MOBILE-ENABLED PAYMENT METHODS AND PUBLIC SERVICE DELIVERY IN DAR ES SALAAM, TANZANIA

Aaron Michael Krolikowski
Green Templeton College
School of Geography and the Environment
University of Oxford
Trinity 2013

Submission for D.Phil. in Geography

Mobile-enabled payment methods and public service delivery in Dar es Salaam, Tanzania

Aaron Krolikowski
Green Templeton College
D.Phil. in Geography
Trinity 2013

ABSTRACT

Rapid expansions of mobile communication technologies across sub-Saharan Africa have generated considerable optimism regarding their impact on socioeconomic development outcomes. Key payment applications, such as mobile-enabled payment instruments (i.e. SMS-based mobile money and wireless pay point services) are experiencing substantial adoption in East Africa and Dar es Salaam was the first city in sub-Saharan Africa to integrate these payment instruments into the urban water sector in mid-2009. Tanzania's largest city is demonstrative of the potential of mobile communication technologies to overcome water provision challenges such as inefficient billing and collection systems and revenue under-collection. This thesis uses Information and Communication Technologies for Development (ICTD) as an organising theoretical perspective to examine relationships between the use of mobile-enabled payment methods for water bill payments and customer payment behaviours, water utility performance, and access to water services. Data were collected using a survey methodology that tested hypotheses related to financial sustainability, petty corruption, satisfaction and service quality in payment practices, and neighbourhood resale in the informal water sector. Data sources include a survey administered to a stratified random sample of 1097 water utility customers; 42 semi-structured interviews with relevant stakeholders within the water sector and telecommunications industry; and a unique water payments database with information on approximately 1,000,000 water-related transactions made by over 106,000 customers. Qualitative and quantitative analyses provide evidence that the use of mobile-enabled payment methods can significantly improve customer payment behaviours (i.e. frequency of payment, annual revenue collection per customer), reduce opportunities for petty corruption (i.e. theft, bribery, and record-keeping), and support better access to improved water sources by unconnected households through neighbourhood resale practices. Implications for urban water provision in sub-Saharan Africa include higher collection efficiencies, more active customer bases, and wider direct and indirect reliance on utility-provided services. This thesis also contributes to ICTD scholarship by providing evidence that the use of mobile-enabled payment methods represents a disruptive transformation that enables more extensive and active citizen participation in the billing and payment processes of public service provision.

ACKNOWLEDGEMENTS

Completing this doctoral work has been both challenging and rewarding in virtually all areas of my life. Although the DPhil requires immense self-motivation and self-reflection, this project could not have been conducted without a broad group of people providing strong support, collaboration, and constant votes of confidence. I am grateful to Dr. Robert Hope for taking an initial risk on a student of relatively unknown capacities and for subsequently fostering the personal and professional growth and development required of an emerging social scientist. I also thank Professor David Bradley for his encouragement and for making the introduction. Other members of the mw4d research group - specifically Tim Foster and Ilana Cohen - were instrumental in shaping my early ideas and perspectives on the broad potential for mobile communication technologies to transform the water sector in sub-Saharan Africa. In Oxford, Michael Rouse (CBE) and Professor Xiaolan Fu provided thoughtful comments that were essential to my understanding of what constituted meaningful and impactful research. To these people I owe an immense intellectual debt I hope to repay by 'paying it forward' throughout my academic career.

This research was completed with the generous financial support of the Skoll Centre for Social Entrepreneurship, the Clarendon Fund Scholarship, and Green Templeton College. I thank Dr. Pamela Hartigan, Mrs. April Lopez, and Oxford University Press for their active involvement in ensuring this research took place.

An extensive network of contacts in Dar es Salaam and throughout Tanzania was critical to data collection and the contextualisation of this thesis. Eng. Jackson Midala and Mr. Kiula Kingu of the Dar es Salaam Water and Sewerage Corporation provided extensive support and permissions on engaging with DAWASCO data and enabled an incredible response to the customer payment preferences survey. The success of this research hinged on their dedicated

and continuous support. Others in Tanzania facilitated introductions and provided their own perspectives on appropriate directions for the research. I'd like to thank Ms. Neli Msuya, Mr. David Taylor, Ms. Julie Adkins, Mr. Rinus Van Klinken, and Mr. Sameer Hirji for sharing their time and perspectives with me as I navigated the often murky world of academic inquiry. I had the pleasure of working with an outstanding and ambitious group of Tanzanian research assistants who displayed unparalleled dedication to the success of this work. For teaching me about Tanzanian politics, the dreams of a new generation, and constantly correcting and improving my Kiswahili, I am grateful to Mr. Wilhelm Oddo, Ms. Mary Mareale, Mr. Benson Rukantabula, Ms. Jennifer Jessey, Mr. Frolence Itala, and Ms. Sarah Mgeni.

Perhaps most important to fieldwork in Dar es Salaam were the participants to this research - water utility customers, utility employees, telecommunications representatives, pay point operators, banking representatives, and individuals from the Ministry of Water. This thesis has been produced from your input and I dedicate it to those who have committed themselves to improving access to water services for all people.

Finally, I would like to acknowledge all those in my life who have provided silent and vocal support to me over the past four years. Even while two continents away or in the seeming hibernation of writing up, you never attempted to deter me from finding answers to the truths I was seeking, even if I always found questions in their stead. Lea, Kate, and Faraz - three pillars of constant personal support to balance the professional rigour of research. To Mom, Dad, Allana, Mark, Alex, Andrew and Adam - we went through a difficult period together and I will always remember that you never begrudged my distance. Last, but certainly not least, I thank the people who have been with me from the beginning and remain with me today - Kelly and Darren - you continue to inspire me to reach for that which appears beyond our grasp as we claim our futures for the benefit of humanity. K*utafuta ukweli, kupata maswali tu.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

DAWASA	Dar es Salaam Water and Sewerage Authority
DAWASCO	Dar es Salaam Water and Sewerage Corporation
EWURA	Energy and Water Utility Regulatory Authority
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
GPRS	General Packet Radio Service
ICT	Information and Communication Technology
ICTD	Information and Communication technologies for Development
LIA	Low-Income Area
MDG	Millennium Development Goal
MM1	Mobile Money Service I
MM2	Mobile Money Service II
NMB	National Microfinance Bank
NRW	Non Revenue Water
PP	Pay Point
SMS	Short Message Service
TCE	Transaction Cost Economics
TZS	Tanzanian Shillings
USD	United States Dollars
WO	Water Office

1. INTRODUCTION

1.1. Exposition: Mobile Communication Technologies and Urban Water Provision

This thesis aims to explore and clarify the linkages between mobile-enabled payment methods, the urban water sector, and key development outcomes in Dar es Salaam, Tanzania. Mobile-enabled payment methods refer to the collection of payment options that rely on mobile communication networks to function (i.e. mobile money services, mobile banking services, and wireless pay point networks). Rapid expansion in the use of mobile and other information and communication technologies (ICTs) in Africa has generated a wide range of mobile-related applications and fostered emergent optimism regarding the future of development in sub-Saharan Africa. Although a variety of research has been done to examine the relationships between mobile technologies and health, education, market efficiency, and economic growth, very little scholarship exists regarding the influence of ICT use on access to water services and performance in the urban water sector.

The significance of urban water utility performance and access to water services as a focus of this study is grounded in the contemporary realities of water provision in sub-Saharan Africa. Over 325 million Africans still lack access to improved water sources, and the proportion of those in urban areas continues to increase as the continent experiences rapid population growth and the effects of sprawling urbanisation (WHO/UNICEF, 2010; WHO/UNICEF, 2012; WHO/UNICEF, 2013). In spite of numerous policy and institutional reforms over past decades (Briscoe, 1996; Jaglin, 2002; Bayliss, 2003; Bakker, 2008; Mugisha and Brown, 2010; Schwartz and Sanga, 2010), only 15% of the population has direct access to piped-water services and 37% of households are dependent on unimproved sources of drinking water (WHO/UNICEF, 2013). Limited financial resources are a primary cause of water sector

failings; an annual 12.9 billion United States Dollar (USD) financing deficit has crippled the ability of African nations to provide adequate water services (AICD, 2010; Banerjee and Morella, 2011). Constrained financial capacities have translated into a sobering fact - most African countries are unlikely to meet the Millennium Development Goal drinking water target by 2015, in spite of the rest of the world reaching that objective in 2010. Bill payments are the primary revenue stream for water utilities and have direct implications for revenue collection and subsequent improvements in service quality and access (Mugabi and Kayaga, 2010). Research on the mechanics and determining factors of water utility customer payment behaviours remains scarce, however, and the advent of mobile-enabled payment methods provides a unique opportunity to increase the significance of this often-overlooked piece of the water sector financing puzzle.

The empirical investigations contained within this dissertation provide evidence to support the claim that the use of mobile-enabled payment innovations has had a positive and significant effect on customer payment behaviours, water utility performance, and access to water services by both connected and unconnected households. Interactions between mobile-enabled payment methods and development outcomes are shaped by the complexities of human behaviour and social interaction, and understanding how these factors influence choice of payment methods and decisions regarding payment practices is central to this thesis. The objective of this introductory chapter is to contextualise the significance, design, and implementation of this research project. Section Two offers background related to the challenges of urban water provision, the growth of mobile telephony in Africa, and explains mobile-enabled payment methods in greater detail. The subsequent section organises the thesis by proposing a conceptual framework that links various elements of the urban water sector with the use of mobile payment innovations. Research questions are presented in relation to this conceptual framework. The dependence of this research on ICTD scholarship

to link an ICT innovation to development outcomes is explored in Section Four, which elaborates on this organising theoretical perspective and ongoing debates regarding the nature of transformation, discursive constructions in ICTD, and other development-related perspectives. Section Five explores the methodological approach taken in this work and covers data collection and sources, principal variables and the analytical methods employed to understand them, and ethical considerations that have characterised my doctoral process. The final section is a roadmap describing the contributions of each empirical chapter and the wider conclusions that are drawn at the end of this dissertation.

1.2. Background and Context

1.2.a. Geographic Context - Tanzania and Dar es Salaam

Tanzania is the largest country in East Africa in terms of land area and population. The country had a population of 44.9 million people as of the 2012 census and is bordered by the Indian Ocean to the East; Kenya and Uganda to the north; Rwanda, Burundi, and the Democratic Republic of the Congo to the West; and Malawi, Mozambique, and Zambia to the south (Figure 1-1) (NBS, 2013). Dar es Salaam is Tanzania's largest city and functions as its chief economic hub and the centre of the permanent government bureaucracy. The city is the largest in East Africa with a population of 4.3 million, and is administratively divided into three districts (i.e. Ilala, Kinondoni, and Temeke), which are further subdivided into 73 wards (i.e. neighborhoods) (Figure 1-2) (Ibid).

Initially a fishing village called Mzizima, Dar es Salaam would benefit from extensive commerce in slave and resources that dominated the Indian Ocean trading networks throughout the 19th Century. Officially founded in 1862 by Sultan Majid of Zanzibar, the city was colonised by German traders and administrators in 1887 until the end of World War One, when the British Empire assumed complete control of German East Africa (Brennan and Burton, 2007). British rule persisted until independence in 1961. Rapid urbanisation and

population growth from rural-urban migration followed independence, as the population ballooned from 93,363 in 1957 to 272,821 in 1967. This process continued throughout the latter half of the 20th Century and by 1979 over half of the city's population was living in unplanned settlements - 478,489 out of a population of 769,445.

Figure 1-1. Map showing the geographic location of Tanzania and Dar es Salaam in relation to Africa and East Africa. *Source: Author.*

Dar es Salaam's population has continued to expand since the turn of the 21st century when there were 2.5 million residents. It is estimated that between 65-90% of the city's 4.3 million citizens now live in unplanned settlements that lack even basic access to safe water sources,

electricity, and other fundamental services (UN-HABITAT, 2011; Dagdeviren and Robertson, 2011). Further, the number of these settlements continues to increase - from 40 in 1985 to over 150 in 2003 (Kombe, 2005) Extensive unplanned settlements pose challenges for urban water service providers who often struggle to provide adequate water services to areas with insecure tenure and low-income populations unable to afford connection fees or monthly bill payments.

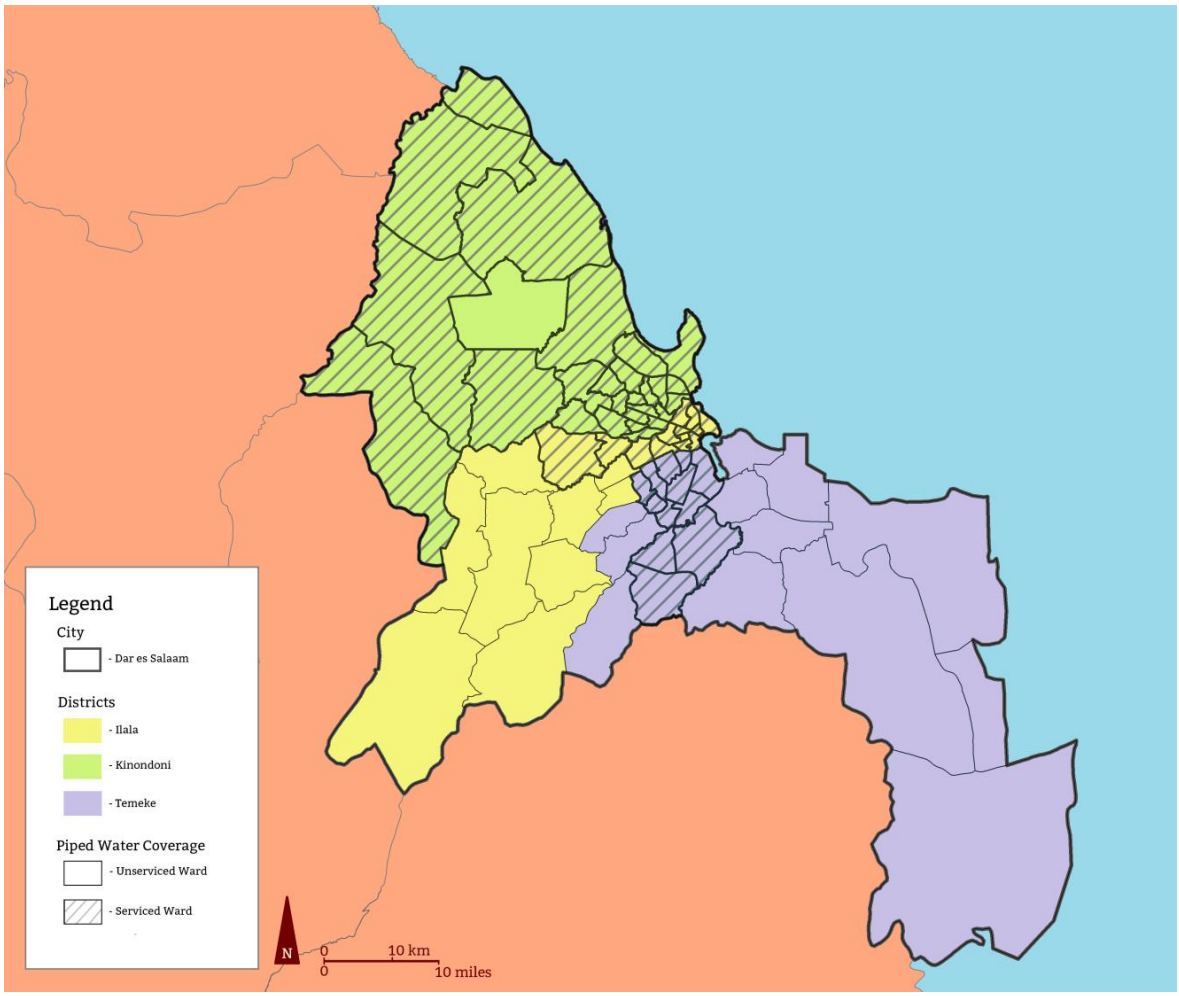

Figure 1-2. Map depicting the geographic extent of Dar es Salaam and piped water coverage. *Source: Author.*

1.2.b. The Development of Urban Water Provision in Tanzania

Water supplies in Dar es Salaam were originally provided from shallow wells in the city, with the first water-supply system conceived in 1891 (JICA, 1991 in Kjellen, 2000). As the population of the city grew, new water sources to the west - the Upper and Lower Ruvu schemes - were developed and large-scale infrastructure was installed (Humphreys, 1995 in Kjellen, 2000). Much of the water supplied from these production systems is lost - over two-thirds of the water delivered from the Upper Ruvu system and approximately 20% of supplied produced by the Lower Ruvu scheme are either consumed or lost to leakage before reaching Dar es Salaam (Kjellen, 2000). Authority for urban water provision was granted to the National Urban Water Authority in 1981, a central authority responsible for regulating and supplying water in Tanzania's urban areas. The decentralisation of the urban water sector began in 1997 with the Water Laws Act, which established the Dar es Salaam Water and Sewerage Authority (DAWASA). This reform recognised the unique challenges faced by water providers in the country's largest city (Mugisha and Brown, 2010). In response to growing international pressure to privatise water provision schemes, the search for a private operator began in 1997 and concluded in 2003 with the commencement of a ten-year lease led by City Water Services Limited - a British joint venture of Biwater and H.P. Gauff (WaterAid, 2008; Mugisha and Brown, 2010). By 2005, the Tanzanian government unilaterally terminated the contract and established a public company - the Dar es Salaam Water and Sewerage Corporation (DAWASCO) - to be the sole operator of water services in Dar es Salaam. DAWASCO continues to operate the water production and delivery system today under contract with DAWASA. DAWASCO currently operates a 1600-kilometre distribution network that covers 48.2% of the urban population, although not all those within the coverage area have household connections (EWURA, 2011). In spite of the inability of many households to afford a water connection, domestic water bills comprise 74% of annual revenues. This makes Dar es Salaam a prime research focus for the study of the impact of novel payment instruments on domestic customer payment behaviours.

1.2.c. Urban Water Services in Sub-Saharan Africa

Urban water providers in Africa are typically overwhelmed by a constellation of challenges preventing the effective delivery of piped water services to populations across the continent. Geographically-limited infrastructures in an era of urban expansion, insufficient operational financing to serve high-poverty populations, and precarious levels of water loss resulting from the unscrupulous activities of citizens and public servants have created conditions characteristic of contemporary African cities (Gonzalez-Gomez, *et al*., 2011; Banerjee and Morella, 2011; Dagdeviren and Robertson, 2011). Over 325 million Africans still lack access to improved water sources and the urban share of that number continues to increase (WHO/UNICEF, 2010; WHO/UNICEF, 2012; WHO/UNICEF, 2013). Although the global Millennium Development Goal (MDG) drinking water target was achieved in 2010, most African nations are unlikely to accomplish the same (WHO/UNICEF, 2012). To do so would require overcoming an annual 12.9 billion USD funding deficit, of which 2.7 billion USD is a consequence of distributional losses, under-collection of revenue, and overstaffing (AICD, 2010; Banerjee and Morella, 2011). Failings in Africa's urban water sector promote the propagation of vested private interests and bureaucratic corruption that actively frustrate progress in utility performance and efficiency (Stalgren, 2006). Insufficient financing and endemic corruption catalyse further deteriorations in service quality and simultaneously risk the de facto institutionalisation of a sub-standard tier of water services characterised by expensive and unaccountable informal service providers (Jaglin, 2002). Barriers to the effective provision of water services persist despite innumerable policy and institutional reforms aimed at restructuring water sectors, enhancing utility performance, and attaining equitable levels of access.

High levels of non-revenue water, expansive unplanned settlements, and increasing demand on a limited water production and delivery system have contributed to a severe decline in the quality of services in Dar es Salaam. Fewer than 27% of utility customers receive reliable

service compared with 100% at independence (WaterAid, 2008), while demand in the city (i.e. 410 million litres per day) far outstrips available supplies (i.e. 204 million litres per day) (Kyessi, 2005). The utility loses 53.7% of its supply as non-revenue water and provides only 9 hours of average daily service. DAWASCO is also considered to be overstaffed by international standards with 9 employees per 1000 connections (Ibid), three times as many as European counterparts (Briscoe, 1996). Commentators describe the city's water obstacles as a corollary of deficient financial resources, political interference, poor billing and payment systems, and neglect of the unique service arrangements required by low-income populations (Kjellen, 2000; Kyessi, 2005; Dill, 2010). The poor performance of the urban water utility in Dar es Salaam, considerable spatial and socioeconomic gaps in service delivery, and a context of rapid population growth and urbanisation has spurred the emergence of a broad array of informal water service providers - water vendors, neighbourhood resellers, tanker trucks - who provide water to the majority of the city's population on a daily basis but at significantly higher prices than officially-provided services (Kjellen, 2000; Thompson, *et al*., 2000; Jaglin, 2002). Water's critical importance to health, economic growth, and quality of life is undermined by continuous declines in Tanzania's urban water sector, which exacerbate existing inequalities and prevent positive movement towards development goals. These obstacles provide an appropriate context to understand how changes in customer payment behaviours may shift patterns of access to officially-provided piped water services in environments facing significant resource constraints.

1.2.d. Mobile Communication Technologies in Africa

The relatively recent proliferation of mobile communication technologies across the continent may offer opportunities to overcome these enduring water service challenges. Mobile phone subscriptions in Africa stood at approximately 16.5 million in 2000, a figure expected to rise to over 700 million by 2016 (GSMA/Deloitte, 2012). Growth in telecommunications capacities is illustrated by changes taking place in East Africa, which has been recognised as a

prominent leader in mobile communications and related innovations (Muwanguzi and Musambira, 2009). In 2002, mobile penetration rates stood at 3.6% in Kenya, 1.7% in Tanzania, and 1.5% in Uganda and by 2012, these figures grew to 69%, 50%, and 42% in Kenya, Tanzania, and Uganda, respectively (GSMA/Deloitte, 2012). Low-income countries with poor landline infrastructures (e.g. Tanzania) are likely to benefit from the rapid adoption of mobile technologies, which creates an enabling environment for 'leapfrogging' - bypassing stages in capacity building or investment through which countries were previously required to pass (Hobday, 1995) - and the acceleration of development processes (James, 2012). Even more, the effects of mobile phones are expected to be amplified and driven by urbanisation (Wong, 2008). According to Foster, *et al*., more people on the continent now have access to mobile phones than piped water supplies (2012). Mass uptake of this technology has spurred innovations that aim to improve social and economic development outcomes; and water is one of many sectors that that have become a prominent focus of these initiatives (Hutchings, *et al*., 2012; Hope, *et al*., 2012).

Governments, civil society organisations, and private sector actors are significantly optimistic about the potential implications of mobile-based innovations for economic growth and entrepreneurship, although evidence regarding human development impacts remains limited. Existing work has demonstrated positive outcomes in fisheries (Jensen, 2007), grain markets (Aker, 2010), agricultural extension services (Aker, 2011), and disease prevention and management (Padma, 2010; Wesolowski, *et al*., 2012). Small and medium-sized enterprises that employ mobile technologies have experienced strengthened material and information flows, and benefit from the more extensive business contacts and expansive social networks that are sustained through mobile phone use (Donner, 2006; Donner and Escobari, 2010; Essegby and Frempong, 2011). Scholarly attention has consequently and disproportionately focused on the broad and positive influence mobile phones have on economic development

and growth (Waverman, *et al*., 2005; Donner, 2008; Aker and Mbiti, 2010). Studies considering the effects of mobile technologies on populations in low-income countries have advanced the general argument that the ability of mobile phones to reduce information asymmetries is contributing to market efficiency gains, welfare improvements, and development. Punctuated increases in the adoption of mobile phones coupled with extensive and innovative applications of the technology throughout African societies have produced a novel context for socioeconomic development that remains largely unexplored by existing academic scholarship.

1.2.e. Mobile-Enabled Payment Methods

In addition to the potential impacts of mobile communication technologies on imperfect information and market efficiency, the emergence of mobile payment innovations has begun shifting the financial landscape of sub-Saharan Africa. Mobile money services[1] are SMS-based money transfer systems that allow individuals to withdraw, deposit, and transfer funds using their mobile phone are now commonplace in many countries, particularly in regions like East Africa and English-speaking West Africa (e.g. Ghana, Nigeria) (Jack and Suri, 2011; Donovan, 2012a). These services facilitate the transfer of domestic remittances (Morawczynski, 2009), enable greater degrees of financial inclusivity (Ivatury and Pickens, 2006; Mas, 2009; Donovan, 2012b), and increase the ease of bill payments and the purchase of certain goods and services (Kshetri and Acharya, 2012). The Kenyan mobile money service M-PESA was established in 2007 and is considered to be the most successful and widely adopted service currently operating (Jack and Suri, 2011). Enthusiastic uptake of mobile money services and other mobile-enabled payment methods can be attributed to minimal banking infrastructures in countries like Kenya and Tanzania, unreliable and dilapidated communications and transportation infrastructure, as well as a high degree of trust

[1] A comprehensive discussion of the operation and history of a mobile money service (i.e. M-PESA in Kenya) can be found in Jack and Suri (2011).

in mobile network operators (Mas and Ngweno, 2010; Mas, 2011; Jack and Suri, 2011). The potentially transformative impacts of mobile money services have only recently been critically examined as tens of millions of Africans now have access to basic financial services through their mobile devices.

Beyond mobile money services, mobile banking services and wireless pay point networks are additional mobile-enabled payment methods that have been established in Tanzania. Mobile money services are SIM-based financial systems that can be managed directly from a mobile handset. The services rely on extensive agent networks for cash-in/cash-out practices and are administered by mobile network operators. Four major mobile money services exist in Tanzania and are operated by largest mobile network operators: Vodacom Tanzania, Airtel Tanzania, Tigo, and Zantel. Mobile banking services are also operated from mobile handsets, but are attached directly to bank account funds that require cash deposits and withdrawals to be made at commercial bank branches. Money can be transferred between mobile money and mobile banking accounts, but it is important to note that these are distinctly different services. Many banks have established mobile banking options for their customers, such as the National Microfinance Bank's 'NMB Mobile' service. This can be used to transfer money, purchase airtime, and pay electricity and water bills. GPRS-enabled pay points, also called wireless pay point networks, are operated out of existing stores and shops (e.g. pharmacies, grocery stores, petrol stations, and kiosks) using specialty point-of-sale devices that communicate using a SIM card and mobile networks. Payments are made using cash and are deposited in specific accounts. Two major wireless pay point networks exist in Dar es Salaam, Tanzania - Selcom Wireless Pay Points and Maxcom MaxMalipo Pay Points; both services are expanding throughout the country. Multiple types and instances of mobile-enabled payment methods available in Dar es Salaam have given Tanzania one of the most diverse payment landscapes in sub-Saharan Africa.

Mobile-enabled payments for water services are being utilitised by an expanding number of urban water service providers and could potentially improve revenue collection, change customer payment behaviours, increase utility performance and efficiency, and reduce the prevalence of corruption within the water sector (Hope, *et al*., 2011; Hope, *et al*., 2012; Foster, *et al*., 2012). DAWASCO was the first urban water utility in sub-Saharan Africa to offer mobile-enabled options to pay for water services in mid-2009. By the end of 2011, over 15% of water payments were being made using mobile-enabled methods and 26% of utility customers had tried the options at least once (Hope, *et al*., 2011). Payment options for water services at the time of data collection included 14 water utility payment offices, over 2000 wireless pay points managed by Selcom Wireless, two mobile money services, 70 bank branches, and multiple mobile banking options. Following the conclusion of data collection in 2012, additional mobile money (i.e. TigoPesa), wireless pay point (i.e. MaxMalipo), and mobile banking services have begun offering mobile water payments. Dar es Salaam offers an optimal context in which mobile-enabled payment methods are experiencing considerable adoption in a city familiar with the impediments that prevent effective water services provision.

1.3. Statement of Research Problem

This thesis asks what impacts, if any, do mobile-enabled payment methods have on urban water provision in low-income countries? For the purposes of this project, sub-research questions follow three primary themes: customer payment behaviours, water utility efficiency and performance, and access to urban water services by low-income individuals and families. Payment behaviours, utility performance, and expanded access reflect dominant strands of thought and debate within the literature on water service provision in developing countries (Jaglin, 2002; Kayaga, *et al*., 2003; Mugabi, *et al*., 2010; Banerjee and Morella, 2011; Dagdeviren and Robertson, 2011; Gonzalez-Gomez, *et al*., 2011). Due to their novelty, mobile-enabled payment innovations have not yet become a focal point of discussion within

this literature and this thesis attempts to make early empirical and theoretical contributions to existing literature and offer new knowledge that can serve as a foundational starting point for the practical and theoretical debates on mobile innovations and water provision that will inevitably emerge. This section begins by introducing and elaborating on the conceptual framework used to explain the relationships between mobile-enabled payment methods and urban water provision. Overarching research questions related to customer payment behaviours, water utility performance, and access to water services are then presented and discussed in relation to this framework. I then briefly review existing literature on each topic and conclude by offering testable hypotheses related to key aspects of the conceptual framework.

1.3.a. Conceptual Framework

The novelty of mobile-enabled payment methods and their conspicuous absence from the urban water services literature necessitates the construction of a new conceptual framework focused on the relationships between mobile-enabled payment methods and the urban water sector. The primary unit of analysis within this framework is the individual water utility customer who chooses to use or not use mobile-enabled payment methods or the water utility payment office to pay a water utility bill.

The use of mobile payment instruments can have, in the first instance, an impact on customer payment behaviours (i.e. the hypothesis of Chapter 2). Changes in customer payment behaviours are expected to then effect changes in water utility performance through variations in revenue collection and cash flow (Kayaga, *et al*, 2003; Kayaga, *et al*., 2004; Mugabi and Kayaga, 2010). Figure 1-3 illustrates a two-way relationship between payment behaviours and water utility performance, which is based on research showing relationships between improved utility performance and customer payment behaviours (Kayaga, *et al.,* 2003; Vasquez, *et al*., 2011; Gonzalez-Gomez, *et al*., 2011). Changes in water utility performance

are similarly expected to influence the choice of payment method, as satisfactory service provision will reduce the need for customers to travel to the utility payment office to settle a bill. This relationship is illustrated with a dotted line because there is not yet empirical evidence to support this proposition.

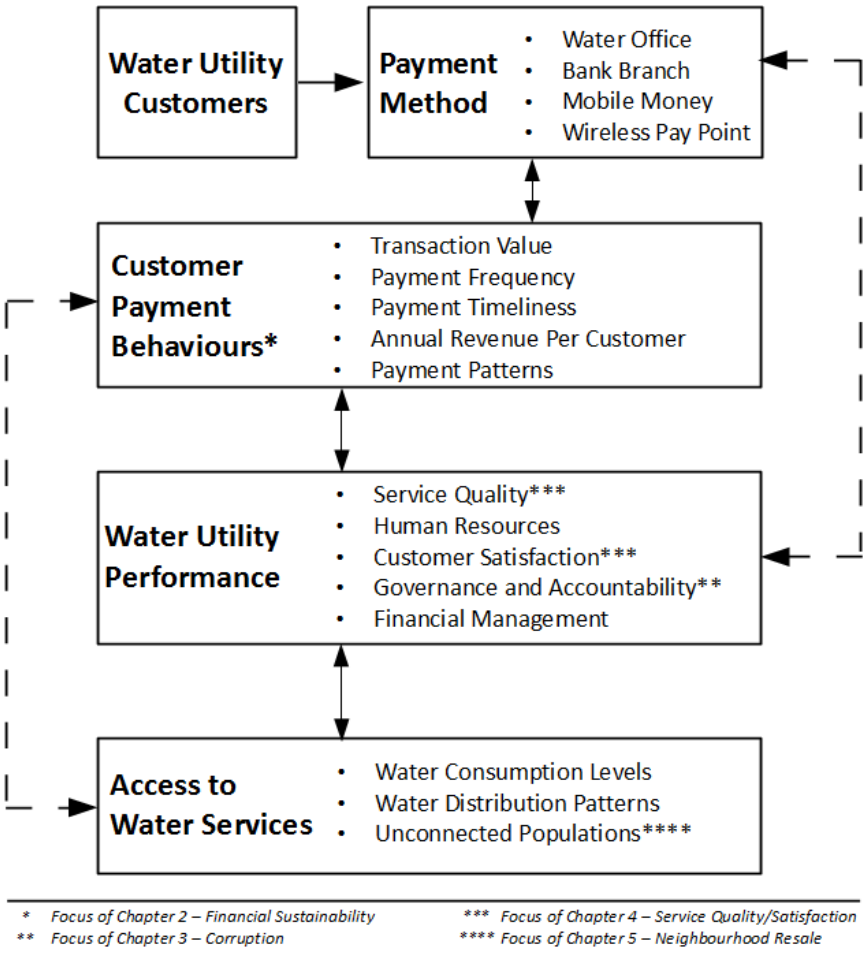

Figure 1-3. Visual representation of the conceptual framework used to structure this dissertation. Framework focuses on the relationships among customer payment behaviours, water utility performance, and access to water services. *Source: Author.*

Whether positive or negative, changes in water utility performance are likely to affect access to water services within a utility's coverage area by influencing water service quality for existing customers and shifting their dependence on the informal water sector. It is well-

established in the literature that water utilities demonstrating strong governance and accountability mechanisms, high levels of service quality, and sound financial management are typically associated with greater access to water services (Davis, 2004; Mwanza, 2005; Kayaga, *et al.*, 2009; Schwartz and Sanga, 2010). Mobile-enabled payment methods may also directly impact water utility performance through expansion or reduction in the roles of key utility staff (e.g. cashiers, billing officers, revenue officers, field agents). This relationship is also illustrated with a dotted line because there is not yet sufficient empirical evidence to support this claim.

Similarly, changes in customer payment behaviours may influence access to water services not through the utility, but through informal service providers and reliance on other alternative water sources. Residents of unplanned and informal settlements tend to pay more for their water services than residents of planned settlements receiving directly piped water supplies (Zerah, 1998; Dagdeviren and Robertson, 2011). This is due to the significantly higher costs for water charged within the informal water sector by water vendors, tanker trucks, and other non-state providers (Kjellen, 2000; Jaglin, 2002; Zuin, *et al.* 2011). Better payment behaviours on the part of water utility customers may lead to a greater availability and accessibility of water supplies through neighborhood resale, which is often less expensive than other informal sources of water services. This two-way relationship is also characterized by a dotted line because empirical evidence for this relationship is not yet found in the existing corpus. Chapter 5 of this thesis attempts to fill this gap. Figure 1-3 offers a visual representation of this framework, while Table 1-1 summarises the constituent elements of customer payment behaviours, utility performance, and water access used in this thesis.

1.3.b. Conceptual Elaborations

The three primary conceptual elements of this dissertation include customer payment behaviours, water utility performance, and access to water services. These concepts have each

been explored and contested within existing water resources literatures, and this subsection briefly evaluates different approaches to each concept.

Customer payment behaviours explored in this thesis are limited to key elements that have a foundation in existing scholarship and include transaction value, payment frequency, payment timeliness, and annual revenue per customer (Figure 1-3). Inefficient billing and collection practices and sub-standard customer payment behaviours deter water utilities from achieving financial sustainability (Kjellen, 2000; Mwanza, 2005; Foster, *et al*., 2012), contributing to over 500 million USD in annual revenue losses across Africa (Banerjee and Morella, 2011). Research from Uganda illustrates how customer payment behaviours are the product of a customer's attitude towards bill payments, perceived ease of payment, and social pressures (Mugabi, *et al.*, 2010; Mugabi and Kayaga, 2010). Customer perceptions of service value and satisfaction may also have a substantial association with payment behaviours (Kayaga, *et al*., 2004). These studies typically use prompt payment (i.e. timeliness) as a primary indicator of payment efficacy. A study of mobile money payments for water services in Kenya focused on payment timeliness, but also examined payment timeliness as an additional measure of payment behaviour (Foster, *et al*., 2012). Transaction value and revenue collection have also been identified as significant aspects of payment behaviours (Addo-Yobo, *et al*., 2006; Mugabi and Kayaga, 2010).

Fluctuations in these elements of payment behaviour translate into variations in utility revenue collection, which results from aggregating payment frequency and transaction size over a period of time. The final element of customer payment behaviours examined by this thesis includes payment patterns, which refer to the monthly and sub-monthly payment frequencies and values that reflect the ability of water utility customers to make multiple monthly payments. Multiple monthly payments are an uncommon payment practice in the pre-mobile

payment landscape. However, the high degree of prevalence of relatively unpredictable income streams in low-income countries has led some scholars to call for a closer evaluation of the potential for payment pattern variations to support low-income households, utility business models, and overall access to water services (Mugabi, *et al*., 2010).

Changes in customer payment behaviours can also change the financial position of urban water utilities, potentially influencing water utility performance through service quality, human resources, customer satisfaction, and other factors related to governance and accountability (Figure 1-3). Existing literature commonly describes water utility performance in relation to the quality of provided services, pointing to the frequency and duration of service, extent of non-revenue water, and the reliability of piped supplies as key indicators of this (Dill, 2010; Schwartz and Sanga, 2010; Gonzalez-Gomez, *et al*., 2011). Service quality and the availability of financial resources is also affected by the efficient use of human resources and staff costs, which represent significant expenditures for African urban utilities (Briscoe, 1996; Schwartz and Sanga, 2010). Customer satisfaction also influences perceptions of water utility performance, particularly as it relates to customer trust in the utility, billing accuracy, and collection ratios (Kayaga, *et al*., 2004; Mwanza, 2005; Deichmann and Lall, 2007; Banerjee and Morella, 2011). Governance and the quality of decision-making creates a context in which service quality, customer satisfaction, and the effective use of human resources can improve or deteriorate (Davis, 2004). Record-keeping, the incidence of petty and grand corruption, financial management, and the relative quality of decision-making are elements of water utility governance and decision-making processes that can change the transparency of a water utility and alter its accountability pathways (Davis, 2004; Stalgren, 2006; McGranahan and Satterthwaite, 2006; Anbarci, *et al*., 2009; Schwartz and Sanga, 2010).

Table 1-1. Elaboration of the elements and indicators used in this dissertation to operationalise the concepts of customer payment behaviours, water utility performance, and access to water services. *Source: Author.*

CONCEPT	ELEMENT	INDICATOR	SOURCES
CUSTOMER PAYMENT BEHAVIOURS	**Adoption**	Proportion of customers	*Foster, et al. (2012)*
	Mechanics	Payment Timeliness	*Mugabi, et al. (2010); Foster, et al. (2012)*
		Payment Frequency	*Alence (2002); Foster, et al. (2012)*
		Revenue Collection per Customer	*Mugabi & Kayaga (2010)*
		Transaction Value	*Addo Yobo, et al. (2006)*
	Patterns	Multiple Monthly Payments	*Mugabi, et al. (2010)*
WATER UTILITY PERFORMANCE	**Service Quality**	Frequency/Duration of Service	*Vasquez, et al. (2011)*
		Non-Revenue Water	*Gonzalez-Gomez, et al. (2011)*
		Reliability of Service Delivery	*Kayaga, et al. (2003); Vasquez, et al. (2011)*
	Customer Satisfaction	Overall Perceptions of Utility	*Kayaga, et al. (2004); Mugisha & Brown (2010)*
		Taste/Smell of Water	*Foster, et al. (2012)*
		Billing Accuracy	*Mwanza (2005); Mugabi, et al. (2010)*
	Financial Management	Collection Ratio	*Kayaga, et al. (2004)*
		Record-Keeping	*Schwartz & Sanga (2010)*
	Human Resources	Staff Efficiency	*Schwartz & Sanga (2010); Banerjee & Morella (2011)*
		Ability to Monitor Water System	*Mwanza (2005); Kayaga, et al. (2009)*
		Staffing Ratios	*Briscoe (1996); Schwartz & Sanga (2010)*
	Governance/Accountability	Petty Corruption	*Davis (2004); Stalgren (2006); Anbarci, et al. (2009)*
		Grand Corruption	*Deinenger & Mpuga (2004); Stalgren (2006)*
		Quality of Decision-Making	*Mwanza (2005); Mugisha & Brown (2010)*
ACCESS TO WATER SERVICES	**Consumption/Distribution**	Active Connections	*Kayaga, et al. (2009); Mugisha & Brown (2010)*
		Production/Consumption Levels	*Kayaga, et al. (2009)*
		Alternative Water Sources	*Kayaga, et al. (2003)*
	Unconnected Populations	Price of Piped/Non-Piped Sources	*Zerah (1998); Bardasi & Wodon (2003)*
		Service Expansions	*Kayaga, et al. (2009); Mugisha & Brown (2010)*
		Access in Unplanned Settlements	*Kayaga, et al. (2009); Dagdeviren & Robertson (2011)*
		Informal Service Providers	*Kjellen (2000); Jaglin (2002); Zuin, et al*. (2011)

Access to water services as it is discussed in this thesis is limited to an exploration of patterns of water consumption and distribution by connected households and the patterns of access that characterise unconnected households (Figure 1-3). Access to water services is typically defined in relation to the quality and convenience of obtaining supplies, and existing definitions focus on the use of particular improved sources, distance delimitations, and time ceilings (World Bank, 1997; UNDP, 2002). The number of active connections, aggregate water production levels, relative prices of water, a greater level of cooperation with non-state service providers, and service expansions have all been identified in the literature as indicative of greater access to water services by serviced populations (Briscoe, 1996; Zerah, 1998; Sansom and Bos, 2008; Kayaga, *et al.*, 2009). Fragmented urban water services in low-income countries require more extensive and holistic evaluations of the urban water sector (Balbo, 1993), which has made limited access by residents of unplanned settlements and unconnected households a major concern. Increases in access have been evaluated in regard to the availability of water in unplanned areas, the extent of secondary distribution networks, community sharing and neighbourhood resale, as well as a greater engagement with alternative models of service provision (Solo, 1999; Jaglin, 2002; Sansom and Bos, 2008; Kayaga, *et al.*, 2009; Schwartz and Sanga, 2010; Dagdeviren and Robertson, 2011).

1.3.c. Research Questions

Three concepts related to urban water provision provide the foundational framework within which I ask research questions that emerge from customer payment behaviours, water utility performance, and comprehensive access to water services. Significantly influenced by the impacts of ICT, my research sub-questions focus on understanding how mobile-enabled payment methods may or may not be creating an enabling environment for the achievement of universal access to water services through key development-related impacts. Specific areas of interest include financial sustainability, corruption, service quality and satisfaction, and dependence on alternative water sources and service providers.

Research questions are drawn from existing literature and are structured by the conceptual framework proposed in Figure 1-3. Effects on financial sustainability are examined by asking the question: "Do mobile-enabled payment innovations change customer payment behaviours for water services?" This question emerges from my conceptual framework at the point of water utility customers and studies the linkages between mobile-enabled payment methods and customer payment behaviours. Changes in corruption are evaluated by asking: "Can mobile-enabled payment methods reduce corruption in urban water provision?" This follows the conceptual pathway that connects water utility customers, mobile-enabled payment methods and water utility performance. We look at the impact of new payment methods on service quality and satisfaction by asking how customer payment behaviours are related to service quality and customer satisfaction. This question takes a slightly different approach in the framework, first by following the connections between utility customers, mobile payment use, and payment practices before interrogating the potential existence of a recursive relationship between payment behaviours and water utility performance. The direct and indirect implications for the informal water economy are explored by asking about the relationships between payment behaviours and neighbourhood resale. The relationship between customer payment behaviours and access to water services is investigated by this question, through pathways that are internal and external to the water utility. Original predictions focused on enhanced financial sustainability, mitigated corruption, a strong relationship between service quality/satisfaction and payment behaviours, and reduced dependence on informal service providers and null hypotheses were developed and tested from specific elements of each conceptual part of the framework.

1.3.d. Delimitations

In any study, it is essential that the boundaries, exceptions, and qualifications be clearly defined and noted through a discussion of the delimitations of a particular research project (Castetter and Heisler, 1977). The scope of this study has been narrowed through delimitations

related to geography, ICT innovation, and relevant development outcomes. Although water provision is a universal practice in urban Africa and mobile communication technologies are rapidly spreading across the continent, Dar es Salaam was chosen as the geographic focus of this study due to its position as the first city to introduce mobile-enabled payment methods for water services, the diverse payment landscape, and a relatively extensive availability of data to support analysis. Mobile-enabled payment options are the chosen ICT innovation largely because the concept was driven by a Tanzanian-owned company (i.e. Selcom Wireless), and because improved billing and payment systems have been identified as a clear need in the urban water sector (Kjellen, 2000; Mwanza, 2005; Banerjee and Morella, 2011). Finally, while many development outcomes have been related to ICT access (i.e. health, education, and economic growth), water access and utility performance have been neglected, and there is limited empirical evidence on corruption-related implications. Delimitations related to geography, choice of innovation, and development outcomes narrow the scope of this thesis and enable a detailed evaluation of the interactions between payment modalities, the water sector, and development outcomes.

