (50.7%) owned the houses they lived in and were assumed not to be incurring monthly rental payments. Mortgage payments were also not considered as a housing expense due to the housing situation (discussed in section 2.5).

Current Water Situation

Respondents were initially asked whether they were connected to the HCC water network and 103 households (approximately 73%) were connected. Ideally everyone should be connected to the network and possible reasons for not being connected could be that respondents had installed a borehole and opted to have the connection closed to avoid paying the fixed service fee for an unreliable service. Another reason could be that the home was built in a relatively new suburb that was yet to be connected to the water network. In such a case, home owners may have opted not to have the connection installed in the first place as it takes too long given the HCC's lack of resources and because in these new suburbs (e.g. Ruwa), water cuts are more severe.

The questionnaire presented respondents with various water sources and they were asked to select their top three sources for both consumptive and non-consumptive purposes. The results of these questions were recorded in Table 5.3.

Table 5.3: Distribution of Water Sources

Water Sources	Frequency of users for non-consumptive purposes	Frequency of users for consumptive purposes
Municipal water	99	53
Private borehole	68	70
Private well	36	35
Friends or relatives	27	26
Water vendor	11	32

(Source: Author's own data from WTP survey)

Use of HCC water is a dominant source with 99 respondents stating that they still use it for non-consumptive uses and 53 respondents also using it for consumptive uses. From general discussions, residents do not trust that the tap water is safe to drink. After the 2008-2009 cholera outbreak, boiling municipal water prior to use became the norm whilst those who could afford it would also purchase water purification tablets which contain chlorine and treat their water privately. The second most popular source for both consumptive and non-consumptive uses was private boreholes followed by private wells, sourcing from friends or relatives, water vendors and rivers or streams in order of decreasing popularity.

Perceptions of water quality and frequency

The respondents that were connected to the HCC were asked to rate the quality of water from 'poor' to 'excellent', the results of which are recorded in Table 5.4.

Table 5.4: HCC Water Quality Perceptions

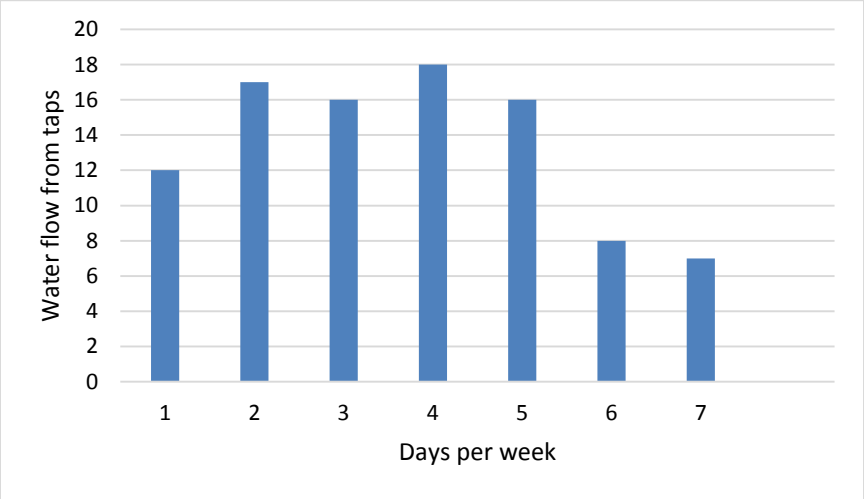
Condition	**Water quality**	**Percentage**
Poor	45	43.7
Sometimes good	33	33
Average	21	20.3
Mostly good	4	3.8
Excellent	0	0

(Source: Author's own data from WTP survey)

Perceptions were leaning towards the negative side with the majority (43.7%) of respondents regarding the water quality as being poor. About 20% deemed the quality to be average whilst none of the respondents thought the quality was excellent.

The number of days per week with water flowing are shown in Figure 5.3 Respondents were asked to state days when there was *any* water from the taps. In other words, no distinction was made between having water for a few hours or the whole day, nor was any distinction made regarding the water pressure. Many respondents mentioned that the water pressure was usually low and in some instances - particularly in high lying areas - could be just a small trickle. There were also two respondents who stated that they have had flowing water for only two days out of the month.

Figure 5.3: Days with Water Flow (weekly)



(Source: Author's own data from WTP survey)

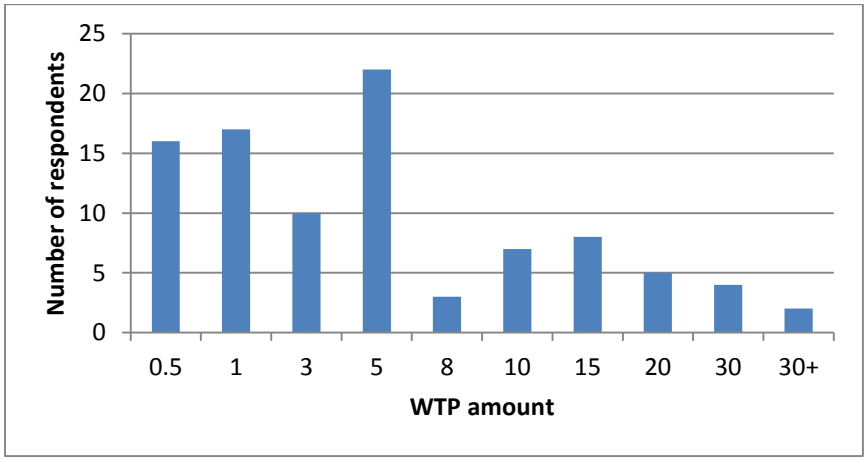
Of the 103 households that were connected to the water network, 81 (78.64%) claimed that they were up-to-date in their water bill payments. For the few that were not consistent in paying their bills, the common explanation was that they simply could not afford to do so. In July 2013, there was a cancellation of outstanding bills by the HCC and 75% of the respondents were aware of this. However, of these 75%, only 44 (31%) regarded this cancellation as being useful. Responses varied from seeing this as being a political ploy as it was near election times, to those who were pleased because they did not have the money. Many respondents were also cognisant of the fact