1.4. Theoretical Framework

1.4.a. Information and Communication Technologies for Development (ICTD)

Rather than a discrete theoretical framework, ICTD acts as an organising theoretical perspective on the interplay between information and communication technologies and socioeconomic development outcomes. ICTD employs the existing array of theories and disciplines within the social sciences to build an explanatory bridge over the often wide space between these two conceptual themes. Information and communications technology (ICT) refers to digital and computer-based innovations that enhance the transfer of knowledge and other forms of information between multiple parties (Unwin, 2009; Heeks, 2010). Although ICT can include radio, television, computers, telephony, and other technologies, current scholarship in the ICTD perspective tends to focus on technologies related to the use of

wireless networks and data communication (i.e. internet) such as mobile phones and computers (Kleine and Unwin, 2009; Kyem, 2012). Development is the aggregation of socioeconomic changes, broadly covering economic growth, human development (e.g. health, education, public service delivery), government transparency and accountability, and cultural transitions, which are all focal points of development studies scholarship (Unwin, 2009; Kyem, 2012). Meaningful assessments of evidence regarding the contribution of ICT to development are now emerging (Heeks, 2010), but the scope and depth of existing analyses remain limited.

Mobile communication technologies - handsets, mobile networks, and related devices - are rapidly becoming the most prominent focal point of ICTD due to their transformative effects on geography and social connections. Like other information systems, mobile networks support processes that connect disparate entities by compressing space, enabling better coordination in real-time, and extending the reach of globalisation (Castells, 2000). The early novelty of mobile technologies in low-income regions engendered a body of ICT-related scholarship that has been criticised for neglecting to identify clear theoretical foundations, being overly descriptive, and lacking in sufficient analytical rigour (Heeks, 2006). Theoretical deficiencies in ICTD led to wider integration of the rich theoretical corpus of the social sciences, which aims to refine or strengthen existing theory for the contemporary era. Examples include the use of actor-network theory in analyses of e-government projects (Stanforth, 2006), the application of stakeholder theory to the study of telecentres (Bailur, 2006), and the evaluation of Sen's capabilities approach in relation to enterprise and gender-based empowerment (Kleine, 2010).

As a relatively new field of study, key aspects of ICTD remain as contested as the concept of development itself. This section explores ongoing debates within ICTD and situates this

dissertation within those discussions. It concludes with brief introductions of four frameworks that have been drawn from the social sciences to evaluate the impact of mobile-enabled payment innovations on aspects of the development of the urban water sector in Dar es Salaam, Tanzania.

1.4.b. Internal Debates

The nature of social transformations engendered by ICT use and the construction of discursive power are debates focused on the ability of ICTs to effect meaningful change in societies suffering from poor development outcomes. Discussions of progressive and disruptive transformation assess how enhanced information and communication flows either work within established societal structures or reinvent social orders all together. Incorporating ICTs into development initiatives can also either restructure the roles of project beneficiaries or reproduce long-established power asymmetries within the development sector. Empirical analyses of changes effected by the use of mobile-enabled payment methods in Dar es Salaam, Tanzania produce insights with the potential to inform ICTD debates.

Progressive vs. Disruptive Transformation

Mobile phones and ICT innovations are having observable impacts on development, but ICTD scholarship has remained weak in forming convincing arguments regarding socioeconomic outcomes, in spite of broad theoretical capabilities to study innovation and social change. This weakness can be attributed to an inability to comprehensively explain the nature of transformations that occur, which has generated two primary perspectives on how ICTs can affect socioeconomic development: progressive and disruptive transformation (Avgerou, 2010). Progressive perspectives maintain that ICT acts as an enabler of transformations within existing international and local social orders. In this view, ICTs 'amplify existing material and informational flows rather than transform them' (Donner and Escobari, 2010: 641). Amplifications of existing social ties occur in relation to the ability of ICTs to redefine

the geography of distance and time, removing obstacles to mobility and communication and impediments to economic development (Kyem, 2012). Information-enhancing innovations expand the control individuals have over their work, market interactions, and trade relationships (Ibid). Studies showing how transformations can occur within existing social orders have examined impacts of mobile telephony on macroeconomic growth (Waverman, *et al*., 2005; Aker and Mbiti, 2010), increases in welfare within fisheries (Jensen, 2007), and efficiency gains in grain markets (Aker, 2010).

Conversely, the disruptive view emerges from the politicised and controversial nature of development, where change is a consequence of power struggles that characterise contested spaces within society. Kyem engages with the tension between disruptive and progressive transformation by describing the deployment of ICT initiatives in sub-Saharan Africa as a paradox (2012). He argues that the neglect of local knowledge and rationalities by development practitioners may ultimately lead to the ineffectiveness of ICTs in Africa. This perspective is indicative of the power dynamics that are threatened by broad access to ICTs, because the widespread use of mobile telephony makes it more difficult to neglect local perspectives. The use of ICTs for socioeconomic development creates new pathways for information transfers that confront conventional models of production, shift the distribution of power within societies, and threaten the interests of many private and public sector actors (Smith, *et al*., 2011). These actors have conventionally benefitted from imperfect information, market inefficiencies, and the high transaction costs. As these barriers are removed through the expanded use of ICTs, low-income citizens are no longer perceived as passive consumers and are using mobile telephony to become active producers and innovators (Heeks, 2009). This transition implies that socioeconomic development goals are not likely to be achieved through existing social, political, and economic structures that have benefitted from political

and economic exclusion, but rather through the activities of those previously and currently marginalised.

Discursive Constructions of ICTD

ICTs can also influence the exercise of power by development practitioners in low-income countries. Information systems embody specific worldviews in which reality is classified, ordered, and constructed in such a way that power is manifested through what is made visible (Bloomsfield and Coombs, 1992). Mobile communications networks allow for an expansive view of reality, but development practitioners and academics limit that which is newly visible as a way to define 'others', identify their 'problems', and legitimise 'professional' intervention in their daily lives (Thompson, 2004). Thompson's perspective shares in post-structuralist critiques which hold that development interventions and practices establish sets of power relations responsible for the problematisation of poverty and the subjectification of residents of low-income countries (Escobar, 1995). ICTD has also been criticised as being overly dependent on modernist philosophies that prioritise material progress and cast users as only passive recipients of the benefits of technology (Diaz Andrade and Urquhart, 2012). ICT projects aimed at improving development outcomes continue to facilitate top-down and supply-led approaches in which those in more powerful positions are the ones to bring 'development' to poor populations (Kleine and Unwin, 2009; Diaz Andrade and Urquhart, 2012). Alternative perspectives acknowledge the tendency for ICT initiatives to act more like solutions looking for problems (Chaudhuri, 2012), but emphasise the flexible nature of information innovations. Hayes and Westrup (2012) espouse this view in their discussion of the reappropriation of M-PESA in Kenya by citizens for domestic remittances; mobile money services were originally designed as a 'development' tool for the repayment of microfinance loans. ICT innovations may therefore restructure relationships between development

practitioners and beneficiaries, facilitating the repurposing of tools intended to address the 'needs' defined by the former to achieve the 'wants' of the latter (Heeks, 2009).

Other Debates

ICTs may foster greater citizen participation and broaden individual agency by changing the dynamics of social networks and the relationships between societies and their governments. Thompson argues ICTD scholarship can contribute established debates within the social sciences related to development (2008). Drawing on the work of Hickey and Mohan (2004), Thompson argues that there needs to be a more strategic focus on the gradual transformation of power relations between the state and society and wider understanding of how ICT innovations may help to bring this transformation about. Mobile telephony enables citizens to participate more widely in civic life by expanding access to the rest of society and reducing the relevance of location and socioeconomic status. Meaningful mobile-enabled participation can be impeded by governmental exploitation of new sources of information, which may violate tenets of trust, privacy, or the rule of law (Unwin, 2010). Thompson suggests that as ICTs elevate networked human agency beyond the 'rationality' of formal systems and structures, traditionally unresponsive institutions will be forced into dialogues with society and may become more dependent upon their constituencies. Governments in low-income countries have long been dependent on foreign aid and commodity exchange for revenue, leaving little space for citizens to demand accountability from their governments. ICT use, and more specifically mobile telephony, is fostering peer-to-peer entrepreneurship independent of conventional infrastructures and markets. An example of this development can be seen through the use of mobile phones by small and medium sized enterprises in Rwanda (Donner, 2006). Mobile payment innovations may also have the potential to increase state dependence on citizen-sourced funding, rather than commodity exchange or aid, placing greater pressure on governments to reform dysfunctional institutions (Moore, 2000). Through

the use of ICT, citizen-centric activities can facilitate network-enabled social lives that routinely challenge existing forms of state monopoly, rent-seeking, and cultural control.

1.4.c. Gaps in ICTD: Public Service Provision and Informational Deficits

Coupled with ICTD's relative novelty, the existence of broad theoretical options and extensive development goals suggest that innumerable gaps in our understanding of the nexus between ICTs and development. ICTD lacks a broad strategic approach by practitioners and scholars to inform policy with findings or achieve varied development objectives. This is partly caused by the abundance of research on discrete and geographically limited initiatives, referred to as 'point' implementations by Thompson and Walsham (2010). Studies on point implementations of ICT projects have encouraged a piecemeal approach that constrains the ability of research to bridge gaps between research, policy, and practice. One such gap that can be addressed by studies of ICT and development is the potential for mobile telephony to enable more effective service delivery by limiting the influence of informational challenges in supply chains, operational procedures, and service delivery (Jagun, Heeks, and Whalley, 2007). Informational deficits increase costs, risks, and time constraints within social and economic processes, and are characteristic of water service provision (Mwanza, 2005), where public infrastructures remain fragmented and inadequate. This thesis addresses this gap by examining the potential of a non-point implementation of an ICT-enabled innovation (i.e. mobile-enabled payment methods) to overcome or bypass uneven social, economic, or geographical inequalities and generate opportunities across both formal and informal sectors.

1.4.d. Selected Theoretical Perspectives

This thesis focuses on the significance of information asymmetries, transaction costs, state-society relations, and the fragmented nature of public water infrastructures in low-income countries. This focus entails the use of four theoretical perspectives that engage key issues in urban water provision, specifically highlighting payments for water services. Transaction cost

economics is a framework which examines the relative costs associated with making a water payment (Gibbons, 2010). According to Williamson (1976), these costs can include search costs, tangible travel costs or additional fees required to make a payment, and more intangible aspects of transactions (e.g. opportunity costs). Transaction cost economics is used in this thesis to comparatively assess different payment modalities and resultant impacts on customer payment behaviours (Chapter 2). Agency theory engages the problem of information asymmetries, particularly in principal-agent problems (Eisenhardt, 1989; Jain, 1998). Imperfect information is endemic to Africa's urban water sector and facilitates corruption-related behaviours (Chapter 3). To evaluate one aspect of citizen-state relations, satisfaction with urban water services and supply reliability are evaluated using perspectives from marketing and behavioural economics (Tversky and Kahneman, 1974; Oliver, 1980) (Chapter 4). Splintering urbanism is also used to evaluate the impact of ICT-related innovations on the fragmentation of public infrastructures and interactions among formal and informal actors (Graham and Marvin, 2001) (Chapter 5). This is particularly pertinent for water services in sub-Saharan Africa, where unequal access to piped water supplies is indicative of wider socioeconomic inequalities.

1.5. Methodological Approach

1.5.a. Methodology

By considering varied and specific contexts in which socioeconomic change arises through the use of information and communication technologies, ICTD encompasses a wide range of disciplinary perspectives and methodological approaches. Such diversity facilitates rich explorations within spaces of development, but simultaneously produces barriers to cross-disciplinary communication (Burrell and Toyama, 2009). Found at the intersection of dissimilar epistemological perspectives, sound methodology can initiate meaningful conversations regarding the validity, reliability, and accuracy of knowledge claims. Likewise,

the legitimacy of ICTD as a field of study is grounded in its capacities for producing perspectives which are comprehensible across research domains.

Four primary concerns guided my approach for collecting data, analysing it, and eventually making claims related to our collective understanding of ICT and development: epistemology, theory, methodology, and methods (Crotty, 1998). These inter-related scales of decision-making are engaged throughout the research process, and can be summarised into categories of knowledge claims, strategies of inquiry, and methods of data collection (Creswell, 2003). ICTD is structured by an implicit assumption that the use or nonuse of ICTs may affect development led to the selection of an epistemologically objectivist approach grounded in a post-positivist theoretical perspective. Post-positivist knowledge claims are associated with the scientific method and emerged out of the work of Compte, Mill, Durkeim, Newton, and Locke (Smith, 1983; Creswell, 2003). Post-positivist thought recognises that one can never be completely sure of knowledge claims made when studying human behaviour and that the evidence or data use to make such claims is imperfect and fallible (Phillips and Burbules, 2000). Contrary to social constructivism, post-positivism embraces a deterministic philosophy firmly based in cause-and-effect relationships; developing numeric measures of observations and studying individual behaviours is paramount (Mertens, 1998; Lincoln and Guba, 2000). Post-positivist perspectives are therefore limited by reductionist attempts to understand complex human behaviours, which distill ideas into discrete sets of testable hypotheses (Creswell, 2003). This research must therefore be cognizant of the realities constructed for participants and the narrow meanings ascribed to the categories and ideas being tested.

This thesis has been developed from a cross-sectional study using a non-experimental survey methodology comprised of questionnaires, structured record reviews, and semi-structured

interviews as primary methods of data collection. Survey designs provide quantitative descriptions of trends and perceptions by studying a sample of a population with the intent of making generalisable inferences regarding key characteristics or behaviours of the population in question (Babbie, 1990; Creswell, 2003). Specifically, this thesis employs a survey methodology to make generalisable inferences regarding impacts of mobile-enabled payment methods on payment behaviours of water utility customers. Payment practices can subsequently influence a variety of socioeconomic development outcomes. Sub-Saharan Africa is home to a large and growing number of urban water users, and Dar es Salaam in particular has over 120,000 active piped water connections. Given large population sizes, survey methodologies offer key advantages over alternative approaches - such as economies of design, cost effectiveness, participant familiarity with the method, and established ways in which to identify attributes of large populations from smaller groups of individuals (Fowler, 1988; Babbie, 1990, Fink, 1995).

1.5.b. Methods and Data Sources

Data collection took place from September 2011 to September 2012 during three trips to Dar es Salaam, Tanzania. Three of the four types of survey data collection methods identified by Fink (1995) were used: questionnaires, interviews, and structured record reviews. Fieldwork commenced with an exploratory visit to Dar es Salaam in September 2011 to gain a broad understanding of the introduction and early adoption of mobile-enabled payment methods for urban water services. Semi-structured interviews with key actors in telecommunications firms, the urban water utility, and civil society were used to construct preliminary narratives regarding the integration of mobile payment methods. A second visit to the city from January-June 2012 focused on laying the groundwork for a utility customer payment preferences questionnaire and gaining access to customer payment data from 2010-2011, which were held by the urban water utility and telecommunications firms. The final research trip took place in August and September 2012 and saw the implementation of the payment

preferences survey and collection of further interview data. Access to the telecommunications firms, mobile network operators, civil society actors, and elements of the urban water sector was facilitated by existing in-country contacts established during previous visits. The following subsections detail processes of data collection employed in this dissertation.

Questionnaire: Water Utility Customer Payment Preferences Survey

A Water Utility Customer Payment Preferences Survey instrument was developed to generate information on the characteristics and payment behaviours of water utility customers in Dar es Salaam. Survey data are used in Chapters 3, 4, and 5. The Dar es Salaam Water and Sewerage Corporation (DAWASCO) officially counts over 140,000 water connections, although only approximately 123,5000 of these are active (i.e. regularly paid for). According to a report on the use of mobile money payments for water services in East Africa, over 99% of active customers in Dar es Salaam pay their water bills at physical payment locations, approximately 12% of which were paying their bills at wireless pay points at the time of the report (Hope, *et al*., 2011).

The questionnaire used to obtain was modeled on the instrument used in Kiamumbi, Kenya by Foster, *et al.* (2012). In coordination with water sector professionals from civil society, the water utility, and the telecommunications sector, this survey was expanded to include questions relevant to the urban context of Dar es Salaam. Questions were initially vetted with the six-member Tanzanian research team that administered the survey in Kiswahili and English. Following this initial vetting of the English and Kiswahili versions of the survey, the instrument was piloted with 20 water utility customers in June 2012. As a result of this pilot, the survey was reformatted to accommodate respondent understanding of the instrument itself, questions and responses were revised to accommodate differences in respondent interpretation, three questions related to relative wealth and connection histories were

removed, and seven questions related to SMS-based billing reminders were added. The final instrument collected categorical, ordinal, and ratio data related to geographic location and housing, demographics, socioeconomics, assets and expenditures, mobile phone use, water use, payment methods and preferences, service satisfaction, disconnections and reconnections, alternative water sources, community supplying behaviours, SMS billing reminders, and payment behaviours. Relating payment behaviours and preferences to key individual socioeconomic and demographic characteristics necessitated the use of the individual and transactions as primary units of analysis.

Selecting payment locations and respondents occurred through a multi-stage process. Existing payment locations were first divided into two groups - those near water offices (i.e. clustered) and those distanced from them (i.e. remote). DAWASCO's service area covers more than 50 wards, ten of which contain water offices. Payment locations within these wards constituted ten sub-sampling frames, and the remaining wards comprised an additional 'remote' sampling frame. Five of the ten clustered sampling frames were randomly selected as survey administration areas and at least one water office, one bank, and two wireless pay points were chosen from the remaining payment locations using simple random sampling. From the remote sampling frame, five wards were chosen using simple random sampling and physical payment locations were selected using the same method. This process created a stratified sample of physical payment locations that attempted to account for distance-related biases in customer perceptions of payment locations and methods. The questionnaire was administered over five weeks, extending beyond the monthly billing cycle to account for variations in payment behaviours influenced by the existence of payment deadlines and billing reminders routinely sent out by DAWASCO. Data were collected at each survey administration site during working hours (i.e. 0800 to 1700 with a lunch break from 1200 to 1300) for a maximum of three and a minimum of two days. All respondents self-identifiing as an adult

(i.e. at least 18 years of age) utility customer with experience paying water bills were invited to complete the questionnaire. Participation in the survey exercise was voluntary and response rate was not captured by survey enumerators. Using Cochran's (1977) formula for finding sample sizes of large populations, it was estimated that a minimum sample size of 768 respondents would be required to ensure statistically significant analyses. Due to the size of the research team and the length of the data collection period, the survey generated 1097 respondents, surpassing minimum sample size requirements.

This research design invites particular forms of selection bias given that participation in the survey was inclusive, voluntary, and response rate was not captured. First, the data demonstrate a significant selection bias when compared to the rest of utility customers. In particular, survey respondents had higher payment frequencies and revenue contributions, which is unsurprising given that the sampling frame was designed to capture actively paying utility customers. Conclusions drawn from these survey data reflect this selection bias. Second, since response rate was not captured and non-respondents were not asked 'why' they did not participate, this research design is unable to identify other forms of unknown bias that may have influenced data collection and consequent conclusions. Finally, it is possible that holding the survey exercise in and around water utility payment offices could have introduced a source of bias emerging from potential coercion by utility staff. Enumerators were instructed to collect survey responses in private areas outside utility offices and other payment locations in an attempt to mitigate this potential source of bias. Enumerators also received basic training in research ethics of survey administration to make them aware of this issue.

Interviews: Semi-Structured Interviews with Relevant Actors and Stakeholders

Comprehensive contextualization of the findings of the customer payment preferences survey and other data sources required a variety of semi-structured interviews with relevant actors

involved in the inception, design, implementation, and/or operation of mobile-enabled payment methods. These data are used extensively in Chapter 3 and nominally in Chapters 2, 4, and 5. Respondents were selected via snowball sampling that originated with key informants in the water sector, the telecommunications industry, and civil society organisations. A total of 42 interviews took place with representatives from the water utility (12), mobile network operators (6), the Ministry of Water (4), banks (3), municipal water officers (3), third party telecommunications companies (3), the regulatory authority (2), the water authority (2), civil society (2), and water committees (2). Interviews covered topics relevant to the impacts of mobile payment innovations and key challenges and opportunities associated with them. Interview guides were prepared by myself and shared with respondents at least two days prior to each interview. Extensive notes were taken during each interview because permission for audio recording was often difficult to obtain, particularly with higher-ranking government officials. These notes were transcribed immediately following each interview and drafts of the transcriptions were shared with respondents to ensure satisfactory interpretation of meaning.

Structured Record Review: Water Payments Database

Actual customer payment behaviours over a two-year period were analysed using a unique water payments database that included payment data provided by the water utility, which operates 14 water payment offices in and around Dar es Salaam; telecommunications companies operating two distinct mobile money services; and a third-party aggregator, which manages over 2,000 wireless pay points located throughout the city. These data are used in Chapter 2, Chapter 4, and Chapter 5. All payments were made between 1 January 2010 and 31 December 2011 at physical payment locations or remotely using a mobile money service. Payment data include 967,459 water payment records with information on account number, date of payment, payment amount, relevant location, and the payment method used; and

106,575 customer records containing information on customer account numbers, mobile ownership, whether or not the account was metered, and the general location (i.e. ward) of each connection. Other information in the database included 972,908 SMS billing reminders (account number, month of reminder), and 5917 disconnection and reconnection records (account number, date of disconnection/reconnection). Different analytical approaches required a variety of sub-divisions within the data, such as whether or not a customer shared their geographic location, the use and non-use of mobile-enabled payment methods, and whether or not a customer participated in the Water Utility Customer Payment Preferences Survey. Key variables related to payment behaviours of each customer, including transaction value, payment frequency, timeliness of payments, and annual revenue per customer were computed from the water payments database.

The uniqueness of these data originates from the fact that record-keeping in most African water utilities has, until recently, been done almost completely on paper. Utilising a grant from the World Bank, DAWASCO implemented an electronic billing and payment system in 2007 that began creating a permanent record for every payment made at water utility payment offices. The introduction of mobile-enabled payment methods in mid-2009 expanded on this system to create an electronic record for all transactions made via all payment methods. It is important to note that such a large-scale database of relatively reliable information from an African water utility is rare. In addition to payment histories for domestic connections, the database contains large commercial and industrial accounts, connection and reconnection fees, as well as large payments made to reconcile arrears and inaccurate meter readings. These outliers were identified and their effects muted using the outlier labelling rule (Tukey, 1977; Hoaglin, Iglewicz, and Tukey, 1986; Hoaglin and Iglewicz, 1987).

Survey: Urban Water and Sanitation Access in Tanzania's Low-Income Areas

A 2010 survey conducted by Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) is an additional data source used in Chapter 5. GIZ commissioned the survey in cooperation with the Ministry of Water and the Energy and Water Utilities Regulatory Authority. The National Survey of Household Access to Water and Sanitation is comprised of 32,000 household surveys from low-income areas (LIAs) in 20 Tanzanian cities, in which Dar es Salaam is included. Data were collected using household interviews, focus group discussions, and interviews with informal service providers by a team of 50 people employed by GFA Consulting Group. Survey data are geographically referenced and include the proportion of the population dependent on informal service providers (ISPs), the proportion of the population reliant on neighbourhood resellers, mean prices for a 20-litre bucket of water, the proportion of the population with a piped-water connection, and the proportion of domestic connections that are disconnected or broken. LIAs as defined by GIZ closely follow UN-HABITAT's (2003) definition of slums by focusing on areas with inadequate access to safe water and sanitation, poor quality housing, high population densities, and low or unpredictable incomes. LIAs in the survey are contiguous with officially-designated administrative boundaries of 'mtaas' (i.e. streets) - geographic areas smaller than the city's wards (i.e. neighbourhoods). The dataset contains information from 171 low-income areas in Dar es Salaam, with 110 falling within the water utility service area. LIAs are located entirely within an associated ward and data from each are linked by attributing relevant ward-level data to each LIA.

Establishing Reliability and Validity

Although a post-positivist theory of knowledge creation allows for a limited level of error in the design, implementation, analysis, and evaluation of a research project, the research instruments have been subjected to safeguards put in place to ensure both reliability and validity of the data collected.

To ensure reliability of the quantitative data used in analyses, payment data from three distinct payment service providers (i.e. mobile network provider, third-party payment aggregator, water utility) were cross-checked using account identification numbers and receipt numbers. These pieces of information enabled me to confirm the relative precision of each dataset. To ensure the reliability of the survey instrument, the questionnaire was piloted with twenty respondents in June 2012 with Kiswahili-speaking enumerators. Question wording and responses were edited to account for linguistic and cultural differences in interpretation. The same enumerators on the pilot were those that administered the survey in August and September 2012. Finally, to ensure the reliability of qualitative data obtained via interviews, I shared interpretive power extensively with participants to confirm that understandings of responses were consistent.

To establish the internal validity of the data collected, multiple data sources were used. The survey instrument was constructed using that used by Foster, *et al*. (2012) as a model. This was done to strengthen the comparative power of my findings with other survey data collected in the field of mobile water payments. Similarly the interview guides used to collect qualitative data were modeled on Davis (2004). External validity of the data was established by the representativeness of sample sizes obtained with the questionnaire and the payment data. Findings from these data are generalisable to actively paying water utility customers in Dar es Salaam. The thesis as a whole also uses a variety of theoretical approaches and data to establish an acceptable degree of external validity for the arguments related to ICTD.

1.5.c. Primary Variables

This thesis employs a wide range of variables and analyses them for significant inter-relationships. This section describes how different categories of variables were obtained from the data sources discussed above. Key categories of variables include measures of payment

behaviour, relative measures of corruption-inducing variables, measures of satisfaction and service quality, and measures of the informal water economy.

Measures of Payment Behaviour

Discussions of customer payment behaviours are ubiquitous throughout this thesis, and behavioural variations are compared across various categorical and scale variables. Payment behaviours are measured using four scale variables (i.e. value, frequency, timeliness, and revenue) and one nominal variable (i.e. mobile use or nonuse). Mean transaction value refers to the average value of transactions made for a specific account and are calculated using "Payment Amount" from each transactional record found in the water payments database. Water payments in Dar es Salaam are made in Tanzanian Shillings (TZS) and are converted to United States Dollars (USD) at a rate of 1600 TZS to 1 USD. The values used in analyses range from 0 to 119140 TZS (74.46 USD). The second behavioural variable, annual payment frequency, refers to the total number of payments made on a specific account during the course of one year and are calculated as a count of the number of payment records available for each account. The range of this variable extends from 0 to 23. Mean transaction timeliness is the average day of the month on which payments were made for specific accounts and was calculated from the water payments database using "Date of Payment" from each transactional record. The value of this variable ranges from 1 to 31. The final scale behavioural variable is Annual Revenue Collection (i.e. Revenue), which is the sum of all "Payment Amount" values made for a specific account over one year. This variable ranges from 0 to 790160 TZS (493.85 USD). Designation of customers as Mobile Users or Nonusers is made using a categorical variable indicating whether or not at least one payment per year was made on a specific account at wireless pay points or using mobile money services. The payment dataset provided by Selcom Wireless contains all payments using mobile-enabled

methods during 2010 and 2011. Water utility and Selcom Wireless payment datasets were linked via water utility customer account numbers included with each payment record.

Relative Measures of Corruption-Inducing Variables

Systematically assessing the influence of mobile-enabled payment methods on corruption in the urban water sector required the analysis of qualitative data obtained from semi-structured interviews. Given the reluctance of most respondents to share information related to corruption, a framework was adopted from Jain (1998) that enabled the comparison of different payment methods on variables related to seven characteristics that may induce corruption-related actions: competitive pressures, monopoly power, economic rents, enforcement mechanisms, monitoring costs, discretionary power, and information asymmetries. Each category contained a variety of sub-elements that influenced the operationalisation of each category, such as "Information Asymmetries," for which the qualitative data were coded for information related to the availability of information, whom the information was held by, and costs of accessing the information. Once coded, each payment method was given a ranking (i.e. high, intermediate, or low) on each measure relative to the other payment methods being considered. Relative measures of corruption-inducing variables were compared across payment methods to determine which options were more likely and less likely to create an enabling environment for corruption.

Measures of Satisfaction and Service Quality

In response to research questions that inquire about the relationships between service reliability, service satisfaction, and customer payment behaviours, key variables were obtained from the Water Utility Customer Payment Preferences Survey. Mean Weekly Supply Hours refers to the total duration of water services delivery to a household throughout a week. This variable was calculated from Question 57 in the survey, which asks respondents to estimate

the average number of days per week and hours per day they receive water. These figures were multiplied, resulting in a scale variable ranging from 0 to 168. Reliability is a customer's perception of the differences between their expectations of water services and the reality of service provision. Reliability was obtained from Question 56 in the survey, which asks "When you turn on the DAWASCO tap, do you know that water will flow every time?" Respondents were able to answer "Yes, Always," "Yes, Sometimes," or "Never Know". These categorical designations were cross-checked with mean weekly supply hours to ensure variable validity. Measures of satisfaction were obtained from Questions 58, 60, and 62 in the survey and asked respondents about their perceptions of the taste and smell of their piped water services, as well as their overall satisfaction with their DAWASCO water supply. Respondents indicated if the taste and smell were "Good," "Acceptable," or "Poor" while overall satisfaction ratings included "Excellent," "Good," "Acceptable," or "Poor".

Measures of the Informal Water Economy

Variables related to the informal water economy were primarily obtained from the GIZ survey on Urban Water and Sanitation Access in Tanzania's Low-Income Areas and the Water Utility Customer Payment Preferences Survey. A descriptive research question regarding the consequences of bill nonpayment is informed by data obtained from Questions 34, 67, and 69 which asked "Have you ever missed a DAWASCO payment?" "Has your water supply been disconnected in the past year?" and "How long was your water supply disconnected?," respectively. Respondents were also asked about their water storage behaviours in Questions 26 (Do you have water storage tanks?) and 26a (How many litres do the tanks hold?), as well as their sharing or neighbourhood resale behaviours in Questions 82 (Have you shared your piped water with non-family members in the past 12 months?) and 85 (How much do you charge per large [20L] bucket?). To gauge each respondent's interaction with alternative service providers, Question 71 asks "Have you used any of the following sources for drinking

water in the past 12 months?" Participants selected multiple responses from a list of sources including a neighbour's DAWASCO tap, a DAWASCO kiosk, wells or boreholes, tanker trucks, cart vendors, rainwater, bottled water, and surface water such as rivers or lakes. For each low-income area surveyed by GIZ, figures were made available related to the proportions of the population in each area with optimal water access, broken or disconnected domestic connections, reliance on neighbourhood resellers, and overall dependence on informal service providers. Data from this survey also included mean bucket price charged by informal service providers in each low-income area. Optimal water access is defined by Tanzania's Ministry of Water as the proportion of the population obtaining water in less than 30 minutes from a domestic connection, public standpipe, or borehole supplied by a licensed service provider. A measure of the proportion of mobile payers in each ward was also used, which was calculated from the water payments database.

1.5.d. Primary Analytical Approaches

The data collected using the methodological approach detailed in this section required various modes of analysis. The Water Utility Customer Payment Preferences Survey produced a large volume of data that needed to be quantified for analysis, which was completed using SPSS version 21. All nominal and categorical responses were coded in binary format - for example, respondents indicating their gender as "Male" were quantified as "1" and all other respondents for that variable were quantified as "0." The same coding was applied to respondents indicating their gender as "Female". For scale variables, the values shared by participants were directly included in the dataset and descriptive statistics (e.g. mean, median, standard deviation, and sample size) were computed for each. This quantification approach enabled quicker creation of sub-samples for comparisons of payment behaviours and other variables. Comparisons of sub-groups were completed using inferential statistics for hypothesis testing, particularly when the ratio data of payment behaviours were being compared. Z-tests and t-test are common approaches to assessing differences across customer groups, and the use of

either test was dependent on the respective sample sizes of groups (Babbie, 2010; Privitera, 2012). Evaluating the relationships between ratio, nominal, and sometimes ordinal data required the use of binary logistic regression to assess the relative impacts and relationships between variables of different data types. Many of the variables produced from the customer payment preferences survey were dichotomous dependent variables, necessitating the use of this statistical technique.

Qualitative data obtained from semi-structured interviews with key actors relevant to mobile-enabled payment methods required a more qualitative analytical approach. After the data were obtained, transcribed, and reviewed extensively, the data were coded in relation to primary corruption-inducing factors identified within existing literature (Rose-Ackerman, 1978; Ades and DiTella, 1997; Jain, 1998; Jain, 2001). The coding process facilitated a descriptive construction of these primary themes that were then summarised into discrete narratives regarding each payment method's relative influence over competitive pressures, monopoly power, discretionary power, economic rents, enforcement mechanisms, information asymmetries, and monitoring costs. Interpretation of these narratives was conducted with the specific intent of assigning relative rankings to each payment method. Analytical findings were compared with existing literature and customer comments from the payment preferences survey for validation.

1.5.e. Ethical Considerations and Positionality

Operationalisation of Ethical Practices

Maintaining high ethical standards in research practice was of paramount importance throughout the entirety of the study, and significant efforts were made to ensure that the University's ethical procedures (i.e. CUREC) were followed beyond the paperwork submitted in the early stages of the DPhil. The greatest ethical challenge emerged from payment data,

which was shared to facilitate the analyses of payment behaviours. Requests for access to customer payment records were immediately met with pointed questions about confidentiality. Customer privacy was maintained by removing names, addresses, and phone numbers from the dataset, and the creation of an anonymised key linking customer account numbers with random ID numbers. Survey practices protected respondents by minimising the amount of personally-identifiable information collected and required verbal consent, rather than written consent, to ensure that the identities of respondents remained anonymous, even if the confidentiality of the data collected was compromised. Although Sieber (1998) suggests a waiting period of 5-10 years to destroy data collected through a research exercise, this project aims to complete the destruction of data by 2015, within three years of data collection. Incentives for survey participation were used (i.e. 500 TZS [0.31 USD] of phone credit), and efforts were taken to ensure that it was not coercive in nature for Tanzanian participants, many of whom live in poverty (Creswell, 2003). In order to minimise potentially coercive effects, enumerators were instructed to share knowledge of the incentive only after the survey was completed. Beyond actual data collection mechanics, I strive to avoid being perceived as a 'safari scholar' (Bulmer and Warwick, 1993), and continue to build trust with in-country contacts by keeping promises related to dissemination of my findings and maintaining personal contacts.

Positionality

Perhaps more personally interesting for me is a reflective examination of my position and role as a researcher throughout the data collection process. As a Caucasian American male studying at the University of Oxford, I was personally surprised by the ability of this particular combination of attributes to open doors - not only for meetings with government officials and other respondents, but also because of the sense of legitimacy my work seemed to bring to a set of innovative payment mechanisms that were still in their infancy at the

beginning of my fieldwork in September 2011. Significant discussion revolved around the usefulness of these options; many stakeholders viewed them as little more than a tactic by private sector actors to enrich themselves at the expense of water customers and public service providers. Previous in-country experiences - in remote rural locations in Northwest Tanzania and a significant amount of time spent in Tanzania's second-largest city (i.e. Mwanza) - also lent credibility to my work, even if I hadn't been working on the issue of mobile-enabled payment methods. Knowledge of Tanzanian politics, development, and history; the growth and early impacts of the telecommunications industry; and conversational Kiswahili skills were also helpful, although the realities of being an outsider were never forgotten and sometimes jarringly obvious. Citizenship, demographic, and socioeconomic factors play notable roles in our interpretations of reality, and minimising the impact of my background on qualitative data analysis was also a concern. To overcome this, I consistently ceded the power of initial interpretation to all interview respondents by offering the opportunity for them to clarify - and in some cases amend - my research notes to ensure that their interpretation of events and reality were being fairly and accurately represented. Berg (2001) refers to this as a process of debriefing, but due to valuable methodological training received during an MPhil in Development Studies, I personally believe that foreign researchers should be willing to relinquish more of their interpretive power than convention dictates.

1.6. Structure of Dissertation

ICTD is broad and encompasses diverse theoretical approaches from the social sciences and this thesis is comprised of four ensuing empirical chapters employing disparate theoretical approaches and a concluding chapter that relates the findings of each self-contained chapter to wider ICTD scholarship and debates.

Chapter Two is a paper entitled "Mobile-Enabled Payment Innovations and the Financial Sustainability of Urban Water Provision." Public service provision in Sub-Saharan Africa is

notoriously inefficient and consistently underperforms due to limited financial sustainability. Using transaction cost economics (Williamson, 1981; Gibbons, 2010), I analyse the large-scale payment database to assess the impact of mobile-enabled payment methods on annual revenue per customer, payment timeliness, transaction volumes, payment frequencies, and transaction values. Findings show that mobile-enabled payment methods significantly impact transaction volumes, values, frequencies, and revenues per customer. Based on these findings, the paper advances the argument that new mobile-enabled payment options hold important implications for the financial sustainability of the urban water utility and identify novel directions for financing public service provision. The paper concludes by questioning the dominance of mobile money services in international development due to key assumptions regarding asset specificity and its role in producing relative transaction costs for each payment instrument.

Chapter Three is a paper which asks the question: "Can Mobile-Enabled Payment Methods Mitigate Corruption in Urban Water Provision?" Corruption at multiple scales is a fundamental impediment to the effective provision of water services. This paper evaluates the relationship between mobile-enabled payment innovations and corruption in water service delivery. Derived from agency theory (Eisenhardt, 1989), the principal-agent framework as described by Jain (1998) and Rose-Ackerman (1978) is used to evaluate this question. Data from the customer payment preference survey and water sector interviews are used to compare four primary payment modalities: water offices, bank branches, wireless pay points, and mobile money services. The arguments presented in this paper suggest that mobile-enabled payment methods can reduce corruption in the water sector by changing the context in which corruption occurs because they increase competitive pressures, reduce monopoly power, minimise discretionary power, prevent access to economic rents, carry strong enforcement mechanisms, reduce monitoring costs, and mitigate imperfect information. The paper also

suggests that mobile-enabled payment methods are encouraging a greater degree of utility and staff specialisation and enabling citizens to dynamically participate in the provision of water services.

Chapter Four examines the importance of service quality and satisfaction to customer payment behaviours and is entitled "Reversing Spirals of Decline? Service Quality, Satisfaction, and Payment Behaviours in Tanzania's Urban Water Sector." Water service providers in Sub-Saharan Africa are constrained by insufficient revenue collection and its impacts on deteriorating service quality and operational performance. 'Spirals of decline' are a common characteristic of many urban water utilities (Mugabi and Kayaga, 2010), but it has been noted that mobile-enabled payment methods may help to overcome this seemingly intractable problem (Foster, *et al*., 2012). This research question investigates the relationships between service quality and payment behaviours through the use of data from the large-scale payment database and the customer payment preference survey. Service quality and satisfaction are partially comprised of variables related to frequency, duration, satisfaction, water quality, and consumption levels. Drawing on behavioural economics (Tversky and Kahneman, 1974) and perspectives from marketing disciplines - specifically expectancy disconfirmation theory and its application to urban service provision (Oliver, 1980; Van Ryzin, 2004) - this paper argues that relationships between service quality, satisfaction, and payment behaviours may not be as explicit or significant as conventionally thought. Instead, spirals of decline can be reversed through a broader focus on increasing customer autonomy and control over the payment process.

Chapter Five - "Mobile Payment Methods and the Influence of 'Good Water Neighbours' on the Informal Water Sector in East Africa" - studies the impact of mobile payment methods on neighbourhood resale and the informal water economy in Dar es Salaam. Urban water

provision in low-income countries is often dominated not by large-scale water utilities, but by secondary networks of water vendors, private selling, and neighbourhood resale of piped water supplies. A growing body of research has been exploring the viability of these alternative arrangements to effectively deliver water services, particularly in unplanned settlements, which are typically beyond the traditional reach of water utilities (Solo, 1999; Jaglin, 2002; Sansom and Bos, 2008; Schwartz and Sanga, 2010; Dagdeviren and Robertson, 2011). This paper explores the ways mobile-enabled payment innovations influence payment behaviours and, through the mechanics of neighbourhood resale, dependence on informal service providers. I advance the argument that mobile-enabled payment innovations can improve the payment behaviours of neighbourhood resellers who act as 'good water neighbours'. These connected households may shift the nature of informal service provision in Dar es Salaam by increasing reliance on neighbourhood resale and reducing dependence on other more expensive informal service providers. Elements of the large-scale payment database, survey responses, and a large GIZ-funded survey of access to water in low-income areas are used to generate conclusions related to neighbourhood resellers, alternative water sources, and customer payment practices.

Chapter Six details the conclusions produced from this dissertation by outlining the major arguments advanced in each chapter and summarising the empirical and theoretical contributions of this work. Broad implications for ICTD scholarship are also discussed and include comments for practitioners on the use of ICT in development projects, policy recommendations focused on the role of mobile technologies in the post-MDG development agenda, and suggestions for researchers on the use of new forms of data and the ethics of obtaining and analysing user-generated data. The chapter concludes with discussions of this project's limitations and the future of global mobile payment systems and their implications for socioeconomic development.

2. MOBILE-ENABLED PAYMENT INNOVATIONS AND FINANCIAL SUSTAINABILITY IN TANZANIA'S URBAN WATER SECTOR

Abstract

Public service provision in Sub-Saharan Africa is notoriously inefficient and consistently underperforms due to limited financial sustainability and poor governance. Expansion of mobile communication technologies across the continent, particularly mobile payment solutions, is changing the context in which public services are provided. A unique large-scale dataset of approximately one million payments for water services made over a two-year period via water utility payment offices, wireless pay points, and mobile money services is used to evaluate impacts of mobile payment innovations on revenue collection for an urban water utility in Dar es Salaam, Tanzania. Transaction volumes, payment values, payment frequencies, transaction timeliness, and annual revenue per customer are compared for customers who use and do not use mobile-enabled payment methods. Mobile-enabled payment methods significantly impact transaction volumes, values, frequencies, timeliness, and revenues per customer. Resultant changes in the nature of transactions and customer payment behaviours hold important implications for the financial sustainability of the urban water utility and represent new directions and solutions for financing public service provision in the era of Africa's 'mobile revolution'.

2.1. Introduction

Growing use of mobile payment instruments in Africa is creating opportunities to significantly improve public service delivery in countries that have consistently struggled to provide water, electricity, sanitation, educational, and health services. Aid-dependent public sectors across sub-Saharan Africa are constrained by limited financial resources, poor governance outcomes, unplanned urban settlement patterns, and dispersed rural populations. This paper examines

the expansion of payment options for water services in Dar es Salaam, Tanzania and assesses changes in customer payment behaviours. Positive payment practices can improve public sector financing, potentially enhancing the ability of public service providers to reach spatially complex and socioeconomically disadvantaged populations.

Service delivery in East Africa's water sector is burdened with rapidly growing cities, impoverished populations, and ageing infrastructures that exacerbate seemingly intractable obstacles to satisfactory and wide-spread water provision. These factors have contributed to a significant decline in the percentage of urban populations accessing piped water services (Banerjee, et al., 2009). This decline is compounded by a sector-wide 12.9 billion USD shortfall in annual spending necessary to meet Millennium Development Goal (MDG) targets (AICD, 2010). Over 2.7 billion USD of revenue is foregone annually due to inefficient utility operations originating in distribution losses, under-collection of revenues and overstaffing (Banerjee and Morella, 2011). Utilities also experience revenue collection constraints, since 40-65% of connected households do not regularly pay for water services (AICD, 2010). Potential gains resulting from strengthening revenue collection represent a significant source of domestic funds that can be used to overcome financing gaps and expand access to water services in urban Africa.

Mobile-enabled payment innovations offer a partial solution for bill under- and non-payment in the urban water sector. Mobile payment instruments facilitate more frequent transactions and higher revenues per customer for the utility and low-cost payment alternatives for customers. These payment options represent a positive fiscal intervention for urban water systems typically characterised by inadequate cost-recovery and financial insufficiency.

Mobile money applications (e.g. M-PESA in Kenya) and the use of GPRS-enabled[2] pay points (e.g. Selcom Pay Points in Tanzania) reduce transaction costs, saving users time and money in the payment process. Increased efficiency and the lower cost of transactions make m-payment services more convenient for users, and facilitate further adoption of mobile-enabled payment options in emerging economies (Kshetri and Acharya, 2012). An existing study of mobile payments for water services in a peri-urban setting in Kenya quantifies these savings, arguing that increased use of mobile payment options may also improve payment timeliness (Foster, et al., 2012). These results identify changes in customer payment behaviours, but offer limited evidence of the potential contribution of these changes to water sector revenues.

This paper demonstrates the impacts of mobile-enabled payment methods on customer payment behaviours and discusses the implications for financing public service delivery. Dar es Salaam's urban water utility introduced mobile money payments for water services in 2009 and has since expanded payment options to include multiple services and the use of wireless pay points. A novel dataset of approximately one million payments made using a variety of methods over a two-year period is used to examine revenue collection for an urban water utility in Tanzania. The paper presents unique empirical evidence of changes in customer payment behaviours related to the use of mobile payment methods. I show that expanded choice in payment methods influences changes in payment behaviours that contribute to increased utility revenue collection through differences in payment amounts, volumes, frequencies, and sub-monthly payment patterns. Demonstrated differences suggest that greater use of mobile-enabled payment methods is facilitating more effective revenue collection than those collected using traditional payment methods alone (i.e. water utility payment offices). This may improve cost recovery and potentially enable the provision of higher quality services by overcoming major challenges in the urban water sector.

[2] General Packet Radio Service, or GPRS, is a mobile data service that is used by mobile phones and forms the bases for mobile-enabled point-of-sale technologies. The remainder of this paper refers to these point-of-sale devices as 'wireless pay points'.

This paper begins with a review of the operational and financial challenges in Africa's urban water sector, which is followed by a discussion of water payment practices and the growth of mobile-enabled payment instruments. Section Three presents transaction cost economics, which structures the theoretical and conceptual frameworks utilised in this study. Methods and data sources are detailed in Section Four, while Section Five presents the findings and analyses that provide evidence of significant changes in payment behaviours influenced by mobile-enabled payment options. Section Six discusses these findings, placing particular emphasis on the changing nature of water transactions in Dar es Salaam and the role of asset specificity and transaction costs in this transition. The final section concludes with a brief discussion of the policy, practical, and research implications of incorporating mobile payment methods into models of urban water service provision.

2.2. Background and Context

Poor customer payment behaviours constrain the ability of urban water service providers to overcome barriers to the effective operation and adequate financing of Africa's urban water systems. This section reviews these primary challenges, examines existing research on water payment practices in East Africa, and concludes with a discussion of mobile telephony in Africa and the emergence of novel mobile-enabled payment instruments.

2.2.a. Operational and Financing Challenges in Africa's Urban Water Sector

Water utilities in Sub-Saharan Africa consistently struggle to provide satisfactory water services to urban populations. Over 325 million people on the continent still lack access to improved water sources and only 19 out of 50 countries are expected to meet the Millennium Development Goal (MDG) drinking water target by 2015 (WHO/UNICEF, 2012; WHO/UNICEF, 2013). Although there have been improvements in water access in rural areas, the number of urban dwellers without access to improved water supplies will continue to constitute an increasing proportion of the total population without adequate access (Ibid).

Direct access to piped supplies has experienced a dramatic decline; only 26% of urban water users were connected in 2010, compared with 50% just 20 years earlier (Banerjee, *et al*., 2009; Banerjee and Morella, 2011). These declines are exacerbated by high levels of water loss and insufficient revenue collection. Using a typology discussed by Alegré, *et al*. (2000), Gonzalez-Gomez, *et al*. report that non-revenue water (NRW) from real, apparent, and unbilled authorized losses can be as high as 70% in some cities (2011). High levels of NRW contribute to significant operational inefficiencies, which often take the form of hidden costs that can create substantial unbudgeted financial burdens (Banerjee and Morella, 2011). Many urban water utilities are unable to recover even half of consumption bills in any billing cycle (Kayaga, 2002). Service providers are also subject to financial constraints because of low tariffs, poor client records, and inefficient billing and collection practices (Mwanza, 2005). Ineffective bill collection alone accounts for an annual loss of over 500 million USD (Banerjee and Morella, 2011). This combination of poor operational performance and insufficient cost-recovery creates a negative feedback loop, trapping water service providers in a vicious spiral of decline (Foster, *et al*., 2012).

Declines in piped-connection coverage can be partially attributed to rapid population growth and high rates of urbanisation (Banerjee, *et al*., 2009). Servicing new urban communities is intrinsically difficult because most urban growth and expansions in low-income contexts occurs within, and takes the form of, unplanned settlements (Dagdeviren and Robertson, 2011). Erratic settlement patterns require innovative approaches to planning and provision models, but most institutional reforms to date (e.g. privatisation, decentralisation, and commercialisation) have not achieved their intended goals (Schwartz and Sanga, 2010). This may be due to the prevalence of corruption and other fraudulent activities that undermine performance and encourage the continued existence of high NRW (Gonzalez-Gomez, *et al*., 2011). Illicit activities - illegal connections like water theft - tend to flourish in Africa's urban

areas, since the availability of resources is insufficient to properly maintain and monitor production and distribution infrastructures. Minimal financial resources result from revenue under-collection, which is a corollary of conventional billing and payment systems heavily burdened by transaction costs (Foster, *et al*., 2012). The combination of these issues presents a picture of African utilities as under-funded, inefficient, overstaffed, unresponsive to customers, and subject to political interference (McGranahan, Satterthwaite, and Thompson, 2003). Improvements in revenue collection via enhanced billing and payment systems may increase utility revenues and, in turn, support advances in water provision throughout urban Africa.

2.2.b. Water Payment Behaviours and Challenges in East Africa

Studies of water payment behaviours have regularly been constructed from hypothetical situations, rather than the realities of utility-client relationships. Willingness to pay and determining household demand for water services are two primary approaches used to understand payment behaviours. Typically part of planning processes, these approaches justify expenditures on water services projects but rarely examine the empirical nature of exchange between customers and service providers once improvements have been made (Mugabi, *et al*., 2010). Contingent valuation methods are the most commonly used, and the literature contains many useful examples of these and other studies from India (Singh, *et al*., 1993; Dutta, Chander, and Srivastava, 2005), Kenya (Mu, *et al*., 1990), Brazil (Briscoe, *et al*., 1990; Casey, Kahn, and Rivas, 2006), Pakistan (Altaf, *et al*., 1993), Uganda (Whittington, *et al*., 1998), and Ethiopia (Tarfasa and Brouwer, 2013). These analyses are beneficial for understanding the ways in which water users conceptualise the value of water supplies, but offer limited evidence of actual customer payment behaviours over time.

More recent examinations of bill payment behaviours have begun to bridge the gap left by willingness to pay studies. Drawing on perspectives from social psychology, Mugabi and

Kayaga's cross-sectional survey of 505 utility customers in 8 cities in Uganda find that customer attitudes towards payment, perceived ease of payment, and social pressures strongly influence intentions to pay, a determining factor in actual payment behaviour (2010). Although valuable, this approach focuses on perceptions and intentions to pay and says little about the nature of water-related transactions. A similar study by Kayaga, *et al*. (2004) identifies perceptions of service value, corporate image, customer satisfaction, and attitudinal loyalty as having significant effects on bill payment behaviour, but does not define or explain the elements of bill payment. These studies use prompt payment, or timeliness, as the primary indicator of payment efficacy (Ibid; Mugabi, *et al*., 2010; Mugabi and Kayaga, 2010). A novel study of payment behaviours in a relatively affluent community outside Nairobi, Kenya compared mobile money payments with bank payments on the basis of frequency and timeliness (Foster, *et al*., 2012). The community received water services from a privately-operated distribution system but could only pay at a single payment office located 8km from the town. Customers were more likely to pay their water bills on time and more frequently when using mobile money services, when compared with the distant bank branch. Payment timeliness and frequency are important for evaluating utility cash flows on a monthly and annual basis, but offer minimal comprehension of impacts on utility revenue collection.

Despite shortcomings in existing literature, examinations of actual payment behaviour inform discussions on which transactional elements may be most appropriate in addressing utility revenue collection. Timeliness is particularly important because delayed payments can undermine monthly cash flows and interrupt water service delivery (Mugabi and Kayaga, 2010). The authors also argue that utilities need systems that can minimise errors and mistakes in billing, since metering inaccuracies and unnecessarily high water bills are barriers to payment. The focus on transaction costs by Foster, *et al*. (2012) illuminates the relationship between ease of payment and revenue collection per customer. Monthly billing cycles can

also be a barrier for customers with irregular incomes (Mugabi, *et al*., 2010), and it is essential that utilities design flexible systems that enable bill payment when money is available, rather than on a monthly basis. Analysing the nature of transactions between customers and utilities requires a focus on key elements such as payment timeliness, frequency of transactions, sub-monthly payment patterns, and annual revenue per customer, which may be useful indicators of customer payment behaviours.

2.2.c. Mobile Telephony and New Payment Instruments

Africa is experiencing significant growth of mobile telephony. Mobile subscriptions on the continent are expected to reach over 700 million by 2016, a penetration rate of 75% up from less than 1% in 2000 (GSMA/Deloitte, 2012). In East Africa, the trend is similar – penetration rates stand at 69%, 50%, and 42% in Kenya, Tanzania, and Uganda, respectively (Ibid). This translates into over 61 million potential mobile users in a region that counted less than 1 million fixed line connections just ten years ago. Existing evidence suggests that mobile telecommunications can have wide-ranging positive influences on development objectives. Enhancing the operations of micro- and small-enterprises (Donner and Escobari, 2010; Essegbey and Frempong, 2011), improving the efficiency of fishery and grain markets (Jensen, 2007; Aker, 2010), preventing the spread of infectious disease (Wesolowski, *et al*., 2012; Padma, 2010), and expanding the reach of agricultural extension services (Aker, 2011) are some of the ways in which mobile technologies are influencing development outcomes.

Mobile technologies are also increasingly being used in financial services, resulting in mobile money services that offer basic functionality to customers (Mas, 2009; Jack and Suri, 2011), mobile banking applications linked to existing customer accounts (Kshetri and Acharya, 2012), and wireless pay points that communicate over mobile networks but do not require handsets (Foster, *et al*., 2012). Empirical studies of novel payment methods have concentrated on questions of financial access (Porteous, 2006; Ivatury and Pickens, 2006;

Alampay and Bala, 2010) and uses for domestic remittances (Morawczynski, 2009). Payments for public services are a key application of these options, which may assist in mitigating challenges presented by inefficient billing and collection systems, poor record-keeping, and inflexible monthly payment patterns.

Widespread use of mobile-enabled payment methods has been thus far limited to East Africa, making it an optimal context for investigating the effects of payment instruments choice on transactions. Differences in transaction costs across different payment instruments - cheques and cash - were first identified by Whitesell (1989), who concluded that the nature of transactions have an impact on the choice of payment method and not the other way around. Subsequent work has also confirmed that payment method choice is influenced by transaction size (Abdul-Muhmin, 2010). The introduction of new payment modalities can contribute to declines in transaction costs, which expand trade and increase production specialisation (Humphrey, *et al.*, 1996). Electronic payments are particularly indicative of this, since the cost of making electronic payments is significantly lower than conventional options (Humphrey and Berger, 1990; Robinson and Flatraaker, 1995). Electronic bill payments are now possible in places around the world, but research has focused on instruments such as direct debit and electronic transfers in North America and Europe (Mantel, 2000; Bounie and Francois, 2011), where mobile payment options are not broadly used. Research in these contexts has been "greatly hindered" by a lack of available data (Hancock and Humphreys, 1998: 1574), an issue that has also been a significant stumbling block in sub-Saharan Africa. The seemingly insurmountable challenges faced by urban water utilities in Africa highlight gaps in the limited scholarship on electronic bill payments and nonexistent research on the use of mobile-enabled payment instruments as major gaps that must be addressed.

2.3. Theoretical Framework: Transaction Cost Economics

Transaction Cost Economics (TCE) provides a structure that can be used to evaluate transactional differences across different payment modalities. A transaction is the transfer of a good or service across a technologically separable interface, where one stage of activity ends and another begins (Williamson, 1981). Interfaces that work well facilitate smooth transfers, whereas delays and breakdowns can emerge from transaction costs associated with an exchange. Transactions are the primary unit of analysis in TCE and are used to comparatively assess the relative influence of transaction costs on different organisational structures (Williamson, 1979; Gibbons, 2010). Payments are more easily made when transaction costs are relatively low, while high transaction costs may change or obstruct them completely. Uncertainty, frequency, and transaction-specific investments create the context in which transactions take place. Relative transaction costs are influenced by asset specificity (i.e. nonredeployable investments required to conduct a transaction), which can be divided into site, physical, and human asset specificity (Williamson, 1981).

Africa's urban water sector is characterised by high degrees of uncertainty due to the prevalence of under-paying and nonpaying customers. Water bill payments are recurrent (i.e. high frequency) and can now be made with a variety of payment modalities, each having their own set of transaction-specific investments and asset specificities. For example, water payment offices run by the utility are transaction-specific investments with substantial site specificity (i.e. payment offices are constrained by geography), whereas mobile money services require considerably smaller transaction-specific investments (e.g. the purchase of a mobile phone) reliant on low physical and human asset specificity (i.e. customers must own a mobile phone and must learn how to use the service). In terms of asset specificity, GPRS-enabled pay points are somewhere between water offices and mobile money services. Wireless pay points have intermediate degrees of site specificity (i.e. pay points are at

physical locations[3]) and physical asset specificity (i.e. point-of-sale devices required for the transaction), and exhibit lower human asset specificity because the act of making shop-based purchases is assumed to be common to water utility customers. Various payment options available to water utility customers in Dar es Salaam have relative degrees of asset specificity, which influence the relative transaction costs of each method.

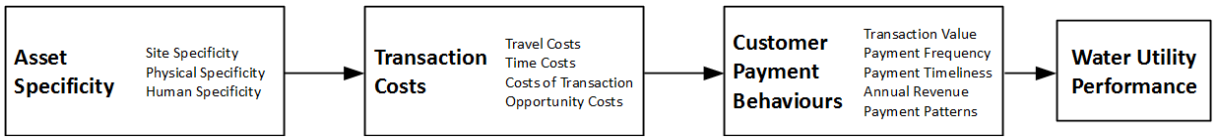

Figure 2-1. Visual representation of conceptual framework detailing the relationships between asset specificity, transaction costs, customer payment behaviours, and water utility performance. *Source: Author*.

The conceptual framework presented in Figure 2-1 illustrates the direct relationship between transaction costs - dimensionalised in multiple ways (e.g. travel, time, transactional[4], and opportunity costs) - and the resultant nature of a transaction. Time costs are related to travel times and waiting in queues, travel cost is the monetary amount required to reach a destination, and opportunity costs refer to missed work or schooling. Site specificity is assumed to be most important for water bill payments, due to the broad availability of mobile communications technologies and their impacts on distance. Water offices are characterised by high degrees of site specificity, which entail high travel, time, and opportunity costs for customers to conduct a transaction. Lower degrees of site specificity are associated with lower transaction costs. Table 2-1 shows how asset specificity can influence the relative

[3] Physical locations can include pharmacies, grocery stores, petrol stations, and kiosks
[4] Transactional (i.e. payment) costs refer to extra fees that are required for payment. Certain mobile money water services charge customers a fee to make a water payment, whereas pay point and water office payments are free in Dar es Salaam.

transaction costs of each payment option. Transactions are operationalised as customer payment behaviours, which include transaction value, payment frequency, payment timeliness, annual revenue collection, and payment patterns. Variations in customer payment behaviours are expected to influence water utility performance, primarily through payment timeliness and revenue collection (Kayaga, *et al*., 2004; Mugabi, *et al.*, 2010; Foster, *et al*., 2012). Using TCE to evaluate transactional differences in bill payment behaviour was previously unnecessary because the development of alternative payment options is a recent phenomenon, especially in Africa. This article takes a step towards understanding the impact of new payment options - with varying degrees of asset specificity and resulting transaction costs - on customer payment behaviours in the urban water sector.

Table 2-1. Relative transaction costs and asset specificity for three payment instrument types.

	ASSET SPECIFICITY			TRANSACTION COSTS			
METHOD	**Site**	**Physical**	**Human**	**Travel**	**Time**	**Payment**	**Opportunity**
Water Office	*High*	*Low*	*Low*	*High*	*High*	*Variable*	*High*
Pay Point	*Intermediate*	*High*	*Low*	*Intermediate*	*Intermediate*	*None*	*Intermediate*
Mobile Money	*Low*	*Intermediate*	*Intermediate*	*Low*	*Low*	*Low*	*Low*

Source: Author

2.4. Data Sources and Methods

Tanzania faces many obstacles to effective water provision and 21 million people in the country still lack access to safe water sources. Urban populations rose from 19% in 1990 to 26% in 2010, while metropolitan access to improved water supplies simultaneously declined from 94% to 79% (WHO/UNICEF, 2012). Non-revenue water in Dar es Salaam – the country's largest city – hovers above 50% and the urban utility continues to search for ways to improve revenue collection (EWURA, 2011). In a study of water vending throughout the city, Kjellen suggests that poor billing and payment collection systems are a primary contributor to water service deficiencies in Dar es Salaam (2000). An exploratory initiative developed in

cooperation with mobile network operators and a Tanzanian telecommunications firm, mobile-enabled payment methods (i.e. mobile money services and wireless pay points) were introduced by the Dar es Salaam Water and Sewerage Corporation (DAWASCO) in mid-2009. Integrating new payment methods with the utility's billing and payment system has generated electronic transaction records on a continent where reliable data is often rare. Comprehensive challenges in the urban water sector and expanded data availability make Dar es Salaam an ideal focus of this study.

A unique dataset of water utility payment records from Dar es Salaam, Tanzania is used to evaluate differences in customer payment behaviours. Data were provided by the water utility, which operates 14 water payment offices in and around Dar es Salaam; a telecommunications company operating a mobile money service; and a telecommunications firm (i.e. Selcom Wireless), which manages over 2,000 wireless pay points located throughout the city. Spanning the first two full years the options were offered (i.e. 2010 and 2011), the dataset contains 967,459 payments made by over 106,575 customers. Each payment record contains information on the date, time, method, and utility account of payment. Existing research on payment instruments and transaction costs finds that large transaction sizes affect payment method choice and associated payment behaviours (Abdul-Muhmin, 2010). Water-related payments in the dataset include large transactions made for large commercial and industrial accounts, connection and re-connection fees, and payments made to reconcile arrears and inaccurate meter readings. These transactions are identified by Williamson as idiosyncratic and can create analytical distortions (1981). To control for these effects, outliers were identified and muted using the outlier labelling rule (Tukey, 1977; Hoaglin, Iglewicz, and Tukey, 1986; Hoaglin and Iglewicz, 1987).

This study uses four primary variables that are compared across groups to evaluate the relative impacts of payment instruments on customer payment behaviours: Payment value, payment timeliness, transaction frequency, and overall revenue collection. First, payment value is a measure that is not typically included within studies of payment behaviours for water services, but the broader payment instrument literature demonstrates that there is a significant relationship between payment instrument choice and transaction value, particularly in transitions to non-cash-based options (Whitesell, 1989; Humphrey and Berger, 1990). The incorporation of payment value as a measure of interest in the water services literature offers advantages in that it speaks to the impact of relative transaction costs on payment behaviours and highlights how subtle variations in both may be associated. However, this measure is limited in that it has not yet been discussed as a key variable within the water payments literature.

The second measure, payment timeliness, has been used throughout the water payments literature (Kayaga, *et al*., 2004; Mugabi and Kayaga, 2010; Foster, *et al*., 2012). In particular, Mugabi and Kayaga (2010) have demonstrated that prompt payment is important for utility revenue collection and the financial sustainability of a water service provider. This widely accepted measure in the water payments literature is however limited in that it says little about annual revenue collection. Furthermore, payment timeliness is insufficient on its own as a measure of customer payment behaviours because many water utility customers in low-income urban areas do not pay on a monthly basis, but rather pay in supra-monthly patterns. Focusing exclusively on payment timeliness reduces our ability to understand payment behaviours in this context.

The third measure is payment frequency, which Foster, *et al*. (2012) show is influenced by payment instrument choice, particularly as it relates to the use of mobile payment options.

Many scholars have highlighted the limited payment behaviours of water utility customers in low-income urban areas (Sansom and Bos, 2008; Schwartz and Sanga, 2010; Mugabi and Kayaga, 2010). This suggests that payment frequency is complementary to payment timeliness because it captures a broader range of payment behaviour from an annual, rather than monthly, perspective. However, this measure is limited by its ability to explain the number of transactions in a single year. Other measures of payment value are necessary to overcome the limitations associated with payment frequency.

Finally, revenue collection is used as an overall measure of a customers' annual billing and payment interactions with an urban water service provider. This measure has not been used comprehensively in studies of customer payment behaviours due to a significant lack of empirical data. We use this measure here because data was made available by the urban water utility in Dar es Salaam. Given the specific limitations of payment value, payment timeliness, and payment frequency, revenue collection offers an aggregate view of customer payment behaviours within a year. The measure provides an absolute number that expresses the combined impact of changes in payment value and payment frequency. However, the measure is limited in that it is missing substantial pieces of information related to billing levels, collection ratios, and yields no way to differentiate between volumetric and flat fee customers. Consequently, we do not examine collection ratios or billing rates. Similarly, over 90% of customers in Dar es Salaam are metered for volumetric consumption.

Four primary approaches were utilised to obtain comparative samples from the dataset (Table 2-2). Annual and monthly transaction-based samples were first selected on the basis of payment method, which include water utility payment offices (WO), wireless pay points (PP), and a mobile money service (MM). Water office transactions are the control group and represent the comparative element for statistical significance in this group for each year.

Customers who have incorporated mobile-enabled methods into their payment practices represent the second sampling group, for which the control group includes customers paying solely at water offices. The third set of analyses is comprised of customer-based samples delineated by the payment method combinations that were used for water service payments in 2011.

Table 2-2. Sampling groups and related analytical variables.

SAMPLE	GROUP	CATEGORIES	VARIABLES
Transactions	**Payment Method**	WO	*Transaction Volume*
		PP	*Transaction Value*
		MM	*Payment Timeliness*
Customers	**Payment Method Use**	WO	*Transaction Value*
		PP	*Payment Timeliness*
		MM	*Payment Frequency*
			Annual Revenue per Customer
Customers	**Payment Method Combination**	WO, PP, MM,	*Transaction Value*
		WO-PP, WO-MM,	*Payment Timeliness*
		MM-PP, WO-MM-PP	*Payment Frequency*
			Annual Revenue per Customer
Customers	**Use/Non-Use of Mobile-Enabled Methods**	$Non\text{-}User_{10}/Non\text{-}User_{11}$	*Transaction Value*
		$User_{10}/Non\text{-}User_{11}$	*Payment Timeliness*
		$Non\text{-}User_{10}/User_{11}$	*Payment Frequency*
		$User_{10}/User_{11}$	*Annual Revenue per Customer*

Source: Author

This yielded seven distinct groups ranging from customers who paid water bills using a single method in a year (i.e. WO, PP, and MM) to those that used all three. Customers that only used water offices in each respective year form the control and comparative element for statistical significance. Samples of utility customers were selected for the final set of comparisons, which were prepared on the pattern of use or non-use of mobile-enabled payment methods over the two year period. This approach created four groups: 1) those who did not use the new methods in either 2010 or 2011 (NU10-NU11); 2) those who used the methods in both years (U10-U11); 3) those who used mobile-enabled methods in 2010, but

not in 2011 (U10-NU11); and 4) those who used mobile-enabled methods in 2011, but not in 2010 (NU10-U11) (Table 2-2). The control group and standard of statistical comparison is the group of customers that did not use mobile-enabled methods to make a water payment during the period of analysis (i.e. NU10-NU11).

Sampling sets were compared across five continuous variables related to basic aspects of transactions and customer payment behaviours. Relative payment volume by transaction type is calculated as a monthly percentage of all payments made and also informs discussions of payment method adoption. Transaction value identifies the size of payments and is expressed in USD[5]. Payment timeliness is the numerical day of the billing cycle each transaction was made and includes values ranging from 1 to 31. In Dar es Salaam, the billing cycle is analogous with the month and the payment deadline is the seventh day of each month. Payment frequency is the mean number of payments made per customer per year. Annual revenue per customer includes all payments made by each discrete customer during the course of a year. A summary of the sampling sets and the variables relevant to each is found in Table 2-2.

Data from a utility customer payment preference survey is also used to make socioeconomic and demographic comparisons of users and non-users of mobile-enabled payment methods. The instrument was designed in collaboration with the water utility, piloted in June 2012, and administered in August and September 2012. Survey responses include data on geographic location and housing, socioeconomic variables, demographic variables, assets and expenditures, mobile phone use, payment methods and preferences, payment behaviours, service satisfaction, disconnections and reconnections, alternative sources of water, community supplying behaviours, and SMS billing reminders. Survey administration was

[5] The conversion from Tanzanian Shilling (TZS) to United States dollars (USD) used in this article is 1600 TZS for 1 USD.

conducted over one billing and payment cycle at water payment offices, bank branches, wireless pay points, and mobile money agents. Systematic random sampling was used to select five target wards (i.e. neighborhoods) that contained a water payment office and five that did not. Within each randomly selected ward, physical payment locations constituted a secondary sampling frame. Random sampling was again used to create a stratified sample of physical payment locations. All water utility customers using the payment locations were invited to participate in the survey.

2.5. Findings and Analysis

From 2010 to 2011, the share of water payments made at water offices has declined while the proportion of transactions conducted using mobile-enabled payment instruments has increased (Table 2-3). In January 2010, 98.0% of payments were made using water offices, whereas 1.1% of payments were made with wireless pay points and 0.8% were conducted via mobile money services. By the end of 2010, these numbers hadn't changed much, with 97.1% of payments being made at water offices, 1.7% of water transactions conducted with pay points, and 1.2% of payments made using mobile money. In 2011, however, the share of payments made using mobile-enabled methods began to quickly expand. In January 2011, relative payment volume for each method remained similar to 2010 (water offices = 96.7%; pay points = 2.1%; mobile money = 1.2%). By the end of the year, wireless pay points accounted for 13.4% of all water payments made in Dar es Salaam and water office payments declined to 84.8%. The number of payments made with mobile money accounted for just 1.8% of these transactions. Adoption of mobile-enabled payment methods for water services in Dar es Salaam was flat in 2010 and rose in 2011 due to expanded use of wireless pay points.

Table 2-3. Relative transaction volumes by payment options (%). Payments for water services in Dar es Salaam, Tanzania; 2010-2011. **Note:** Totals do not add to 100% due to rounding of figures to the nearest 0.1.

		WATER OFFICE (%)	PAY POINT (%)	MOBILE MONEY (%)
2010	**Jan** *(n = 31896)*	*98.0*	*1.1*	*0.8*
	Feb *(n = 35441)*	*98.1*	*1.0*	*0.8*
	Mar *(n = 36562)*	*97.8*	*1.4*	*0.9*
	Apr *(n = 31224)*	*97.8*	*1.2*	*0.9*
	May *(n = 36734)*	*97.5*	*1.4*	*1.1*
	Jun *(n = 38374)*	*98.1*	*0.8*	*1.0*
	Jul *(n = 37735)*	*97.3*	*1.6*	*1.1*
	Aug *(n = 40722)*	*97.8*	*1.1*	*1.1*
	Sep *(n = 38169)*	*97.9*	*1.1*	*1.0*
	Oct *(n = 43713)*	*97.0*	*1.7*	*1.4*
	Nov *(n = 41902)*	*97.4*	*1.4*	*1.1*
	Dec *(n = 41064)*	*97.1*	*1.7*	*1.2*
2011	**Jan** *(n = 40979)*	*96.7*	*2.1*	*1.2*
	Feb *(n = 36242)*	*95.2*	*3.4*	*1.3*
	Mar *(n = 43452)*	*96.9*	*1.7*	*1.4*
	Apr *(n = 33861)*	*96.6*	*2.1*	*1.2*
	May *(n = 41078)*	*96.1*	*2.5*	*1.4*
	Jun *(n = 42261)*	*95.7*	*3.0*	*1.4*
	Jul *(n = 45739)*	*90.0*	*8.5*	*1.6*
	Aug *(n = 47353)*	*89.0*	*9.4*	*1.7*
	Sep *(n = 46076)*	*88.6*	*10.1*	*1.3*
	Oct *(n = 47200)*	*89.9*	*8.5*	*1.5*
	Nov *(n = 46186)*	*90.2*	*8.0*	*1.7*
	Dec *(n = 43496)*	*84.8*	*13.4*	*1.8*

Source: Water Payments Database

Over the same period (2010-2011), the number of customers using mobile-enabled payment methods increased while fewer customers turned to water offices to make their payments (Table 2-4). Over 99% of water utility customers in Dar es Salaam used water offices to make payments in 2010, compared with just 2.6% of customers using wireless pay points and 1.3% using mobile money services. In 2011, the proportion of customers incorporating wireless pay points into their payment practices increased to 20.5%. This figure is matched by a decline in the number of customers using water offices (92.9%) and a slight increase in the proportion of customers using mobile money. The final two columns in Table 2-4 show the proportion of all payments made by customers opting to use each payment method. For

example, the 2.6% of customers using pay points in 2010 were responsible for 4.2% of the payments made in that year, although these payments could have been made using multiple instruments at different points during the year. These columns illustrate that while the number of customers using water offices to make payments declined from 2010 to 2011, these customers still account for most of the payments made in 2011 (98.3%). Important to note is that the 20.5% of customers who used pay points in 2011 were responsible for 27.8% of all payments made that year, while a small but growing proportion of customers and payments used mobile money services in 2011. Of the 13091 customers who started paying for water services in 2011, 80.0% paid solely at water offices, 18.1% used wireless pay points, and 2.1% made payments using mobile money. Mobile-enabled payment methods became more significant to utility revenue streams as an increasing number of customers incorporated the new methods into their payment practices.

Table 2-4. Proportion of water utility customers using each payment method in 2010 and 2011, and the proportion of payments made by that group in the same years. **Note:** Totals do not add to 100% because customers may have used multiple payment methods over the course of a single year.

	CUSTOMERS (%)		**PAYMENTS** (%)	
Method	**2010** *N=77695*	**2011** *N=81384*	**2010** *N=440606*	**2011** *N=500583*
WO	*99.4%*	*92.9%*	*97.4%*	*98.3%*
PP	*2.6%*	*20.5%*	*4.2%*	*27.8%*
MM	*1.3%*	*2.4%*	*2.1%*	*3.5%*

Source: Water Payments Database

Transaction attributes for payments made in 2011 are compared in Table 2-5 because of increased use of mobile-enabled payment instruments in that year. Although payment frequency and annual revenue are related to aggregate customer payment practices, transaction value and timeliness are variables that can be used to compare the transactions made with each payment instrument. In 2011, payments made at water utility payment offices had a mean value of 18.08 USD and were, on average, paid on the 14th day of the month.

Transactions conducted using wireless pay points had a significantly lower transaction value (Value = 15.40; z = -32.43) and were made significantly later than water office payments (Timeliness = 14.5; z = 10.51). Mobile money payments for water services were also significantly lower (Value = 16.47; z = -8.64), but exhibited no change in timeliness when compared to water office payments. These data show that transactions conducted using mobile-enabled payment methods are significantly lower in value than those made at water offices.

Table 2-5. Comparison of value and timeliness for transactions made with different payment instruments.

	TRANSACTION VALUE (USD)			**PAYMENT TIMELINESS** (Day of Payment)		
METHOD	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
WO	*18.08*	*15.19*	*438707*	*14*	*8.4*	*438707*
PP	*15.40****	*14.03*	*31237*	*14.5****	*8.1*	*31237*
MM	*16.47****	*14.79*	*6399*	*14.1*	*8.6*	*6399*

Source: Water Payments Database **p<0.05, **p<0.01, ***p<0.001*

Customer payment behaviours in 2011 were also compared, and Table 2-6 shows positive variations in payment practices for customers using mobile-enabled payment methods. Utility customers conduct transactions solely at water offices are used as the control group for comparison with payment behaviours of customers that have begun using wireless pay points and mobile money services to pay their water bills. These customers exhibited an average payment value of 18.73 USD, mean transaction timeliness of 13.9, made an average of 5.4 payments per year, contributing 116.39 USD in average annual revenue per customer to DAWASCO. Compared with these payment behaviours, customers incorporating wireless pay points into their payment practices exhibited significantly lower transaction values (Value = 15.35 USD; z = -71.42), significantly later payment dates (Timeliness = 14.2; z = 10.88), payments made with significantly greater frequency (Frequency = 7.5; z = 66.47), which overall contributed significantly higher revenue per customer to the utility (Revenue = 120.80

USD; z = 4.88). Customers using mobile money services to make some or all of their water services payments also exhibited significant changes in payment behaviour including lower transaction values (Value = 15.41; z = -28.62), later transactions (Timeliness = 14.4; z = 7.18), greater payment frequency (Frequency = 6.3; z = 10.97), and higher revenue contributions (Revenue = 125.00 USD; z = 3.41). These data show that customers using mobile-enabled instruments have payment behaviours that are significantly different from those of customers making payments only at water offices.

Table 2-6. Comparison of transaction value, timeliness, frequency, and annual revenue for customers using different payment instruments in 2011.

	VALUE (USD)			**TIMELINESS** (Day of Payment)			**FREQUENCY** (Payments/Year)			**ANNUAL REVENUE** (USD)		
METHOD	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
WO	*18.73*	*15.46*	*324088*	*13.9*	*8.4*	*324088*	*5.4*	*3.7*	*59532*	*116.39*	*104.23*	*59532*
PP	*15.35****	*13.97*	*129924*	*14.2****	*8.4*	*129924*	*7.5****	*3.5*	*15946*	*120.80****	*100.50*	*15946*
MM	*15.41****	*14.41*	*16324*	*14.4****	*8.7*	*16324*	*6.3****	*3.5*	*1885*	*125.00****	*107.97*	*1885*

Source: Water Payments Database **p<0.05, **p<0.01, ***p<0.001*

Analyses of the various combinations of payment methods customers used in 2011 show that the sole use of either wireless pay points or mobile money services is associated with poorer payment behaviours than customers who paid only at water offices (Table 2-7). Compared with this latter group, customers paying only with wireless pay points had significantly lower transaction values (Value = 16.23 USD; z = -8.86), later transactions (Timeliness = 14.3; z = 2.73), less frequent payments (Frequency = 3.0; z = -21.37), and contributed much less in revenue to the utility (Revenue = 60.71 USD; z = -22.72). Customers using only mobile money services for water payments also had significantly lower (Value = 16.65 USD; z = -5.80) and less frequent payments (Frequency = 4.4; z = -5.76), resulting in significantly lower revenue collection for the utility (Revenue = 82.93 USD; z = -7.26). Customers using only a

single mobile-enabled payment instrument to conduct their transactions have significantly worse payment behaviours than those who only pay at water offices.

Table 2-7. Mean annual payment value, timeliness, frequency, and revenue collection grouped by mobile-enabled payment method usage each year; 2010-2011.

	VALUE (USD)			TIMELINESS (Day of Payment)			FREQUENCY (Payments/Year)			ANNUAL REVENUE (USD)		
Combination	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
WO	*18.73*	*15.46*	*324088*	*13.9*	*8.4*	*324088*	*5.4*	*3.7*	*59532*	*116.39*	*104.23*	*59532*
PP	*16.23****	*15.23*	*2942*	*14.3***	*7.9*	*2942*	*3.0****	*3.5*	*989*	*60.71****	*75.88*	*989*
MM	*16.65****	*15.67*	*1920*	*13.7*	*8.6*	*1920*	*4.4****	*3.6*	*434*	*82.93****	*95.63*	*434*
WO, PP	*15.55****	*14.04*	*120761*	*14.1****	*8.4*	*120761*	*7.8****	*3.3*	*14770*	*124.44****	*100.43*	*14770*
MM, WO	*18.44**	*15.51*	*8183*	*14.3***	*8.5*	*8183*	*6.4****	*3.3*	*1264*	*135.60****	*107.15*	*1264*
MM, PP	*19.15*	*14.44*	*1109*	*14.1*	*8.1*	*1109*	*5.6*	*3.7*	*196*	*148.93***	*183.53*	*196*
MM, WO, PP	*11.96****	*11.76*	*6756*	*14.6****	*8.8*	*6756*	*8.3****	*3.0*	*280*	*156.71****	*112.45*	*280*

Source: Water Payments Database **p<0.05, **p<0.01, ***p<0.001*

Contrary to the sole use of a single payment instrument, customers who used a combination of payment methods - often including both water offices and mobile-enabled options - exhibited better payment behaviours (Table 2-7). Using customers who only paid using water offices in 2011 for comparison, customers who paid at water offices and pay points had significantly lower (Value = 15.55 USD; z = -65.32), later (Timeliness = 14.1; z = 7.06), and more frequent payments (Frequency = 7.8; z = 77.17). This contributed to a significant increase in annual revenue collection per customers (Revenue = 124.44 USD; z = 8.65). A similar pattern emerges for customers who used water offices and mobile money to make their transactions (Value = 18.44, z = -1.67; Timeliness = 14.3, z = 4.21; Frequency = 6.4, z = 10.63; Revenue = 135.60 USD, z = 6.31). Customers who used only pay points and mobile money services did not exhibit significant variations in transaction value, timeliness, or frequency, although the aggregation of slight changes in these variables contributed to a significantly greater level of revenue collection (Revenue = 148.93 USD; z = 2.48). The most significant changes in customer payment behaviours were evident for customers who used a combination of all three

payment instruments: water offices, pay points, and mobile money. These customers had the lowest transaction values (Value = 11.96 USD; z = -46.49), the latest transaction timeliness (Timeliness = 14.6; z = 6.48), highest payment frequency (Frequency = 8.3; z = 16.12), and highest revenue collection per customer (Revenue = 156.71 USD; z = 5.99). These data show that customers who combine payment instruments exhibit better customer payment behaviours and contribute significantly more to utility revenue collection.

The results thus far illustrate that customers using mobile-enabled payment methods exhibit significantly better payment behaviours than customers who do not use the options, but do payment behaviours change when a customer begins using these methods? Table 2-8 shows variations in customer payment behaviours from 2010 to 2011 for distinct groups of customers that did or did not use mobile-enabled payment methods in each year. For customers who did not use the options (Non-user_{10}/Non-user_{11}) in either 2010 or 2011 (i.e. a control group), payment behaviours improved from 2010 to 2011. There was no change in the value of transactions as payments were made significantly later (1.5%) and with greater frequency (5.3%) over this two-year period. This group of customers contributed more to the utility in revenue in 2011 (5.4%) than in 2010. Customers who used mobile-enabled methods in both years (i.e. another control group) exhibited minimal, but significant, variations in value (-2.3%), timeliness (6.2%), and frequency of payments (3.9%) from 2010 to 2011. An examination of customers who did not use mobile-enabled payment instruments in 2010 but did so in 2011 yields evidence that the adoption of these methods strongly influenced customer payment behaviours. The adoption of these methods by over 13,000 customers in 2011 led to significant declines in average payment value (-8.4%), later transactions (2.2%), significantly more frequent payments (27.9%), and greater revenue collection per customer (12.7%). For customers who used mobile methods in 2010 but did not do so in 2011, their average payment value significantly increased (9.8%), payment timeliness became later

(4.5%), and payment frequency declined significantly (14.1%). These changes did not significantly influence revenue collection. Use and non-use of mobile-enabled payment methods may significantly change customer payment behaviours, particularly the frequency with which payments are made, contributing to improvements in revenue collection when customers adopt electronic payment instruments.

Table 2-8. Mean annual payment value, timeliness, frequency, and revenue collection grouped by combinations of payment methods used by customers in 2011.

		VALUE (USD)		TIMELINESS (Day of Payment)		FREQUENCY (Payments/Year)		ANNUAL REVENUE (USD)	
User Group		**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
$Non\text{-}User_{10}$/	**Mean**	*18.73*	*18.67*	*13.6*	*13.8****	*5.7*	*6.0****	*119.02*	*125.45****
$Non\text{-}User_{11}$	**SD**	*15.54*	*15.29*	*8.5*	*8.4*	*3.6*	*3.7*	*105.94*	*106.05*
	N	*277721*	*294083*	*277721*	*294083*	*48569*	*48273*	*48569*	*48273*
$User_{10}$/	**Mean**	*16.87*	*16.48**	*13.0*	*13.8****	*7.6*	*7.9**	*132.20*	*136.61*
$User_{11}$	**SD**	*14.66*	*14.13*	*8.3*	*8.1*	*3.7*	*3.7*	*104.21*	*101.76*
	N	*12313*	*12761*	*12313*	*12761*	*1574*	*1582*	*1574*	*1582*
$Non\text{-}User_{10}$/	**Mean**	*17.18*	*15.73****	*13.8*	*14.1****	*6.1*	*7.8****	*111.35*	*125.53****
$User_{11}$	**SD**	*14.84*	*14.10*	*13*	*8.4*	*3.7*	*3.4*	*103.82*	*101.94*
	N	*84500*	*108715*	*84500*	*108715*	*13630*	*13505*	*13630*	*13505*
$User_{10}$/	**Mean**	*18.84*	*20.69****	*13.4*	*14.0****	*7.1*	*6.1****	*140.25*	*141.83*
$Non\text{-}User_{11}$	**SD**	*15.90*	*16.03*	*8.6*	*8.3*	*3.7*	*3.7*	*107.21*	*109.57*
	N	*7974*	*6727*	*7974*	*6727*	*1086*	*1082*	*1086*	*1082*

Source: Water Payments Database **p<0.05, **p<0.01, ***p<0.001*

These findings have shown that mobile-enabled payment methods support better customer payment practices, but the payment records provide only limited evidence of the socioeconomic and demographic differences between users and non-users of the new payment instruments. Table 2-9 provides a comparison of these customers on a variety of characteristics. Users of mobile-enabled payment methods are more likely to be female, have slightly larger households, and tend to be older than non-users. Levels of education are also slightly divergent, as nonusers are more likely to have a university-level education. Approximately one-third of users of mobile-enabled payment methods have no more than a primary-level education, compared to only one-quarter of non-users. Users of these methods

are also more likely to be self-employed or unemployed when compared to their counterparts who only pay at water offices. Utility customers who have used mobile-enabled payment methods for water bill transactions spend more on mobile services and less on transport than non-users. In Dar es Salaam, users of mobile-enabled options have lower levels of education, are more often female, and spend less on transport than those who do not use mobile-enabled methods.

Table 2-9. Demographic and socioeconomic comparison of users (n = 112) and non-users (n = 504) of mobile-enabled payment methods. Variables marked with an asterisk (*) are reported as the median of all values. Data are reported for respondents providing a valid utility account number (n = 616).

VARIABLES		USERS	NON-USERS
Demographic	Male	*43%*	*50%*
	Female	*57%*	*50%*
	Age*	*37.5*	*36*
	Household Size*	*7*	*6*
Employment	Full Time	*27%*	*28%*
	Part Time	*6%*	*8%*
	Student	*5%*	*9%*
	Self-Employed	*43%*	*38%*
	Unemployed	*23%*	*17%*
Education	Primary	*34%*	*26%*
	Secondary	*40%*	*39%*
	University	*19%*	*26%*
	Vocational	*8%*	*5%*
	None	*1%*	*3%*
Expenditures* *USD Monthly*	Food	*187.50*	*187.50*
	School	*34.38*	*37.50*
	Transport	*24.69*	*37.50*
	Mobile	*25*	*21.25*
	Electricity	*25*	*25*

Source: Utility Customer Survey Data

2.6. Discussion

Following the introduction of mobile-enabled payment methods for water services transactions in Dar es Salaam, Tanzania in mid-2009, the number of utility customers using these electronic options has risen substantially. Payment instruments such as wireless pay points and mobile money services change the experience of paying water bills for customers

by reducing the distance, time, and costs required to make water-related transactions. Customers have responded to this increased ease of payment by incorporating these options into their payment practices, with particular emphasis on wireless pay points. This paper provides strong evidence that mobile-enabled payment instruments enable changes in the nature of water-related transactions that facilitate overall improvements in customer payment behaviours.