that this was not a particularly strategic move considering that the council claims to have no money. It should also be mentioned that this relief was only extended to residential users and not to commercial users; the latter have greater consumption levels and outstanding bills to the HCC.

Willingness to pay

When presented with the hypothetical situation and asked whether they would be willing to contribute to the necessary USD 2.5 billion, 94 (66.19%) of the respondents said they would be willing to pay. In the scenario presented in the questionnaire, respondents would be required to pay a monthly amount per household for a period of three years to raise the necessary funds. They were required to select an amount from the payment card (replicated in Table 5.5) showing various amounts and the results were captured in Figure 5.4.

Figure 5.4: WTP amounts and Frequency of Choice



(Source: Author's own data from WTP survey)

The distribution of responses is positively skewed in favour of lower payment amounts. The modal payment amount was USD5 with 23.4% of the respondents stating that they would be WTP that much per month.

Those who were not willing to pay were asked a follow-up question for their reasons. The majority mentioned either concern that the HCC would misuse the funds or not being able to afford to commit to the proposed payment terms. For a few of the respondents, it was a combination of both these factors. A few respondents were concerned about whether the HCC would be able to maintain

the new infrastructure once constructed whilst another objected to the part about having a third party come and perform the infrastructure upgrades and preferred that the tender be given to a local company to promote local industry development.

Table 5.5: Questionnaire Payment Card

0.50/ R5	1/R10	3/R30	5/R50	8/R80
10/R100	15/R150	20/R200	30/R300	More than 30

(Source: Author's own data from WTP survey)

Given the responses from the payment card, the mean WTP for those who were WTP was USD7 per month. These results are comparable to those of a similar study performed in the high density suburb of Mabvuku in Harare by Ndedzu *et al.* (2012) where WTP for improved water service was USD8.58 monthly.

5.3. Probit regression results

The data from the study was run using the STATA 12 statistical software with WTP being the dependent variable. The resultant coefficients (and their respective standard errors) as well as the estimated marginal effects are reported in Table 5.6. The actual STATA regression output is included in Appendix 5.

Table 5.6: Probit model Results and Marginal Effects

Variable	**Coefficient**	**Marginal Effects (dy/dx****)**
Gender (Male)	-0.7744** (0.3985)	-0.2879477
Formal income 2	-0.3773 (0.8163)	-.0775995
Formal income 3	-1.5419* (0.8619)	-.4895477
Formal income 4	-2.0657** (0.9767)	-.6756591
expenses	-0.0010* (0.0006)	-0.0004033
connection	0.5828 (0.4520)	0.2252664
Household size	-0.2483*** (0.0947)	-0.0933952
Education 2	1.4228*** (0.4509)	.5219532
Education 3	1.7230*** (0.5210)	.5992248
Constant	1.9731** (0.9934)	
Log likelihood	-27.381787	
LR Chi^2 (9)	101.2***	
Pseudo R^2	0.6485	
Number of observations	114	
Note: *, **and *** correspond to the 10%, 5% and 1% level of significance. **:** Values in brackets are standard errors. **:** **** dy/dx for factor levels is the discrete change from the base level.		

(Source: Author's own computations)

5.3.1. Gender

The marginal probability that males would be WTP was approximately 29% less than that for females. The gender variable was statistically significant at the 5% level. A negative coefficient indicates that being men are less likely to be WTP compared to women. Similar results of females having a higher probability of being WTP were observed in studies by Moffat *et al*. (2011) and Mezgebo and Ewnetu, (2015).

Females could also have a greater probability of being WTP because in many households, women play a bigger role in securing water for the home thus they have more experience with the challenges of poor water service provision (Kayaga *et al.,* 2003).

Another perspective to consider is how much value is placed on women's time. As women are becoming more educated and working in economic sectors outside of the household, their time is worth more. Thus households where the women are employed could be willing to pay a higher amount because there is a greater trade-off between working and securing water. Results supporting this were observed in Kenya where pastoralists were not willing to pay for improvements in their domestic water systems. Part of the reasons given for this was that the male heads of the households believed that "there was no value to freeing time for women, because they did not help to care for cattle" (Sengupta *et al*., 1997:5). In this case, the pastoralists placed little value on women's time as the latter were 'unemployed'.

5.3.2. Income from formal employment

In analysing the probabilities of respondents being WTP, income range group 1 (USD0-USD349.99) was used as the base year and it was concluded that the probability that a respondent would be WTP decreased with higher income. Income range group 2 (USD350-USD849.99) had a probability of being 8% more likely to be WTP than respondents in range group 1. The probabilities for respondents in range group 3 (USD850-1 499.99) and 4 (USD1 500-USD2 500+) were 49% and 67% (respectively) less likely to be WTP than those in range group 1.

The coefficient for range group 2 was not statistically significant. However, the coefficients for range group 3 were significant at the 10% level and range group 4 was significant at the 5% level, relative to range group 1. There was a negative correlation between income from formal employment and being WTP thus the higher the income of the respondent, the less likely they

would be WTP. These results go against the expected results that there would be a positive relationship primarily due to increased disposable income (Moffat *et al.*, 2011).

Similar results were observed in a study by Casey *et al.* (2006) to determine the WTP for improved water service in Brazil. A possible reason for this negative relationship in Harare could be that those respondents with higher incomes are likely to have devised more long-term solutions to the water shortages (e.g. installing boreholes and wells). With such a reliable alternative water source, they would not see the need to pay for improved municipal water service which has questionable quality standards. Such a notion is supported by evidence from a study by Gunatilake and Tachiiri (2012) in Khulna, Bangladesh where it was observed that those respondents who had wells were less likely to be WTP for public water connections.

5.3.3. Expenses

Monthly household expenditure (expenses) was significant at the 10% level. The marginal effect suggest that the likelihood of being WTP decreases by about 4% for every USD10 increase in expenses. There was also a negative relationship between increasing monthly expenditure and the likelihood that one would be WTP which concurs with results in a study by Behailu *et al.* (2012). These results are particularly applicable to the Zimbabwean context where the majority of incomes remain below the poverty line and with increased expenses, there is a lower probability of being WTP (Moyo, 2014).

5.3.4. Connection to HCC network

Respondents that were connected to the HCC water network were 22% more likely to be WTP than those who were not connected to the HCC network. However, the coefficient was not statistically significant. Nevertheless, such a result could be applicable to the Harare context as those that are not connected to the network could possibly have an alternative water source that is reliable enough to warrant disconnecting from the public network. Such respondents are unlikely to be significantly inconvenienced by the water cuts and would thus not be willing to pay for something that does not directly affect them.

5.3.5. Household size

The household size coefficient was statistically significant at the 1% level. In particular, the probability of a respondent being WTP declines by roughly 9.3% for each additional person in the household. This could be due to the higher expenses that are synonymous with households with more individuals thus the more individuals in a household, the less likely they would be willing to make the relevant financial commitment. A larger household size could also mean more people in the household who were available to fetch water thus the 'individual inconvenience' would be less unlike if the task were designated to a few individuals.

5.3.6. Education

Using level 1 (11 years of formal education) as the base level, the probability of being WTP increased as years of formal education increased. Respondents in level 2 (14 years of formal education) and 3 (17+ years of formal education) were 52% and 60% (respectively) more likely to be WTP than respondents with level 1 education. The coefficients for levels 2 and 3 education were statistically significant at the 1% level.

The coefficients for the second and third level of education indicate a positive relationship between being WTP and increasing level of education. These results are as expected and they are also supported by results from similar studies by Fonta *et al.* (2007), Suranga and Gunaratne (2007), Null (2012) and Mezgebo and Ewnetu (2015). A possible reason for this positive relationship is that the more educated an individual becomes, the more they can fully appreciate the positive external benefits that can be realised with good water service provision for all (e.g. increased GDP - see section 2.1). Once an individual is able to recognize the additional benefits that go beyond the household level, they would be willing to pay to ensure provision for everyone. Furthermore, increased education results in an increase in welfare thus shifting the demand curve for improved water service provision to the right and increasing WTP (Mezgebo and Ewnetu, 2015).

5.4. Conclusion

Education levels in Zimbabwe are relatively high and approximately 42% of the sample had at least a tertiary qualification. Most (90%) of the households had at least one member who was formally employed thus there was a source of regular income. Formal income levels were concentrated in the middle to higher income ranges whilst those for informal income were mostly limited to lower income ranges.

Approximately 73% of respondents stated that they were connected to the HCC water network. Days with water flow per week ranged from one day to all seven days and the median was four days out of the week. There were complaints that despite having water flow, the water pressure is often rather low. Sourcing water from private boreholes and wells were the most popular alternatives followed by sourcing from friends and family then lastly purchasing from water vendors.

Predicting the probability of being WTP proves to be a useful tool in determining whether the hypothetical proposal could eventually come into fruition. The last objective of this research was to determine the WTP of consumers for improvements in water service delivery. Approximately 66.2% of the respondents stated that they were WTP and the probit model was used to analyse how certain variables influenced the probability of a respondent being WTP. The variables included in the regression were gender, income from formal employment, expenses, household size and education level. The analysis also included the marginal probabilities of being WTP for each variable whilst all others were at their respective means.

With the exception of income from formal employment, all the coefficients had the expected signs. Formal income was expected to have a positive relationship with the probability of being WTP; however, all the coefficients for the different levels had negative signs. This was attributed to the possibility of having increased ability to afford more reliable substitutes for water service with increased income thus such respondents would not be significantly affected by the state of water service delivery.