Payments made using wireless pay points and mobile money services are significantly smaller in value and are conducted later than transactions completed at water offices. Evidence presented in Table 2-5 shows significantly lower payment values for both wireless pay point and mobile money transactions. Higher transaction costs associated with water office payments makes it necessary for utility customers to conduct higher-value transactions. If the difference between the total cost of making a payment and the value of the transaction itself is too low, customers may choose to forego payment, particularly if those resources can be used more effectively elsewhere. Wireless pay points and mobile money services increase ease and reduce costs of making payments, which expands opportunities for conducting lower-value transactions. Existing work in transaction cost economics has found that the size of a transaction can influence transaction costs and the choice of payment instrument (Whitesall, 1989; Abdul-Muhmin, 2010; Bounie and Francois, 2011). These studies espouse a view of transactions as static and unchanging, where the transaction is constant and must be paid or not paid. Evidence from Dar es Salaam, where bills can be partially paid, illustrates that transactions can also be dynamic and responsive to various payment instruments.

How does a change in relative transaction cost influence payment practices? Lower costs of making payments not only reduce the size of transactions, it also allows customers to make payments on a more regular basis. Few customers in Dar es Salaam make monthly payments

for water services; in reality, most customers pay once every three or four months. I argue that these low frequencies are a consequence of the high transaction costs associated with water utility payment offices. If it is expensive in terms of time and money to make monthly trips to a payment office, this trip will be made less often than if it is less expensive. Mobile-enabled payment methods represent a cheaper option for paying, which has therefore bolstered the payment frequencies of those customers choosing to use these methods. Evidence on customer payment behaviours in Table 2-6 shows how significantly key variables and transactional elements have shifted with the incorporation of mobile options. Customers using mobile-enabled payment methods make smaller-value payments with significantly greater frequency than those that do not use the options, which contributes to significantly higher revenue collection for the utility.

It should also be noted that mobile-enabled payment methods made payments later, on average, than water office payments. No payment method was associated with 'timely' transactions made on or before the seventh of the month, but wireless pay points were associated with the latest payments overall. Payment timeliness is significant for monthly cash flows, which are important for the financial vitality of a utility (Mugabi and Kayaga, 2010). A previous study of mobile water payments also showed a significant impact on payment timeliness (Foster, *et al.*, 2012). The experience of mobile-enabled payments in Dar es Salaam does not share in these findings, as the later dates of transactions suggest that the new methods are not making a meaningful contribution to improving monthly cash flow. On the contrary, it is possible that the ease of making a payment using wireless pay points and mobile money can incentivize late payments. Increased ease of payment makes it easier to forget to pay a bill, but also makes it much simpler to correct that mistake with lower cost options that were previously unavailable.

Also significant is the importance of combining payment methods, which significantly expands revenue collection. Customers who used only one option in their payment practices were infrequent payers who exacerbated revenue under collection. Poor payment behaviours were most significant for customers who used only either wireless pay points or mobile money services, and the combination of both options did not significantly change payment behaviours. The high mean revenue collection for customers using both mobile money and pay points, without commensurate changes in payment frequency or transaction value, cannot be directly attributed to the new options without further socioeconomic and demographic information on those customers in particular. On their own, mobile-enabled payment methods do not improve customer payment behaviours or utility revenue collection. Allowing customers to combine mobile-enabled and water office payment options generated significant improvements in payment practices and clearly observable per-customer revenue gains for utilities. Mobile-enabled payment methods cannot yet be viewed as viable replacements for water office payments, but rather should be perceived as complements to them.

Customers who combine all three payment options demonstrate the best payment behaviours of all utility customers, making the lowest value and highest frequency payments, which translates into the highest per-customer revenue contributions to the utility. This shows that having more payment options may contribute to better payment practices, but it essential that the payment instruments have variable transaction costs. This paper carried an analytical assumption that the act of paying a water bill begins at a household and terminates at the point of payment; the reality of human life might suggest otherwise. The ease of payment afforded by mobile-enabled payment methods allows customers to incorporate the act of paying a bill into their daily activities, rather than taking a day of travel and waiting. As customers move around Dar es Salaam during the course of a day, transaction costs for these three methods are constantly changing in relation to an individual's available time, distance from various

payment locations, and potential need to visit a utility office for a customer inquiry. Having multiple payment methods available enables good payment practices of customers by facilitating payments that can now be made at any time, from any location, and for any amount.

Evidence from this study suggests that wireless pay points may be more effective and appropriate for customers operating in low-income countries. Adoption of mobile-enabled payment methods has occurred at an asymmetric rate, with wireless pay points experiencing wider adoption for water services payments by the end of 2011 than mobile money services. Customers using wireless pay points also exhibit better payment behaviours than those using mobile money. This may be a consequence of wireless pay points having lower relative transaction costs, which contravenes an earlier assumption that mobile money services had the lowest relative transaction costs for water bill payments. Evidence of significant differences in transaction value and timeliness across water office payments and mobile-enabled methods illustrate the importance of site specificity in determining transaction costs. Less clear is the relative importance of human asset and physical asset specificity in determining transaction costs in this context. Human asset specificity, which is highest for mobile money because of the need to learn a new application and potentially a new device (i.e. mobile handset), appears to be more significant than previously thought due to the decreased role mobile money plays in Tanzania for water service payments. Wireless pay points have a degree of physical asset specificity (i.e. the point-of-sale device), but this does not appear to add transaction costs for customers, because they themselves do not use the device or need to know how it works.

2.7. Conclusions

The introduction of mobile-enabled payment methods for water services is changing the nature of water-related transactions and the payment behaviours of water utility customers in Dar es Salaam, Tanzania. Using a unique dataset of payments for water services in Dar es

Salaam, this paper argues that mobile payment innovations reduce the transaction costs involved in making a water-related payment. Reductions in transaction costs enabled declines in the value of transactions, increases in payment frequency, later payment timeliness, and overall increases in annual revenue collection per customer. These findings hold potentially significant implications for the long-term financial sustainability of the urban water sector by creating opportunities to improve cost-recovery, achieve reductions in distributional losses, and enable declines in labour inefficiencies. Research findings also provide evidence for more nuanced understanding of the relationships between transactions and payment instruments, as well as the importance of asset specificity in identifying the strengths and weaknesses of novel mobile-enabled payment methods.

This study holds practical implications for policy- and decision-makers in the urban water sector. Mobile-enabled payment methods can support greater financial sustainability in urban water provision by improving cost recovery through greater levels of revenue collection. Customers may have the ability and desire to pay their water bills, but if their opportunity to do so is burdened with high transaction costs, as is the case with water utility payment offices, underpayment and nonpayment is a likely outcome. Utilities aiming to improve cost recovery might be able to do so by increasing the ease of payment for customers; wireless pay points and mobile money services are two payment instruments that have supported this shift in Dar es Salaam and may prove useful in other contexts. Mobile-enabled payment methods also decrease the number of transactions that are conducted within utility payment offices, freeing up limited staff and financial resources that can be used strategically by utility managers. Utility missions of providing adequate water services to their urban populations will not be realised if the complementary interactions between mobile methods and water offices are overlooked. The growth of mobile-enabled payment methods in East Africa has led to a call by public officials to close utility payment offices, the most visible example being Uganda's e-

water initiative (Wafula, 2011). Significant revenue gains achieved through the combination of multiple payment channels suggest that closing water offices may actually harm utility revenues, rather than augment them.

Research implications of these findings are also pertinent, as they have opened new avenues of inquiry into the growing role in daily life of electronic payments in general and mobile payments specifically. Urban water literatures continue to identify the issues of customer nonpayment and underpayment of bills as a substantial constraint in the urban water sector. Conventionally, poor service quality and inadequate utility performance are labeled as causes of this condition. The significant improvements in customer payment behaviours facilitated by mobile-enabled payment methods suggest that more empirical examinations into the reasons for nonpayment and underpayment are required. Furthermore, once a utility has raised additional revenue by expanding customer payment options, there is no understanding of the decision-making processes of utilities in this context. How will they use the resources and will water services quality or access be improved as a consequence? This presents an interesting question for scholars of governance and corruption in the water sector, since many of the potential implications of enhanced revenue and cost recovery are contingent on the fair and honest dealings of decision-makers. Finally, this study has revealed some sobering insights into the usefulness of mobile money services for water payments in Dar es Salaam. The widening popularity of wireless pay points - which tend to fit more easily into patterns of life before the 'mobile revolution' - far outstrips adoption of mobile money. This points cautiously to the appropriateness of different payment options and financial instruments across sectors. While useful for banking and basic financial services, mobile money services do not appear to be the best alternative to water office payments in Dar es Salaam. More active research and comprehension is needed if the growing field of payment instruments reliant on

mobile communication technologies are going to be used as tools to effectively promote development outcomes and quality-of-life gains in low-income countries.

3. CAN MOBILE-ENABLED PAYMENT METHODS REDUCE PETTY CORRUPTION IN URBAN WATER PROVISION?

Abstract

Corruption in the urban water sector constrains economic growth and human development in low-income countries. This paper empirically evaluates the ability of novel mobile-enabled payment methods to reduce information asymmetries and mitigate petty corruption in the urban water sector's billing and payment processes. Overcoming these barriers may promote improved governance and water service delivery. The case of Dar es Salaam is used to explore the role of mobile-enabled payment instruments through the use of a stratified random sample of 1097 water utility customers and 42 interviews with representatives from the water sector, the telecommunications industry, civil society, and banking institutions. Results show that mobile-enabled payment methods can reduce information asymmetries and the incidence of petty corruption to promote improved financial management by making payment data more transparent and limiting the availability of economic rents in the billing and payment process. Implications for African urban water services include wider availability and more effective use of human and financial resources. These can be used to enhance water service delivery and citizen participation in the production of urban water supplies. The use of mobile-enabled payment methods in the urban water sector represents an application of mobile communication technologies in a low-income country with proven potential for scalability that simultaneously supports the achievement of development objectives.

3.1. Introduction

Petty corruption causes significant but often invisible financial losses within Africa's urban water sector (Plummer and Cross, 2006; AICD, 2010). Practices such as bribery, theft, and collusion continue to flourish in the absence of adequate mechanisms to identify and mitigate

illicit activities that confound revenue collection and customer-utility interactions. Given that the proportion of urban populations in sub-Saharan Africa receiving piped water supplies has remained unchanged since 1990 (WHO/UNICEF, 2013), it is surprising that few empirical studies have addressed this increasing political, financial, and development policy challenge. Dar es Salaam, Tanzania launched the first mobile-enabled payment system for urban water services in 2009. This application of mobile communication technologies, and in particular new payment instruments for water bill transactions, offers experience and evidence to examine whether mobile-enabled payments are tackling corruption, and if so, how.

The adoption of mobile phones and extension of mobile networks has outpaced access to improved water sources in sub-Saharan Africa, which over 323 million people still lack (WHO/UNICEF, 2013). Even though the world has recently achieved the Millennium Development Goal (MDG) drinking water target in 2010, many countries in Africa are not on track to attain this goal and it is unlikely that they will do so by 2015 (Ibid). Service providers also face financial inefficiencies that result from low tariffs, unreliable client records, and inefficient billing and collection systems (Mwanza, 2005). In a study of water vending throughout Dar es Salaam, Tanzania - the focus of this study - Kjellen suggests that political interference and poor billing and payment collection systems are primary contributors to service deficiencies in Dar es Salaam (2000). Incorporating mobile technologies and related innovations into water services delivery is a growing trend that has generated significant optimism for the future of the water sector on the continent (Georgiadou, *et al.*, 2011; Hope, et al., 2012; Foster, et al., 2012; Hutchings, *et al*., 2012).

Although urban water providers are faced with a complex set of challenges over which they have limited control, petty corruption may be a barrier that utilities can now influence through the integration of mobile technologies into water service operations. Plummer and Cross

identify administrative corruption in payment systems as a primary source of corruption in Africa (2006), and significant financial resources are lost to corruption as rent-seeking behaviours decrease investment opportunities by increasing the cost of capital and limiting the productivity of potential internal and external investments (Mauro, 1995; Tanzi and Davoodi, 1997; Wei, 1999). Informal payments for services are common and are used to falsify meter readings, expedite connections, and for collusive activities that exacerbate water theft and financial losses (Davis, 2004). The information-enhancing properties of mobile technologies and related payment innovations represent an opportunity to reduce dead-weight loss in water service delivery (Hope, *et al*., 2012) and potentially combat petty corruption, consequently enhancing service quality and provision.

This paper analyses the relationship between petty corruption and alternative mobile-enabled payment channels (i.e. mobile money services and wireless pay point networks) in water sector billing and payment processes. Using the principal-agent framework to assess differences across payment methods for key corruption-inducing and -mitigating factors, we explore the ways in which mobile communication technologies might reduce the potential for, and incidence of, corruption in the urban water sector. Section Two reviews drivers of petty corruption and discusses emergent mobile-enabled payment options that can be used to reduce its incidence in the urban water sector. Section Three employs agency theory and the principal-agent framework to describe the conceptual relationships that structure this paper. Data obtained via semi-structured interviews and a customer payment preferences survey are described in Section Four, which is followed by a presentation and discussion of how corruption-inducing variables are influenced by multiple payment methods - water offices, bank branches, mobile money services, and wireless pay point networks. Wireless pay point networks and mobile money services are particularly effective at constraining opportunities for corruption by minimising customer-staff interactions, limiting the availability of economic

rents, and diminishing the effective monopoly Dar es Salaam's water utility previously held over payment services. The paper concludes with an evaluation of the potential impacts of mobile payment innovations on petty corruption and the shifting nature of interactions between customers and the utility in a context of broad utilisation of mobile communication technologies in the billing and payment process.

3.2. Corruption and Mobile Technology in the Water Sector

3.2.a. Corruption in the Urban Water Sector

The urban water sector has traditionally been perceived as a locus for petty corruption. Monopoly structures of provision and in payment services reduce competitive pressures within the sector as the technical complexities of production and distribution decrease transparency and create information asymmetries (Elshorst and O'Leary, 2005; Anbarci, *et al.*, 2009). High and constant demand for water services reinforces the position of power enjoyed by water suppliers and encourages bribes and other payments, and constant interactions between consumers and service providers foster an environment in which utility staff enjoy significant levels of discretionary power (Stalgren, 2006). Klitgaard presents an institutional perspective that positions corruption as a function of monopoly power, discretionary power, and transparency or accountability (1988; from Stalgren, 2006). Institutions characterised by low levels of competition (i.e. extensive monopoly power) and high levels of discretion expand the prevalence of corruption while the converse is true where there is transparency in political and economic exchanges and citizens have the ability and capacity to express dissatisfaction (Ibid, Stalgren, 2006). Corruption consequently flourishes in the urban water sector, where transparency is traditionally limited and monopoly power is the norm. Petty corruption in the billing and payment process is often operationalised as informal transactions by individuals for falsified meter readings; expediting of repair work and new connections; avoiding disconnection; as well as concealment, installation, or ignoring of illegal connections (i.e. collusion).

Widespread information asymmetries and the high costs of obtaining information challenge water provision in sub-Saharan Africa and enable corruption, which occurs in places where the availability of and access to information is constrained and the ability of knowledge transfer is limited. Corruption violates key normative principles of transparency, accountability, participation, and probity (McGranahan and Satterthwaite, 2006), and refers to activities in which powers of public offices, or the powers entrusted to private actors, are abused for personal gain in a way that violates social norms and values (Jain, 2001). Of the three primary forms of corruption that exist - grand, bureaucratic, and legislative (Rose-Ackerman, 1978) - bureaucratic corruption is most closely related to water services provision in general and water payment systems specifically (Davis, 2004). Bureaucratic corruption points to the actions of appointed bureaucrats and agency staff that contravene regularised interactions with superiors or the public and can include petty and grand corruption. Fraudulent activities such as paying or receiving bribes or the outright theft of revenues are common within the urban water sector, particularly in low-income countries (Ibid, Stalgren, 2006). The voluntary or coerced illegitimate transfers of funds and favors that comprise petty corruption frequently occur at individual scale, but are typically overlooked due to the small value of transfers relative to the larger kickbacks and payments made during procurement procedures, institutional hiring processes, and infrastructure development.

Mitigating the prevalence of petty corruption in the water sector can be partially accomplished through reductions in imperfect information and by manipulating the contextual settings in which water provision takes place. Greater access to information has been shown to deter petty corruption in the delivery of public services such as health and education (Deininger and Mpuga, 2005; Reinikka and Svensson, 2011). In the water sector, participatory monitoring and oversight mechanisms built on transparent access to public accounts and decision-making are ways to enhance information flows (Stalgren, 2006). Imposing financial or social

penalties for corruption, as well as reducing monopoly power through increased competition in service provision, can also be used to alleviate illicit activities associated with corruption (Ibid). Increasing competition in payment services are expected to have a similar effect. Drawing on data from India's urban water sector, Davis highlights the significant role that information technologies can play in reducing the discretionary power of civil servants and enhancing information sharing between customers and the utility (2004). At the time of her study, key initiatives such as computerised application procedures and published fee schedules increased customer convenience and decreased the magnitude of informal payments in the connection process. Using information technologies in the billing and payment process may diminish the prominence of corruption in the water sector by limiting the discretionary power of ground-level utility employees (e.g. meter readers, cashiers), decreasing monitoring costs for utility managers, and increasing the likelihood of enforcement and sanctions being applied to individuals engaged in corruption.

3.2.b. Mobile Communication Technologies and Urban Water Provision

Increased penetration of mobile phones and mobile networks across sub-Saharan Africa bolsters the potential for these technologies to be used to address petty corruption. Since 2002, mobile phone subscriptions[6] on the continent have climbed from 16.5 million to a projected 700 million in 2016 (GSMA/Deloitte, 2012). Similar trends are taking place in East Africa. 2002 penetration[7] rates stood at 3.6% in Kenya, 1.7% in Tanzania, and 1.5% in Uganda. By 2012, these figures grew to 69%, 50%, and 42% in Kenya, Tanzania, and Uganda, respectively (Ibid). Empirical explorations of mobile technology's impacts have touched on the operations of micro- and small-enterprises (Donner and Escobari, 2010; Essegbey and Frempong, 2011), improving efficiency in fisheries (Jensen, 2007) and grain markets (Aker, 2010), preventing disease (Padma, 2010; Wesolowski, *et al*., 2012), and agricultural extension

[6] Mobile phone subscriptions refer to the absolute number of mobile phone accounts within a designated population.

[7] Mobile phone penetration refers to subscriptions as a proportion of designated populations (James and Versteeg, 2007).

services (Aker, 2011). These studies show that use of mobile communication technologies can reduce information asymmetries, although the delivery of public services such as urban water provision has been neglected.

New payment instruments have been developed that operate using mobile phones and mobile communication networks. Mobile money services, such as M-PESA in Kenya, are currently the most well-known of these new payment options. Jack and Suri (2011) present a comprehensive overview of the development and operation of mobile money systems, which allow citizens to deposit, withdraw, and transfer money using the SMS capabilities of their mobile phones. Customers in many urban areas can now use these instruments to pay for public services, such as water, electricity, taxes, and educational fees (Kshetri and Acharya, 2012). Existing empirical studies focus almost exclusively on mobile money services and questions of financial access (Ivatury and Pickens, 2006; Alampay and Bala, 2010; Donovan, 2012) and domestic remittances (Morawczynski, 2009). These studies have so far overlooked alternative mobile-enabled payment methods. One such alternative is the emergence of networks of GPRS[8]-enabled point-of-sale devices, which contribute considerably to the diversification of East Africa's payment landscape. Wireless pay points transmit payment data and other information in real time over mobile networks, but do not require customers to own a mobile phone since transactions are carried out at routine physical retail locations like pharmacies, kiosks, grocery stores, and petrol stations. Pay points are often more numerous and a shorter distance from clients than water payment offices, and the process of conducting a transaction is more familiar to customers than using mobile money. The existence of this option and its prevalence in countries such as Tanzania and Rwanda has not yet been acknowledged by mobile money experts. Minimal engagement with public service delivery

[8] General Packet Radio Service, of GPRS, is a mobile data service that is used by mobile phones and forms the bases for mobile-enabled point-of-sale technologies. The remainder of this paper refers to these point-of-sale devices as `wireless pay points'.

and the lack of acknowledgement of a new mobile-enabled payment solution indicate significant gaps in the current mobile-enabled payments literature.

Beyond mobile-enabled payment instruments, mobile communication technologies are increasingly being used in the water sector's billing and payment processes. Mobile phones remove barriers to communication traditionally associated with low-income countries and facilitate remote and real-time interactions between utility managers and their staff. Mobile phones are also used by customers to communicate directly with utility customer service representatives and other employees. Monthly SMS billing messages are sent by the utility to gently remind customer to pay their bills and utility clients have the ability to obtain their account balance via SMS billing inquiries. In Dar es Salaam, Tanzania, customers receive billing reminders free-of-charge and billing inquiries incur a 150 TZS fee [0.09 USD]. Applications of mobile communication technologies in the urban water sector enhance information availability and access, and may therefore diminish the prevalence of corruption.

3.3. Theoretical Framework: Agency Theory and Principal-Agent Problems

Agency theory, and its specific focus on principal-agent relationships, is appropriate for the analysis of actor interactions at multiple scales in a context of high information asymmetries (Rose-Ackerman, 1978; Jain, 1998). Agency theory engages with problems in which the goals of a principal and an agent conflict and verification of what an agent is actually doing is difficult or expensive to verify (Eisenhardt, 1989). Contractual relationships between principals and agents are the primary unit of analysis within agency theory, although analytical attention is often paid to each actor who is assumed to be characterised by self-interest, risk aversion, and bounded rationality (Ibid). Corruption emerges because agents have incentives to disregard the interests of their principals due to the exploitability of imperfect information. Principals find it difficult to oversee agents because monitoring is

costly. Limiting corruption must include the identification of mechanisms that mitigate corruption by reducing information asymmetries and lowering monitoring costs within the interactions between actors. Figure 3-1 illustrates the conceptual framework employed in this paper, which is discussed in detail below.

Three conditions may influence an actor's propensity towards corruption within the principal-agent framework: discretionary power, economic rents, and enforcement mechanisms (Jain, 2001). Discretionary power is the authority to design and administer regulations or services and is granted to administrators and bureaucrats, whose exercise of power is costly to monitor. Generally, the more discretionary powers an individual has, the greater the propensity toward corruption-related activities (Johnson, Kaufmann, and Zoido-Lobaton, 1998). Economic rents are monetary resources that can be captured by identifiable groups via bribes, informal payments, or theft. Enforcement mechanisms and penalties refer to the probability of being caught and are commonly influenced by the ability of sanctions to be levied, the independence of the judiciary, and equal access to the law. Whereas penalties and enforcement are deterrents to corruption that can be exercised by the principal, discretionary powers and economic rents create opportunities for petty corruption and are within the purview of the agent (Jain, 2001). Abating these opportunities should consequently focus on reductions in discretionary power, limiting the availability of economic rents, and expanding the probability of enforcement.

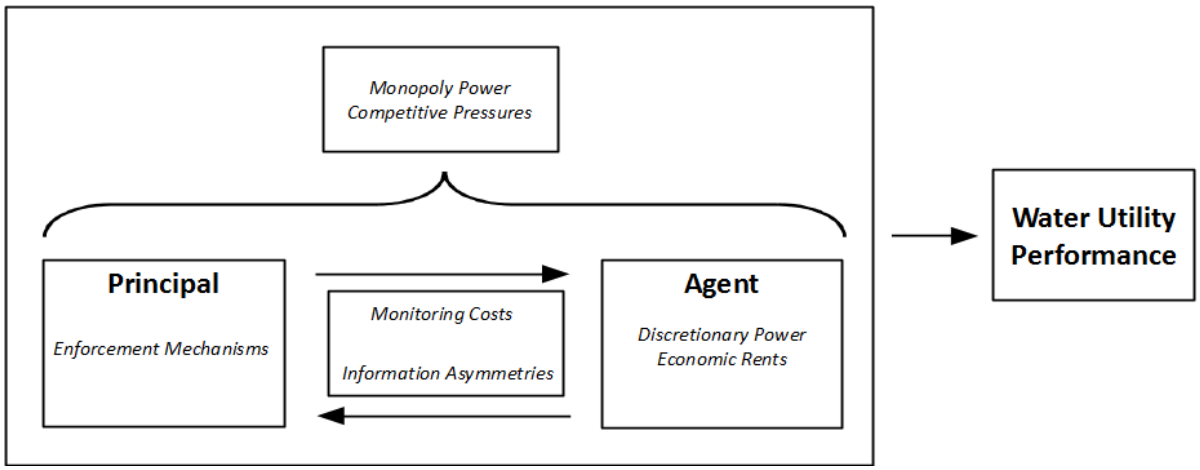

Figure 3-1. Conceptual framework detailing the relationship between the principal-agent framework and water utility performance, influenced by mechanisms related to actors, their interactions, and the external environment. *Source: Author*

Changes in the environment external to actors and their respective interactions also have modifying effects on corruption. Ades and DiTella (1997) suggest three possible approaches that can be used to influence exogenous variables: legal, business, and market. Legal interventions increase the costs and risks associated with corruption by strengthening laws and enforcement mechanisms. Business interventions attempt to 'buy out' corruption by offering incentives to officials to not engage in corruption-related activities. Market interventions rely in the increased role of competition and markets, reducing the range and value of transactions that can potentially be exploited. Increased competition with bureaucracies, resulting from a service provider allowing clients to obtain services from other organisations, is a market intervention that influences the incidence of corruption (Schleifer and Vishney, 1993). Rose-Ackerman (1978) also argues that competitive pressures can reduce the level of corrupt payments or drive them to zero, particularly in cases where civil servants have considerable monopoly power. The introduction of mobile-enabled payment methods may constitute a market-based intervention in payment services that can reduce corruption if it breaks monopoly power by increasing competitive pressures through shorter and quicker financial pathways that foster greater transparency.

Mobile communication technologies change the nature of information exchange between two individual entities, and applications of this technology, such as mobile-enabled payment methods, can potentially influence the prevalence of petty corruption in the water sector. The growing use of mobile phones throughout sub-Saharan Africa is improving communication as mobile-enabled payment options create automated and virtually cash-less payment pathways. These technologies may be influencing the corruption-related conditions affecting principal-agent relationships: monopoly power, competitive pressure, discretionary power, economic rents, enforcement mechanisms, monitoring costs, and information asymmetries.

By using these seven conditions to structure analysis of qualitative data, it becomes possible to identify factors that can influence the development of petty corruption within a principal-agent interaction. It is advantageous to use this approach because it offers multiple proxies for understanding the potential for petty corruption when direct data on the incidence and extent of corruption is not available, such as this case. This advantage is also a limitation in that it offers only an indirect examination of the realities of petty corruption within water-related transactions in Dar es Salaam. Focusing on these seven thematic elements provides little more than a systems-level view of transactions and the relative, rather than absolute, measure of petty corruption that may be occurring between the utility, its employees, and bill-paying customers.

3.4. Methods, Data Collection, and Analytical Approach

3.4.a. Research Setting

Dar es Salaam, Tanzania was chosen as the geographic focus of this study because of its diverse payment landscape, adoption rates of mobile-enabled methods, and the availability of data. Borne out of an initial agreement between the water utility, a telecommunications firm (i.e. Zain, now Airtel Tanzania), and a third-party Tanzanian technology company (i.e. Selcom Wireless), mobile-enabled payment methods were introduced in mid-2009. Mobile-

enabled payment instruments are payment options that rely on the use of mobile communication technologies to transmit electronic transaction information. In Dar es Salaam, this designation includes mobile money services (i.e. Vodacom's M-PESA and Airtel Money from Airtel Tanzania) and wireless point-of-sale networks (i.e. Selcom Wireless Pay Points). One additional mobile money service (i.e. Tigo's TigoPesa) and another wireless point-of-sale network (i.e. MaxMalipo by Maxcom Limited) began accepting water bill payments after data collection took place between September 2011 and September 2012.

At the beginning of 2010, mobile money payments and wireless pay points accounted for 0.4% and 1.1% of water transactions, respectively. By the end of 2011, mobile money was used for 1.6% of water payments and 13.4% of payments were made using pay points; at the same time over 25% of utility customers had tried these methods at least once. Although mobile money water transactions made with mobile money have remained relatively static, wireless pay point networks accounted for approximately one out of every four water-related transactions made in 2012. The utility absorbs fees for payments made using M-PESA and Selcom Wireless Pay Points, while customers must pay a standard mobile money fee if they pay their water bill using Airtel Tanzania. Comparisons of adoption of these methods and descriptions of the financial relationships between water utilities and telecommunications firms in East Africa can be found in Hope, *et al*. (2011) and Foster, *et al.* (2012). Based on their findings and analyses, it is possible that Dar es Salaam has experienced one of the highest levels of adoption of mobile-enabled payment methods for water bill payments.

The Dar es Salaam Water and Sewerage Corporation (DAWASCO) is a publically-formed independent operator responsible for providing piped water services to the city of Dar es Salaam, but struggles to ensure adequate supplies. Demand for piped water services mushroomed as urbanisation and population growth inflated the nation's urban population

from 19% in 1990 to 26% in 2010. Metropolitan access to improved water supplies simultaneously declined from 94% to 79% over the same period and the proportion of urban populations with piped connections plummeted to just 23% (WHO/UNICEF, 2010). Urban expansion in Tanzania typically takes the form of unplanned settlements, and it is estimated that over 65% of the urban population lives in these areas unserved by urban water utilities (UN-HABITAT, 2011; Dagdeviren and Robertson, 2011). Water provision in Dar es Salaam continues to decline as fewer than 27% of utility customers receive reliable service, compared with 100% at independence in 1961 (WaterAid, 2008). Scholars have described the city's water obstacles as a corollary of deficient financial resources, political interference, petty corruption, poor billing and payment systems, and neglect of the unique service arrangements required by low-income populations (Kjellen, 2000; Kyessi, 2005; Dill, 2010). Mugisha and Brown (2010) and WaterAid (2008) provide an overview of the historical development of urban water services in Dar es Salaam.

3.4.b. Methods and Analytical Approach

Evaluations of actor-, interaction-, and environment-related hypotheses employ qualitative data obtained from semi-structured interviews and key elements of a survey administered to water utility customers in Dar es Salaam, Tanzania. Methodological approaches to exploring the relationship between corruption and public service delivery are diverse and have included game-based methods (Barr, Lindelow, and Serneels, 2009), analyses of large datasets (Deininger and Mpuga, 2005; Anbarci, *et al*., 2009), interviewing, and surveys (Davis, 2004). A survey methodology based on Davis (2004) is taken to identify key elements of each payment method and contextualise the corruption-related activities that may take place within each payment pathway. Data include 42 interviews with individuals involved in the design, implementation and operation of mobile-enabled payment instruments and 1097 survey responses from water utility customers.

Table 3-1. Affiliations of respondents participating in interviews.

INSTITUTION	RESPONDENTS
Water Utility	*12*
Mobile Network Operators	*6*
Water Committees	*5*
Ministry of Water	*4*
Banking Institutions	*3*
Third-Party Telecom Firms	*3*
Municipal Water Officers	*3*
Water Authority	*2*
Water Regulator	*2*
Civil Society	*2*

Source: Author

Semi-structured interviews focused on billing and payment processes available to water utility customers in Dar es Salaam, Tanzania, and perceptions of corruption-related activities for both traditional and mobile-enabled payment methods. The interviews took place between September 2011 and September 2012. Respondents were selected via snowball sampling that originated with key informants within the public water sector, the telecommunications sector, and civil society organisations. Participants came from a variety of sectors, which is detailed in Table 3-1. Payment preference surveys were administered by a six-person research team to water utility customers throughout Dar es Salaam between August and September 2012. The survey was developed by the author in partnership with the water utility and piloted in June 2012. Survey responses include geographic location and housing, socioeconomic variables, demographic variables, assets/expenditures, mobile phone use, payment methods and preferences, payment behaviours, service satisfaction, disconnections/reconnections, alternative sources of water, community supplying behaviours, and SMS billing reminders. 1097 responses were generated and customers were invited to share their thoughts on the

performance of the water utility. Customers were randomly sampled during one billing cycle and the survey was administered at physical payment locations (i.e. water offices, banks, select mobile money agents, and pay point locations). Payment locations were identified using systematic random sampling of wards that contain water offices and those that do not. Within each randomly selected ward, physical payment locations were also randomly selected to comprise a sampling frame generating a stratified group including water offices, banks, and wireless pay points. All water utility customers were invited to participate in the survey.

Qualitative data obtained from semi-structured interviews and the customer survey were coded in relation to seven primary corruption-inducing factors. Descriptive narratives were constructed from the coded data for each theme to evaluate each payment method's relative influence over competitive pressures, monopoly power, discretionary power, economic rents, enforcement mechanisms, information asymmetries, and monitoring costs. Relative rankings of "High", "Intermediate", and "Low" are used to illustrate how each payment instrument moderates corruption-related forces in relation to the others.

3.5. Evidence and Analysis

An overview of the billing and payment process for each payment method is found in Table 3-2, and the socioeconomic and demographic characteristics of customers who use and do not use mobile-enabled payment instruments are summarised in Table 3-3. These summaries were assembled from interviews with key actors as described in Table 3-1. Each subsection begins by presenting data related to the various elements influencing the context in which petty corruption occurs - monopoly power, competitive pressures, discretionary power, economic rents, enforcement mechanisms, monitoring costs, and information asymmetries. Data are then analysed and related to the conceptual framework introduced in Section Three.

Table 3-2. Summary of the billing and payment process for four payment methods used in Dar es Salaam, Tanzania.

STEP	WATER OFFICE	BANK BRANCH	PAY POINT	MOBILE MONEY
Meter Reading	*Meter reader - physical visit to customer house*	*Meter reader - physical visit to customer house*	*Meter reader - physical visit to customer house*	*Meter reader - physical visit to customer house*
Data Entry	*Billing officer - manual entry at utility office*	*Billing officer - manual entry at utility office*	*Billing officer - manual entry at utility office*	*Billing officer - manual entry at utility office*
Bill Generation	*Revenue manager - paper bill at utility office*	*Revenue manager - paper bill at utility office*	*Revenue manager - paper bill at utility office*	*Utility IT staff - electronic bill via SMS*
Bill Distribution	*Meter reader or mail - physical distribution*	*Meter reader or mail - physical distribution*	*Meter reader or mail - physical distribution*	*Utility IT staff - electronic distribution*
Bill Payment	*Cashier - collects cash at utility office*	*Teller - collects cash at bank branch*	*Pay point operator - sends electronic cash via SMS/data*	*Customer - sends electronic cash via SMS*
Balance Inquiries	*Utility staff - customer visit to utility office*	*Utility staff - customer visit to utility office*	*Pay point operator - balance inquiry via SMS*	*Customer - balance inquiry via SMS*

Source: Author

Table 3-3. Demographic and socioeconomic comparison of users (n = 112) and non-users (n = 504) of mobile-enabled payment methods. Variables marked with an asterisk (*) are reported as the median of all values.

VARIABLES		USERS	NON-USERS
Demographic	Male	*43%*	*50%*
	Female	*57%*	*50%*
	Age*	*37.5*	*36*
	Household Size*	*7*	*6*
Employment	Full Time	*27%*	*28%*
	Part Time	*6%*	*8%*
	Student	*5%*	*9%*
	Self-Employed	*43%*	*38%*
	Unemployed	*23%*	*17%*
Education	Primary	*34%*	*26%*
	Secondary	*40%*	*39%*
	University	*19%*	*26%*
	Vocational	*8%*	*5%*
	None	*1%*	*3%*
Expenditures* *USD Monthly*	Food	*187.50*	*187.50*
	School	*34.38*	*37.50*
	Transport	*24.69*	*37.50*
	Mobile	*25*	*21.25*
	Electricity	*25*	*25*

Source: Utility Customer Survey Data

Monopoly Power

The extent of a water utility's monopoly power over payment services is assessed in relation to the existence and relative adoption rates of alternative payment services. Dar es Salaam's water utility was the sole provider of water bill payment services and collected approximately 100% of transactions before the introduction of mobile-enabled payment instruments in 2009. DAWASCO operates 14 water offices throughout its serviced area that act as central clearinghouses for bill payments, customer inquiries, and offices for managerial and operational staff. 2011 payment data show that these offices collected 92.2% of all water-related transactions and an average of 39495 payments per month (Table 3-4). 2011 saw a six fold increase in the share of payments collected through wireless pay points, suggesting that the share of payments collected by water offices continues to decline. Four banks with 53 branches are also able to collect water payments, but these locations received less than 20 payments per month in 2011 and accounted for less than 1% of all water-related transactions. Over 2000 wireless pay points are located throughout Dar es Salaam and in 2011 they collected 6.2% of all water payments (2698 monthly transactions). Two mobile money services serviced by over 10,000 agent locations in the city collected 1.6% of all water payments in 2011 (702 transactions/month). A cashier working for the water utility stated that the use of mobile-enabled methods has created "noticeable declines in the amount of customers" paying at water offices, which "frees up staff for other tasks." When asked about the low numbers of bank payers, a bank-based respondent suggested that the expansion of mobile banking channels would lead the growth of water payment collection.

Monopoly powers enable an entity to be the sole provider of a particular good or service, and the existence of formally-recognised payment services illustrates that there is no longer an official monopoly on payment services in Dar es Salaam. Expanding adoption of recent additions to the payment landscape in the city - wireless pay points in particular - also

suggests that the water utility no longer holds a monopoly over payment services in the urban water sector (Table 3-4).

Table 3-4. Comparison of four payment methods for monopoly power. Variables marked with a (*) are reported as mean monthly values in 2011.

PAYMENT METHOD	SERVICES	LOCATIONS	PAYMENTS (%)*	PAYMENTS (#)*
Water Office	*1*	*14*	*92.2*	*39485*
Bank Branch	*4*	*53*	*<1*	*18*
Wireless Pay Point	*2*	*2000+*	*6.3*	*2698*
Mobile Money	*3*	*10000+*	*1.6*	*702*

Source: Author

Alternative payment channels offer payment services at a larger number of locations with a more expansive geographic footprint. The share of payments collected by water offices has fallen and continues to do so since the introduction of new payment instruments in 2009. Wireless pay points and mobile money services are useful for the act of making payments and appear to have diminished pressure on utility cashiers. Diminished demand for utility-provided payment services means that the utility is able to direct more financial and human resources toward other tasks. Although customers increasingly turned to these new payment instruments to pay their water bills, they remain reliant on water offices for other services related to disconnection/reconnection, customer care, and billing issues.

Competitive Pressures

Examining differences in competitive pressures required the collection of data related to reconciliation periods[9], transport methods, wait times, geographic extent, open hours per week, and water sector perspectives (Table 3-5). Water offices are found in only 13 of 73 Dar es Salaam wards (i.e. neighbourhoods) and are open for approximately 45 hours each week from Monday-Saturday. A majority (52%) of customers takes public transport to make water

[2] Reconciliation period refers to the time interval between when a payment is made and when that payment is reflected in customer accounts.

office payments, and the median wait time at the payment location is 10 minutes. The reconciliation period for these payments is 8 hours. Bank branches, conversely, have a reconciliation period of 7 days and are only open for 37 hours per week. Approximately 48% of bank payers travel via personal car to the branches, which are located in 29 wards. Wireless pay points and mobile money services are found or can be used in all 73 of the city's wards and are characterised by immediate reconciliation periods. Customers using wireless pay points prefer to walk (33.3%) or take public transport (31.2%), and they experience a low median wait time of 5 minutes. Mobile money payments can be made at any time during the week (168 hours) and wireless pay points are open for approximately 105 hours per week.

Table 3-5. Comparison of four payment methods for competitive pressures.

PAYMENT METHOD	**RECONCILIATION PERIOD**	**TRANSPORT METHOD**	**MEDIAN WAIT** (minutes)	**NO. OF WARDS** (out of 73)	**OPEN HOURS** (hrs/wk)
Water Office	*8 Hours*	*Public*	*10*	*13*	*45*
Bank Branch	*7 Days*	*Personal Car*	*7*	*29*	*37*
Pay Point	*Immediate*	*Walk*	*5*	*73*	*105*
Mobile Money	*Immediate*	*N/A*	*10 (at agent)*	*73*	*168*

Source: Author; Utility Customer Survey Data

These figures are complemented by comments made by respondents in interviews. One area manager noted that although customers often have the ability to pay their water bills, they do not want to "move to the office" to make a payment. Travel and time savings afforded by mobile money and pay point payments, coupled with the ability to pay at any time, meant that customers typically stopped paying at water offices when they learned of alternative mobile-enabled methods. Referring specifically to Selcom pay points, a second area manager declared that pay points were "everywhere" and that multiple sites are usually within walking distance from any point in the city. The ability to pay at any time with pay points in particular was discussed by multiple respondents, who emphasized Sundays, holidays, non-work hours,

power outages, and internal network failures as new periods of time that were now open to water-related transactions. One Ministry of Water official summarised the benefits of the new payment instruments by saying "Mobile money and pay points make the billing and payments process more user-friendly and efficient - this makes people more willing to pay their bills." Respondents also offered alternative perspectives – customer and utility personnel commonly criticised pay point receipts for being too similar to other and for low-quality ink that has a tendency to fade over time. There was also concern about transitions towards mobile-enabled methods. An employee overseeing one of Tanzania's mobile money services declared that "citizens are requiring time to become sensitised to the concept of electronic cash. This is very new for most of the population."

Competitive pressures are market-based mechanisms that impact the relative desirability of a particular good or service. Wireless pay points and mobile money services exhibit the fastest reconciliation times, which immediately credit customer accounts (Table 3-5). Bank branches take one week to achieve the same objective, while the water utility requires one business day. Mobile money services are the most geographically competitive because they can be used in all areas of the city. Wireless pay points are also widely available and typically require small amounts of travel, standing in stark contrast to the utility's 14 water offices, which require costly travel and longer wait times. Customer ability to pay at any time is expanded with mobile money services that can be used at any time and wireless pay points, which are not constrained by holidays or weekends and stay open longer than water offices. Water offices are only available to customers during working hours, when many people are required to be at their places of employment. Water offices do retain certain competitive advantages; mobile-enabled payment methods cannot offer the same customer services that are found at water offices. Despite these differences, wireless pay points and mobile money services have

expanded competition with the payment services offered by water offices, particularly for those customers who need only to pay their bills.

Discretionary Power

In payment interactions between a water utility customer and a payment service provider, discretionary power is held and exercised by the individual receiving the payment. Commercial assistants, cashiers, and commercial managers hold this power when utility-provided payment services are used in Dar es Salaam. A commercial assistant with DAWASCO indicated that he has the most customer interaction of any utility position, and that his job entailed meter reading, bill distribution, disconnections, and encouraging customers to pay their bills. Conversations with commercial managers at the utility confirm this. Commercial managers are responsible for bill generation, creating daily reports, supervising commercial assistants, and ensuring that daily and weekly revenue collection targets are met. Although interviews with commercial managers stressed that commercial agents are not allowed to collect money from customers, an area manager with DAWASCO stated that it is common practice in Dar es Salaam for customers to "pay commercial assistants to prevent disconnection when accounts are in arrears." A different area manager commented that "Sometimes, the meter readers will negotiate with customers to prevent them from being disconnected." Cashiers at DAWASCO are responsible for collecting payments, producing receipts, and entering payment data into the utility's computerized billing system. One cashier noted the cumbersome process required to change payment information when an error had been made, which required intervention from the commercial manager and revenue officers. Still another cashier stated "It is difficult for cashiers to give correct change and so we must round the amount." Outside utility payment offices, bank tellers and managers hold some degree of discretionary power when water payments are made at banks. Pay point operators and the managers of mobile money services also retain discretionary power if mobile-enabled

payment instruments are used. Few complaints were aired in relation to the actual operation of mobile money services or wireless pay points, both of which are subject to strict rules-of-process that limit the ability of individual actors to make decisions regarding transactions. Bank tellers, mobile money managers, and wireless pay point operators rarely do more than accept and record payments.

Discretionary power refers to the ability to design and/or administer regulations or particular services, and is highest when there are repeated interactions between consumers and suppliers (Stalgren, 2006). Evidence suggests that water utility commercial assistants, who have the greatest degree of interaction with customers, are endowed with more extensive discretionary power than other utility staff and employees at banks, wireless pay points, or mobile money services (Table 3-6). Commercial assistants enjoy a relatively high level of autonomy in their job, which requires broad geographic movement and large amounts of time spent away from their supervisors, who are based at area utility offices. This allows for disconnection-related negotiations with customers to take place more easily without oversight. Cashiers, who have relatively lower levels of discretionary power, can exercise it while rounding the change given to customers and can choose to correct or ignore purposeful or accidental errors made when entering payment information. Discretionary power held by commercial managers is derived from their ability to revise revenue reports and modify payment information, although there was no evidence to suggest that this was occurring illicitly. Bank employees, pay point operators, mobile money agents, mobile network operators have lower levels of discretionary power in accepting payments from customers. In Dar es Salaam, the entities employing these individuals have local shareholders or are owned by foreign companies or investors that hold employees to high standards of practice that limit discretionary powers. Pay point operators and mobile money agents are third-party entities have marginally higher levels of discretionary power, but the financial penalties and social stigma that can be levied by mobile

network operators and other stakeholders in response to abuses of power induce judicious exercises of it. Utility meter readers hold relatively high levels of discretionary power throughout the billing and payment process, but discretionary power is limited at the point of transaction for all payment methods.