Being connected to the HCC network and falling income range group 2 (USD350-USD849.99) were found to be statistically insignificant in explaining the WTP of respondents. Income range group 3 (USD850-USD1 499.99) and expenses were found to be significant at the 10% level.

Gender, and formal income range group 4 (USD1 500-USD2 500+) were significant at the 5% level whilst household size and education levels 2 (14 years of formal education) and 3 (17+ years of formal education) were statistically significant at the 1% level. Variables for education (levels 2 and 3) and those for higher income levels (levels 3 and 4) were found to have the greatest impact on the marginal probability of being WTP. The more an individual had higher education levels or formal income, the more likely they would be WTP. The same can be said for being female. Regarding household size, increasing household size was associated with reduced probability of being WTP.

Chapter six will give an overall summary of the research as well as the main conclusions drawn from the survey. The summary will be followed by a brief discussion of possible recommendations for future policy considerations.

CHAPTER 6

Conclusions and Recommendations

6.1. Conclusions

The research set out to determine whether Harare residents are willing to pay more for improved water service provision. To address this, the contingent valuation (willingness to pay survey) approach was used. The survey was conducted using a random sample to represent the whole service area that is covered by the Harare City Council (HCC). In addition to this, the study also investigated the various issues that influence the production and pricing of water service delivery – a merit 'good'. Furthermore, the different aspects surrounding why the HCC is unable to provide a reasonable level of service to Harare residents were discussed. This chapter gives a summary of the key findings of the study and also gives some recommendations for future policy planning and possible research.

In Chapter 2, the issues surrounding the water problem in Harare were analysed using the typical stages of water service provision as a framework. The analysis discussed the individual problematic issues in the stages with the most challenges (abstraction, treatment and distribution). The main challenges highlighted were the lack of adequate capacity for water treatment plants, insufficient water treatment chemicals and also the poor condition of water in the water bodies from which the HCC sources its water - namely Lake Chivero (Nhapi *et al*., 2002). There was also the poor condition of the water distribution pipeline network which saw over half the volume of processed water being lost before it is billed to the consumers (non-revenue water - NRW) through leakages and theft (Mapimhidze, 2014).

Further contributing to the problem is the general political instability with the government fitting the conventional description of a predatory State (Kovacs, 2012; Moselle & Polak, 2001). The lack of credibility of a government has a negative effect on the WTP of residents for public projects. The lack of trust by citizens in a single sector can also radiate to other sectors and this has further repercussions on the overall GDP of the country (Zak & Knack, 2001; Beugelsdijk *et al*., 2004) The chapter concluded that the problems surrounding water provision in Harare are multifaceted

but poor planning and management were seen as prominent contributing factors leading to the HCC's grim financial position (Magadza, 2003; Mapimhidze, 2014).

The microeconomic theory of the supply of public goods by a natural monopoly was discussed in Chapter 3 with particular focus on water service provision (impure public good) by public utilities. Chapter 3 included various factors authorities must consider when managing a utility (its regulation). There is further discussion on the factors to consider when pricing water. It was concluded that water pricing should be equitable, efficient, simplistic and include opportunity costs forgone whilst also allowing the public utility to recover its associated costs of provision (Barberan & Arbues, 2008; Gupta, 2011). Thus water pricing principles state that water tariff design should not only incorporate economic efficiency, but given the unique life sustaining features of water, must also take into account social aspects (Rogers *et al.*, 2002). MC and AC pricing were analysed and it was seen that MC pricing is more applicable when the authorities are pursuing efficient resource use and consumer welfare goals whilst AC pricing is more in line with continuity and cost recovery for the utility (Chambouleyron, 2004; Gupta, 2011). In Harare, water pricing is based on a MC pricing framework to maximise resource use and safeguard consumer welfare.

Chapter 4 was devoted to the description of how the questionnaire was designed and the methods that were utilised. The design of the questionnaire was predominantly based on the procedural structure given by Perman (2011) and also consulting Arrow (1997), Cuccia (2011), and Wedgewood and Sansom (2003). Two pilot studies were conducted to test the questionnaire. The initial pilot study was on a group of environmental economists who did not have first-hand experience with the water problem in Harare. This group provided feedback on the construction of the questionnaire as well as its adherence to environmental economics principles. The second pilot study aimed to test how the questionnaire would be received by the average Harare resident and was conducted on a group of Harare residents who had limited knowledge of environmental economics. Feedback from the second pilot study showed that respondents were more responsive to face-to-face interview scenarios than self-completion questionnaires.

Once the questionnaire was administered, it was found that out of the total 141 responses, approximately 66.2% of the respondents stated that they would be willing to pay and contribute to the USD $2.5billion that the HCC requires for various projects to increase capacity and refurbish infrastructure (Moyo, 2013). The average amount this group (66.2% of the sample) of respondents

was willing to pay was approximately USD$7 in monthly contributions per household over a three year period.

Chapter 5 gave the descriptive results from the questionnaire as well as the empirical results from the probit regression. It was seen that consumers are very sceptical of the quality of the HCC water (Karimakwenda, 2013). Despite numerous assurances from the HCC, approximately 76% of the sample rated the HCC water quality as being below average. Figure 6.1 shows a picture of water collected from a tap in Budiriro high density suburb in January 2015. Once collected, the bucket was sealed and left to sit overnight.