Economic Rents

Payment funds constitute the economic rents that can be captured by actors during the process of making a transaction. When paying at a water office, customers hand physical currency to cashiers, who indicated that they commonly engage in practices such as rounding and accidentally giving incorrect change. When asked about M-PESA, a DAWASCO area manager said "I like it when people pay with M-PESA. It prevents petty theft by the cashiers if they need to borrow money and it means that the money from one day can't be stolen from our office at night if the bank closes before the cashiers can make the deposit." Customer interactions with other utility staff can also provide economic rents, as was described by a utility area manager, who commented on the negotiations that take place between commercial assistants and customers. "If the account is in arrears, the customer might give them 50,000 shillings [31.25 USD[10]]. Sadly, sometimes only 45,000 shillings [28.13 USD] can make it back to the office." Noting the differences between transactions made at mobile-enabled payment methods and water offices, respondents from telecommunications companies stated that the utility does not handle any cash when transactions are made using wireless pay points or mobile money services, and that the funds are transferred electronically from one account to another. There are also perceptions that mobile-enabled options are streamlining payment channels. As one Ministry of Water official pointed out - "Things like M-PESA are making the supply chain shorter for customers and [the water utility]. The process is now very easy

[3] The conversion from Tanzanian Shillings to United States Dollars used in this paper is 1 USD : 1600 TZS.

for customers." Electronic payment channels appear to restrict the availability of economic rents from water payments in Dar es Salaam's billing and payment processes.

Economic rents are the resources that fuel a large portion of corruption-related activities and most often result from the abuse of discretionary power. Jain (2001) considers two important factors related to economic rents: identifiable sources of rents and the groups or individuals that may seek to capture them. In the payment process for all payment methods, the dominant source of potential economic rents is the funds used to pay water bills (Table 3-6). For non-utility entities, there is a possibility that the rents can be captured by bank staff (e.g. tellers or managers), pay point operators, and mobile network operators, but there was no evidence to suggest that this is occurring at the point of payment. More sophisticated and electronic forms of theft, however, are possible.

In the utility, three primary sources of economic rents can be captured by employees: negotiations with customers to prevent disconnections, theft of daily revenues occurring before bank deposits are made, and petty theft at the point of payment. These rents can more easily be captured by cashiers and commercial assistants because the cash is physical and there is often no official record of the transaction until payments have been properly documented and manually entered into the utility billing system. Although bill payments are potential sources of economic rents for mobile-enabled payment methods, they are less likely to be captured because of their electronic nature. Once a payment is made using mobile money or at a pay point, the payment systems immediately create an electronic record that is difficult to erase or manipulate. As a result, economic rents tend to be more commonly available to, and captured by, utility staff.

Table 3-6. Analytical summary of variables related to corruption. Comparison of four payments methods used for water services transactions in Dar es Salaam, Tanzania.

VARIABLE	ELEMENT	WATER OFFICE	BANK BRANCH	PAY POINT	MOBILE MONEY
Monopoly Power	Number of Services	*Low*	*Intermediate*	*Intermediate*	*High*
	Locations	*Low*	*Intermediate*	*High*	*High*
	Share of Payments	*Declining*	*No Change*	*Rising*	*Rising*
Competitive Pressures	Reconciliation	*Intermediate*	*Low*	*High*	*High*
	Geography	*Low*	*Intermediate*	*High*	*High*
	Open Hours	*Low*	*Low*	*High*	*High*
Discretionary Power	Held By *(Level of Power)*	*Meter Reader* (High) *Cashier* (Intermediate) *Comm. Manager* (High)	*Teller* (Low) *Manager* (Low)	*Operator* (Low)	*Network Operator* (Low)
Economic Rents	Source	*Bill Payments* *Connections, etc.* *Bank Deposits*	*Bill Payments*	*Bill Payments*	*Bill Payments*
	Captured By	*Utility Staff*	*Bank Staff*	*Pay Point Operators*	*Mobile Network Operators*
Enforcement Mechanisms	Probability of Being Caught	*Low*	*High*	*High*	*High*
	Sanction *(Likelihood)*	*Employment Termination* (Low) *Criminal Charge* (Low)	*Employment Termination* (High) *Criminal Charge* (Intermediate)	*Contract Termination* (High) *Criminal Charge* (Intermediate)	*Employment Termination* (High) *Criminal Charge* (Intermediate)
Monitoring Costs	Mechanism *(Cost)*	*Paper Receipt* (Low) *Record-Keeping* (High)	*Paper Receipt* (Intermediate) *Record-Keeping* (Intermediate)	*Paper Receipt* (Intermediate) *Record-Keeping* (Low)	*SMS Receipt* (High) *Record-Keeping* (Low)
Information Asymmetries	Information Held By	*Utility*	*Utility/Bank*	*Selcom Wireless*	*Mobile Network Operator*
	Availability of Information	*Low*	*Low*	*High*	*High*
	Cost to Access Information	*High*	*High*	*Intermediate*	*Intermediate*

Source: Author

Enforcement Mechanisms

Insights into enforcement mechanisms governing the different payment methods emerged from interviews with respondents from across the payment landscape. When asked about the payment arrangements with customers made by commercial assistants, a commercial manager with the water utility said: "My meter readers are human beings and most of them have worked here for a long time. I cannot punish them for these things." An area manager with DAWASCO also stressed the difficulty of proving that cashiers were responsible for any kind of theft. Conversely, when asked about the security of paying water bills using mobile money, at the bank, or with wireless pay points, respondents from respective institutions all said there were very strong safeguards in place to prevent theft and manipulation. Interviews of telecommunications industry respondents revealed that there are strict consequences, such as contract termination and criminal charges, for employees involved in illegal activities. For cash paid directly at wireless pay points, the deposited funds are closely followed and accounted for. It is more difficult for employees conducting transactions with alternative payment methods to engage in petty corruption without consequence.

Enforcement mechanisms governing the activities of principals, agents, and clients include access to legal processes, the relative size of sanctions for corrupt behaviour, and an independent judiciary. We assume that all customers and employees, regardless of their choice of payment method, operate under the same judiciary and have equal access to the law. Because of this, sanctions are an appropriate comparative variable, chiefly as they relate to the probability of being caught, potential sanctions for individuals engaged in corruption, and the likelihood that sanctions will be applied (Table 3-6). For payments made via water offices, employees that might be engaged in petty corruption were much less likely to be caught or punished than those working at bank branches, operating pay points, or administering mobile money services. If an employee does engage in petty corruption, they may face termination if

they work for the utility, a bank, or a mobile network operator. For wireless pay point operators, service contract termination is a consequence of illegal and corruption-related activities. In all cases, criminal charges are also possible. The likelihood of these sanctions being carried out is lower for water utility employees because there are often political and managerial consequences for firing a utility employee, even as a consequence of illicit activity. These individuals usually have longer tenures than their managers, and cultural perceptions of petty corruption prevent sanctions. Bank and telecommunications companies are stricter with employees and most companies have a zero tolerance policy for theft, bribery, or other related actions. Payments made via mobile-enabled payment methods and the individuals that collect them are subject to stronger enforcement mechanisms than are exercised within the water utility.

Monitoring Costs

The ability of principals to engage in monitoring payment-based interactions between two parties is operationalised with some form of confirmation that the transaction had occurred. Payments are monitored through receipts and the internal records created when transactions are completed. In Dar es Salaam, payments made at water offices are confirmed with a detailed DAWASCO-branded receipt from payment information that is manually-entered by cashiers. Manual entry of payment information is susceptible to manipulation; and utility cashiers, commercial assistants, and area managers confirmed that this practice is common but not reflective of their personal behaviours. Water payments made at bank branches automatically generate bank-branded receipts from transaction data entered by bank tellers, but all three bank representatives indicated that tellers were not able to make any changes to a payment record once a transaction was complete. Payments made at wireless pay points automatically produce an electronic record of the transaction and customers are given a paper receipt summarising the payment details. Mobile money payments also automatically

generated electronic transaction records and customers receive a confirmation SMS from the mobile money service provider that a payment had been made. A manager from Selcom wireless, the company that aggregates data from mobile money and pay point transactions, stated that the electronic nature of payment records makes it nearly impossible for the information to be manipulated.

Respondents also indicated shortcomings with the receipts and confirmations generated by wireless pay points and mobile money services, respectively. A billing officer with DAWASCO pointed out that mobile money payments do not generate receipts, but only SMS confirmations that a payment had been made. Cashiers from across DAWASCO's offices stated that mobile money confirmations are hard to locate after a specific time period, emphasizing the limited storage capacity of feature phones, which are common in Tanzania. Transactions made with Selcom pay points automatically generate both a physical receipt and electronic record, but utility staff and customers have faced problems with them. One commercial manager indicated that Selcom receipts are too small, do not have enough information, and can fade over time. A cashier with the utility also highlighted the similarities between pay point receipts and those she received at the grocery store. An area manager discussed the differences in receipts and suggested that "customers prefer hard copies" of receipts, and that DAWASCO staff require "physical proof of payment to monitor the progress of a payment." The lack of paper records in mobile money payments makes it difficult to track payments and potential complaints.

Monitoring costs refer to the ability of principals to maintain effective oversight of their agent's actions and are compared by comparing the relative cost of mechanisms used to this end (Table 3-6). In the process of making a payment, the customer (i.e. principal) ensures that payments are credited to their accounts by agents (i.e. those receiving payments) through the

use of receipts, which are matched by a transaction record generated in different ways by each payment method. Water offices produce highly detailed receipts that are recognizable throughout Dar es Salaam and are often held up as the highest form of evidence that a payment had been made. Record-keeping practices for payments made at water offices are not, however, subject to the same safeguards as bank branches, wireless pay points, and mobile money services. For wireless pay points and mobile money services in particular, automatic creation of electronic transaction records prevents the manipulation of payment data. This enables customers to have greater confidence in their own transaction history. Monitoring individual transactions made with mobile money is difficult, however, because these payments only generate SMS confirmations that are easily lost by customers. Wireless pay points provide receipts to customers but are criticised for their lack of detail, poor-quality ink, and similarity to other receipts. These factors make it more costly for customers to monitor individual payments when they pay using mobile-enabled payment instruments when compared with water office payments. The use of mobile-enabled payment methods improves record-keeping practices, which reduces the costs of monitoring complete transaction histories for both customers and the utility.

Information Asymmetries

Payment data is the information that is transferred within the relationship between customers and the water utility, and relevant information asymmetries are grounded in the knowledge of whether or not a bill was paid, as well as the ease of accessing payment information after a transaction is complete. The act of making a payment at a water office is familiar to customers, but carries the risk that the funds will be lost to theft, bribery, or other forms of petty corruption. According to a civil society respondent, utility customers often have knowledge and confirmation of their payment but have little understanding of what happens after they complete a transaction. Records of transactions made at water offices are held in a

utility-controlled database, and accessing this payment data requires customers to physically visit a utility office to request the information. Conversely, payments made using wireless pay points or mobile money services are collected and recorded by third-party companies (e.g. mobile network operators, Selcom Wireless) that allow customers to access their personal payment records using SMS-based balance inquiries. A mobile commerce representative from a mobile network operator stated that customers are increasingly using this increased availability of payment information to inform their interactions with commercial assistants and cashiers, a point confirmed by a utility area manager.

Respondents also noted that some commercial assistants have taken advantage of errors that emerged from customer unfamiliarity with mobile money services. One area manager said that he commonly encourages customers to use M-PESA and pay points due to their preventative impacts on theft, but that money can be left hanging if customers input the wrong account number. Cash hanging was also mentioned by another area manager, who attributed the issue to rare mobile network outages. A billing officer with DAWASCO said that he usually helps people pay using mobile money because "they need help navigating the menus." Contrary to his managers, a commercial assistant stated: "I do not teach customers how to use M-PESA to pay bills. There are others who are supposed to do this." Another commercial assistant asserted that M-PESA payments take two or three months to credit customer accounts, and that he continued to disconnect people because the new balances and payments were not reflected. A representative from a civil society organisation expressed dissatisfaction with this practice by saying “Meter readers in Dar have just been creating confusion with customers. They know they can use the SMS messages to see a customer has paid, but they choose not to.” When asked about the relationship between customers and utility staff, a respondent involved with wireless pay points said that as they learn that SMS balance inquiries are

available, customers increasingly check their account balance via SMS if they are visited by a commercial assistant on a disconnection exercise.

In principal-agent interactions, information asymmetries are the imbalances of knowledge that exist between a principal and an agent and can be taken advantage of by the agent to disregard the interests of the principal. For water bill payments in Dar es Salaam, customers give those who receive the payment the task of applying transaction-related information to their accounts so that water services can be maintained or improved (Table 3-6). In this interaction, asymmetrical information occurs when there is a lack of knowledge on the part of the utility or customers regarding the amount, time, date, location, and affiliated account of the payment. When payments are made using mobile-enabled payment methods, these small pieces of information are held in 'transparent control' by actors (e.g. telecommunications companies) who are third-parties to the transaction being made. Primary parties to the transaction - the principal (customer) and the agent (utility) - can access and view the payment information, but they are unable to manipulate it as a third-party entity holds both the data and associated editing rights. Payments made with mobile money or pay points are immediately credited to customer accounts, but commercial assistants have been reluctant to share this information with customers or assist them in correcting input errors. This allows utility staff to create opportunities for petty corruption by maintaining information imbalances regarding the functionality of payment instruments. Asymmetries of information decline as customers become more knowledgeable about pay points, mobile money payments, and other mobile-related innovations such as balance inquiries; making it more difficult for utility staff to exploit these imbalances. Information asymmetries are highest when utility staff are involved in transactions and lowest when third-party payment service providers operate payment channels that make payment information more transparent and easily accessible for all parties.

3.6. Discussion and Conclusions

The introduction of mobile money and wireless pay points in Dar es Salaam has reduced opportunities for petty corruption in water bill payments. Increases in the adoption, number, and geographic and temporal availability of alternative payment services is expanding competition with, and deconstructing the monopoly of, utility-provided payment services. Enforcement mechanisms affecting pay points and mobile money services are stronger and stricter than sanctions that are often loosely applied to water utility employees. Moreover, electronic payment channels reduce the availability of economic rents and minimise interactions between utility customers and staff, diminishing the discretionary powers of the latter. The operation of mobile-enabled payment services by third-party companies can support the reduction of information asymmetries in water-related transactions by increasing the transparency of payment data and ensuring the integrity of alternative payment channels. Continued uptake of wireless pay point networks and mobile money services by utility customers is likely to further mitigate the incidence of petty corruption in Tanzania's urban water sector and improve utility collection ratios, efficient use of staff resources, and enhancing internal record keeping and financial management.

Beyond alternative payment services, other innovative uses of mobile communication technologies may be mitigating petty corruption in the water sector's billing and payment process by reducing information asymmetries between customers and utility staff. Balance inquiries and billing reminders requested and sent via SMS provide customers with real-time information regarding their water accounts. Multiple respondents emphasised that DAWASCO clients are using these small pieces of data to inform their discussions with commercial assistants and other utility employees, preventing the exploitation of imperfect information. DAWASCO is also experimenting with customer-led meter readings, which are submitted on a monthly basis via SMS. Although still in pilot phase, customers will be able to send this information to the utility, which will automatically generate and send an electronic

bill to be potentially paid using mobile money services or wireless pay points. Transitioning the entire billing and payment process to a mobile-based and customer-focused system may increase efficiency, reduce petty corruption, and free up financial resources for more effective use in urban water provision. Further research on these related innovations and their implications for corruption and financial sustainability in the water sector is needed.

Relationships between citizens and water service providers are changing with the integration of mobile communication technologies into water provision. Rather than being passive consumers, DAWASCO customers now have the opportunity to participate in the production of water supplies and services. Choosing to pay water bills using mobile money services or wireless pay points in Dar es Salaam simultaneously increases convenience for water users and improves water utility performance. This shift in the role of customers has clear implications for agency theory and principal-agent perspectives. Using mobile communication technologies reduces information asymmetries and monitoring costs in interactions between principals and agents, but also empowers many citizens to collectively monitor and share information regarding the activities of water services providers[11]. The role of citizen-as-principal is developing into society-as-principal. Under the watchful eye of many principals, assumptions regarding the risk aversion of agents suggest that corruption is likely to decline as the probability of being caught for engaging in illicit activities increases considerably. This poses questions regarding the foundational elements of agency theory. How will assumptions of self-interest be articulated for large groups of people with competing preferences? What are the implications for assumptions of bounded rationality when the perspective of principals is a collective one? Do the obstacles of moral hazard and adverse selection persist as a major challenge to principal-agent problems when interactions are conducted in a context characterised by significantly greater transparency? The growth of mobile communication

[11] Georgiadou, *et al*. (2011) refer to this phenomenon as the "human sensor web."

technologies and their rapid integration into East Africa's public service delivery systems present still unique settings in which these questions can start being addressed.

Mobile technologies, and in particular mobile-enabled payment instruments, are tools that can be utilised by public service providers in initiatives aimed at improving service delivery and development outcomes. Challenges posed to the global water sector by inadequate financing, poor governance, corruption, urbanisation, and population growth require careful attention to contextual realities and a thorough understanding of the strengths and limitations of key mobile-based innovations. These solutions can help overcome some, but not all, of these challenges. Expanding access to water services in both rural and urban areas is a multi-dimensional, complex, and gradual process and it is unlikely that the use of mobile technologies alone will lead to greater access to water services and other key public goods. It is far more probable that the benefits they bring – reduced monitoring costs, closed financing systems, mitigated information asymmetries, increased competition – will reshape the realities in which mobile innovations and water services interact.

4. Spiraling Out of Decline? Service Quality, Satisfaction, and Payment Behaviours in Tanzania's Urban Water Sector

Abstract

Reversing downward cycles of poor performance and weak finance in urban water service provision requires scarce financial resources, adequate service levels, and existing customers willing to pay for them. Service quality and customer satisfaction are conventionally assumed to have a positive and direct relationship with customer bill payment practices and utility cost recovery, but there is insufficient evidence to support this claim. Relationships among service quality, satisfaction, and customer payment behaviours are evaluated using a unique panel data set of 615 water utility customers from Dar es Salaam, Tanzania. Analyses apply parametric and nonparametric statistical techniques. Results indicate that the payment practices of existing customers are not significantly associated with heterogeneous levels of service quality or customer satisfaction. Incorporating mobile-enabled payment methods into payment practices significantly increases transaction frequency and annual revenue collection without commensurate changes in service quality. Taste- and smell-related factors also significantly influence customer payment behaviours. Wider incorporation of mobile-enabled payment methods into the water sector may improve water utility performance and access to water services by broadening customer autonomy in the billing and payment process, and supporting the development of strategies for reversing negative finance-performance feedback loops. Future studies in urban water services should clearly delineate between existing and potential customers.

4.1. Introduction

Urban water service provision across sub-Saharan Africa appears to be perpetually locked in a downward cycle of poor performance and insufficient revenue collection. Most countries on

the continent are not on track to achieve the Millennium Development Goal (MDG) target for drinking water by 2015, and the number of urban dwellers without access to improved water supplied nearly doubled between 1990 and 2011 (WHO/UNICEF, 2012; WHO/UNICEF, 2013). While access to safe water supplies deteriorates, financing the large-scale water production and distribution systems that dominate the continent's urban areas is becoming ever-more difficult. Africa's urban water sector faces an annual 12.9 billion USD shortfall in annual spending necessary to meet MDG targets (AICD, 2010; Banerjee and Morella, 2011), which is partially the consequence of ineffective bill collection practices and high proportions of connected urban households in sub-Saharan Africa that do not regularly pay their water bills (i.e. 40-65%) (Ibid). This cycle constrains service providers, who must strategically utilise limited financial resources to maintain rapidly worsening infrastructures that distribute insufficient water supplies to growing urban populations most often located in unplanned settlements.

The concept of "spirals of decline" in the urban water sector has been used to describe the negative feedback loop that results from interactions between low-quality service delivery and insufficient revenue collection (Mwanza, 2005; Foster, *et al.*, 2012). It presents an intuitive picture of water delivery in sub-Saharan Africa, where urban service providers are often unable to provide adequate levels of service, collect enough revenue to recover operations and maintenance costs, or improve customer satisfaction with received services (Kayaga, *et al.* 2004). Any attempt at reversing spirals of decline raises paradoxical questions that implicitly assume causal relationships between service quality, satisfaction, and customer payment behaviours. If inadequate service quality is related to poor payment practices and revenue collection, then the opposite should also be true. But, if revenue collection improvements are dependent on the delivery of higher-quality services and better services require expanded

revenue collection, how can water service providers improve either without considerable financial support coming in the form of donor intervention or government subsidies?

This paper contributes to established literatures on urban water service delivery by asking the question: how do water bill payment practices differ with variations in service quality and customer satisfaction? Using a conceptual framework drawn from expectancy disconfirmation theory and performance theory, we test the hypothesis that there are direct relationships between service quality/satisfaction and customer payment practices. A unique panel dataset of 615 water utility customers from Dar es Salaam, Tanzania is used to examine the validity of the satisfaction-performance relationship within the urban water sector. This dataset was constructed from a customer payment preference survey and a database of water-related transactions made at water offices, wireless pay points, or with mobile money services. Analyses employing inferential statistics, binary logistic regression, and nonparametric tests yield limited evidence that the payment practices of existing customers are associated with service quality or overall customer satisfaction. Any significant improvements in revenue collection were tied to the use of mobile-enabled payment methods and for customers satisfied with the taste of their piped water. These findings generate notable implications for the strategic use of limited financial resources by water service providers and identify differences in the relative importance of service quality for existing and potential customers.

This paper is organised as follows. Section Two describes the primary theoretical approaches used to identify relationships between service quality and satisfaction and briefly reviews the determinants of water payment behaviours. This paper uses a utility-theoretic model drawn from expectancy disconfirmation and performance theories to build a conceptual framework to structure the methods and analytical approaches, described in Section Three, which test satisfaction-performance relationships. Section Four summarises findings, which do not

provide support for direct relationships between satisfaction, service quality, and payment behaviours. The subsequent section discusses these results in relation to the importance of water aesthetics, the limited influence of overall satisfaction, and the importance of distinguishing between existing and potential customers. The final section concludes by suggesting that increased customer autonomy in the billing and payment process, as is afforded by mobile-enabled payment methods, may have significant implications for reversing spirals of decline in Africa's urban water sector.

4.2. A Review of Service Quality, Satisfaction, and Water Payment Behaviours

4.2.a. Evaluating Service Quality and Satisfaction

Theoretical explorations of the relationships between service quality, satisfaction, and resultant customer behaviours have traditionally been in the purview of marketing scholars. Service quality and satisfaction are considered to be two distinct constructs and are primary influences in the production of customer purchase behaviours in service environments (Taylor and Baker, 1994; Rust and Oliver, 1994). Service quality is conceptualised as an aggregation of specific observations of performance aspects and is defined as the relative superiority or inferiority of the services provided by an organisation (Bitner and Hubbert, 1994). Satisfaction is the accumulation of perspectives on multiple factors and is defined as a summary cognitive reaction to service incidents in which expectations are compared with the realities of service provision (Oliver, 1980; Rust and Oliver, 1994).

Expectancy disconfirmation theory and performance theory have emerged as the two dominant explanatory models in studies of the satisfaction-performance relationship (Deichmann and Lall, 2007). Expectancy disconfirmation theory holds that satisfaction is a function of the difference between expectations and subsequent service outcomes, where services that exceed customer expectations are likely to result in higher customer satisfaction

(Oliver, 1980). When service quality falls below expectations, the converse is likely. Performance theory is grounded in theoretical perspectives on anchoring and adjustment (Tversky and Kahneman, 1974), and suggests that expectations of service quality are formed by a reference, or anchor, which constitutes a standard of comparison. Satisfaction levels are consequently a product of relative differences with the anchor, and may have little to do with absolute service quality. Satisfaction perceptions link the realities of service quality with subsequent customer behaviours. Satisfied customers are said to be more likely to inform others about their services, remain loyal, and engage in repeat sales while contributing to firm profitability (Heskett, *et al*., 1997).

Existing evidence of the satisfaction-performance relationship remains mixed when using either theoretical approach. Some studies identify a positive and significant relationship between satisfaction and performance (Mittal, *et al*., 2005; Jermais, 2009), while others find a positive but insignificant relationship (Yeung and Ennew, 2000; Yu, 2007). Still others have found counterintuitive (Gupta and Zeithaml, 2006), threshold-bound (Helgesen, 2006), and lagged relationships (Bernhardt, *et al*., 2000; Westlund, *et al*., 2005). Contradictory results also dominate studies relating service quality and customer behaviours and loyalty (Zeithaml, *et al*., 1996; Oliver, 1999; Homburg, Koschate, and Hoyer, 2005). Within the water services literature, only one study addresses customer satisfaction and payment behaviours, finding a positive but insignificant relationship between satisfaction and payment timeliness (Kayaga, *et al*., 2004). Despite the global focus on water access and the relentless deterioration of urban water infrastructures, there is virtually no scholarly understanding of the satisfaction-performance relationship in the water sector.

Analyses of the satisfaction-performance relationship in urban service sectors have emerged in attempts to improve public service delivery. This approach was first applied to urban public

services with Van Ryzin's study of service satisfaction in New York City (2004), and was subsequently used to examine citizen shops in Portugal, public sector management performance in South Korea, and various services in England and the United States (Roch and Poister, 2006; James, 2009; Im and Jong Lee, 2011; Carvalho and Brito, 2012). These studies have also produced mixed results and determinants of satisfaction tend to vary with geography and sectoral focus (Myburgh, *et al.*, 2005; Andaleeb, *et al*., 2007; Lewis and Pattinasarany, 2009; Van Ryzin and Charbonneau, 2010; James, 2011; Russ and Takahashi, 2013). The urban water sector has also received some attention, although utility performance has not been evaluated in relation to satisfaction (Deichmann and Lall, 2007; Vasquez, *et al*., 2011; Fattahi, *et al*., 2011).

The absence of urban water services from literature on customer satisfaction and firm performance is due to conventional characterisations of the sector as naturally monopolistic. In the context of natural water provision monopolies commonly found in Europe and North America, customer satisfaction is perceived as less important because the client base is captive and choice is restricted, generating little evidence of the economic consequences of neglecting it (Donkor, 2013). Water sectors in low-income countries - particularly in sub-Saharan Africa - are fundamentally different than their European and North American counterparts due to the fragmented nature of public service delivery in developing countries (Balbo, 1993). In these contexts, clients are not captive and are free to choose among a variety of water service options (Solo, 1999; Jaglin, 2002; Kjellen and McGranahan, 2006; Kooy and Bakker, 2008). Despite inconsistent findings from marketing literature on service-satisfaction-behaviour interactions and analytical neglect of urban water services, conventional comprehensions of urban water sector dynamics implicitly assume clear relationships among service quality, customer satisfaction, and payment practices. The lack of empirical evaluation of this assumption is the gap in existing scholarship that this paper seeks to address.

4.2.b. Water Payment Practices and their Determinants

Urban water providers in sub-Saharan Africa consistently struggle to achieve cost-recovery due to insufficient revenue collection resulting from ineffective billing and payment systems and the non-payment or under-payment of account balances. Over 50% of connected households fail to regularly pay for their water service, contributing to an annual revenue loss of over 500 million USD (AICD, 2010; Banerjee and Morella, 2011). Irregular household incomes are prevalent in urban Africa and are one reason it may be difficult for households to conform to monthly billing cycles (Mugabi, *et al*., 2010). Delayed payments and unpaid bills reduce monthly cash flows and annual revenue collection, leading to water service interruptions and unsatisfactory water provision (Mugisha and Brown, 2010; Mugabi and Kayaga, 2010). Inadequate financing of water delivery systems impedes utilities from improving or even maintaining sufficient service quality levels, trapping much of Africa's urban water sector in downward spirals and vicious cycles of poor operational performance and low cost-recovery (Mwanza, 2005; Foster, *et al*., 2012). The water services literature points to the existence of recursive relationships between service quality, customer satisfaction, and financial sustainability, where a decline in one factor is attributable to deterioration in the others.

Despite the significance of bill payment to the financial sustainability of urban water provision, the determinants and impacts of customer payment behaviours have received only limited scholarly attention. Mugabi, *et al*. argue that water sector practitioners show interest in consumer behaviours, often through willingness-to-pay studies, before the implementation of water supply projects or improvements (2010). The nature of exchange between consumers and water providers after improvements have occurred is rarely subjected to empirical scrutiny. A modest amount of significant research from Uganda shows that customer intentions to pay bills can be influenced by perceived social pressure (Addo-Yobo, *et al*., 2006); socio-demographic factors such as gender, occupation, income, residential tenure, and

education (Kayaga, Calvert, and Sansom, 2003; Mugabi and Kayaga, 2010); customer attitudes towards payment, and perceived control over the payment process (Mugabi, *et al*., 2010). Furthermore, a cross-sectional survey of 11 major towns in Uganda found that perceptions of service value and customer satisfaction can significantly influence customer payment intentions (Kayaga, *et al*., 2004). These studies offer valuable insights into customer *intentions* to pay for water services, but there have been no empirical examinations of the direct relationships various factors, such as service quality and customer satisfaction, and *actual* payment behaviours in the context of an urban water utility in sub-Saharan Africa.

4.2.c. Conceptual Framework

Limitations on the ability of urban water utilities to deliver higher-quality services, extend service coverage, and mitigate internal operational deficiencies are commonly attributed to constrained financial resources resulting in part from customer dissatisfaction with poor-quality services. To test this commonly held assumption, an overarching question is posed: "In a context of heterogeneous service quality, do service quality and satisfaction influence customer payment behaviours?"

From this, three sub-questions are used to structure analyses:

1) Does heterogeneity in service quality influence customer satisfaction?
2) Does heterogeneity in service quality influence customer payment practices?
3) Does heterogeneity in customer satisfaction influence customer payment practices?

Drawing on the utility-theoretic models employed by Deichmann and Lall (2007) and Vasquez, et al (2011), we assume that a customer's individual payment behaviours are related to the latent utility they receive from it. Deichmann and Lall describe satisfaction as a function of expectations and actual service delivery, whereas Vasquez, *et al*. expand this model to include the consumption of other water-related goods and services, as well as characteristics of the water user. For the purposes of these analyses, we adopt the conceptual

approach utilised by these studies and treat real customer payment behaviours (U) as a variable function of static levels of satisfaction (C) and service quality (A):

$$U = f(A, C)$$

From this perspective, a higher level of customer satisfaction with received water services is expected to be associated with better payment behaviours, such as frequency, timeliness, and revenue (i.e. $f_C > 0$). Similarly, customers receiving higher-quality services are also expected to have better payment behaviours (i.e. $f_A > 0$). The opposite is expected for customers receiving poor-quality services or exhibiting low satisfaction levels. We also expect a positive relationship between service quality and satisfaction, in which higher-quality water services are expected to be associated with higher customer satisfaction levels based on the findings of studies that have shown that service quality in the urban water sector partially influences customer satisfaction (Kayaga, *et al*., 2004; Deichmann and Lall, 2007; Vasquez, *et al*., 2011). Satisfaction and service quality shape customer attitudes and intentions towards payment (Kayaga, *et al*., 2004; Mugabi, *et al.*, 2010; Mugabi and Kayaga, 2010), which is expected to translate into actual payment behaviours that impact water utility performance. This conceptual framework is visually represented in Figure 4-1.

The studies discussed above were explicitly designed to identify the key variables that inform interactions between service quality and customer satisfaction. Focusing on the determinants of satisfaction, a substantial amount of work has been completed on the relationship between the quality of public service provision and customer satisfaction (Van Ryzin, 2004; Deichmann and Lall, 2007; Mugabi and Kayaga, 2010; and Vasquez, *et al*., 2011). This exploratory study does not seek to assess the determinants of satisfaction, but rather the

existence of associations between variations in customer satisfaction and payment behaviours, as well as variations in service quality and payment behaviours.

Mugabi and Kayaga (2010), Kayaga, *et al.* (2003, 2004), and Mugabi, *et al.* (2010) have examined the determinants of satisfaction under the assumption that they also have a direct impact on customer payment behaviours. This study does not share in this assumption, but rather takes an exploratory approach to evaluate the influence of satisfaction and service quality heterogeneity on customer payment behaviours. This study uses Deichmann and Lall's distinction between variables that can be measured with some degree of accuracy (i.e. objective measures) and those that are subjectively expressed (2007). In light of data limitations mentioned below, this study conceptualises objective measures as components of service quality (i.e. frequency, duration, and reliability) and customer satisfaction is comprised of subjective measures (i.e. overall satisfaction, taste satisfaction, and smell satisfaction). As this conceptualisation is not derived directly from expectancy disconfirmation theory or performance theory, this study offers an exploratory look into the determinants of customer payment behaviours from the perspective of service quality and satisfaction. Although this limitation prevents a comprehensive contribution to existing theoretical debates related to the determinants of satisfaction, the study does raise key questions related to the influence of customer satisfaction and service quality on real customer payment behaviours.

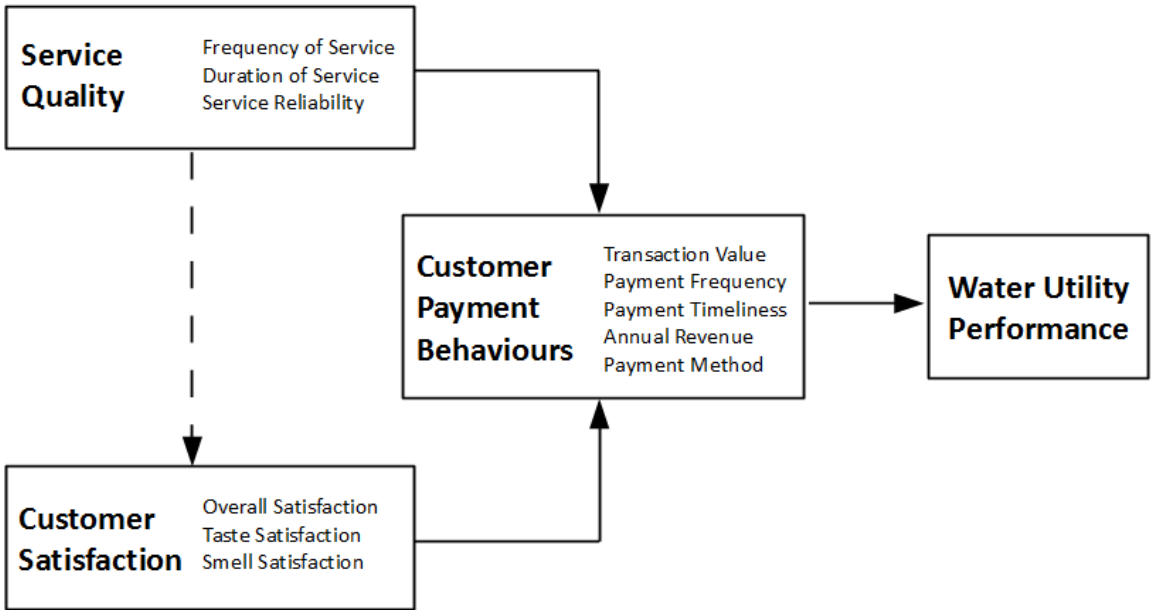

Figure 4-1. Conceptual framework detailing the relationships between service quality, customer satisfaction, and customer payment behaviours. *Source: Author.*

4.3. Methods

4.3.a. Research Setting

Dar es Salaam, Tanzania was chosen as the geographic focus of this paper because of data availability on customer payment behaviours and the heterogeneity of water services provided by the urban water utility. A dearth of reliable customer payment data previously limited the ability of empirical research to disentangle interactions among payment practices, service quality, and customer satisfaction in the water sector. Mobile communication technologies have proliferated across Africa (Aker and Mbiti, 2010), and the expansion of mobile-enabled payment options throughout East Africa (Morawczynski, 2009; Mas,2009; Kshetri and Acharya, 2012) has enabled the digitisation of water-related transaction data. This is particularly pertinent in Dar es Salaam, where the utility has allowed customers to pay using mobile-enabled payment options (i.e. mobile money services[12] and GPRS[13]-enabled pay

[12] Mobile money services refer to financial platforms that allow basic financial functions to be conducted via mobile phones. See Jack and Suri (2011) for a detailed description of this payment instrument.

points) since mid-2009. The introduction of mobile payment methods facilitated improvements in the billing and payment system that have resulted in some of the most reliable electronic water-related transaction records in sub-Saharan Africa.

The Dar es Salaam Water and Sewerage Corporation (DAWASCO) is a publically-formed independent operator responsible for providing piped water services to the city of Dar es Salaam, but struggles to ensure adequate supplies. Demand for piped water services mushroomed as urbanisation and population growth inflated the nation's urban population from 19% in 1990 to 26% in 2010. Metropolitan access to improved water supplies simultaneously declined from 94% to 79% over the same period and the proportion of urban populations with piped connections plummeted to just 23% (WHO/UNICEF, 2010). Water provision in Dar es Salaam continues to decline as fewer than 27% of utility customers receive reliable service, compared with 100% at independence in 1961 (WaterAid, 2008). Scholars have described the city's water obstacles as a corollary of deficient financial resources, political interference, petty corruption, poor billing and payment systems, and neglect of the unique service arrangements required by low-income populations (Kjellen, 2000; Kyessi, 2005; Dill, 2010). Mugisha and Brown (2010) and WaterAid (2008) provide an overview of the historical development of urban water services in Dar es Salaam.

4.3.b. Methods

A multi-dimensional panel dataset was used to evaluate the relationships between service quality, satisfaction, and payment behaviours for users and non-users of mobile-enabled payment methods. A water payments database and the results of a water customer survey (n=1097) conducted in Dar es Salaam, Tanzania are used to construct the panel data set. Survey respondents were invited to share their utility account numbers, which were used to

[13] General Packet Radio Service, or GPRS, is a mobile data service that is used by mobile phones and forms the bases for mobile-enabled point-of-sale technologies. The remainder of this paper refers to these point-of-sale devices as 'wireless pay points'.

join survey data with their 2011 payment records found in the water payments database. A total of 615 respondents (56.1% of all survey participants) provided a valid account number, enabling analysis of 4655 payments made during that year. Of these, 112 used mobile-enabled payment methods in 2011. Payment indicators were calculated from the water payments database and service quality/satisfaction variables were obtained from survey responses.

Water Payments Database

Data from 2011 regarding customer payments for water services was provided by the water utility in Dar es Salaam, which operates 14 water payment offices in and around the city; telecommunications companies operating two discrete mobile money services; and a third-party integrator managing over 2,000 wireless pay points located throughout the city. In 2011, 513923 payments were made to the utility by 81389 customers. A structured record review was conducted to examine payment records detailing the date, time, payment method, and utility account number of each transaction. There were a considerable number of large transactions not directly related to the payment behaviours of domestic water utility customers. These include connection and reconnection fees, industrial and commercial accounts, and large payments made to settle outstanding balances. Outliers were identified and muted using the outlier labelling rule (Tukey, 1977; Hoaglin, Iglewicz, and Tukey, 1986; Hoaglin and Iglewicz, 1987).

Water User Payment Preferences Survey

Water user payment preference surveys were administered to water utility customers throughout Dar es Salaam during August and September 2012. The instrument was designed in collaboration with the water utility and was piloted in June 2012. Survey responses include data on geographic location and housing, socioeconomic variables, demographic variables,

assets and expenditures, mobile phone use, payment methods and preferences, payment behaviours, service satisfaction, disconnections and reconnections, alternative sources of water, community supplying behaviours, and SMS billing reminders. Respondents were sampled geographically and temporally. Survey administration was conducted over one billing cycle and at physical payment locations such as water offices, bank branches, wireless pay point locations, and mobile money agents. Systematic random sampling was used to select five target wards (i.e. neighborhoods) that contained a water utility payment office and five that did not. Within each randomly selected ward, physical payment locations constituted a secondary sampling frame. Random sampling was again used to create a stratified sample of physical payment locations that included water offices, bank branches, and wireless pay points. All water utility customers using the payment locations were invited to participate in the survey.

4.3.c. Variables

Key variables were identified as being descriptive of customer payment behaviours, service quality, and service satisfaction. Customer payment behaviours were taken from the water payments dataset and measured through analyses of transaction value, transaction timeliness, annual payment frequency, annual revenue per customer, and the use or non-use of mobile-enabled payment methods. Service quality variables were collected from the survey and include weekly service hours and a question regarding service reliability. Customer satisfaction with received water services was also collected from the survey and includes taste- and smell-related satisfaction, as well as an overall summary rating of satisfaction.

Customer payment behaviours are comprised of transaction value, transaction timeliness, annual payment frequency, and annual revenue per customer. An additional categorical variable identifying payment method choice as the use or non-use of mobile-enabled payment methods is used to structure results. A customer is designated a "Mobile User" if they made at

least one transaction in 2011 using a mobile money service or wireless pay point. All other customers are identified as a "Mobile Non-User." Transaction value is the monetary amount of a single payment. Mean transaction value was calculated from all payments made by a specific customer in 2011. Transaction timeliness is the numerical date on which a payment was made and is expressed as the number of the day of the month in which the transaction takes place (e.g. 1-31). The mean timeliness of all transactions per customer was computed for 2011. Annual payment frequency refers to the number of payments made by a customer in a year. Annual revenue per customer is the sum total of all payments made in a particular year by a specific customer. Payment timeliness, revenue collection, and payment method have been used previously as indicators of customer payment behaviours (Kayaga, *et al*., 2004; Foster, *et al*., 2012; Donkor, 2013); this study disaggregates annual revenue collection into its constituent parts of transaction value and payment frequency.

Service quality is measured by weekly water supply hours and customer perceptions of service reliability, which were both obtained from survey responses. Customers indicated the number of hours per day and days per week that they received piped-water services from the water utility. Water supply hours vary significantly both within and across days and were therefore calculated as total weekly supply hours. This continuous variable ranges in value from 0 to 168. Service reliability was measured using the question "If you turn on your utility tap, do you know if water will flow?" Participants used ordinal responses (i.e. "Always," "Sometimes," or "Never") to characterise the reliability of their service. This variable was cross-referenced with service quality to ensure validity (Table 4-1). Payment behaviour variables are compared for each level of service reliability.

Table 4-1. Comparison of weekly service hours with satisfaction and reliability variables. Significance tests are compared with mean weekly service hours for All Respondents.

	Weekly Service Hours (WSH)		
Variable	***Mean***	***σ***	***n=***
All Respondents	*55.52*	*54.79*	*594*
Reliability			
Always	*120.71****	*57.12*	*62*
Sometimes	*62.21**	*52.53*	*246*
Never	*33.99****	*40.54*	*190*
Satisfaction (Overall)			
Excellent	*47.53*	*58.90*	*32*
Good	*57.37*	*57.19*	*241*
Acceptable	*59.34*	*50.73*	*192*
Poor	*52.54*	*57.55*	*102*
Satisfaction (Taste)			
Good	*57.98*	*58.09*	*308*
Acceptable	*55.70*	*51.26*	*230*
Poor	*51.04*	*53.31*	*26*
Satisfaction (Smell)			
Good	*61.20*	*58.74*	*245*
Acceptable	*50.58*	*50.59*	*270*
Poor	*65.95*	*57.26*	*37*

Source: Utility Customer Survey Data *p<0.05, **p<0.01, ***p<0.001

Service satisfaction is measured using smell- and taste-related variables, as well as ratings of overall satisfaction levels, also taken from survey responses. Examining the determinants of satisfaction is beyond the scope of this study and a summary variable is used in recognition of the ongoing debates surrounding the elements of service satisfaction. In response to the question "Overall, how would you rate your utility water supply?" respondents chose from ordinal responses (i.e. "Excellent," "Good," "Acceptable," or "Poor") to identify their relative satisfaction level with the services they receive. Taste-related satisfaction was measured using ordinal options in response to the question "How do you rate the taste of your utility-provided water?" Similarly, smell-related satisfaction was measured in response to the question "How do you rate the smell of your utility-provided water?" For both questions, respondents shared

their satisfaction ratings as "Good," "Acceptable," or "Poor." Customer payment behaviours are compared across each satisfaction level and mean weekly supply hours are used for comparing different levels and types of service satisfaction.