Figure 6.1: HCC Water Collected from Harare Residence

(Source: Author's own collection)

Upon opening, dark brown sediment had settled at the bottom of the bucket. Such observations are common and lead to perceptions which negatively impact WTP.

The probit regression made use of six independent variables with being WTP as the dependant variable. Selection of the variables was based on the results of a comprehensive study by the World Bank across three continents to determine the factors influencing WTP for water service in the developing country context. In addition, existing literature as well as author's knowledge of the local environment were also used. These variables were gender, income from formal employment, monthly expenditure, household size, education level and being connected to the HCC water network.

Education level was found to have a statistically significant positive correlation with being WTP whilst that for household size was negative. Women were also found to be more likely to be WTP than males. Monthly expenditure showed a negative correlation with the likelihood of being WTP whilst being connected to the HCC network was found to be statistically insignificant. Regarding formal employment income, ranges three (USD850-USD1 499.99) and four (USD1 500-USD2 500+) were statistically significant and had a positive correlation with the probability of being WTP whilst income range two (USD350-USD849.99) was statistically insignificant. In other words having increased education levels, higher incomes or being female increased the probability of an individual being WTP whilst the probability of being WTP was lower for larger households.

6.2. Recommendations

The results of the study give insight into households' perceptions with respect to the quality of service they are receiving from the HCC as well as some of the factors influencing their WTP for improved water service delivery by the HCC. The investigation also sheds some light on the complex mix of problems at the core of the water crisis in Harare. In an attempt to solve – or at least alleviate these problems, the following suggestions are therefore made:

6.2.1. Reduce Non-revenue Water (NRW)

Approximately 50-60% of the HCC's water output is being lost as NRW (through theft and leakages) (Moyo, 2013). Such losses are badly affecting revenue flow as the HCC is paying for the necessary processing and treatment of this water but since NRW is not sold to consumers, the HCC does not collect any revenue. By addressing the issue of NRW, the HCC stands to increase its current revenue by 100% once all the water produced is being properly billed to consumers. Thus before embarking on new expansion projects, it is recommended that the HCC use any funds

that they might raise to initially refurbish existing infrastructure and pipelines. This could also include automating the current system as per their cooperation agreement with their eThekwini counterparts (AllAfrica, 2013).

6.2.2. Pricing policy adjustments

It would not be sufficient to make a decision on whether Harare water is too cheap or expensive based on a comparison with other cities because different cities have different pricing structures (for example the number of pricing blocks). However, it is advisable that the HCC revisit its pricing policy in light of their financial position (Gupta, 2011). Most respondents stated that they were up-to-date in their water bill payments thus this could prove to be an effective way of raising funds. For instance, if the HCC was to increase (reasonably) the fixed charge for water, the research findings suggest that consumers are in the habit of paying and assuming that they do, then the HCC could get some much needed finance.

This proposition is however heavily dependent on the extent of the price increase (Pashardes & Hajispyrou, 2002). An increase that is too low would not be able to raise significant finance whilst too high an increase could prove to be too much for the consumers and they might not pay the entire bill which would ultimately cost the HCC more (losing both fixed and variable tariff components). It is paramount that should the HCC decide to increase water tariffs, they consider various other social factors such as income levels and living standards of the Harare residents (see section 3.6).

6.3. Areas for further study

There are also other options that require additional research to determine their feasibility in the Harare context. Initially the HCC could look into reducing their service commitment load by making more use of underground water to service certain areas for example, the satellite towns. This is a common practice in the developed world where small towns are wholly (or partially) serviced using underground water (Gupta, 2011). An example is the UK which is serviced by 25 water suppliers – each water supplier with a certain geographical coverage. Of the 25, 13 make use of underground water in varying degrees. Cholderton and District Water services two small villages in Wiltshire with water sourced solely from boreholes and aquifers whilst others such as

Portsmouth Water and South East Water use underground water in conjunction with surface sources (USwitch, 2015).

Alternatively, given the size of the HCC's existing service area, underground water could be dedicated to specific users for example residential areas, whilst HCC water – given the reservations consumers have about its quality, is directed towards industrial and agricultural areas. The HCC would continue to have jurisdiction over its current service area, however it would also rely on underground water to supplement its current water output which is approximately 65% (400ML) of the required output (Chenga, 2013).

Such a venture in Harare should only be deemed as a temporary measure to buy the HCC time to repair and expand its existing infrastructure without cutting back on already strained water output. Furthermore, there is also the effect that this will have on the water table thus it should not be deemed as a long term solution. This option might not prove to be particularly popular with existing users of underground water – particularly those with shallow wells as it will most likely lead to a lowering of the water level in their wells which might require them to invest more money in increasing the depth of their wells.

Consider private public partnerships

Another option worth looking into could involve the government authorities being more supportive of private water vending businesses. This could not only increase providers but also hopefully increase competition in the private water vending industry and ultimately lower the prices[32] that private vendors charge (Manzungu & Chioreso, 2012). There would however need to be strict quality control and monitoring mechanisms put in place to ensure that the water being sold is potable and can be traced back to its source. Monitoring and quality control could be handled by existing organisations such as the Upper Manyame Subcatchment Council which is responsible for monitoring ground water in the Manyame catchment area (Upper Manyame, 2015).