4.4. Findings and Analysis

Data were analysed for variations in customer payment behaviours in response to heterogeneous service quality and differing levels of customer satisfaction. Although conventional approaches have assumed normal distributions in payment behaviour data (Kayaga, *et al*., 2004), recent critiques suggest using non-parametric tests for more robust analyses (Donkor, 2013). Analytical approaches therefore include means comparisons, binary logistic regression, and non-parametric tests (i.e. Kolmogorov-Smirnov and Mann-Whitney U). The first subsection highlights the outcomes of z- and t-tests evaluating the relationships between service quality and satisfaction (Table 4-1), and interactions with customer payment behaviours (Table 4-2; Table 4-3). Findings show that service quality is closely related to service reliability, but exhibit limited association with aspects of service satisfaction. There is significant variation in customer payment behaviours based on the use of mobile-enabled payment methods, but payment behaviours do not show evidence of being influenced by service quality or service satisfaction. Taste-related dissatisfaction with utility-provided water is an exception. The second subsection utilises binary logistic regression to more closely evaluate the relationships between service quality, service satisfaction, and customer payment behaviours (Table 4-4; Table 4-5). These analyses also yield limited evidence of associations. The final subsection employs the Mann-Whitney U test for equality of distributions to examine the data without conventional assumptions of normality (Table 4-6; Table 4-7). These tests do not yield evidence to supporting assumptions relating satisfaction, service quality, and payment behaviours.

4.4.a. Means Comparisons

Service Quality and Service Satisfaction

Table 4-1 summarises results of analyses that examine the relationship between service quality and service satisfaction. Comparisons of mean service hours for differing levels of service reliability show a strong relationship between these two variables. Customers indicating a high level of service reliability receive significantly greater service hours (120.71 hours/week; $z = 8.58$; $p < 0.001$) than those who indicated moderate reliability of the water services they receive (62.21 hours/week; $z = 1.66$; $p < 0.05$). Customers reporting a low reliability of service received water for significantly fewer hours than the population mean (33.99 hours/week; $z = -5.82$; $p < 0.001$). Closely-linked with variation in weekly service hours, the measure of service reliability used in this study appears to be an acceptable aspect of service quality.

Weekly supply hours do not exhibit significant variation when compared with taste- and smell-related or overall satisfaction (Table 4-1). Levels of satisfaction related to taste do not appear to be associated with service quality, as there was limited variation in weekly service hours (Good = 57.98, n = 308; Acceptable = 55.70, n = 230; Poor = 51.04, n = 26). A similar result was obtained when comparing service quality with smell-related satisfaction (Good = 61.20, n = 245; Acceptable = 50.58, n = 270; Poor = 65.95, n = 37). Overall satisfaction ratings were also dissociated with weekly supply hours (Excellent = 47.53, n = 32; Good = 57.37, n = 241; Acceptable = 59.34, n = 192; Poor = 52.54, n = 102). Evidence from Dar es Salaam suggests that service quality is not related to customer satisfaction in the urban water sector.

Table 4-2. Comparison of weekly service hours with satisfaction and reliability variables for mobile users and non-users. Significance tests compare weekly service hours for mobile users with mobile non-users.

	MOBILE USERS (WSH)			**MOBILE NON-USERS** (WSH)		
VARIABLE	***Mean***	***σ***	***n=***	***Mean***	***σ***	***n=***
All Respondents	*49.67*	*46.76*	*108*	*56.73*	*56.35*	*487*
Reliability						
Always	*91.29*	*58.89*	*7*	*124.45*	*56.33*	*55*
Sometimes	*60.47*	*48.07*	*49*	*62.64*	*53.69*	*197*
Never	*28.90*	*24.12*	*31*	*34.98*	*43.01*	*159*
Satisfaction (Overall)						
Excellent	*31.50*	*39.33*	*6*	*49.78*	*61.83*	*27*
Good	*49.47*	*47.70*	*49*	*59.39*	*59.31*	*192*
Acceptable	*64.29*	*46.69*	*34*	*58.28*	*51.63*	*158*
Poor	*35.13*	*43.17*	*15*	*55.54*	*59.37*	*87*
Satisfaction (Taste)						
Good	*49.84*	*49.51*	*55*	*59.56*	*59.69*	*254*
Acceptable	*56.40*	*45.82*	*42*	*55.54*	*52.51*	*188*
Poor	*28.50*	*31.67*	*4*	*55.14*	*55.91*	*22*
Satisfaction (Smell)						
Good	*53.00*	*49.64*	*44*	*62.74*	*60.47*	*202*
Acceptable	*53.73*	*47.65*	*49*	*49.88*	*51.3*	*221*
Poor	*43.50*	*34.44*	*6*	*70.29*	*60.13*	*31*

Source: Utility Customer Survey Data *p<0.05, **p<0.01, ***p<0.001

Table 4-3. Customer payment behaviours as related to satisfaction, reliability, and payment method choice variables. Significance tests are compared with customer payment behaviours for All Respondents.

	VALUE (USD)			**FREQUENCY**			**TIMELINESS**			**REVENUE** (USD)		
VARIABLE	***Mean***	***σ***	***n=***	***Mean***	***σ***	***n=***	***Mean***	***σ***	***n=***	***Mean***	***σ***	***n=***
All Respondents	*21.85*	*15.10*	*594*	*7.63*	*3.81*	*615*	*14.57*	*5.13*	*615*	*147.78*	*101.83*	*601*
Mobile Users	*20.35*	*14.79*	*110*	*9.01****	*3.14*	*112*	*14.93*	*4.87*	*112*	*165.85**	*104.24*	*110*
Mobile Non-Users	*22.16*	*15.15*	*485*	*7.31*	*3.88*	*504*	*14.50*	*5.18*	*504*	*143.51*	*100.97*	*492*
Reliability												
Always	*22.22*	*13.27*	*59*	*7.02*	*4.13*	*63*	*15.16*	*5.41*	*63*	*147.18*	*102.67*	*62*
Sometimes	*22.72*	*15.04*	*238*	*8.03*	*3.68*	*246*	*14.54*	*5.04*	*246*	*165.15**	*109.49*	*238*
Never	*20.34*	*13.59*	*191*	*7.76*	*3.79*	*196*	*14.53*	*5.17*	*196*	*141.65*	*94.22*	*194*
Satisfaction (Overall)												
Excellent	*19.17*	*10.89*	*31*	*7.66*	*3.87*	*32*	*15.14*	*4.71*	*32*	*150.98*	*109.47*	*32*
Good	*21.99*	*14.13*	*237*	*7.54*	*3.83*	*246*	*15.10*	*4.92*	*246*	*145.78*	*93.85*	*240*
Acceptable	*22.12*	*14.81*	*197*	*7.83*	*3.72*	*201*	*13.96*	*5.31*	*201*	*156.77*	*105.96*	*198*
Poor	*22.24*	*18.42*	*101*	*7.6*	*3.86*	*108*	*14.37*	*4.87*	*108*	*140.34*	*109.63*	*103*
Satisfaction (Taste)												
Good	*22.27*	*14.55*	*305*	*7.51*	*3.85*	*318*	*14.57*	*5.13*	*318*	*153.96*	*101.89*	*312*
Acceptable	*21.82*	*15.44*	*235*	*7.88*	*3.74*	*241*	*14.51*	*5.13*	*241*	*146.28*	*103.51*	*234*
Poor	*14.56**	*10.30*	*26*	*7.69*	*4.17*	*26*	*13.99*	*4.38*	*26*	*95.85***	*63.35*	*26*
Satisfaction (Smell)												
Good	*22.10*	*14.05*	*238*	*7.39*	*3.85*	*250*	*14.56*	*5.17*	*250*	*151.28*	*100.54*	*244*
Acceptable	*21.62*	*15.37*	*279*	*7.70*	*3.80*	*285*	*14.50*	*5.15*	*285*	*141.68*	*99.09*	*279*
Poor	*19.40*	*14.42*	*37*	*8.66**	*3.70*	*38*	*13.72*	*4.29*	*38*	*158.19*	*117.95*	*37*

Source: Utility Customer Survey Data; Water Payments Database *p<0.05, **p<0.01, ***p<0.001

Mobile Payment Options and Service Quality

Table 4-2 shows variation in weekly supply hours as it relates to customers opting to use and not use mobile-enabled payment methods. Customers using mobile payment methods in 2011 (n = 108) received an average of 49.67 supply hours per week, while those not using the options (n = 487) received 56.73 supply hours per week. Despite these observable differences, these findings are not significant. Table 4-2 also demonstrates that there is no significant variation in service quality between users and non-users of mobile payment methods for different levels of service satisfaction and reliability. These findings show that the decision to use a certain payment method (i.e. mobile-enabled) may not be influenced by service quality or reliability.

Service Satisfaction and Payment Behaviours

To explore the significance of water services satisfaction to actual customer payment behaviours, three elements related to satisfaction were compared: taste, smell, and overall satisfaction. Mean values of payment behaviour indicators (i.e. value, frequency, timeliness, and revenue) were computed and compared with the differing levels of satisfaction experienced by customers. Mean values for each payment behaviour were aggregated by satisfaction level and serve as the basis for comparison in each test from which the findings are described below.

Respondents were asked to rate their satisfaction with the taste of their water on a simple scale consisting of "Good", "Acceptable", and "Poor." Participants were also given the opportunity to detail taste-related concerns (e.g. salty, metallic, chemical tastes), although relating these elements to satisfaction is beyond the scope of this study. At the conclusion of the survey, 318 respondents providing a valid account number rated their taste-related satisfaction as "Good," 241 participants considered the taste of their water to be "Acceptable," while 26

water users identified theirs as "Poor." Table 4-3 shows the outcome of these analyses after the removal of outliers from the payment data. Those rating taste satisfaction as "Good" showed no significant variation (Value = 22.27[14]; Frequency = 7.51; Timeliness = 14.57; Revenue = 153.96) from the population means for the four payment behaviour indicators. Similarly, there was no significant difference from population means for those water users rating their satisfaction with the taste as "Acceptable" (Value = 21.82; Frequency = 7.88; Timeliness = 14.51; Revenue = 146.28). For those participants who perceived their taste-related satisfaction to be "Poor," the mean value of their payments was significantly lower than the population mean (Value = 14.56; $t = -2.44$; $p < 0.05$), as was the average revenue collected each year (Revenue = 95.85; $t = -2.58$; $p < 0.01$). The other two indicators did not vary significantly (Frequency = 7.69; Timeliness = 13.99). Satisfaction is associated with low payment values when customers are dissatisfied with the taste of their water; low transaction values also influence revenue collection per customer, which is significantly lower than those who find the taste of their water to be "Acceptable" or "Good".

Satisfaction with the smell of water received constitutes the next variable, which also employed an ordinal "Good," "Acceptable," and "Poor" approach. For those respondents answering this question and providing a valid account number, 250 rated their smell-related satisfaction as "Good," 285 as "Acceptable," and 38 as "Poor." As above, the results in Table 4-3 illustrate the results of analyses following the removal of outliers. Customers satisfied with the smell of the water they received exhibit no significant variation in payment behaviours (Value = 22.10; Frequency = 7.39; Timeliness = 14.56; Revenue = 151.28). Comparable findings (i.e. no significance) characterize those users who view their satisfaction with the smell of the water they receive as "Acceptable" (Value = 21.62; Frequency = 7.7; Timeliness = 14.5; Revenue = 141.68). Customers not at all satisfied with the smell of their

[14] The conversion from Tanzanian Shilling (TZS) to United States dollars (USD) used in this article is 1600 TZS for 1 USD.

water paid more frequently than their more satisfied counterparts (Frequency = 8.66; z = 1.66; $p < 0.05$), but did not vary significantly in relation to the other three payment behaviour indicators (Value = 19.40; Timeliness = 13.72; Revenue = 158.19). Smell-related satisfaction with water services is not related to customer payment behaviours, except for customers dissatisfied with the smell of their water; these customers tend to make more frequent transactions than other water users.

The final variable related to satisfaction is the overall satisfaction rating given to utility-provided water services in Dar es Salaam (Table 4-3). Participants who chose to respond to the question identified one of four ordinal options to describe their water services - "Excellent" (n=32), "Good" (n=246), "Acceptable" (n=201), or "Poor" (n=108). Customers rating their water services as "Excellent" exhibited payment behaviours similar to the wider sample (Value = 19.17; Frequency = 7.66; Timeliness = 15.14; Revenue = 150.98). Those perceiving their services to be "Good" (Value = 21.99; Frequency = 7.54; Timeliness = 15.10; Revenue = 145.78) and "Acceptable" (Value = 22.12; Frequency = 7.83; Timeliness = 13.96; Revenue = 156.77) did not have significant variation in their payment behaviours. Respondents not satisfied with the water services they receive had payment behaviours similar to their more satisfied counterparts (Value = 22.24; Frequency = 7.6; Timeliness = 14.37; Revenue = 140.34). In all cases, there was no significant variation in payment behaviours at any level of satisfaction. These findings diverge from previous studies in that summary satisfaction with water services does not appear to influence customer payment behaviours in Dar es Salaam.

Mobile Payment Options and Customer Payment Behaviours

Water utility customers opting to use mobile-enabled payment methods show significant variation in certain payment behaviours (Table 4-3). Customers using a mobile payment

method at least once in 2011 paid with significantly greater frequencies (Frequency = 9.01; z = 4.95; $p < 0.001$) when compared with their counterparts who paid their water bills solely at water payment offices (Frequency = 7.31). Revenue collection was also significantly higher for those who used mobile-enabled methods (Revenue = 165.85; z = 2.04; $p < 0.05$) as opposed to those who did not (Revenue = 143.51). Between these two groups, mean transaction value and average timeliness of payments were not significantly different from one another. Echoing the findings of previous studies, the use of mobile-enabled payment methods influences customer payment behaviours, particularly payment frequencies, which translate into higher revenue collection per customer.

4.4.b. Binary Logistic Regression

Relationships between customer payment behaviours and service quality and satisfaction were also tested using binary logistic regression. Data were coded for optimal and sub-optimal customer payment behaviours and associated service quality and satisfaction indicators. Upper and lower quartiles of payment value and annual revenue per customer were calculated with the upper quartile of each being characterised as "High" and the lower quartile as "Low." The payment deadline in Dar es Salaam, Tanzania is on or before the seventh day of each month. Therefore, "On-Time" payments are those made between days 1 and 7 and "Late" payments are those made on or after the eighth day of each month. Payment frequency is considered "High" when customers make at least 6 payments per year and "Low" when they make fewer than this. Service quality is characterised by two variables: mean weekly supply hours and reliability. Water supply is considered "High" in the upper quartile of service hours ($\geq$ 84 hours/week) and "Low" for the bottom quartile ($\leq$ 14 hours/week). Water services are considered to be reliable if customers indicated "Always" or "Sometimes" and not reliable for customers indicating that water supplies are "Never" reliable. Satisfaction indicators include overall, taste-, and smell-related satisfaction. Satisfaction is designated as "High" for customers who rated their water services as "Excellent" or "Good," and "Low" for those

customers indicating their services were "Acceptable" or "Poor." For smell- and taste-related satisfaction, customer ratings of "Good" and "Poor" are used directly in the logistic models.

Optimal Payment Behaviours

Table 4-4 illustrates the outcomes of four binary logistic models for customer payment behaviours, service quality, and service satisfaction. The Hosmer-Lemeshow test statistic for High-Value payments is 0.968, which indicates the model is well calibrated to the data. There is no significant relationship, however, between any variable and payment value. On-Time payments are three times more likely to made when satisfaction with the taste of water is high [Exp(B) = 3.011; Sig = 0.008], but no other variable appears to be related to payment timeliness (Hosmer-Lemeshow = 0.723). Payment frequency is similarly unaffected by service quality or satisfaction (Hosmer-Lemeshow = 0.985). There does appear to be a significant relationship between the reliability of water services and revenue collection [Exp(B) = 1.756; Sig = 0.005], but this is likely to be related to higher rates of revenue collection for customers who receive a greater level of water services (see Table 4-1 for relationship between reliability and service hours). No other variables appears to influence revenue collection (Hosmer-Lemeshow = 0.752). In general, high levels of satisfaction and service quality are unrelated to optimal payment behaviours.

Sub-Optimal Payment Behaviours

Four binary logistic regression models for sub-optimal payment behaviours and low levels of satisfaction and service quality are shown in Table 4-5. The model for Low-Value payments has a Hosmer-Lemeshow statistic of 0.956, but shows no significant association between low quality, satisfaction, and payment value. Poor service quality and low satisfaction do not have any significant relationship with payment timeliness (Hosmer-Lemeshow = 0.747), payment frequency (Hosmer-Lemeshow = 0.865), or revenue collection (Hosmer-Lemeshow = 0.766).

The relatively high values of the Hosmer-Lemeshow statistics suggest that these models are well calibrated to the data, but that the data exhibit no association with payment behaviours. Regression analyses used in this section reinforce the finding of means comparisons that suggest limited relationships between customer payment behaviours, service quality, and service satisfaction.

Table 4-4. Logistic regression for optimal payment behaviours and service quality and satisfaction indicators. N=594.

RESPONSE	EXPLANATORY	B	STD. ERROR	SIG	EXP(B)
Value [High]	Supply (High)	*0.331*	*0.214*	*0.122*	*1.392*
	Reliability (High)	*-0.074*	*0.194*	*0.704*	*0.929*
	Satisfaction (High)	*-0.142*	*0.208*	*0.496*	*0.868*
	Taste (Good)	*0.080*	*0.251*	*0.751*	*1.083*
	Smell (Good)	*-0.306*	*0.256*	*0.233*	*0.737*
	Constant	*-0.866*	*0.173*	*0*	*0.421*
	Hosmer-Lemeshow		*0.968*		
	Pseudo R2		*0.013*		
	Chi-Square		*5.278*		
Timeliness [On-Time]	Supply (High)	*-0.146*	*0.396*	*0.713*	*0.864*
	Reliability (High)	*-0.079*	*0.339*	*0.816*	*0.924*
	Satisfaction (High)	*-0.530*	*0.363*	*0.114*	*0.589*
	Taste (Good)	*1.102*	*0.415*	*0.008*	*3.011***
	Smell (Good)	*-0.736*	*0.410*	*0.073*	*0.479*
	Constant	*-2.61*	*0.316*	*0*	*0.074*
	Hosmer-Lemeshow		*0.723*		
	Pseudo R2		*0.036*		
	Chi-Square		*5.321*		
Frequency [High]	Supply (High)	*0.211*	*0.211*	*0.316*	*1.235*
	Reliability (High)	*0.152*	*0.183*	*0.407*	*1.164*
	Satisfaction (High)	*0.234*	*0.196*	*0.234*	*1.263*
	Taste (Good)	*-0.448*	*0.240*	*0.062*	*0.639*
	Smell (Good)	*0.108*	*0.240*	*0.652*	*1.114*
	Constant	*0.616*	*0.166*	*0*	*1.852*
	Hosmer-Lemeshow		*0.985*		
	Pseudo R2		*0.016*		
	Chi-Square		*6.938*		
Revenue [High]	Supply (High)	*-0.325*	*0.225*	*0.150*	*0.723*
	Reliability (High)	*0.563*	*0.199*	*0.005*	*1.756**
	Satisfaction (High)	*0.135*	*0.211*	*0.524*	*0.993*
	Taste (Good)	*-0.007*	*0.258*	*0.978*	*1.102*
	Smell (Good)	*0.097*	*0.260*	*0.708*	*1.144*
	Constant	*-1.346*	*0.187*	*0.524*	*0.260*
	Hosmer-Lemeshow		*0.752*		
	Pseudo R2		*0.023*		
	Chi-Square		*9.542*		

Source: Utility Customer Survey Data; Water Payments Database *p<0.05, **p<0.01, ***p<0.001

Table 4-5. Logistic regression for sub-optimal payment behaviours and service quality and satisfaction indicators. N=594.

RESPONSE	EXPLANATORY	B	STD. ERROR	SIG	EXP(B)
Value	Supply (Low)	*0.103*	*0.226*	*0.650*	*1.108*
[Low]	Reliability (Low)	*-0.042*	*0.203*	*0.835*	*0.959*
	Satisfaction (Low)	*-0.223*	*0.195*	*0.254*	*0.800*
	Taste (Poor)	*0.787*	*0.482*	*0.102*	*2.198*
	Smell (Poor)	*-0.407*	*0.472*	*0.254*	*0.666*
	Constant	*-1.044*	*0.17*	*0*	*0.352*
	Hosmer-Lemeshow		*0.956*		
	Pseudo R2		*0.010*		
	Chi-Square		*4.060*		
Timeliness	Supply (Low)	*-0.010*	*0.375*	*0.979*	*0.990*
[Late]	Reliability (Low)	*-0.188*	*0.338*	*0.578*	*0.829*
	Satisfaction (Low)	*-0.315*	*0.335*	*0.347*	*0.730*
	Taste (Poor)	*1.425*	*1.110*	*0.199*	*4.158*
	Smell (Poor)	*-1.070*	*0.558*	*0.055*	*0.343*
	Constant	*2.896*	*0.314*	*0*	*18.110*
	Hosmer-Lemeshow		*0.747*		
	Pseudo R2		*0.022*		
	Chi-Square		*5.274*		
Frequency	Supply (Low)	*0.034*	*0.205*	*0.870*	*1.034*
[Low]	Reliability (Low)	*0.221*	*0.183*	*0.227*	*1.248*
	Satisfaction (Low)	*0.056*	*0.177*	*0.753*	*1.057*
	Taste (Poor)	*-0.322*	*0.478*	*0.500*	*0.725*
	Smell (Poor)	*0.624*	*0.386*	*0.105*	*1.867*
	Constant	*-0.838*	*0.159*	*0*	*0.432*
	Hosmer-Lemeshow		*0.865*		
	Pseudo R2		*0.011*		
	Chi-Square		*4.709*		
Revenue	Supply (Low)	*0.346*	*0.220*	*0.116*	*1.413*
[Low]	Reliability (Low)	*-0.022*	*0.203*	*0.912*	*0.978*
	Satisfaction (Low)	*-0.053*	*0.195*	*0.861*	*0.948*
	Taste (Poor)	*0.088*	*0.505*	*0.812*	*1.092*
	Smell (Poor)	*0.102*	*0.431*	*0.785*	*1.108*
	Constant	*-1.201*	*0.174*	*0*	*0.301*
	Hosmer-Lemeshow		*0.766*		
	Pseudo R2		*0.007*		
	Chi-Square		*2.873*		

Source: Utility Customer Survey Data; Water Payments Database.

4.4.c. Nonparametric Tests

Mixed and contradictory findings in studies of the satisfaction-performance relationship may result from the nature of performance-related variables and the parametric statistical approaches used to analyse them. Donkor argues that nonparametric techniques may be more powerful and appropriate when dealing with data that violate the assumptions of normality, independence, and homoscedasticity common to parametric methods (2013). The

Kolmogorov-Smirnov test is employed to evaluate the distributions of key variables for normality and the Mann-Whitney U statistic, which tests independent samples for equality of distributions. Table 4-6 shows the results of the Kolmogorov-Smirnov test, which shows that payment timeliness is the only variable fully characterised by a normal distribution. The other variables - supply hours, value, frequency, and revenue - exhibit non-normal distributions and were consequently tested using the Mann-Whitney U statistic. Each variable was tested across four paired customer groups, including those who rated their service as reliable/not reliable, satisfied/not satisfied, good taste/poor taste, and good smell/poor smell (Table 4-7). Results show that even using nonparametric techniques, there are no statistically significant relationships between payment behaviours and overall service quality or satisfaction.

4.4.d. Socioeconomic and Demographic Characteristics

Users and non-users of mobile-enabled payment methods are socioeconomically and demographically similar, although key differences tend to distinguish these two groups (Table 4-8). Utility customers who have used mobile-enabled payment methods for water bill transactions spend more on mobile services and less on transport than non-users. Expenditures on food, electricity, and school-related expenses are similar for both groups. Females are more likely to use these methods and users of mobile-enabled payment options have slightly larger households and tend to be older than non-users. Rates of education are also slightly divergent, as non-users are more likely to have a university-level education while approximately one-third of users have no more than a primary-level education. Users of mobile-enabled payment methods are also more likely to be self-employed or unemployed when compared to their counterparts who only pay at water offices. In Dar es Salaam, users of mobile-enabled options have lower levels of education, are more often female, and spend less on transport than their counterparts who do not use the payment instruments.

Table 4-6. Application of Kolmogorov-Smirnov test of normality to key variables related to service quality and customer payment behaviours.

	DESCRIPTIVE STATISTICS			KOLMOGOROV-SMIRNOV		
VARIABLE	**Mean**	**SD**	**N**	**Statistic**	**N**	**Sig.**
Supply Hours	*55.52*	*54.79*	*594*	*4.87*	*594*	*0.00****
Value	*21.85*	*15.10*	*594*	*3.21*	*594*	*0.00****
Frequency	*7.63*	*3.81*	*615*	*3.08*	*615*	*0.00****
Timeliness	*14.57*	*5.13*	*615*	*0.76*	*615*	*0.61*
Revenue	*147.78*	*101.83*	*601*	*3.04*	*601*	*0.00****

Source: Utility Customer Survey Data; Water Payments Database *p<0.05, **p<0.01, ***p<0.001

Table 4-7. Application of Mann-Whitney U test of equality of distributions to Supply Hours, Value, Frequency, and Revenue to assess reliability, overall satisfaction, and taste-/smell-related satisfaction.

	PAIRWISE COMPARISON		MEAN RANK		MANN-WHITNEY U TEST			
VARIABLE	**i**	**j**	**i**	**j**	**U**	**W**	**Z**	**Sig.**
Supply Hours	Reliable	Not Reliable	*362.75*	*227.23*	*23948*	*64989*	*-9.63*	*0.00****
	Satisfied	Not Satisfied	*293.63*	*300.79*	*42760*	*80161*	*-0.51*	*0.61*
	Good Taste	Not Good Taste	*298.29*	*296.65*	*43780*	*84841*	*-0.12*	*0.91*
	Good Smell	Not Good Smell	*313.38*	*286.35*	*38861*	*99936*	*-1.89*	*0.06*
Transaction Value	Reliable	Not Reliable	*296.06*	*298.94*	*43677*	*87930*	*-0.20*	*0.84*
	Satisfied	Not Satisfied	*290.32*	*303.33*	*41713*	*77224*	*-0.92*	*0.36*
	Good Taste	Not Good Taste	*291.76*	*303.44*	*42358*	*88111*	*-0.83*	*0.41*
	Good Smell	Not Good Smell	*280.43*	*308.83*	*38259*	*66462*	*-1.98*	*0.05**
Payment Frequency	Reliable	Not Reliable	*315.21*	*300.72*	*45050*	*92021*	*-1.02*	*0.31*
	Satisfied	Not Satisfied	*312.75*	*304.08*	*45524*	*102477*	*-0.60*	*0.55*
	Good Taste	Not Good Taste	*301.61*	*314.84*	*45193*	*95914*	*-0.93*	*0.35*
	Good Smell	Not Good Smell	*308.52*	*307.64*	*45494*	*112289*	*-0.06*	*0.95*
Revenue Collection	Reliable	Not Reliable	*306.21*	*295.84*	*43591*	*89344*	*-0.73*	*0.46*
	Satisfied	Not Satisfied	*297.20*	*304.10*	*43659*	*80244*	*-0.49*	*0.63*
	Good Taste	Not Good Taste	*295.56*	*306.80*	*43418*	*91623*	*-0.79*	*0.43*
	Good Smell	Not Good Smell	*298.72*	*302.58*	*43103*	*73484*	*-0.27*	*0.79*

Source: Utility Customer Survey Data; Water Payments Database *p<0.05, **p<0.01, ***p<0.001

Table 4-8. Demographic and socioeconomic comparison of users (n = 112) and non-users (n = 504) of mobile-enabled payment methods. Variables marked with an asterisk (*) are reported as the median of all values.

VARIABLES		USERS	NON-USERS
Demographic	Male	*43%*	*50%*
	Female	*57%*	*50%*
	Age*	*37.5*	*36*
	Household Size*	*7*	*6*
Employment	Full Time	*27%*	*28%*
	Part Time	*6%*	*8%*
	Student	*5%*	*9%*
	Self-Employed	*43%*	*38%*
	Unemployed	*23%*	*17%*
Education	Primary	*34%*	*26%*
	Secondary	*40%*	*39%*
	University	*19%*	*26%*
	Vocational	*8%*	*5%*
	None	*1%*	*3%*
Expenditures* *USD Monthly*	Food	*187.50*	*187.50*
	School	*34.38*	*37.50*
	Transport	*24.69*	*37.50*
	Mobile	*25*	*21.25*
	Electricity	*25*	*25*

Source: Utility Customer Survey Data

4.5. Discussion of Results

Multiple statistical analyses failed to yield evidence substantiating assumptions of direct relationships between service satisfaction and quality and payment behaviours for existing customers. Water utility customers in Dar es Salaam tend to make payments more frequently when using mobile-enabled payment methods, therefore contributing more revenue to the utility. Conversely, customer payment behaviours exhibited limited variation in relation to heterogeneous service quality and disparate satisfaction levels. These findings are discussed in relation to the research questions and conceptual framework presented in Section Two, marketing theory, and water services literature.

Variations in customer satisfaction are not associated with the heterogeneous service quality delivered by Dar es Salaam's urban water utility. Minimal variation in weekly service hours for customer groups expressing different levels of satisfaction shows that customers with regular access to piped-water supplies are not more satisfied with their received services than their less fortunate counterparts. This affirms findings produced by existing studies from Uganda, India, and Nicaragua which describe satisfaction as multi-dimensional and often unrelated to the realities of service quality (Kayaga, *et al.*, 2004; Deichmann and Lall, 2007; Vasquez, *et al.*, 2011). Expectancy disconfirmation theory and anchored adjustments to satisfaction are also supported by this finding (Tversky and Kahneman, 1974; Oliver, 1980). Significant deterioration of water services in Dar es Salaam has solidified relatively low customer expectations whether through prior experiences with the utility or peer observations. Low expectations, produced from consistently poor service quality, are likely more influential in determining satisfaction levels than actual service quality.

Heterogeneity in service quality has a nominal effect on payment behaviours and has no impact on payment method choice. High levels of perceived service reliability are significantly associated with weekly service hours (Table 1) and the amount of revenue collected per customer (Table 6). That most connections in Dar es Salaam are metered makes this finding intuitive; households receiving greater volumes of water pay for their higher consumption levels. Choice of payment method also appears to be independent of service quality, particularly when all payment options are used to pay for services from a monopoly provider. Customers receiving higher-quality services do not exhibit higher payment frequencies - common for users of mobile-enabled payment methods - or changes in transaction value or timeliness, suggesting the existence of asymmetries between customer intentions to pay and actual payment behaviours. By focusing on customer intentions and loyalties, existing work in water services literature (Kayaga, *et al.*, 2004; Addo-Yobo, *et al.*,

2006; Mugabi, *et al*., 2010) and from marketing disciplines (Oliver, 1980; Heskett, *et al*., 1997; Taylor and Baker, 1994) left a gap between intentions to pay and real payment behaviours. Empirical evidence of actual payment behaviours for water services in urban Tanzania shows that better payment practices and water service quality are not related, suggesting that optimal and sub-standard payment behaviours can be found throughout the service quality spectrum.

Revenue collection does not shift with differences in overall customer satisfaction; satisfied customers make payments with similar values, frequencies, and timeliness as their unhappier counterparts. Customer payment behaviours may not fluctuate with differing overall satisfaction levels, but they are influenced by customer perceptions of taste and smell. Customers dissatisfied with the taste of their water make lower-value payments at the same frequency as other customers, negatively impacting revenue collection. Those satisfied with the taste of their water are more likely to pay on time, but resultant effects on revenue collection are negligible. Dissatisfaction with the smell of piped water was significantly and curiously associated with higher payment frequencies. These findings raise three significant points related to service aesthetics, customer satisfaction, and the need for more specific analytical units in urban water literatures. Water services literatures tend to focus on quantifiable aspects of urban water services - service hours or the frequency of interruptions - over the aesthetic aspects of water itself, such as smell and taste. Although water utilities and regulatory agencies commonly monitor utility performance using service hours as a metric, these figures may be less important to end consumers and revenue collection than previously thought. Limited impacts of customer satisfaction on payment practices also raise questions on the efficacy of satisfaction improvements as a means to increase revenue collection from existing customers.

Rather than a dismissal of satisfaction as a normative ideal, these findings call attention to the need for an analytical division between *existing* and *potential* customers when discussing urban water provision in low-income countries. Those paying for the water services they receive are existing customers that are unlikely to vary their payment practices in light of heterogeneous service quality and satisfaction. Having better services than other customers does not translate into better payment practices. Those not paying for received water services and those who do not receive utility services are potential customers who cannot or do not access piped water services because of household income, geographic location, or an unwillingness to pay for poor quality services. Dar es Salaam likely contains many *potential* customers with the ability to obtain piped water services that choose not to do so because they may perceive the quality of provision to be unacceptable. Changes in service quality for existing customers may consequently shift levels of customer satisfaction that can be used to attract new (i.e. *potential*) customers, improve trust in the utility, and expand service loyalty - essential elements in Africa's competitive urban water sectors where alternatives to directly-provided services are abundant (Kjellen, 2000; Mugabi, *et al*., 2010). This analytical distinction has been overlooked in existing discussions of water utility performance.

4.6. Conclusions

Findings generated by this study challenge conventional understandings of interactions across service quality, customer satisfaction, and financially sustainable urban water services. Insufficient financial resources have contributed to the deterioration of water services in many of Africa's urban areas, spurring the proliferation of alternative sources of water such as tanker trucks, water vendors, and private wells or boreholes (Jaglin, 2002; Banerjee and Morella, 2011). Improvements in service quality and customer satisfaction may support the expansion of a utility's customer base by drawing from the pool of *potential* customers, but may not improve collection efficiencies from *existing* customers. For customers already paying for water services, water aesthetics such as taste and smell have a greater influence on

payment practices than service quality. This study has generated significant insights into the dynamics of urban water provision, which hold key implications for understanding spirals of decline and the rising influence of mobile communication technologies within the sector.

Addressing negative feedback loops, or spirals of decline, in Africa's urban water sector has routinely focused on interactions between service quality and their impacts on revenue collection. Although poor service quality may provoke customers to obtain water elsewhere, the water provider in Dar es Salaam still retains a large customer base which is provided with heterogeneous services. Existing customers demonstrate their willingness to pay by actually paying for all or part of their utility-provided services, regardless of service quality differences or satisfaction levels. Improving service quality to attract new customers or to encourage existing nonpayers to pay requires financial resources that must first come from existing customers - a client pool already distinguished by substantial underpayment. Existing customers do not exhibit variations in payment behaviours with differences in service levels or overall satisfaction, but revenue collection from this group increases through the use of mobile-enabled payment methods. Mobile-enabled payment methods have begun to simplify previously complex processes of bill payment by eliminating the need to travel long distances to make a transaction, reducing the cost of making a payment, and by making it easier for populations with irregular incomes to access water services. Funds generated from increased revenue collection can be subsequently used to improve water services delivery and expand customer bases within and eventually beyond distribution network footprints. It may therefore be possible to reverse spirals of decline by focusing on the distinct needs of existing customers and simplifying payment processes.

The increasing ubiquity of mobile communication technologies, mobile payment systems, and other innovations across Africa opens opportunities for new ideas and approaches in the

provision of satisfactory urban water services. Mobile-enabled payment innovations help utilities achieve the normative goals of cost recovery and the provision of satisfactory water services to populations within their service areas. They also facilitate a greater degree of customer autonomy over when they pay, how they conduct transactions, and the monetary amount they are willing and able to spend at a given time. Water providers may be able to further improve revenue collection, service quality, and their customer base by increasing customer autonomy within other parts of the billing and payment process. Customer-reported meter readings, payment reminders, balance inquiries, bill distribution, and customer service systems - all conducted via SMS - are being explored across Africa as a means to improve customer experiences with the payment process, reduce financial burdens on utilities, and eventually improve service quality through revenue augmentation. Expanded use of mobile communication technologies in the water sector may also pressure utilities to improve services. Because constructions of satisfaction are grounded in referencing to peers or anchors (Tversky and Kahneman, 1974; Oliver, 1980), the nature of satisfaction judgments may also shift as satisfaction references will no longer be constrained by geographic proximity. Broadened social networks facilitated by mobile technologies may reframe customer expectations and resulting satisfaction levels.

Water providers in sub-Saharan Africa should not be intimidated by shifting expectations brought about through the use of mobile communication technologies. Utilities are tasked with the production and delivery of water services to entire urban populations, a duty that remains unfulfilled by most service providers in sub-Saharan Africa. Creating policy environments that enable existing customers to actively engage with public service provision may be an indirect but effective strategy for widening water access. The advent and expansion of mobile technology in Africa has established a foundation on which customer-focused initiatives, and associated safeguards against their exploitation, can be built. This can improve service

delivery and satisfaction for customers, strengthen utilities, and open opportunities for wider experimentation in water service provision strategies appropriate to contemporary contexts.

5. Mobile-Enabled Payment Methods and the Influence of "Good Water Neighbours" on the Informal Water Sector in Tanzania

Abstract

Urban water service fragmentation in Africa produces and exacerbates socioeconomic inequalities and forces low-income populations to depend extensively on informal service providers for expensive water of uncertain quality. Neighbourhood resale of piped water supplies lies at the intersection of formal and informal water provision and offers higher-quality water supplies at prices more affordable for unconnected populations. Integration of mobile-enabled payment methods for water services in East Africa has contributed to improvements in customer payment practices, including those engaged in neighbourhood resale. A large-scale water payments dataset, 1097 utility customer surveys, and survey data of water access in Tanzania's urban low-income areas are used to demonstrate interactions between neighbourhood reseller payment practices and fragmentation in the informal water sector. Findings show that mobile payment options facilitate better payment behaviours by neighbourhood resellers, significantly shortening disconnection lengths and expanding direct and indirect access to piped water supplies. Broad reliance on neighbourhood resellers is also related to declines in dependence on alternative informal service providers. Neighbourhood resellers with good payment practices are identified as 'good water neighbours' that act as secondary distribution networks for utility-provided supplies in low-income areas. Strategies aimed at increasing the prevalence of these alternative providers can expand access to improved water supplies for unconnected households, enhance utility revenue collection, and may mitigate fragmentation within the urban water sector.

5.1. Introduction

In spite of the presence of conventional water production and distribution networks in Africa's cities, urban water provision is spatially and socioeconomically fragmented. Conspicuously rife with inequalities of access, pricing, and quality, the urban water sector is distinguished by underperforming utilities that provide unpredictable and geographically limited supplies, as well as informal service providers who ensure that water is available, but not necessarily affordable, within utility coverage areas and beyond. Collignon and Vezina estimate that between 30-80% of households in African cities rely on these small-scale providers (2000), and low-income areas in East Africa exhibit high rates of dependence on informal service providers (Thompson, *et al*., 2000). Current studies indicate that this trend has not abated (Zuin, *et al.*, 2011; Nnaji, Eluwa, and Nwoji, 2013). Across the continent, the poorest quintile of society is four times as likely to rely on unimproved water sources when compared with the richest quintile, and piped water is little more than a pipe dream for populations in the three lowest-income quintiles (UNHABITAT, 2011). Although the Millennium Development Goal for drinking water was reached in 2012, the number of urban dwellers in Africa without access to adequate water supplies continues to rise as urbanisation and population growth expand the extent of low-income areas and unplanned settlements, which are traditionally bypassed by conventional delivery infrastructures (Dagdeviren and Robertson, 2011; WHO/UNICEF, 2012; WHO/UNICEF, 2013). Fragmented, decentralised, and labour-intensive informal water economies form the production and distribution networks that supply water to the majorities of urban populations deemed to be beyond the spatial or commercial reaches of formal services provided by African water utilities.

Small-scale and non-state water service providers have been an increasingly significant fixture in Africa's urban water sector since the late 1960s, as water utilities struggled to keep pace with expanding urban populations. Thompson, *et al*. describe this trend at the "single most important change in the nature of secondary water supplies" (2000: 46). These alternatives fill

crucial gaps in water access left by conventional urban water authorities and utilities through the sharing and delivery of water in low-income communities and other areas of cities unserviced or under-serviced by piped-water systems. Informal service providers have a broad geographic reach, serve all socioeconomic strata, and are financially sustainable (Solo, 1999), but these advantages come at a cost. Water provided through the informal water economy is significantly more expensive and of unreliable quality when compared with utility provided services (Jaglin, 2002), and low-income populations disproportionately bear the consequential financial and health-related burdens. Although they provide access to water throughout urban areas, the stratified nature of Africa's urban water sector threatens to perpetually lock low-income populations into a sub-standard system of water access.

The proliferation of mobile communication technologies across Africa has engendered optimism about the potential for new tools to enhance water service delivery by overcoming seemingly intractable problems related to financial sustainability, corruption, and water security (Hope, *et al*., 2012; Foster *et al.,* 2012; Kshetri and Acharya, 2012). Mobile-enabled payment methods are major applications of this technology that improve water bill payment processes using mobile money services (e.g. M-PESA in Kenya) and GPRS[15]-enabled pay points (e.g. Selcom Wireless Pay Points in Tanzania) (Hope, *et al*., 2011). Use of these payment methods in the water sector improves customer payment behaviours through increases in payment frequency and annual revenue collection (Krolikowski, 2013).

Neighbourhood resellers are one type of informal service provider that provides water supplies at a significantly lower cost than other alternatives, such as cart vendors or private wells and boreholes. Since water sold through neighbourhood resale sometimes originates from utility-provided supplies, the payment practices of neighbourhood resellers may have an

[15] General Packet Radio Service, or GPRS, is a mobile data service that is used by mobile phones and forms the bases for mobile-enabled point-of-sale technologies. The remainder of this paper refers to these point-of-sale devices as ‘wireless pay points’.

impact on the nature of informal water provision in urban areas. Interactions between payment behaviours, neighbourhood resale practices, and the nature of informal water provision are evaluated in response to the question: How do customer payment practices, including the use or nonuse of mobile-enabled payment methods, influence fragmentation in the urban water sector?

This paper evaluates the payment practices of neighbourhood resellers to identify relationships between water services fragmentation and customer payment behaviours. Analyses show that greater reliance on neighbourhood resale can potentially reduce fragmentation, diminish existing inequalities of access, and improve water utility performance. Section Two presents a brief review of 'splintered' urban water services in developing cities, and Section Three proposes a conceptual framework that focuses on the relationships between customer payment behaviours and neighbourhood resale practices. The fourth section begins with a discussion of the informal water sector in Dar es Salaam, Tanzania - the focus of this study - and then details the methods and data sources used for subsequent analyses. Hypotheses are tested using a unique water payment database and utility customer payment preferences survey, as well as a comprehensive dataset on water and sanitation access in low-income areas throughout urban Tanzania. Findings presented in Section Five illustrate the linkages between customer payment behaviours and the functioning of the informal water economy in Dar es Salaam. These findings are discussed in Section Six, which proposes the existence of 'good water neighbours' - neighbourhood resellers who frequently pay their water bills and contribute significantly higher levels of revenue to the utility. The final section concludes with a description of further areas of research that emerge from the limitations of this study, as well as a contribution to ongoing debates regarding the role of informal service providers in urban water services.

5.2. Fragmentation in the Urban Water Sector

Urban water provision around the world is characterised by a diverse typology of water sources and distribution networks run by state, private, or small-scale non-state providers . Graham and Marvin argue that networked infrastructures influence and reproduce spatial and socioeconomic inequalities, and that new forms of water provision have emerged in high- and middle-income countries as a consequence of the liberalisation and commercialisation of water services around the world (2001). Exclusionary provision models threaten equality of access in countries that already enjoy universal coverage and are contributing to the 'splintering' of control over water provision systems, stratification in service delivery, and the development of premium networked spaces (Graham, 2000; Graham and Marvin, 2001; Graham, 2002). This trend is particularly noticeable in emerging economies, where concerns regarding the quality of municipal water supplies have driven the construction of private water networks for select buildings and housing areas (Boland, 2007). Socioeconomic water service fragmentation in high- and middle-income cities challenges the normative ideals of equity and universal coverage.