Consumers have adopted various coping mechanisms and it is advised that the HCC explore the idea by Manzungu and Chireso (2012) and look into compensating consumers who have developed more long term coping strategies to the water crisis. Some form of compensation is necessary

[32] A 5 000 litre delivery of water costs between USD55-USD75 (approximately ZAR700-ZAR960) depending on factors such as distance.

because by providing their own water, the residents are performing a service that the HCC should have provided. As the HCC lacks funds for direct compensation, they could implement a system similar to the rebates offered to electricity consumers who make use of solar power - maybe reducing the monthly fixed charge the consumers face.

Taxing new residential developments

The HCC is also unable to keep up service capacity expansion with the rate of residential property development. Ideally, catering for future property developments should be included in the strategic plans of the utility and capacity expansion plans to cater for them would have already been in place. In the case of Harare, this projection was not adequately done and there are also other issues intensifying this problem.

Rapid property development is a sign that Zimbabweans have limited options regarding financial security (see section 2.5) thus a common option is investing in property (Moyo, 2014). To allow HCC capacity growth to match the rapid property development, the relevant authorities could look into introducing a form of 'service expansion' tax. The tax would be a once off fee charged on all new housing developments to fund capacity increases for their areas.

It can be argued that capacity increases are ordinarily expenditures that must be financed by the government, however this study has demonstrated that the situation in Harare is far from ordinary. Under these circumstances it might be necessary to overlook what the government should or should not do (or have done) and rather focus on how to best secure the health of the population and continuity of this crucial service.

6.4. Limitations of the WTP study

Contingent valuation - though backed by the NOAA, can be subject to numerous biases (see Appendix 3) (most of which cannot be completely eliminated, only alleviated). Therefore, the results of such studies are not 100% accurate. They can however be further tested for reliability through statistical validity tests as well as criterion tests which compare the hypothetical WTP to actual cash payments (Loomis *et al*., 1996). It would also be helpful to compare the results generated with other non-market valuation techniques (Dikgang & Hosking, 2010).

The study demonstrates that the majority (66.19%) of consumers were WTP an average of approximately USD7 per household. Should this programme be properly implemented and assuming 350 800 (66.19% of the total 530 000) households pay, approximately USD88.4 million can potentially be realised over the three year period. It is important to understand that this figure is still purely hypothetical and one of the disadvantages of a WTP study is that WTP amounts are based on people's *intentions* to pay. As a result, any planning should not be based on this full amount because it is likely that in reality only a proportion of the money will be collected.

Once refurbishment is complete and capacity has been increased, perhaps the HCC could look into switching from MC pricing to AC pricing in order to maintain production efficiency and continuity of the utility. Despite AC pricing not prioritising consumer welfare, in Zimbabwe MC pricing (which seeks to promote consumer welfare) has resulted in the consumers possibly being in a worse-off position with issues such as the cholera outbreak, inconveniences from erratic water supply as well as time and financial losses from seeking alternatives to municipal water service.

The problems in Zimbabwe are indeed a complex mix of various factors with multiple players and multiple agendas, however there is no mistaking that all the 'players' need to rally together and make water security 'everybody's business'.

APPENDICES

Appendix 1: The WTP Questionnaire

Water Service Delivery in Harare: A Willingness to Pay (WTP) Analysis

Good day, my name is Lynsey Mugomba and I am a Masters student with Rhodes University. As part of my dissertation I will be conducting a Willingness to Pay (**WTP**) study for improved water services. Every household in Harare has to some extent been affected by the municipal water shortages currently being experienced. A city with Harare's population dynamics requires 1400 mega litres (ML) of water daily but the Harare City Council has capacity to produce 650ML, after theft and leakages from burst pipes- only 400ML reaches consumers. Apart from the critical life sustaining roles that water plays, there are also various economic and social functions that water serves.

Please be advised that this is an anonymous survey and you will not be required to give your name or contact details. Should you choose to do so, you may stop taking the survey at any point. Furthermore, the results of the study may be made available to the public at a later date.

Please complete as honestly as you can and also assist by giving feedback where appropriate. If there is any part that you are unsure of- you are welcome to ask me for further clarification. The questionnaire consists of 23 questions and it should take approximately 10 minutes to complete.

SECTION 1: Household demographics

Please fill-in accordingly

1. What is the gender of the head of the household (breadwinner) **M / F**

2. Are you the head of the household? **YES / NO**

3. What is the highest educational qualification of head(s) of household
Please place an "X" on the relevant option(s).

Primary School	
O-level	
A-level	
Diploma	

Graduate	
Post-graduate	
Other (Please specify)	

4. How many people live in this household?

Adults:	Children under 14 years:

5. Of the adults, how many are employed?

**Formal employment would mean receiving a regular (monthly) payslip*

Formally*:	Informally:

6. Please *circle* the relevant range of the **total** monthly income (USD-after tax) for the household?

a. From formal employment

Less than $149.99	$150-$349.99	$350-$499.99	$500-$849.99	$850-$1199.99
$1200-$1499.99	$1500-$1999.99	$2000-$2499.99	More than $2500	

b. From informal employment (monthly average)

Less than $149	$150-$349	$350-$499	$500-$849	$850-$1199
$1200-$1499	$1500-$1999	$2000-$2499	More than $2500	

7. Apart from income from employment, do you receive any other income from people outside of the household? (e.g. from the UK) **YES / NO**

7.2. If "YES" what is the **annual** estimate of money received (USD)?

$…….