Spatial and socioeconomic inequalities resulting from splintered urban water provision are common in developing countries, where low-income urban populations are routinely denied access to directly provided piped water supplies. Relative spatial homogeneities of European and North American industrial cities stand in stark contrast to the heterogeneous urban forms - illegal settlements, slums, and planned districts - commonly found in African, Asian, and Latin American cities (Balbo, 1993). 'Splintered' urban water systems in these contexts have developed over time and continue to perpetuate heterogeneous patterns of access and supply (Kooy and Baker, 2008). In these countries, only privileged urban enclaves benefitted from the networked water infrastructures that enabled near-universal coverage and access in wealthy states during the 19th and 20th centuries (Gandy, 2006). Contemporary delivery of utility-provided water services reflects these historical patterns, and standardized monopolistic

networks in low-income countries have become the premium networks they are supposedly being superseded by (Coutard, 2002). Piped water networks selectively expand into communities that are deemed to be commercially viable (Boland, 2007), resulting in unequal access to safe water supplies that adversely and disproportionately impacts poor urban populations. Those living outside the boundaries of water distribution networks depend on alternative water sources and expend considerable financial resources and labour to meet household needs (Solo, 1999). Service quality is often also inadequate for connected households, who consequently increase dependence on informal service providers. Dependence on alternative water sources and resulting inequalities in sub-Saharan Africa have been discussed by recent studies from Nigeria (Nnaji, Eluwa, and Nwoji, 2013), Burkina Faso (Dos Santos and LeGrand, 2013), Uganda (Mugambe, Tumwesigye, and Larkan, 2013), and Ghana (Stoler, *et al*., 2012). Rather than paying more for premium networked services, urban populations in Africa and elsewhere commonly obtain alternative water supplies that are of lower-quality and higher cost than piped connections. Few studies, however, have explored the potentially critical role played by neighbourhood resale, which lies at the intersection of formal and informal water provision, at mitigating the negative impacts of fragmentation.

Inadequate formal service provision combined with the relative reliability of alternative supplies contributes to broad reliance on non-utility water sources in urban Africa. Sources include cart vendors, neighbourhood resellers, rainwater, wells and boreholes, tanker trucks, or bottled water. Because of their improvisational nature, there is not a standard definition of the alternative sources comprising the informal water sector (Kariuki and Schwartz, 2005). Water vending and neighborhood resale complement piped-water systems that deliver insufficient water services, and connected households engage non-state providers in periods of water scarcity, utility outages, or when disconnected for failing to pay their bills (Kjellen, 2000). Broad reliance on the informal water sector is bolstered through relative advantages

over water utilities: full cost recovery, limited unaccounted-for-water, personable customer service, no upfront connection fees, and the capacity to effectively reach poor populations (Solo, 1999; Ozpryszko, *et al*., 2009). On a continent where more than two-thirds of urban populations live in unplanned settlements (Dagdeviren and Robertson, 2011), informal service providers are typically the only available alternatives to the erratic supply patterns and limited geographic extents of large-scale formal water distribution networks (Drangert, *et al*., 2002; Sansom and Bos 2008; Schwartz and Sanga, 2010).

Despite relative advantages, dependence on the informal water sector is not a long-term solution for Africa's urban water sector. Jaglin cautions against over-reliance on the informal water sector, arguing that the existence and effectiveness of alternative suppliers constrain future expansions of better-quality and formally provided services to low-income neighbourhoods (2002). Vending and reselling are relatively low-cost in terms of required investments, but are accompanied by high labour costs and significantly higher per-litre prices for consumers (Mashauri and Katko, 1993; Zerah, 1998; Kjellen, 2000). This means that poor populations, who often cannot afford household connections (Kayaga and Franceys, 2007), pay significantly higher prices for water when compared to piped supplies. Dependence on the informal water sector carries with it the risk of institutionalizing two tiers of service that lock low-income groups into more inconvenient, costly, and poor-quality supplies (Jaglin, 2002). While less desirable than having a household connection, water obtained via neighbourhood resale requires lower costs (e.g. time and money) and is of higher quality than other alternative sources (Mashuari and Katko, 1993; Keener, Luengo, and Banerjee, 2010; Zuin, *et al*., 2011). Greater comprehension of the dynamics of neighbourhood resale can contribute to the identification of solutions that improve direct and indirect access to water services without placing additional costs on the utility or low-income unconnected populations.

5.3. Conceptual Framework

Neighbourhood resellers are central to secondary water distribution networks across sub-Saharan Africa (Collignon and Vezina, 2000). Widespread prevalence of neighbourhood resale facilitates access to utility-provided water by unconnected households, particularly in places where standpipes are uncommon (Ibid). The conceptual framework presented in Figure 5-1 illustrates how supplies from the formal water sector are distributed to unconnected households dependent on the informal water sector via the neighbourhood resale of piped water. Each water utility customer acting as a neighbourhood reseller must pay their bills to continue receiving the supplies that are subsequently resold. Customers exhibit payment practices that include transaction value, payment frequency, payment timeliness, and annual revenue contributions. Conceptual elements of payment behaviours are taken from existing work on water bill payment practices (Kayaga, *et al*., 2004; Mugabi, *et al*., 2007; Mugabi, *et al*., 2010; Foster, *et al*., 2012; Donkor, 2013). Where there are multiple payment options, as is the case in East Africa's urban areas, payment method choice may also be significant (i.e. use or non-use of mobile-enabled payment methods) (Foster, *et al*., 2012). Payment behaviours consequently influence the prevalence of resale through their impacts on disconnections and other penalties for late or nonpayment, consistency of resold supplies, price per bucket relative to other informal providers, and resale or sharing patterns such as the number of clients and absolute price per bucket (Zerah, 1998; Solo, 1999; Kjellen, 2000; Mugabi and Kayaga, 2010; Zuin, *et al*., 2011). Customer payment behaviours may also indirectly affect dependence on the informal water sector through impacts on availability of supplies and relative pricing. Poor payment behaviours can constrain the ability of neighbourhood resellers to engage in resale while the converse may be true with customers who exhibit positive payment practices.

In this study, neighbourhood resale and dependence on alternative sources of water are conceptualised as two distinct constructs due to key differences in each. Building on existing studies that define the boundaries of the informal water sector (Solo, 1999; Kjellen, 2000;

Jaglin, 2002), Zuin, *et al*. (2011) highlight the existence of substantial differences between neighbourhood resale and other forms of non-state water providers. In particular, neigbourhood resale is typically less expensive than other alternative sources and the source of the water supplied is easier to ascertain than water vendors and tanker trucks that transport water from outside a settlement. Differentiating between neighbourhood resale and dependence on alternative sources (i.e. all other informal sources) offers a more granular perspective on the informal water sector that enables direct comparisons. This approach, however, is limited in that there are no established measures of 'dependence' in the water sector. We overcome this limitation by using proportions of the population using each type of informal vendor or water source.

Hypotheses produced from this framework are used to identify whether good payment practices are associated with neighbourhood resale and, indirectly, access to piped water supplies. Neighbourhood resellers with good payment practices (i.e. 'good water neighbours') should have a greater capacity for indirect resale of utility water; the combination of available supplies and lower relative costs may increase reliance on neighbourhood resale and reduce dependence on significantly more expensive water vendors and tanker trucks. Good water neighbours should therefore exhibit positive payment practices, be less likely to miss payments or be disconnected, have the capacity to provide constant supplies, and sell water at lower prices than other informal service providers. Payment-related aspects of 'good water neighbours' are tested using the following hypotheses: 1) neighbourhood resale has no influence on utility customer payment behaviours; 2) payment behaviours are not associated with penalties for late or missed payments; 3) payment behaviours are not associated with dependence on alternative water sources; and 4) payment behaviours are not associated with neighbourhood resale practices.

5.4. Methods and Data Sources

Elements of resale that make a neighbourhood reseller a 'good neighbour' are examined using a combination of primary and secondary data sources. Primary data were collected in 2012 and include a large database that includes 967,459 water-related payments made over 2010-2011 and a 615-response subset of 1097 responses to a water utility customer payment preference survey conducted in Dar es Salaam. A 2010 survey conducted by Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) was also used. The project focused on access to water and sanitation in low-income areas in 20 of Tanzania's cities, including dependence on informal service providers and other aspects of the informal water economy. Survey methodologies have been used extensively in studies of water vending, neighborhood reselling, and informal water economies (Kjellen, 2000; Bardasi and Wodon, 2003; Stoler, *et al*., 2012). Characteristics of water access in the city's low-income areas were obtained from the GIZ water and sanitation dataset, payment indicators were calculated from the water payments dataset, and all other variables were obtained from survey responses.

5.4.a. Research Setting: Dar es Salaam, Tanzania

Piped water provision in Dar es Salaam, Tanzania is simultaneously challenged and complemented by informal service providers who emerged in a context of deteriorating water services. Between 1967 and 1997, the city grew from 50,000 to over 3 million people and this growth was accompanied by declining supply hours; only 27% of the population received uninterrupted supplies in 1997 compared with 100% in 1967 (WaterAid, 2008). Per capita consumption of piped supplies over this period fell over 75% in low-income areas as the number of residents per connection rose from 17 in 1968 to 50 in 2005. Increasing demand, a lack of new infrastructural investments, and poor maintenance practices contributed to severe declines in service quality within the city. These changes have led to water vending and neighborhood resale of utility supplies emerging as the most common alternatives to household water connections in Dar es Salaam (Kjellen, 2000; Kyessi, 2005; Dill, 2010).

Informal service providers are the norm in a city where over 76% of households continue to lack direct access to piped-water supplies.

A mobile phone survey (n=324) completed by an independent consulting firm in June 2012 found access to water services in the city to be considerably dependent on utility-providers water but simultaneously constrained by erratic service hours and frequent outages. In Dar es Salaam, 33.7% of citizens rely on wells or boreholes, 31% primarily obtain water from neighbours, 9.5% have water delivered to their house via truck or cart vendor, and 23.1% of citizens have taps within their houses or plots. Water bought from neighbourhood resellers is significantly more expensive than piped-water and most often comes from a tap serviced by utility water supplies (88.7%), and is rarely obtained from a well or borehole (6.9%). Direct or indirect access to water mains does not, however, guarantee a reliable water supply. Less than one in seven (15.6%) households with access to piped water enjoyed a continuous supply and more than half of households receiving water did so on fewer than four days per week (Listening to Dar, 2012).

Unreliable supplies drive all water users to obtain water from informal service providers, whether or not they have a piped connection. The importance of small-scale providers to households with piped connections is unknown. For citizens who did not have direct access to utility water supplies, 37.4% indicated this was due to being located outside the utility service area and 35% stated that connection costs were too high. The price of utility water was a marginal concern (2.3%) and few individuals expressed satisfaction with their current engagement with informal service providers (2.4%). Although direct access to piped-water may be constrained by geography and income, the high costs (i.e. time, financial, labour, opportunity) of obtaining water via the informal water economy suggest that citizens may prefer household connections over dependence on alternative sources.

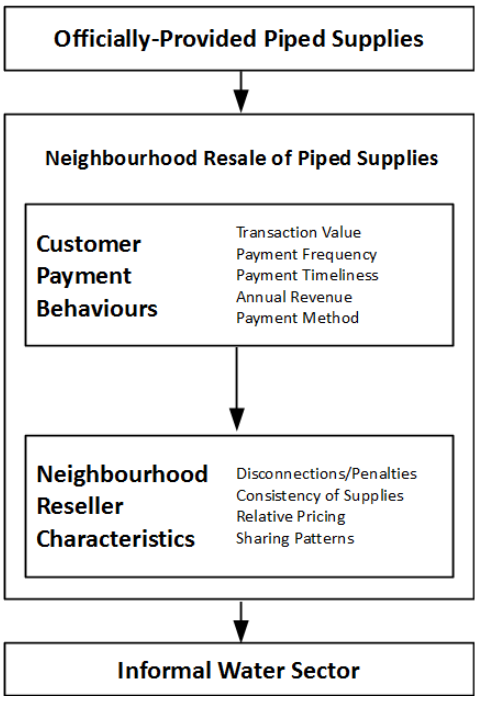

Figure 5-1. Visual representation of conceptual framework detailing the relationships between customer payment behaviours, neighbourhood resale, and the informal water sector. *Source: Author*.

5.4.b. National Survey of Household Access to Water and Sanitation

The 2010 GIZ survey is comprised of 32,000 household surveys from low-income areas in 20 Tanzanian cities, in which Dar es Salaam is included. Survey data are geographically referenced and focus on the proportion of the population dependent on informal service providers, the proportion of the population reliant on neighbourhood resellers, mean prices for a 20-litre bucket of water, proportion of the population with a piped-water connection, and the proportion of domestic connections that are disconnected or broken, among others. Low-income areas as defined by GIZ closely follow UN-HABITAT's (2003) definition of slums by focusing on areas with inadequate access to safe water and sanitation, poor quality housing, high population densities, and low or unpredictable incomes. Low-income areas in the survey are contiguous with officially-designated 'mtaas' - small geographic areas that are smaller than the city's wards (i.e. neighbourhoods). Approximately 170 low-income areas in Dar es

Salaam were surveyed, with 110 of these falling within the water utility service area. The primary data used in this study are aggregated at the ward level and are associated with the GIZ survey data by linking to the ward in which each low-income area is located.

5.4.c. Water Payments Dataset

Payment data for 2011 were obtained from the Dar es Salaam Water and Sewerage Corporation (DAWASCO), telecommunications companies operating two separate mobile money services, and a third-party integrator managing over 2,000 wireless pay points located throughout Dar es Salaam. In 2011, 513923 payments were made to the utility by 81389 customers. Payment data are aggregated by ward for customers from whom geographic location was obtained. Of 81389 active utility customers in 2011, 32176 shared their home location, which enables analyses of 199149 payments. Of the geographically-referenced customers, 6944 incorporated mobile-enabled payment methods into their payment practices and made a total of 54404 payments using both mobile payment innovations and water offices. Payment data and the proportion of utility customers using mobile-enabled payment methods were calculated for 52 of Dar es Salaam's 73 wards. Payment records detail the date, time, payment method, and utility account number for each transaction. Large transaction amounts are common within the dataset due to the prevalence of connection and reconnection fees, industrial and commercial accounts, and large payments made to settle outstanding balances. These large transactions are not directly related to the regular payment behaviours of domestic water utility customers and are considered to be outliers, which were identified and muted using the outlier labelling rule (Tukey, 1977; Hoaglin, Iglewicz, and Tukey, 1986; Hoaglin and Iglewicz, 1987).

5.4.d. Water Payment Preferences Survey

Water utility customer payment preference surveys were administered to 1097 water utility customers throughout Dar es Salaam during August and September 2012. The instrument was

designed in collaboration with the water utility and was piloted in June 2012. Survey responses include data on geographic location and housing, socioeconomic variables, demographic variables, assets and expenditures, mobile phone use, payment methods and preferences, payment behaviours, service satisfaction, disconnections and reconnections, alternative sources of water, community supplying behaviours, and SMS billing reminders. Survey administration was conducted over one billing cycle and at physical payment locations such as water offices, bank branches, and wireless pay point locations. Systematic random sampling was used to select five target wards that contained a water payment office and five that did not. Within each randomly selected ward, physical payment locations constituted a secondary sampling frame. Random sampling was again used to create a stratified sample of physical payment locations that included water offices, bank branches, and wireless pay points. All water utility customers using the payment locations were invited to participate in the survey.

The survey invited participants to share their account numbers to facilitate analyses of their transactional histories. Of the 1097 respondents, 615 shared a valid account number which linked the surveys to 4655 water-related payments made in 2011. Respondents in the dataset are grouped along two factors - their use or non-use of mobile-enabled payment methods and whether or not they shared their tap water, for free or at cost, with nearby members of their community. Of the 615 respondents, 122 are classified as community sharers and 112 incorporated mobile-enabled payment methods into their 2011 payment practices.

5.4.e. Statistical Analysis and Measures

Neighbourhood resellers interact with the informal water economy in two primary ways: in their role as informal service providers and as customers of other alternatives when piped supplies are minimal or interrupted, when household storage capacity is limited, or when they have been disconnected. Water users in Dar es Salaam are most likely to obtain water from

other neighbours with functioning taps, wells or boreholes, tanker trucks, cart vendors, or rain water. Variables used to analyse dependence on alternative sources include storage capacity, mean length of disconnections, and mean weekly supply hours. Proportions of customers who have missed a payment, been disconnected, store water, and actively engage with informal service providers are also calculated for this purpose. Resale practices include the proportion of respondents that share water, the mean number of water users they sell to, and the mean price charged for a 20-litre bucket of water. Payment behaviours and resale practices are compared across utility customers who are and are not neighbourhood resellers and those who use and do not use mobile-enabled payment methods.

Payment behaviour measures include transaction value, transaction timeliness, annual payment frequency, and annual revenue per customer. An additional categorical variable identifying the use or non-use of mobile-enabled payment methods is used to structure results. A customer is a "Mobile User" if he or she made at least one transaction in 2011 using a mobile money service or wireless pay point. All other customers are identified as "Mobile Non-Users." Transaction value is the monetary amount of a single payment and mean transaction values are calculated from all payments made by each customer in 2011. Transaction timeliness is the numerical date on which a payment was made and is expressed as the number of the day of the month in which the transaction takes place (e.g. 1-31). Mean timeliness is computed for payments made by each customer in 2011. Annual payment frequency refers to the number of payments made by each customer in 2011. Annual revenue per customer is the sum total of all payments made in a particular year by a specific customer. The mean values of the four continuous measures of payment behaviour are calculated for each ward, as are the proportions of payments and payers that have incorporated mobile-enabled payment methods into their payment practices.

From the GIZ household survey, variables related to the functioning of the informal water economy are used. These variables include proportions of the population in each low-income area that has access to adequate water services, the proportion with domestic connections, and the proportion of domestic connections that are disconnected or broken. Data on alternative sources is also available and includes the proportion of the population relying on informal service providers, neighbourhood resellers, public standpipes, and populations that must travel more than 30 minutes to obtain water supplies. Mean price per 20-litre bucket of water in each low-income area is employed in this analysis.

Due to the nature of the data being analysed, binary logistic regression and inferential statistics are used in analysis. Binary logistic regression evaluates linkages between payment practices and different elements of the informal water economy. Population proportions exhibiting a certain characteristic (e.g. dependence on the informal water sector, use of mobile-enabled payment methods, etc.) are divided into quartiles and the upper (i.e. "High") and lower (i.e. "Low") quartiles of each measure is used as a variable in statistical analyses. Goodness-of-fit is tested using the Hosmer-Lemeshow test. Means comparisons are used for continuous variables that do not need to be transformed, such as payment behaviours (i.e. value, frequency, timeliness, and revenue), water storage, number of users, bucket price, length of disconnection, and weekly supply hours.

Table 5-1. Differences in payment behaviours for utility customers that are and are not engaged in neighbourhood resale of piped water supplies.

	VALUE (USD)			**FREQUENCY** (Payments/Year)			**TIMELINESS** (Day of Payment)			**REVENUE** (USD)		
Group	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
All	*21.85*	*15.10*	*594*	*7.63*	*3.81*	*615*	*14.57*	*5.13*	*615*	*147.78*	*101.83*	*601*
Sellers	*22.67*	*14.29*	*117*	*7.41*	*3.99*	*122*	*14.7*	*5.09*	*122*	*163.50**	*117.82*	*119*
Non-Sellers	*21.64*	*15.29*	*477*	*7.68*	*3.77*	*493*	*14.54*	*5.14*	*493*	*143.91*	*97.23*	*482*

Source: Utility Customer Survey Data; Water Payment Database *p<0.05, **p<0.01, ***p<0.001

5.5. Findings and Analysis

5.5.a. Payment Practices and Neighbourhood Resale

Water utility customers engaged in neighbourhood resale of piped-water supplies demonstrate expected differences in payment behaviours when compared with those that do not resell their water (Table 5-1). Payment values, frequencies, and timeliness are similar for both resellers (Value=22.67[16]; Frequency=7.41; Timeliness=14.7) and those that do not resell (Value=21.64; Frequency=7.68; Timeliness=14.54) officially-provided piped water supplies. Revenue contributions made by neighbourhood resellers (Revenue=163.50 USD) is significantly higher than revenue from non-resellers (Revenue=143.91) ($z=1.68$; $p<0.05$). This is a consequence of higher consumption rates resulting from the higher number of households that rely on a single connection for water. Beyond differences in revenue, payment behaviours are similar for customers engaged and not involved in neighbourhood resale.

Using mobile-enabled payment methods significantly influences payment behaviours for all customers, whether or not they are engaged in neighborhood resale (Table 5-2). Customers that resell water and use mobile payment methods have significantly lower transaction values ($t=2.80$, $p<0.01$), significantly higher payment frequencies ($t=2.17$; $p<0.05$), and significantly higher annual revenue contributions ($t=4.74$; $p<0.001$) than neighbourhood resellers who only pay at water offices. For customers that do not resell water, payment frequencies ($z=4.85$; $p<0.001$) and annual revenue contributions ($t=2.19$; $p<0.05$) are significantly higher with the incorporation of mobile-enabled payment methods into their payment practices. Payment timeliness was not influenced by the use of these payment options for any group of customers. Descriptive statistics of payment behaviours across mobile use/non-use and neighbourhood resale are found in Table 5-5.

[16] The conversion from Tanzanian Shilling (TZS) to United States dollars (USD) used in this article is 1600 TZS for 1 USD.

5.5.b. Penalties for Poor Payment Practices

Due to the prominence and competitiveness of informal service providers in Dar es Salaam, unsatisfactory services or erratic supplies push utility customers to engage with the informal water economy to ensure adequate household water supplies. Utility customers incorporating mobile payment methods into their payment practices in 2011 exhibited minimal differences in missed payments and disconnection histories (Table 5-3). Proportions of customers who have missed a payment are similar for both mobile payment users (23.2%) and non-users (21.3%). Users of mobile-enabled payment methods were slightly less likely to have experienced a disconnection (23.2%) than non-users (26.2%). Comparing the estimated length of disconnections for mobile payment users (n=23) and non-users (n=109) who have been disconnected shows that mobile payment users have significantly shorter disconnection lengths than mobile non-users ($t=3.46$, $p<0.01$). This suggests that mobile payment users and non-users experience missed payments and disconnections with similar frequency, but the disconnection period is shorter than customers only using water offices.

Table 5-2. Differences in payment practices for utility customers that are or are not engaged in neighbourhood resale of piped water supplies, segmented by use and non-use of mobile-enabled payment methods.

		VALUE (USD)			**FREQUENCY** (Payments/Year)			**TIMELINESS** (Day)			**REVENUE** (USD)		
	Group	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
MOBILE USERS	**All**	*20.35*	*14.79*	*110*	*9.01*	*3.14*	*112*	*14.93*	*4.87*	*112*	*165.85*	*104.24*	*110*
	Sellers	*20.37***	*13.74*	*18*	*8.32**	*3.42*	*19*	*15.02*	*6.38*	*19*	*174.69***	*130.18*	*18*
	Non-Sellers	*20.35*	*15.06*	*92*	*9.15****	*3.09*	*93*	*14.91*	*4.54*	*93*	*164.13**	*99.09*	*92*
MOBILE NON-USERS	**All**	*22.18*	*15.16*	*484*	*7.32*	*3.88*	*503*	*14.49*	*5.18*	*503*	*143.74*	*100.95*	*491*
	Sellers	*23.09*	*14.41*	*99*	*7.24*	*4.08*	*103*	*14.64*	*4.85*	*103*	*161.50*	*116.07*	*101*
	Non-Sellers	*21.95*	*15.35*	*385*	*7.34*	*3.83*	*400*	*14.46*	*5.27*	*400*	*139.14*	*96.28*	*390*

Source: Utility Customer Survey Data; Water Payments Database *p<0.05, **p<0.01, ***p<0.001

Table 5-3. Missed payments, disconnections, and length of disconnection for 132 utility customers.

GROUP	MISS PAYMENT (%)	DISCONNECTED (%)	LENGTH OF DISCONNECTION (Days)		
			Mean	SD	N
All	*21.6*	*25.7*	*14.28*	*13.96*	*132*
Mobile Users	*23.2*	*23.2*	*11.83***	*13.98*	*23*
Mobile Non-Users	*21.3*	*26.2*	*14.8*	*13.97*	*109*

Source: Utility Customer Survey Data *p<0.05, **p<0.01, ***p<0.001

5.5.c. Dependence on Alternative Water Sources

Despite receiving directly-supplied piped-water and having positive payment practices, users of mobile-enabled payment methods often receive unpredictable services and must rely on alternative water sources to fill gaps left by the utility (Table 5-4). Users of mobile-enabled payment methods (49.67 hours/week, n=108) receive water for approximately the same duration of mobile non-users (56. 82, n=486). The proportion of customers storing water is also similar. Approximately 58% of users of mobile-enabled payment methods store water and have a mean storage capacity of 1859 litres, which compares with 56.3% of mobile non-users and a storage capacity of 2040 litres. Mobile payment users also rely on cart vendors (19.6%), wells and boreholes (43.8%), and tanker trucks (7.1%) at levels similar to mobile non-users (19.7%; 44.7%; 4.4%). The direct provision of water services to households does not subsequently prevent the need for alternative water sources, and the use of mobile-enabled payment methods does not appear to influence these metrics either.

Table 5-4. Examination of service hours, storage, and dependence on alternative sources by water utility customers**.**

Group	WEEKLY SUPPLY HOURS			STORE WATER (%)	STORAGE (Litres)			ALTERNATIVE SOURCES (%)				
	Mean	SD	N		Mean	SD	N	Nghbr	Vendor	Truck	Well	Rain
All	*55.52*	*54.79*	*594*	*56.6*	*2005*	*1541*	*323*	*6.5*	*19.67*	*4.88*	*44.55*	*3.25*
Mobile Users	*49.67*	*46.76*	*108*	*58*	*1859*	*1535*	*62*	*6.25*	*19.64*	*7.14*	*43.75*	*3.57*
Mobile Non-users	*56.82*	*56.37*	*486*	*56.3*	*2040*	*1543*	*261*	*6.56*	*19.68*	*4.37*	*44.73*	*3.18*

Source: Utility Customer Survey Data.

Optimal access to water services in Dar es Salaam's low income areas is defined by Tanzania's Ministry of Water as the proportion of the population obtaining water in less than 30 minutes from a domestic connection, public standpipe, or borehole supplied by a licensed service provider. Table 5-5 shows that optimal water access is highest in areas that are characterised by high rates of use of mobile-enabled payment methods [Exp(B) = 4.878; Sig = 0.002], high annual revenue collection from utility customers [Exp(B) = 3.122; Sig = 0.029], and low rates of disconnected or broken domestic connections [Exp(B) = 3.389; Sig = 0.022]. These findings illustrate that optimal access to water services in Dar es Salaam's low-income areas is facilitated by positive payment behaviours and higher proportions of domestic connections that remain functional. Greater functionality of household taps, supported by payment practices, is associated with broader access to water services.

Dar es Salaam's low-income areas have varying levels of dependence on informal service providers. Table 5-5 illustrates that key predictors of lower degrees of dependence on alternative providers include a high prevalence of domestic connections [Exp(B) = 29.699; Sig = 0.000], higher rates of reliance on neighbourhood resellers [Exp(B) = 4.153; Sig = 0.036], and frequency of payment to a lesser extent [Exp(B) = 2.703; Sig = 0.090]. Although neighbourhood resellers are also designated as informal service providers, reliance on them appears to decrease overall dependence on informal service providers. Coupled with higher proportions of the population receiving utility water supplies, these findings suggest that dependence on alternative sources is lowest when low income populations have access to utility-supplied water, whether through primary domestic connections or accessing supplies through neighbours.

Table 5-5. Findings of binary logistic regression for aspects of water access in 110 low-income areas.

RESPONSE	EXPLANATORY	B	STD. ERROR	EXP(B)
Optimal Water Access	Mobile Payers (High)	*1.585*	*0.511*	*4.878***
[High]	Revenue (High)	*1.139*	*0.521*	*3.122**
	Broken/Disconnected (Low)	*1.220*	*0.533*	*3.389**
	Constant	*-2.284*	*0.420*	*0.102*
	Hosmer-Lemeshow		*0.628*	
	Pseudo R2		*0.249*	
	Chi-Square		*20.372****	
Informal Service Providers	Domestic Connections (High)	*3.391*	*0.658*	*29.699****
[Low]	Reliance on Neighbours (High)	*1.424*	*0.679*	*4.153**
	Frequency (High)	*0.994*	*0.586*	*2.703*
	Constant	*-3.019*	*0.574*	*0.049*
	Hosmer-Lemeshow		*0.739*	
	Pseudo R2		*0.487*	
	Chi-Square		*45.081****	
Bucket Price	Mobile Payers (Low)	*1.735*	*0.591*	*5.667***
[Low]	Broken/Disconnected (Low)	*2.2132*	*0.566*	*8.428****
	Reliance on Neighbours (High)	*1.228*	*0.596*	*3.415**
	Constant	*-2.819*	*0.498*	*0.060*
	Hosmer-Lemeshow		*0.507*	
	Pseudo R2		*0.429*	
	Chi-Square		*37.436****	
Reliance on Neighbours	Value (High)	*1.026*	*0.496*	*2.789**
[High]	Frequency (High)	*1.341*	*0.474*	*3.821***
	Broken/Disconnected (Low)	*0.723*	*0.531*	*2.06*
	Constant	*-2.063*	*0.411*	*0.127*
	Hosmer-Lemeshow		*0.929*	
	Pseudo R2		*0.171*	
	Chi-Square		*13.730***	

Source: GIZ Survey Data *p<0.05, **p<0.01, ***p<0.001

Table 5-6. Mean costs (USD) per cubic meter by water sources in Dar es Salaam, Tanzania as reported by utility customers.

SOURCE	MEAN	SD	N
Bottle	*257.57*	*94.74*	*191*
Vendor	*12.83*	*7.59*	*224*
Truck	*10.44*	*6.04*	*72*
Neighbour	*4.09*	*2.83*	*75*
Well	*2.51*	*1.53*	*341*
Rain	*0.00*	*N/A*	*27*
Piped Water	*0.53**		

Source: Utility Customer Survey Data **Official Utility Rate*

Bucket price is the monetary value of a single large bucket of water, which has a relatively standard volume of 20 litres. Mean bucket price varies greatly across Dar es Salaam, and Table 5-6 demonstrates per-cubic-metre pricing differences for a variety of alternative water sources. Neighbourhood resale is significantly less costly than bottled water, tanker trucks, and water vendors; but is significantly more expensive than water obtained from wells or boreholes, rainwater, and utility supplies. Bucket price in the city's low-income areas tends to be lowest when the proportion of utility customers using mobile payment innovations is low [Exp(B) = 5.667; Sig = 0.003], when lower proportions of domestic connections are disconnected or broken [Exp(B) = 8.428; Sig = 0.000], and when reliance on neighbourhood resellers is high [Exp(B) = 3.415; Sig = 0.039] (Table 5-5). Table 5-3 also shows that reliance on neighbourhood resellers in low-income areas is significantly associated with the positive payment behaviours of utility customers. Higher mean transaction values [Exp(B) = 2.789; Sig = 0.039] and higher payment frequencies [Exp(B) = 3.821; Sig = 0.005] are related to greater reliance on neighbourhood resellers. When utility customers in low-income areas exhibit positive payment behaviours, unconnected customers are more likely to rely on these households for water services that are more affordable than other alternative sources.

5.5.d. Payment Behaviour and Resale Practices

Although the use of mobile-enabled payment methods improves payment behaviours for neighbourhood resellers, impacts on resale practices are mixed (Table 5-7). Approximately 17% of customers using mobile-enabled payment methods share their water, compared to 20.5% of customers that do not use mobile methods. There is no significant difference in the number of users served by community sharers between mobile payment users (Number of Users=5.24, n=17) and non-users (Number of Users=5.48, n=90). Prices charged for 20 litre buckets of water are significantly higher (Price=0.054 USD; n=19) for users of mobile payment methods than prices charged by non-users (Price=0.047 USD; n=122) (t=6.60; p <

0.001). Using mobile-enabled payment methods is related to higher per-bucket prices and no significant difference in the number of users served by neighborhood resellers.

Table 5-7. Differences in neighbourhood resale practices of utility customers that do and do not use mobile-enabled payment methods.

GROUP	SELL WATER (%)	NUMBER OF USERS			BUCKET PRICE (TZS)		
		Mean	SD	N	Mean	SD	N
All	*19.8*	*5.44*	*3.83*	*107*	*75.66*	*64.69*	*122*
Mobile Users	*17*	*5.24*	*3.7*	*17*	*86.84***	*72.35*	*19*
Mobile Non-Users	*20.5*	*5.48*	*3.88*	*90*	*73.59*	*63.35*	*103*

Source: Utility Customer Survey Data *p<0.05, **p<0.01, ***p<0.001

Table 5-8. Demographic and socioeconomic comparison of resellers (n = 122) and non-resellers (n = 493) of directly-provided piped water services in Dar es Salaam. Variables marked with an asterisk (*) are reported as the median of all values.

VARIABLE		RESELLERS	NON-RESELLERS
Demographic	Male	*54%*	*47%*
	Female	*45%*	*52%*
	Age*	*38*	*36*
	Household Size*	*6*	*6*
Employment	Full Time	*32%*	*27%*
	Part Time	*5%*	*8%*
	Student	*7%*	*9%*
	Self-Employed	*39%*	*39%*
	Unemployed	*20%*	*17%*
Education	Primary	*27%*	*28%*
	Secondary	*39%*	*39%*
	University	*26%*	*24%*
	Vocational	*3%*	*6%*
	None	*4%*	*2%*
Expenditures* *USD Monthly*	Food	*150.00*	*187.50*
	School	*25.00*	*37.19*
	Transport	*22.50*	*28.13*
	Mobile	*17.50*	*20.00*
	Electricity	*25.00*	*25.00*

Source: Utility Customer Survey Data

5.5.e. Socioeconomic and Demographic Characteristics

Although neighbourhood resellers command higher prices for water supplies than water piped to household connections, these individuals do not appear to be socioeconomically or demographically distinct from other utility customers. In Dar es Salaam, resellers are socioeconomically and demographically similar to their non-reselling counterparts, although median expenditures on food, mobile, school, and transport tends to be lower for resellers (Table 5-8). Table 5-9 shows that users of mobile-enabled payment methods are more likely to be female, less likely to have higher levels of education, and have slightly lower expenditure levels than non-users of the new payment instruments. Consequently, there is limited evidence to suggest that resellers or users of mobile-enabled payment methods share certain characteristics.

Table 5-9. Demographic and socioeconomic comparison of users (n = 112) and non-users (n = 504) of mobile-enabled payment methods. Variables marked with an asterisk (*) are reported as the median of all values.

VARIABLES		USERS	NON-USERS
Demographic	Male	*43%*	*50%*
	Female	*57%*	*50%*
	Age*	*37.5*	*36*
	Household Size*	*7*	*6*
Employment	Full Time	*27%*	*28%*
	Part Time	*6%*	*8%*
	Student	*5%*	*9%*
	Self-Employed	*43%*	*38%*
	Unemployed	*23%*	*17%*
Education	Primary	*34%*	*26%*
	Secondary	*40%*	*39%*
	University	*19%*	*26%*
	Vocational	*8%*	*5%*
	None	*1%*	*3%*
Expenditures* *USD Monthly*	Food	*187.50*	*187.50*
	School	*34.38*	*37.50*
	Transport	*24.69*	*37.50*
	Mobile	*25*	*21.25*
	Electricity	*25*	*25*

Source: Utility Customer Survey Data

5.6. Discussion

5.6.a. The Influence of 'Good Water Neighbours'

'Good water neighbours' come from across the socioeconomic and demographic spectrums of utility customers and benefit the urban water sector by engaging in neighbourhood resale and employing positive payment practices sometimes supported by mobile payment instruments. Water obtained from neighbourhood resellers is typically less costly than bottled water, cart vendors, and tanker trucks. These alternative sources require associated labour and transport costs that inflate water prices to approximately two, three, and sixty-three times more than water bought from neighbourhood resellers. Wider reliance on neighbourhood resale allows families to purchase larger volumes of water for a smaller percentage of their household income. Utility-provided supplies are often the source of resold water, suggesting it may also be higher in quality when compared with less expensive water from wells, boreholes, or rainwater. This is particularly true in Dar es Salaam, where approximately 89% of resold water comes from utility supplies. Neighbourhood resale offers unconnected populations water that is relatively more affordable, of higher quality, and more geographically proximate than other alternative sources. Positive payment practices can also produce advantages that supplement the benefits of affordability, location, and quality. Frequent payments and higher revenue contributions contribute to shorter disconnection lengths for neighbourhood resellers, and low-income areas distinguished by better payment behaviours of utility customers were less dependent on other informal service providers and had smaller proportions of disconnected or broken domestic connections. Positive payment practices increase the likelihood of functional connections low-income areas and may expand the ability of water utilities to provide more frequent and uninterrupted services, facilitating greater access to improved water supplies at lower cost by unconnected urban populations.

The advent of mobile-enabled payment methods in Tanzania's urban water sector has made it easier for resellers of piped water to become 'good water neighbours'. These payment options

reduce the relative cost of making a water payment, which improves payment frequencies and revenue collection. Neighbourhood resellers do not need to use mobile payment methods to improve their payment practices, but are more likely to become 'good water neighbours' if they do. Utilities are also incorporating mobile payment technologies into their business practices to capture benefits. In 2012, Dar es Salaam's urban water utility began bringing wireless pay points on disconnection exercises to make it possible for customers to choose directly between disconnection and remotely making a payment. Operational changes such as this may eventually lead to lower disconnection rates, translating into greater proportions of domestic connections remaining functional and broader availability of water supplies throughout the city for both connected and unconnected populations. As the use of mobile-enabled payment methods continues to expand, the benefits engendered by positive payment practices may increase household water availability, ensure better access for nearby unconnected populations, and improve revenue collection for resource-constrained utilities.

5.6.b. Neighbourhood Resale and Fragmentation in the Urban Water Sector

Neighbourhood resellers simultaneously depend on, and are part of, the informal water sector and are forced to purchase water from informal service providers when water services are interrupted. The findings of this study show that bill payment practices of neighbourhood resellers have both direct and indirect impacts on the functioning of Dar es Salaam's urban water sector. Missed payments, late payments, and disconnections can all reduce reliance on neighbourhood resellers and expand dependence on other informal service providers. The inflated volumetric prices charged by cart vendors, tanker trucks, and private schemes implies that negative consequences of paying more for what may be lower quality water supplies will be most severe in low-income areas. In these same areas, dependence on expensive informal service providers is lowest when domestic connections are high and there is broad reliance on neighbourhood resellers. In low-income areas where domestic connections are common, neighbourhood resellers are likely to be found in greater abundance and the per-bucket price

paid for water by unconnected populations, while still inflated, is lower than water obtained from other informal service providers. Through the use of mobile payment options that facilitate positive payment practices, neighbourhood resellers can more effectively ensure that their supplies are less likely to be interrupted, enabling a greater degree of resale to urban populations that require it the most.

Positive payment practices by neighbourhood resellers may also help to reverse the fragmentation of Africa's urban water sector and mitigate the socioeconomic inequalities that it produces. Rather than creating additional premium network spaces, having 'good water neighbours' reduces water-related financial burdens on unconnected households and expands indirect reliance on utility-provided services. Water providers may consequently be more able to reach minimum economies of scale necessary for effective and financially sustainable water delivery. When resold water comes from utility-provided sources, as is the case in Dar es Salaam, neighbourhood resellers informally extend the reach of the utility by acting as decentralised secondary distribution networks. The lower cost and higher quality of water sold by trusted neighbours outcompetes other alternative sources, as evidenced by the inverse relationship between reliance on neighbourhood resale and dependence on other informal service providers. For most of the city's population, neighbourhood resale can facilitate broad access to improved water sources by expanding direct and indirect reliance on the urban water utility.

Good payment behaviours can also indirectly increase the competitiveness of the formal water sector. Data show that the price-per-bucket charged by neighbourhood resellers using mobile methods is significantly higher than other sellers who pay their bills solely at water offices (Table 5-7). In Dar es Salaam's low-income areas, bucket prices are lowest when accompanied by lower rates of nonfunctioning domestic connections, higher reliance on

neighbourhood resellers, and lower rates of use of mobile-enabled payment methods (Table 5-5). If positive payment behaviours support greater levels of consumption and resale, neighbourhood resellers may already be receiving more expensive monthly volumetric bills. Since higher monthly bills are more noticeable than an increase in daily customers or additional sales to existing customers, there may be a false impression that water prices have increased. Higher per-bucket prices charged by Dar es Salaam's 'good water neighbours' are still far below other informal service providers, but make piped water supplies more competitive with the informal water sector. This dynamic relationship may also reduce fragmentation within the urban water sector, potentially influencing existing spatial and socioeconomic inequalities.

5.7. Conclusions

Fragmentation within Africa's urban water sector has made the informal water sector a critical resource for low-income populations. Neighbourhood resellers, utility customer that must pay bills to maintain their domestic connections, have the ability to influence the function of the informal water economy and reduce fragmentation within the sector by improving their payment behaviours. Positive payment behaviours, which can be supported by the use of mobile-enabled payment methods, contribute to shorter disconnection periods for customers and higher revenue collection for the utility. Good water neighbours are utility customers with good payment behaviours who are engaged in neighbourhood resale, and the existence of good water neighbours in an area is associated with higher rates of functioning domestic connections, a greater reliance on neighbourhood reselling of piped-water services, and lower levels of dependence on informal service providers that charge high prices to low-income populations unable to afford household connections. More extensive direct and indirect consumption of piped-water supplies may increase the relative competitiveness of utility-provided services. This can dynamically shift the composition of the informal water economy to be more reliant on lower-cost and higher-quality water supplies and simultaneously support

the mitigation of inequalities that result from heterogeneous access to fragmented water services.

Due to differences in spatial aggregation of data, low sample sizes for certain statistical tests, and the complex dynamics of the urban water sector in different geographical and temporal contexts, the findings of this study have generated further questions and avenues of inquiry. Although a broad literature discusses the existence and respective elements of the informal water sector, a more nuanced understanding of customer choice when deciding among informal service providers is necessary. Such research will generate further insight into interactions between formal and informal water sectors, and the potentially significant role of neighbourhood resale in reducing water services fragmentation. Beyond benefits that arise from positive payment behaviours, the use of mobile-enabled payment methods also creates a perverse incentive against bill payment. If remedying disconnections becomes as simple as walking around the corner to a wireless pay point or sending an SMS mobile money payment, customers may neglect bill payments until penalties become imminent. Other unintended consequences are likely to emerge from the application of mobile technologies in the water sector, and comprehension of potential pitfalls is required as new technologies are incorporated into utility operations. Research on payment practices in the water sector remains limited; as barriers to information, communication, and payments are removed, the nature of urban water provision will need to be matched by flexible and responsive scholarship.

Although urban populations across sub-Saharan Africa rely on small-scale non-state providers to provide access to water supplies, the benefits of large-scale capital-intensive water production and distribution systems should not be overlooked. In response to the fragmented nature of water supplies, scholars of the urban water sector have called for wider integration

and legitimization of informal service providers (Drangert, *et al*., 2002; Sansom and Bos, 2008; Schwartz and Sanga, 2010). The diversity of providers within the informal water sector demonstrates that policymakers should take a closer look at the advantages and disadvantages conferred by each. Neighbourhood resellers that act as secondary distribution networks for piped-water services may benefit from such an examination, as they generally charge lower prices than other informal providers. Consumption of piped water via this pathway also indirectly supports utility revenue collection goals and expands a customer base to more effectively attain requisite economies of scale.

As it currently stands, neighbourhood resale across much of sub-Saharan Africa is technically illegal (Zuin, *et al.*, 2011). More research is needed to meaningfully assess the merits of neighbourhood resale relative to other vendors. If a case can be made, it is possible that sector professionals may begin to see resale practices as a collaborative form of legitimate access. Institutionalising this supply path within utility water pricing schemes (i.e. tariff structures), however, should be approached with caution. Although resale compares favourably with other informal water suppliers, it still performs poorly when compared with utility-provided supplies (Zuin, *et al.*, 2011). Focusing on the benefits and drawbacks of different informal service providers will allow urban water sector professionals to effectively attain water access goals by working with rather than against the informal water sector, and may open up new spaces in which mobile technologies can be used to catalyse this process.