If you **do not** receive any money, please continue to Question **8.**

8. What is the estimate of your total monthly expenses? UDS$……..

9. Do you rent or own the house you live in? **please circle* **OWN / RENT /OTHER**

9.2. If you rent, how much is the monthly rental fee? UDS$.....

Other (Please specify)……

10. How many rooms are there in the house (**excluding** bathrooms and toilets)? ……..

SECTION 2: Existing Water Situation

11. Are you connected to the Harare Council water network? **YES / NO**

**Please circle the relevant option*

11.2. If "**Yes"**, approximately how many days a week does water flow? …….

12. What do you think are the reasons behind the water shortages in Harare? …….....

……

……

……

……

13. What are your main sources of water for **non-consumptive** purposes?

***Please "tick" your **Top 3** sources of water for **non-consumptive** uses (e.g. bathing and laundry).*

Municipal water connection	
Private Well	
Private Borehole	
Water vendor	
River or stream	
Water from friends or relatives	
Other (Please specify)	

14. What is your main source of water for **consumptive** purposes?

***Please "tick" your **Top 3** sources of water for **consumptive** uses (e.g. drinking and cooking).*

Municipal water connection	
Private Well	
Private Borehole	
Water vendor	
River or stream	
Water from friends or relatives	
Other (Please specify)	

15. Can you estimate how much it costs (USD) you monthly to get water from other sources when there is no municipal water? ……. **N/A**

16. What are your views regarding the **frequency** of water flow provided by the City Council?

***please circle*

Poor Sometimes good Average Mostly good Excellent

17. What are your views regarding the **quality** of water provided by the City Council?

***please circle*

Poor Sometimes good Average Mostly good Excellent

18. Are you up to date in your water bill payments? **YES / NO**

18.2. If 'No' please explain why ……
……
……

19. Are you aware of the recent cancellation of outstanding water bills by the City of Harare? **(YES/NO)**

20. Do you think this action was helpful is solving the current water crisis? **(YES/NO)**

20.2. Please explain……

SECTION 3: Willingness to Pay for Improvements

In order to restore sufficient coverage of water to Harare, **USD$2.5 billion** is required toward various projects which include upgrading current water treatment plants, dam construction and replacing worn pipelines.
Assuming that a **third party** body (separate from government) was established to carry out these upgrades with money being paid directly them and also taking into consideration your current expenditure/inconvenience (or not) due to the water shortage;

21. Would you be willing to contribute a monthly levy towards this amount? **YES / NO**
**please circle accordingly*

21.2. If '**YES**', please continue to **Question 21** and if '**NO**' please explain why below

……
……
……

22. How much would you be willing to pay as a monthly levy to the third party body (in addition to monthly water bill)? The levy would be payable monthly over a 3 year period. (USD/ZAR)
Please circle the amount **closest to how much you would be willing to pay (USD/ZAR)*

$0.50/ R5	$1/R10	$3/R30	$5/R50	$8/R80
$10/R100	$15/R150	$20/R200	$30/R300	More than $30

23. Are there any other remarks you might have or information you would like to add regarding the water situation in Harare?

……

Appendix 2: Early Battle with Water Hyacinth at Lake Chivero

Year	Occurrence/ Actions taken
1937	First sighting of water hyacinth (WH) reported in one of the tributaries that feed into the Manyame river
1952	Lake Chivero is constructed
1957	WH reported in Lake Chivero
1960	WH infestation is regarded as being manageable using herbicides particularly 2,4-Dichlorophenoxyacetic acid (2,4-D)
1971	Lake is in a hypertrophic state. Bilharzia related snails observed on the foreshore and national boat races are cancelled Use of 2,4-D is banned and mechanical harvesting of WH commences
1985-87	Over USD420 000 spent on mechanical control of WH and water lettuce (*Pistia stratiotes*)
1986	Second outbreak of WH infestation and herbicide Glyphosate is sprayed
1987-88	Use of Glyphosate is stopped and manual removal with a crane is used
1990	*Neochetina* weevils released into the lake in January and their spread is confirmed three months later. In August, the weed infestation was exerting pressure on the dam wall and damaging irrigation equipment leading to the reintroduction of 2, 4-D and glyphosate at higher concentrations.
1990-94	An estimated 1.3 million USD is used on mechanical and chemical control
1992	In August the Ministry of Land, Agriculture and Water Development agrees with the Ministry of Environment on a site for the monitoring of the biological control mechanisms in place. In November, the *Neochetina* weevils are observed to have increased in population to 0.4 adults per plant.
1996	*Neochetina* weevils are present on almost 100% of the plants at 4-5 adults per plant. Success of this method of control becomes evident as sizes of weed mats

	on surface and plant vigour are significantly reduced; the proportion of flowering plants has also decreased to 15% of total weed population.
1997	WH coverage has decreased from highest value of 35% to 4%. Manual removal of weeds stops in July. The removal process also meant removal of the *Neochetina* weevils on the weeds and they were dumped on dry ground which adversely impacted their performance.

(Source: Adapted from Luis *et al.*, 2000)

The above table highlights the history of water hyacinth in Lake Chivero and how the Harare authorities have attempted to deal with it over a sixty year period (1937-1997).

Appendix 3: Main Biases of CV Studies

Type of Bias	Description
Hypothetical	Occurs due to the hypothetical nature of the study as opposed to having actual values
Part-whole	When a respondent is asked to value a good with a value identical to a more inclusive good.
Insensitivity to scope	When the WTP given by the respondent fails to reflect the extent of the situation presented to them.
Warm-glow	Such effects arise when the respondent gives an extreme value in an attempt to show their commitment to the cause or possibly gain favour from the interviewer.
Interviewer bias	When the identity of the interviewer affects the answers of respondents to differ from the typical answers.
Prominence	When the respondent alters their impression of the good being investigated to be more important- since it is worthy of having such a study done about it.
Temporal embedding	This occurs when willingness to pay fails to vary with frequency of payments i.e. when respondents claim to be willing to pay similar monthly and annual payments
Strategic	Occurs when respondents believe their responses will affect their tax burden thus they deliberately understate their WTP in response to the incentive to free ride.
Starting-point	When respondents base their WTP values relative to other values that were presented to them during the course of the study.
Information	When the respondents' lack of knowledge is reflected in their respective WTP value
Yea-saying	When the respondent gives an exaggerated WTP to close ended questions in a bid to please the interviewer
Sequence effects	When the respondent is asked to give WTP for a series of goods and the responses reveal that the WTP values given were related to the

	sequence in which the goods were presented to the respondent for valuation.

(Source: Adapted from Perman, 2011)

Appendix 3 gives the main biases associated with using the CV method. In some situations the biases might overlap, however many of the biases can be reduced in the design phase of the questionnaire. Strategic bias can for instance be minimised by performing four actions as suggested by Mitchell and Carson (2013). First, one must remove all outliers, then emphasising to the respondents that it would be guaranteed that *everyone* would pay (i.e. no free riding). This is followed by concealing their bid and finally making the proposed change based on that bid. This final step is to prevent respondents thinking that the proposed change will be automatic regardless of their bids.

Appendix 4: Burst Water Pipe in Harare

(Source: Authors own collection)

The above image shows a burst water pipe along Josiah Chinamano Street in the Avenues area in Harare on the 15th of March 2015. Such burst water pipes are a common sight in Harare and they

result in leakages of treated water. These leakages were identified as a contributing factor to the water problem in Harare.

Appendix 5: Probit Model STATA Output

Probit regression — Number of obs = 114

LR chi2 (9) = 101.02

Prob > chi2 = 0.0000

Log likelihood = -27.381787 — Pseudo R2 = 0.6485

wtp	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf.**	**interval**
gender	-0.7744	0.3985	-1.94	0.052	-1.5556	0.0067
formalincome_2	-0.3773	0.8163	-0.46	0.644	-1.9773	1.2226
formalincome_3	-1.5419	0.8619	-1.79	0.074	-3.2314	0.1473
formalincome_4	-2.0657	0.9767	-2.11	0.034	-3.9802	-0.1513
expenses	-0.0010	0.0006	-1.68	0.093	-0.0023	0.0001
connection	0.5828	0.4520	1.29	0.197	-0.3032	1.4688
householdsize	-0.2483	0.0947	-2.62	0.009	-0.4341	-0.0626
education~2	1.4228	0.4509	3.15	0.002	0.5388	2.3067
education~3	1.7230	0.5210	3.31	0.001	0.7018	2.7442
constant	1.9731	0.9934	1.99	0.047	0.0259	3.9203

(Source: Authors own computations)

The above results were computed using STATA 12 statistical software package.

Appendix 6: Marginal Effects Calculations

Conditional marginal effects Number of obs = 114

Model VCE : OIM

Expression : Pr(wtp), predict()

Expression at:

0.gender = .5438596 (mean)

1.gender = .4561404 (mean)

1.formaly = .1315789 (mean)

2.formaly = .4035088 (mean)

3.formaly = .2192982 (mean)

4.formaly = .245614 (mean)

expenses = 695.1316 (mean)

0.conxn = .2368421 (mean)

1.conxn = .7631579 (mean)

hhsize = 3.859649 (mean)

1.education = .377193 (mean)

2.education = .3070175 (mean)

3.education = .3157895 (mean)

Delta-method

		Margin	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
gender							
	0	0.75711	0.099401	7.62	0	0.5622871	0.9519324
	1	0.469162	0.114612	4.09	0	0.2445275	0.6937967
connection							
	0	0.459773	0.164805	2.79	0.005	0.13676	0.7827854
	1	0.685039	0.090424	7.58	0	0.5078124	0.8622659
education							
	1	0.262013	0.103622	2.53	0.011	0.0589181	0.4651070
	2	0.783966	0.097468	8.04	0	0.5929313	0.9750002
	3	0.861237	0.100784	8.55	0	0.6637036	1.0587710
formalincome							
	1	0.910138	0.130305	6.98	0	0.6547447	1.165530
	2	0.832538	0.091846	9.06	0	0.6525242	1.012552
	3	0.42059	0.125212	3.36	0.001	0.1751792	0.666000

4	0.234479	0.151163	1.55	0.121	-0.061795	0.5307519

(Source: Authors own computations)

The above results were computed using STATA 12 statistical software package. The marginal effects were calculated whilst all other variables were at their mean values.

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