6. CONCLUSIONS

6.1. Exposition

Incorporating mobile-enabled payment options into the urban water sector can expand access to water services in low-income cities through progressive improvements in water utility performance supported by revenues obtained through enhanced customer payment behaviours. Analyses exhibit strong support for the claim that mobile-enabled payment methods increase the ease of making water-related transactions, which in turn reduces transaction values and increases customer payment frequency. Combined with strong support related to reductions in opportunities for petty corruption facilitated by these methods, better customer payment behaviours improved revenue collection in Dar es Salaam during the first two years of utility implementation and customer adoption. An examination of the causes behind these changes provides partial support for the claim that better customer payment practices are related more to greater degrees of autonomy in the payment process than differences in service quality or satisfaction. There is also partial support for the argument that customers opting to use novel payment methods can influence the structure of the informal water economy by broadening reliance on neighbourhood resale. This dissertation has produced findings which illustrate the wide-ranging effects that information and communication technologies (ICT) can have within urban water provision.

Higher revenue collection facilitated by the use of mobile-enabled payment methods can indirectly improve water utility performance and access to water services. Reductions in geographic and temporal constraints have also made the payment process more accessible to families with irregular incomes or households unable to afford connection fees or save for monthly bills. For customers paying with mobile-enabled methods, there is substantial evidence showing that an increased prevalence of multiple monthly payments may be a

consequence of minimised transaction costs. Payments made using these methods limit the availability of economic rents and improve record keeping, which can be used to increase water utility transparency. More extensive information flows can widen existing accountability pathways and reduce forms of petty corruption that prevent households from accessing water distribution networks (Davis, 2004). Customer use of mobile-enabled payment methods might also increase the availability of water in a geographic area by expanding the proportion of 'good water neighbours' that engage in resale of piped water. Neighbourhood resellers using mobile payment instruments have better payment practices, fewer disconnections, shorter disconnections, and lower per-bucket prices than other informal service providers. 'Good water neighbours' provide a critical link between connected and unconnected households, which ensures that low-income populations receive water and demonstrates latent demand for directly-provided water services within Dar es Salaam's coverage area.

The originality of this study and its subject matter has opened further avenues of inquiry regarding the relationships between mobile-enabled payment methods and key development outcomes. This chapter discusses some of these questions and the study's significance across multiple arenas - theoretical, practical, policy, and research. The implications of this work are presented not in relation to the discrete findings of each chapter described above, but rather as they pertain to broader discussions of ICT and development as it fits into practice, policymaking, and scholarship. Instead of identifying the direct consequences of this research, which was done in each respective chapter, I instead ask: "What lessons can we learn?" Each subsection in this concluding chapter engages with pertinent questions and issues that are likely to be significant in the coming decades, such as the increasing availability of data, the use of ICT in development projects, and the significance of mobile technologies in a post-MDG world.

6.2. Theoretical Implications

ICTD research relies on broad engagement with theory from across the social sciences, and this dissertation has employed perspectives from behavioural economics, organisational studies, and urban and regional studies. This section begins with a summary of the theoretical contributions made by each empirical chapter and then relates them to wider debates and discussions within ICTD.

6.2.a. Theoretical Contributions

Transaction cost economics was used in Chapter 2 to evaluate the relative transaction costs of traditional and mobile-enabled payment methods and found that payment methods with lower transaction costs facilitate better customer payment behaviours and improvements in utility revenue collection. Although mobile communication technologies significantly shift the nature of distance and geography and mobile money payments are made directly from a customer's phone, these methods have experienced slow uptake while the number of transactions made with wireless pay points continues to climb. Transaction cost economics focuses on asset specificity, and these findings suggest that reductions in physical distance to a payment location matters in altering customer payment behaviours, but is not the only important aspect. Mobile money services require an intermediate level of human asset specificity (i.e. customers must learn to use and trust the system). Conversely, wireless pay points simultaneously reduce distance and require little additional human asset specification since the process of making a payment at a pay point is comparable to making one at a water office. Chapter 2 yields insight into the relationship between payment instrument and contexts and questions the appropriateness of mobile money payments for water utility transactions in Dar es Salaam, Tanzania.

Agency theory and the principal-agent framework were utilised in Chapter 3 to assess the impact of mobile-enabled payment methods and related applications on petty corruption in the

urban water sector. New payment instruments reduce opportunities for petty corruption through the creation of automated and electronic payment pathways, and the use of mobile phones in general reduces monitoring costs and mitigates information asymmetries within principal-agent interactions. Other mobile-enabled innovations, such as SMS billing inquiries and billing reminders, reduce the discretionary power of utility employees and create opportunities for customers to monitor utility activities. These impacts are changing the context in which corruption has flourished in and are making it more difficult for agents to engage in illicit behaviours. Chapter 3 shows that mobile technologies enable customers and society in general to be more active in water utility operations, raising questions regarding key assumptions of actors in principal-agent problems - namely, the articulation of self-interest and bounded rationality for a large number of individuals.

Satisfaction-performance relationships in the urban water sector were examined in Chapter 4 with the use of expectancy disconfirmation theory and performance theory, which emerged from marketing and behavioural economics as a means to describe individual constructions of satisfaction. Service quality and satisfaction do not influence existing customers' actual payment behaviours, but may have some influence over attracting or driving away potential customers. These findings contravene widely-held assumptions in the water service literature that interventions aimed at improving water service quality and customer satisfaction can directly influence water utility performance. Instead, Chapter 4 highlights the significant impact the introduction of mobile-enabled payment methods have had on customer payment behaviours. Utilities can increase ease of payment for existing customers, from which additional revenues can be used to enhance service quality and satisfaction thereby potentially attracting new customers.

The notion of 'splintering urbanism' was challenged in Chapter 5 as a way to evaluate the direct and indirect implications of mobile-enabled payment methods for the informal water sector. Neighbourhood resale is a form of informal service provision that can lie at the intersection of officially-delivered piped water services and water access by unconnected and marginalised populations. The use of mobile payment instruments improved the payment practices of neighbourhood resellers, which is associated with reduced dependence on more expensive alternatives. The splintering urbanism thesis has already been criticised for neglecting low-income countries where urban infrastructures are already splintered, but findings in Chapter 5 imply that the introduction of mobile-enabled payment methods may contribute to a recentralisation of water services in urban areas, rather than supporting broader fragmentation.

6.2.b. Implications for ICTD

Debates in ICTD regarding the nature of social transformation resulting from the integration of ICT-enabled innovations are informed by the results of this thesis, particularly the outcomes discussed in Chapters 4 and 5. ICTD scholars question whether social changes can be attributed to interactions that emerge from the strengthening of existing social orders or if they are the consequence of reordered patterns and distributions of power. This thesis has produced evidence supporting ideas of both progressive and disruptive transformations, but I argue that changes facilitated by ICT are inherently disruptive. Chapter 5 illustrates how the use of mobile-enabled payment methods by neighbourhood resellers can contribute to greater degrees of direct and indirect reliance on utility-provided services in Dar es Salaam. Although using mobile innovations to enhance utility performance is essentially a progressive transformation, we must be careful to not confuse normative expectations of urban service provision and the practical realities being studied. Many actors in Dar es Salaam's urban water sector were benefitting from the failings of the urban water utility as existing power structures have petrified in this context. Indeed, many actors continue to benefit from a social

order based partly in the inadequate provision of water services, where economic rents and marginalised populations are easily exploited. Reducing fragmentation in the water sector - while strengthening the utility - is already disrupting existing distributions of power and is likely to continue doing so. Disruptive transformations also bolster the role of citizens, in addition to obstructing actors from engaging in nefarious activities. Mobile-enabled payment methods allow citizens to become active in the production and improvement of public services, rather than passive consumers of sub-standard public goods. As the findings of Chapter 4 suggest, the transition in Dar es Salaam can be considered disruptive because it is largely fuelled by increased customer autonomy over the payment process and the gradual redistribution of power to society. This and other transformations may become increasingly disruptive as the use and integration of mobile communication technologies are adopted by larger segments of Tanzanian society.

Although development practitioners have been largely absent from the design, implementation, and operation of mobile-enabled payment methods in Dar es Salaam, growing optimism regarding the potential impacts of mobile money represents a potentially new era in development discourses. Mobile payment innovations, and in particular mobile money services alone, are beginning to resonate with the global development sector and there is a risk of development projects being built around mobile money, rather than mobile money being integrated into interventions where appropriate. Mobile money payments for water services in Dar es Salaam have not been adopted nearly as extensively as wireless pay points, which have continued to grow dynamically since their introduction in 2009. Much of the international development community has overlooked the existence of alternatives to mobile money, in spite of considerable satisfaction with pay points on the part of customers, utilities, and merchants. Development practitioners are likely to continue this trend, using mobile money - a relatively unused instrument for water services payments in Tanzania - to further

their aims while simultaneously shaping development discourses and subjugating low-income populations with tools that are not yet fully understood. On a personal note, it is my hope that this research brings attention to this potentially damaging practice, preventing the hype surrounding mobile money services from overshadowing the present and potentially future successes of alternative innovations (e.g. wireless pay points). Mobile money's popularity is already shaping development discourses and practices, attracting large amounts of donor support, and reducing the likelihood that limited financial resources will be channeled into interventions and tools that may be more effective in improving development outcomes.

Mobile communication technologies and related payment instruments endow citizens and societies in general with the ability to overcome negative aspects of disruptive transformation and misguided development discourses. Each empirical chapter in this thesis points to the increasing role of citizens as active participants in the production of public services. Chapter 2 illustrated that incorporation of mobile-enabled payment instruments into a customer's payment practices resulted in higher revenue collection for the utility and Chapter 3 highlights the notable influence of payment method choice on mitigating opportunities for corruption. Finding minimal evidence of the satisfaction-performance relationship in Tanzania's urban water sector implied that revenue increases are largely due to expanded choice in payment methods. Coupled with other uses of mobile technology in the water sector, this finding underscores the importance of customer autonomy in water service delivery. Chapter 5's focus on the informal water economy demonstrates that even at the boundary of official-water production, mobile-enabled payment methods can facilitate greater access to water services by increasing the effectiveness of neighbourhood resellers. These findings all point to a shift in the participatory role of citizens - communication technologies may engender a new form of participation that does not burden society with extra costs, roles, duties, or responsibilities. Citizens can increase their participation in the urban water sector and potentially improve

service delivery and development outcomes simply by choosing alternative payment methods that are typically more convenient than conventional payment offices. Although an in-depth discussion of participation in international development is beyond the scope of this dissertation, the influence of mobile technologies on existing participatory models is worthy of further scholarly attention.

6.3. Practical Implications

6.3.a. Use of ICT in Development Projects

Initially centred on radio, television, and film, the use of ICT in development projects has become increasingly common throughout the global development sector. Contemporary development practitioners intently focus on mobile phones and networks to enhance agricultural supply chains, expand citizen monitoring of government activities, and improve health diagnostics and reporting. Following the 2007/2008 success of Ushahidi's crowdsourcing approach to containing post-election violence in Kenya, certain initiatives such as community mapping and citizen accountability initiatives are beginning to take a primary role in dominate donor agendas. Critics of this approach often need to look no further than the endless list of 'dead' Ushahidi maps to come to the conclusion that ICT-enabled projects might only produce ephemeral results. In reality, many interventions experience success for their period of operation, but subsequently face difficulties in scaling up their operations when funding or community interest evaporate (Zanello and Massen, 2012). Programmes in the water sector with the objective of improving transparency and accountability rarely meet intended targets, as was the case with Daraja's Maji Matone initiative and the H2O Initiative in Zanzibar. In line with the theoretical perspective of ICTD that ICT can be the 'cause' of a development 'effect', these well-intentioned projects tend to frame problems in ways that enable a straightforward and simplistic applications of ICT innovations.

This research on mobile-enabled payment innovations offers insight into this dilemma of development practice, where the increasingly conventional approach to ICT incorporation loses sight of the complexities of development, where indirect causes of development problems are likely to require complex and indirect innovations. Even more, interventions ought to be context appropriate and generate as much benefit and as little disruption as possible to people's lives. My first fieldwork visit to Tanzania in September 2011 enlightened me to the fact that most of the relevant stakeholders (e.g. utility, mobile network operators, Selcom Wireless) all agreed that wider adoption of mobile-enabled methods by customers would bring positive benefits. Unfortunately, no single entity saw their responsibilities as encompassing the advertising and marketing required to make the citizens of Dar es Salaam aware of their options. One civil society interview respondent who had moved to Dar es Salaam from Uganda expressed surprise at the information that mobile water payments were also an option in Tanzania. Uganda's National Water and Sanitation Corporation advertised extensively, generating considerable public awareness. In spite of the limited advertising and awareness of mobile payment methods in Tanzania, adoption continued to expand, prompting the simple question of "Why?"

The answer to this question possibly lies in the difficult realities of paying water bills in places similar to Dar es Salaam, where the time, energy, and patience required to make a payment at DAWASCO offices was often insufficient. In short, mobile-enabled payment methods represent a significant improvement over the alternative. Unfortunately, something as mundane as a new approach to bill payment is unlikely to attract donor support over a provocative and potentially controversial one-shot accountability programme. Alternative bill payment options, however, may actually have much wider development impacts, as has been demonstrated in this thesis. The global development sector will require fresh approaches if

the practice of development is likely to effect positive and long-term change through the use of mobile phones and other ICTs.

6.3.b. Raising Revenue for Public Service Provision

In early 2011, Uganda's National Water and Sewerage Corporation announced plans to close all water payment offices in an attempt to save money on insurance, utilities, and staff costs. Customers were instructed to pay their bills using mobile money services and at bank branches around the country. In mid-2013, Dar es Salaam's water utility announced a similar programme in which all water payment offices would be closed. The rationale behind these decisions - to conserve financial resources and improve revenue collection - seems intuitive on the surface. This research has produced findings that run contrary to such intuitive thinking and suggest that the dual decisions in Kampala and Dar es Salaam may be misguided. Revenue collection in Dar es Salaam was highest when customers combined water offices and mobile-enabled payment methods throughout the year; those customers who used only a single mobile-enabled payment method paid less frequently and contributed significantly less revenue than their counterparts paying using a combination of methods or solely at water offices. Decisions to close water payment offices may end up bringing in less revenue overall than if they had been left open as an option to customers.

There is value in the option to pay a bill at a water payment office. Customer service issues, billing inquiries, connection or reconnection needs, and other items require a utility office and observations from fieldwork indicate that most customers complete multiple tasks at the same time they pay their water bills. Preventing customers from paying bills at water offices is akin to reducing their perceived control over the payment process, which is likely to depress payment behaviours. The significance of mobile-enabled payment methods lies in their role as a complement to, rather than replacement for, existing payment options. That ICT innovations are not a development panacea reinforces the notion that they should be viewed

merely as tools for the support of development aims, such as raising revenue for public service provision. Furthermore, it is the individuals with choice of payment options who should make decisions regarding use or nonuse, not the water utility management, elected officials, or development practitioners.

6.4. Policy Implications

6.4.a. Towards Mobile Water Services Ecosystems

Service providers throughout Africa are gradually expanding the creative integration of mobile communication technologies into the urban water sector. Beyond Tanzania, the introduction of mobile-enabled payments for water services in Kenya, Uganda, Swaziland, Zambia, and Ghana may also enhance progress towards development goals in these countries (Hope, *et al*., 2011). In addition to payments, utilities and policymakers are experimenting with other mobile-based innovations or practices that may also have considerable implications for development. Hope, *et al*., (2011) also discuss the potential socioeconomic impacts of automated smart water systems that rely on mobile networks to enable better monitoring and central utility control of water production systems and distribution networks. The comprehensive information generated from smart water systems can support strategic decisions regarding the effective use of financial resources. In Kisumu, Kenya, the urban water authority is piloting the use of pre-paid water meters that are integrated with mobile money services and can be remotely disconnected and reconnected if bills go unpaid. Such a system assures individuals and households that they will only be billed for consumption, a major concern of utility customers in Dar es Salaam. In response to customer dissatisfaction with utility staff interactions, DAWASCO is also developing an SMS-based meter reading and reporting system which customers can use to bypass monthly visits from utility staff. Monthly SMS bill payment reminders can also improve customer payment behaviours, a finding which builds on arguments made by Mugabi, *et al*. (2010) that payment reminder visits from utility staff significantly influence attitudes towards payment. Since such changes

are likely to disrupt existing power structures benefitting from inadequate water services, good policies that shift the water sector towards mobile-enabled 'ecosystems' that facilitate citizen involvement are likely to face political and other types of obstruction. Nevertheless, aggregating mobile-based innovations in the water sector suggest that urban water provision in sub-Saharan Africa is likely to improve significantly as customers become more active in the billing and payment process and utilities gain more comprehensive and relatively low-cost knowledge about their distribution networks.

6.4.b. Societal Oversight of Public Service Provision

Establishing mobile-enhanced operational improvements in the urban water sector will simultaneously expand the role of the citizen in water provision and decrease information asymmetries between utilities and their employees. Mobile technologies are already being used in Dar es Salaam to rapidly obtain cost-effective data on the state of water services provision in the city. Since mid-2010, the Listening to Dar project has generated monthly monitoring reports on various issues of public concern (e.g. education, health, consumption, and water) to generate information trails used by civil society organisations to improve accountability in public services. Better oversight also occurs when customers use available information - from monitoring reports to SMS balance inquiries - to press for expanded accountability during their personal interactions with the utility. Personal observations from Dar es Salaam suggest that customers currently perceive the utility as distant and frustratingly opaque. Rapid urbanisation in predominantly rural Tanzania exacerbates these views, creating situations in which many migrants must learn how to interact with water utilities. Greater degrees of citizen participation in water provision allow customers to progressively increase not only their knowledge of account balances and personal water consumption, but also comprehension of how water services ought to be provided. The transformation of utility customers from passive consumers to active producers (Heeks, 2009) entails more societal

oversight of public service provision, leading to corruption mitigation, transparency improvements, and meaningful participation without placing additional burdens on citizens.

6.4.c. Mobiles and Development in the Post-MDG World

International development policies are typically organised around the Millennium Development Goals (MDGs), which are set to expire in 2015. This thesis repeatedly states that sub-Saharan Africa is not on track to meet the Millennium Development Goal for drinking water by this time, in spite of the rest of the world's success on this front. Drinking water targets are likely to decline in importance in the post-MDG world, but focus on this problem should not diminish until sub-Saharan Africa reaches this goal, which this thesis argues can be supported through the use of mobile communication technologies. ICTD research continues to provide empirical support for the potentially transformative effects of ICT, bringing us to a question of the role of mobile technologies in the post-2015 development agenda. Development projects, policy, and discourses will inevitably be shaped by the almost ubiquitous use of mobile phones. Data collection, progress monitoring, and programme evaluation are already becoming increasingly grounded in mobile technologies as development interventions themselves integrate mobile telephony into the DNA of their projects. International development policymakers must also recognise that overdependence on mobile technologies and oversaturation of development projects with ICT are probable outcomes of this trajectory. As with many ideas and technologies that generate significant optimism, development policies and projects may not be seen as 'legitimate' unless 'mobile' appears in proposals. Discourses of development, however, may eventually be constrained by an increasing prevalence of citizen voice, communicated through mobile telephony, within development projects. Good ideas will spread quickly, bad ideas will not, and development practitioners will experience diminished capacities to control and direct discussions of success, failure, and progress within the domain of international development.

6.5. Research Implications

6.5.a. New Forms of Data: Pathways or Pitfalls for Public Service Provision?

Adoption of mobile phones and the integration of mobile innovations into various aspects of society mean that the creation of electronic data trails will become increasingly common. Understanding how to interrogate and comprehend these data trails requires patience and the ability to identify interconnections between seemingly unrelated concepts. Arguments contained within this thesis are almost completely based on analyses of data that had previously been unavailable or significantly unreliable. Expanded data availability will generate high-quality research and insights for the improvement of public service provision, but will also produce arguments obtained from the inappropriate use and interpretation of user-generated data. Consequently, it is difficult to predict how effective these new data will be at enhancing quality of life in low-income countries.

There is certainty, however, that a new era of research will emerge from the ubiquitous availability of datasets, databases, and government records. Scholars must remain vigilant in the sceptical approach to data, because there is little to guarantee the quality of these new forms of data. My experiences with the water payment datasets from Dar es Salaam illustrate this point. Although records were available and precise, understanding the data required intimate knowledge of Tanzanian society and practices associated with water service delivery. The mere existence of new datasets is not enough, and researchers must continuously seek to understand the origins and dynamics of information before analysing it. Although the increasing prevalence of reliable data on development throughout Africa can potentially yield incredible insights, there are many stumbling blocks and methodological questions that must be addressed as research continues to move in this direction.

6.5.b. Research Ethics of User-Generated Data

A major question generated by expanded data availability is related to the ethical use of user-generated data, particularly where it is difficult and cost-prohibitive to obtain consent. Personal identifying information is often part of these datasets, and the burden of removing this information has unfortunately fallen to the researcher. This reality presents obvious opportunities for potential abuses of data and information. Even when data have become completely anonymised, key ethical issues related to data handling, confidentiality, and privacy remain paramount. Researchers receive ethics training and traditionally obtain approval from institutional review boards if studies involve human subjects. But what constitutes a human subject in the information age? Companies and service providers can now provide researchers with large datasets that originate from mobile phone usage without the knowledge or consent of their customers. Do such releases of information require the approval of institutional review boards and other bodies involved in research ethics? If not, how do we ensure that respondents are protected, and if so, how can consent be obtained from the large numbers of people who have generated this data? Current debate concerning ethical interactions with new forms of user-generated data is limited and does not discuss key issues related to the aggregation of data by a third-party such as a mobile-network operator or public service provider. Existing standards of research ethics would describe these datasets as secondary forms of information. This designation provides insufficient protections for respondents, a particularly pertinent argument in light of our increasing cognizance of the power of meta-data. These ethical questions require extra attention from researchers to ensure that the coming deluge of user-generated data is treated with the same careful respect we extend to other forms of information.

6.6. Limitations of Research

Primary limitations of this research emerge from constraints imposed by the methodological approach taken to understand the relationships between mobile-enabled payment methods and

various aspects of the urban water sector. Post-positivist perspectives place emphasis on conversations and conclusions that are yielded by datasets and other elements that rely on quantitative measurement of human behaviours. Context and constructed meanings are two aspects of reality commonly lost through this perspective. Findings generated by both qualitative and quantitative data are also subject to other interpretations, and maintaining openness to alternative viewpoints on the same data creates space for continued dialogue on the issues raise within this dissertation while leaving the entirety of this project exposed, but receptive, to critical engagement. Using a questionnaire within survey methodologies are also problematic and restrict the generalisability of claims I have made. As with all surveys, my sample allows me to make arguments only about the specific mechanics of bill payment behaviours, utility performance, and water access in Dar es Salaam. Similarly, some analyses within this thesis are based on small sub-sample sizes that limit their explanatory power.

Focusing on the realities of the questionnaire and the process of data collection, I found that trusting enumerators to be honest in their practice of data collection and relying on respondents to share valid responses is often a challenge. There is always a danger of collecting false information and potentially losing information and meaning as collected data was translated into English. Because of these and other challenges, I retained a significant level of scepticism when analysing survey data from water utility customers in Dar es Salaam. Scepticism is also required when utilising data provided by other sources - such as a water utility, mobile network operator, and GIZ. It is difficult to ascertain the true validity of a dataset when one is not involved in its collection, and there are multiple stages in the research process (e.g. collection, transcription, and entry) at which the quality of information can be compromised. I was also missing key pieces of information - the geographic extent of water utility infrastructures, billing data, water supply data - that could have enabled a more comprehensive testing of my hypotheses.

This dissertation is also limited by its research design, which produced cross-sectional quantitative data that was insufficient for analyses that would have facilitated stronger arguments related to causality between the use of mobile-enabled payment methods and customer payment behaviours. Although the findings of this research do illustrate a diverse set of associations between the novel payment instruments and outcomes related to transaction value, timeliness, frequency, and revenue, I was unable to collect primary data on the socioeconomic, demographic, and geographic characteristics of the utility's 106,000 customers. Even if it were, many account holders do not pay their bills themselves. In light of this large volume of unknown and potentially unobtainable data, controlling for all potential covariates becomes exceedingly difficult. This condition not only limits the ability of a researcher to make arguments regarding the direct influence of one variable on another (i.e. causality), it may also result in findings that do not reflect the reality of a phenomenon due to omitted variables. One analytical approach that could be used to overcome these limitations is the use of the instrumental variables method, which uses variables that are uncorrelated with the omitted variable(s) to estimate effects (Angrist and Kreuger, 2001).

That the use of mobile-enabled payment methods is associated with significant variations in payment behaviours suggests that this is an important area of continued study. Longitudinal data, panel data, and other data collected from a broad range of geographic areas may help to further contextualize these findings in a more comprehensive body of research that offers a nuanced view of these associations. Subsequent studies and future research can strive to overcome the limitations presented by omitted variables through the use of the instrumental variables method, or through comprehensive research design that uses randomised controlled trials (Baker, 2000).

Personal biases may also play a role in restricting the explanatory power of this dissertation. First, my work contains a strong pro-ICT approach into which I have attempted to infuse academic scepticism and objectivity. This perspective originated in my early trips to Tanzania, which date to 2007. At this time, few people owned mobile phones and the Kenyan elections to the north were beginning to enter a stage of significant contestation. Early fascination with the power of mobile telephony to prevent human rights abuses and improve communication in rural areas significantly influenced my subsequent interests in the role of ICT in development. Indeed, it is this bias that led me to study the use of mobile-enabled payment methods in the water sector. I remain optimistic about the transformative power of mobile phones, but this research project has made me aware of the infinite number of factors that can confound, prevent, and obstruct processes of socioeconomic change in low-income countries. My work is also tinged with a pro-Africa bias that has emerged from anecdotal experiences related to positive changes in African development trajectories, such as high rates of economic growth, progress on democratic transfers of power, and improvements in health and education. Intellectual and personal investment in the future of Tanzania and the wider continent has given my work a sense of urgent agency; prospects for quality-of-life gains for everyday citizens are reliant on wider comprehension of the continent's challenges and investigations into potential tools that can be used to overcome them. These biases have no doubt influenced my work and the perspectives and interpretations I have used to understand the data I have collected. Even still, I credit these biases with endowing me with the inspiration and motivation required to complete this doctoral research.

6.7. Summary and Conclusion

Deciding how to complete the ordinary practice of paying a water bill may seem like a mundane task, but this thesis has demonstrated that ostensibly lacklustre choices such as these may hold significant and positive implications for human development. The unique information-enhancing properties of novel mobile-enabled payment methods allow simple

errands like bill payments to have substantial effects on key issues, including the financial sustainability of public service provision, corruption, and access to adequate water supplies by all segments of a population. Mobile payments and other mobile-enabled innovations will experience considerable growth in use within the global water sector, but there is still a broad dearth of academic scholarship evaluating their potential impacts. The findings, analyses, and discussions that comprise the arguments within this thesis propose cautious optimism about their gradual influence on socioeconomic development objectives. Mobile-enabled payment methods will continue to generate tangible effects throughout the urban water sector, most significantly by reframing the role of citizens in service provision from passive consumers to active participants.

Although this research has contributed to debates within the urban water services literature and produced theoretical insights that contravene existing interpretations of urban water systems, its greater contributions to knowledge lie in the interpretation of ICTD scholarship as a whole. Broader comprehension of the interrelationships between information and communication technologies and development outcomes may prompt social science researchers to re-evaluate certain tenets of their own personal academic approaches and overarching research funding biases. Development objectives that we focus on so intently must move away from 'needs' - which are often defined in paternalistic terms - and towards 'wants' - the demands made by low-income and marginalised populations. By focusing on ICT innovations designed and implemented by and for Tanzanians that have already have already gone to scale in Dar es Salaam and continue to do so elsewhere in Africa, it is my hope that this thesis can help to reframe what constitutes acceptable ICTD research.

REFERENCES

Chapter 1

Addo-Yobo, F.N., Njiru, C., and Sohail, M. (2006). "Determinants of households' intention to pay for improved water services: an application of the theory of reasoned action." *Journal of Water Supply: Research and Technology - AQUA*. 55(6): 419-425.

Ades, A., and Di Tella, R. (1997). "The new economics of corruption: a survey and some new results." *Political Studies*. 45(Special Issue): 496-515.

AICD. (2010). "Africa's Infrastructure: A time for transformation." Washington, DC: World Bank and Agence Française de Développement.

Aker, J. (2010). "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger." *American Economic Journal: Applied Economics*. 2(3): 46-59.

Aker, J. (2011). "Dial A for Agriculture: A review of information and communication technologies for agricultural extension in developing countries*." Agricultural Economics*. 42: 631-647.

Aker, J. and Mbiti, I. (2010). "Mobile phones and economic development in Africa." *The Journal of Economic Perspectives*. 24(3): 207-232.

Anbarci, N., Escaleras, M., and Register, C. (2009). "The Ill Effects of Public Sector Corruption in the Water and Sanitation Sector." *Land Economics*. 85(2): 363-377.

Avgerou, C. (2010). "Discourses on ICT and Development." *Information Technologies and International Development*. 6(3): 1-18.

Babbie, E. (1990). *Survey Research Methods*. 2nd ed. Belmont, CA: Wadsworth.

Babbie, E. (2010). *The Practice of Social Research*. 12th ed. London: Wadsworth .

Bailur, S. (2006). "Using stakeholder theory to analyze telecenter projects." *Information Technologies and International Development*. 3(3): 61-80.

Bakker, K. (2008). "The ambiguity of community: Debating alternatives to private sector provision of urban water supply." *Water Alternatives*. 1(2): 236-252.

Balbo, M. (1993). "Urban planning and the fragmented city of developing countries." *Third World Planning Review*. 15(3) 23-35.

Bannerjee, S., and Morella, E., (2011). *Africa's water and sanitation infrastructure: access, affordability, and alternatives*. Washington, DC: World Bank.

Bayliss, K. (2003). "Utility Privatisation in Sub-Saharan Africa: A case study of water." *Journal of Modern African Studies*. 41(4): 507-531.

Berg, B.L. (2001). *Qualitative Research Methods for the Social Sciences*. Boston: Allyn and Bacon.

Bloomfield, B., and Coombs, R. (1992). "Information Technology, Control, and Power: The Centralization and Decentralization Debate Revisited." *Journal of Management Studies*. 29(4): 459-484.

Brennan, J., and Burton, A. (2007). "The Emerging Metropolis: A history of Dar es Salaam, circa 1862-2000." IN: *Dar es Salaam: Histories from an Emerging Metropolis*. Brennan, J., Burton, A., and Lawi, Y. (eds). Pp 13-75. Dar es Salaam: Mkuki na Nyota Publishers.

Briscoe, J. (1996). "Financing Water and Sanitation Services: The Old and New Challenges." *Water Supply*. 14(3-4): 1-31.

Bulmer, M., and Warwick, D. (1993). *Social Research in Developing Countries: Surveys and Censuses in the Third World.* London: UCL Press.

Burrell, J., & Toyama, K. (2009). "What constitutes good ICTD research?" *Information Technologies and International Development.* 5(3): 82-94.

Castells, M. (2000). *The Rise of the Network Society*. 2nd ed. Wiley-Blackwell: Chichester, UK.

Castetter, W.B., and Heisler, R.S. (1977). *Developing and Defending a Dissertation Proposal*. Philadelphia, PA: Center for Field Studies, School of Education, University of Pennsylvania.

Chaudhuri, A. (2012). "ICT for Development: Solutions Seeking Problems." *Journal of Information Technology*. 27(4): 326-338.

Cochran, W. (1977). *Sampling Techniques.* London: Wiley.

Creswell, J. (2003). *Research Design: Qualitative, Quantitative, and Mixed Method Approaches*. London: Sage.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process*. London: Sage.

Dagdeviren, H., and Robertson, S. (2011). "Access to Water in the Slums of Sub-Saharan Africa." *Development Policy Review*. 29(4): 485-505.

Davis, J. (2004). "Corruption in Public Service Delivery: Experience from South Asia's Water and Sanitation Sector." *World Development*. 32(1): 53-71.

Deichmann, U., and Lall, S. (2007). "Citizen feedback and delivery of urban services." *World Development.* 35(4): 649-662.

Diaz Andrade, A. and Urquhart, C. (2012). "Unveiling the modernity bias: A critical examination of the politics of ICT4D." *Information Technology for Development*. 18(4): 281-292.

Dill, B. (2010). "Public-public partnerships in Urban water provision: The case of Dar es Salaam." *Journal of International Development*. 22(5): 611-624.

Donner, J. (2006). "The use of mobile phones by microentrepreneurs in Kigali, Rwanda: Changes to social and business networks." *Information Technologies and International Development*. 3(2): 3-19.

Donner, J. (2008). "Research Approaches to Mobile Use in the Developing World: A Review of the Literature." *The Information Society*. 24(3): 140-159.

Donner, J. and Escobari, M. X. (2010). "A Review of evidence on mobile use by micro and small enterprises in Developing Countries." *Development.* 22: 641–658.

Donovan, K. (2012a). "Mobile Money, More Freedom? The Impact of M-PESA's Network Power on Development as Freedom." *International Journal of Communication*. 6: 2647-2669.

Donovan, K. (2012b). "Mobile Money and Financial Inclusion." In: Kelly, T., and Minges., M (eds.). *Information and Communication for Development 2012.* Washington, DC: World Bank.

Eisenhardt, K. (1989). "Agency Theory: An Assessment and Review." *Academy of Management Review*. 14(1): 57-74.

Escobar, A. (1995). *Encountering Development: The Making and Unmaking of the Third World*. Princeton University Press: Princeton.

Essegbey, G., and Frempong, G. (2011). "Creating space for innovation – The case of mobile telephony in MSEs in Ghana." *Technovation*. 31: 679-688.

Energy and Water Utilities Regulatory Authority (EWURA). (2011). *Water Utilities Performance Report for 2009/2010.* United Republic of Tanzania. Dar es Salaam, Tanzania: Government Printers.

Fink, A. (1995). *The Survey Handbook*. London: Sage.

Foster, T., Hope, R., Thomas, M., Cohen, I., Krolikowski, A., and Nyaga, C. (2012). "Impacts and implications of mobile water payments in East Africa." *Water International*. 37(7): 788-804.

Fowler, F. (1988). *Survey Research Methods*. London: Sage.

Gibbons, R. (2010). "Transaction-Cost Economics: Past, Present, and Future?" *Scandinavian Journal of Economics*. 112(2): 263-288.

Gonzalez-Gomez, F., Garcia-Rubio, M., and Guardiola, J. (2011). "Why Is Non-revenue Water So High in So Many Cities?" *International Journal of Water Resources Development*. 27(2): 345-360.

Graham, S., and Marvin, S. (2001). *Splintering Urbanism: Networked Infrastructures, Technological Mobilities, and the Urban Condition*. London: Routledge.

GSMA/Deloitte. (2012). *Sub-Saharan Africa Mobile Observatory 2012.* London: GSM Association.

Hayes, N., and Westrup, C. (2012). "Context and the processes of ICT for development." *Information and Organization*. 22: 23-36.

Heeks, R. (2006). "Theorizing ICT4D Research." *Information Technologies and International Development*. 3(3): 1-4.

Heeks, R. (2009). "The ICT4D 2.0 Manifesto: Where next for ICTs and International Development." Development Informatics Group, University of Manchester. *IDPM Working Paper No. 42*. Available at: http://www.sed.manchester.ac.uk/idpm/research/publications/wp/dl/dl_wp42.htm

Heeks, R. (2010). "Development 2.0: Transformative ICT-enabled development models and impacts." *Communications of the ACM*. 53(4): 22-24.

Hickey, S., and Mohan, G. (eds.) (2004). *Participation: From Tyranny to Transformation? Exploring New Approaches to Participation in Development*. London: Zed Books.

Hoaglin, D., Iglewicz, B., and Tukey, J. (1986). "Performance of some resistant rules for outlier labelling." *Journal of the American Statistical Association.* 81: 991-999.

Hoaglin, D., and Iglewicz, B. (1987). "Fine tuning some resistant rules for outlier labelling." *Journal of the American Statistical Association.* 82: 1147-1149.

Hobday, M. (1995). *Innovation in East Asia: The Challenge to Japan*. Aldershot: Elgar.

Hope, R., *et al*. (2011). *Mobile water payment innovations in urban Africa*. School of Geography and the Environment and Skoll Centre for Social Entrepreneurship at Säid Business School, University of Oxford, UK.

Hope, R. *et al*., (2012). "Harnessing mobile communications innovations for water security." *Global Policy.* 3(4): 433-442.

Humphreys, H. (1995). *Rehabilitation of Dar es Salaam Water Supply in the United Republic of Tanzania, Final Report*. Dar es Salaam: National Urban Water Authority.

Hutchings, M., *et al*. (2012). *mWASH: mobile phone applications for the water, sanitation, and hygiene sector*. Oakland, CA: Pacific Institute and Nextleaf Analytics.

Ivatury, G., and Pickens, M. (2006). "Mobile phone banking and low-income customers: Evidence from South Africa." Washington, DC: Consultative Group to Assist the Poor (CGAP).

Jack, W., and Suri, T. (2011). "The Economics of M-PESA." NBER Working Paper No. 16721.

Jaglin, S. (2002). "The right to water versus cost recovery: participation, urban water supply and the poor in sub-Saharan Africa." *Environment and Urbanization*. 14(1): 231-245.

Jagun, A., Heeks, R., and Whalley, J. (2007). *Mobile telephony and developing country micro-enterprise: A Nigerian case study.* Working Paper No. 29. University of Manchester: Institute for Development Policy and Management.

Jain, A. (1998). *Economics of Corruption*. Mass: Kluwer Academic Publishers.

Jain, A. (2001). “Corruption: A Review.” *Journal of Economic Surveys*. 15(1): 71-121.

James, J. (2012). "The distributional effects of leapfrogging in mobile phones." *Telematics and Informatics*. 29: 294-301.

Jensen, R. (2007). “The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector.” *The Quarterly Journal of Economics*. 122(3): 879-924.

JICA. (1991). *The Study on Rehabilitation of Dar es Salaam Water Supply in the United Republic of Tanzania: Final Report*. Volume 2, Main Report. Dar es Salaam: Japan International Cooperation Agency.

Kayaga, S., Calvert, J., and Sansom, K. (2003). "Paying for water services: effects of household characteristics. *Utilities Policy*. 11: 123-132.

Kayaga, S., Franceys, R., and Sansom, K. (2004). “Bill payment behaviour in urban water services: empirical data from Uganda.” *Journal of Water Supply: Research and Technology – AQUA*. 53(5): 339-349.

Kayaga, S., Fisher, J., and Franceys, R. (2009). "Improved Access to Urban Water Services in Uganda." *Municipal Engineer*. 162(3): 165-170.

Kjellen, M. (2000). “Complementary Water Systems in Dar es Salaam, Tanzania: The Case of Water Vending.” *International Journal of Water Resources Development*. 16(1): 143-154.

Kleine, D. (2010). "ICT4WHAT? Using the Choice Framework to Operationalise the Capability Approach to Development." *Journal of International Development*. 22(5): 674-692.

Kleine, D., and Unwin, T. (2009). "Technological Revolution, Evolution, and New Dependencies: What's New About ICT4D?" *Third World Quarterly*. 30(5): 1045-1067.

Kombe, W. (2005). "Land use dynamics in peri-urban areas and their implications on the urban growth and form: the case of Dar es Salaam, Tanzania." *Habitat International*. 29(1): 113-135.

Kshetri, N., and Acharya, S. (2012). “Mobile Payments in Emerging Markets.” *IT Professional*. 14(4): 9-13.

Kyem, P. (2012). "Is ICT the panacea to sub-Saharan Africa's development problems? Rethinking Africa's contentious engagement with the global information society." *Progress in Development Studies*. 12(2-3): 231-244.

Kyessi, A. (2005). "Community-based urban water management in fringe neighbourhoods: The case of Dar es Salaam, Tanzania." *Habitat International*. 29(1): 1-25.

Lincoln, Y., and Guba, E. (2000). "Paradigmatic Controversies, Contradictions, and Emerging Confluences." IN: Denzin, N., and Lincoln, Y. (eds). Pp 163-188. *The Sage Handbook of Qualitative Research*. 2nd ed. London: Sage.

Mas, I. (2009). "The Economics of Branchless Banking." *Innovations*. 4(2): 57-75.

Mas, I. (2011). "Why are banks so scarce in Developing Countries? A Regulatory and Infrastructure Perspective." *Crtitical Review: A Journal of Politics and Society*. 23(1-2): 135-145.

Mas, I., and Ng'weno, A. (2010). "Three Keys to M-PESA's Success: Branding, Channel Management, and Pricing." *Journal of Payments Strategy and Systems*. 4(4): 352-370.

McGranahan, G., and Satterthwaite, D. (2006). *Governance and getting the private sector to provide better water and sanitation services to the urban poor*. IIED Human Settlements Discussion Paper Series. Theme: Water-2.

Mertens, D. (1998). *Research Methods in Education and Psychology: Integrating Diversity with Quantitative and Qualitative Approaches*. London: Sage.

Moore, M. (2000). "Political Underdevelopment." *Paper Presented at the 10th Anniversary Conference of the Development Studies Institute, London School of Economics, New Institutional Theory, Institutional Reform, and Poverty Reduction*. London. 7-8 September.

Morawczynski, O. (2009). "Exploring the usage and impact of "transformational" mobile financial services: The case of M-PESA in Kenya." *Journal of East African Studies.* 3(3): 509-529.

Mugabi, J., Kayaga, S., Smout, I., and Njiru, C. (2010). "Determinants of customer decisions to pay utility water bills promptly." *Water Policy*. 12(2): 220.

Mugabi, J., and Kayaga, S. (2010). "Attitudinal and socio-demographic effects on willingness to pay for water services and actual payment behaviour." *Urban Water Journal*. 7(5): 287-300.

Mugisha, S., and Brown, A. (2010). "Patience and action pays: a comparative analysis of WSS reforms in three East African cities." *Water Policy*. 12(5): 654.

Muwanguzi, S., and Musambira, G.W. (2011). "The Transformation of East Africa's Economy Using Mobile Phone Money Transfer Service: A Comparative Analysis of Kenya and Uganda's Experiences." *Journal of Creative Communications*. 4(2): 131-146.

Mwanza, D. (2005). "Promoting Good Governance Through Regulatory Frameworks in African Water Utilities." *Water, Science, and Technology*. 51(8): 71-79.

NBS. (2013). *Tanzania in Figures: 2012*. Dar es Salaam: National Bureau of Statistics.

Oliver, R.L. (1980). "A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions." *Journal of Marketing Research*. 17: 460-469.

Padma, T. (2010). "Developing solutions." *Nature.* 466(7304): 6-7.

Phillips, D., and Burbules, N. (2000). *Postipositivism and Educational Research*. New York: Rowman and Littlefield.

Privitera, G. (2012). *Statistics for the Behavioral Sciences*. Thousand Oaks, CA: Sage Publications.

Rose-Ackerman, S. (1978). *Corruption: A Study in Political Economy*. Ann Arbor, MI: Academic Press.

Sansom, K., and Bos, A. (2008). "Utility and non-state water service provision for the urban poor." *International Journal of Water*, 4(3/4): 290-303.

Schwartz, K., and Sanga, A. (2010). "Partnerships between utilities and small-scale providers: Delegated management in Kisumu, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C*. 35(13/14): 765-771.

Sieber, J. (1998). "The Psychology of Whisteblowing." *Science and Engineering Ethics*. 4(1): 7-23.

Smith, L. (1983). "Quantitative versus qualitative research: An attempt to clarify the issue." *Education Researcher*. 12(3): 6-13.

Smith, M., Elder, L., and Erndon, H. (2011). "Open Development: A New Theory for ICT4D." *Information Technologies and International Development*. 7(1): iii-ix.

Solo, T.M. (1999). "Small-scale entrepreneurs in the urban water and sanitation market." *Environment and Urbanization*. 11(1): 117-132.

Stalgren, P. (2006). *Corruption in the Water Sector: Causes, Consequences, and Potential Reform*. Stockholm.

Stanforth, C. (2006). "Using Actor-Network Theory to Analyze E-Government Implementation in Developing Countries." *Information Technologies and International Development*. 3(3): 35-60.

Thompson, J., Porras, I., Wood, E., Tumwine, J., Mujwahuzi, M., Katui-Katua, M., and Johnstone, N. (2000). "Waiting at the tap: changes in urban water use in East Africa over three decades." *Environment and Urbanization*. 12(2): 37-52.

Thompson, M. (2004). "ICT, power, and developmental discourse: A critical analysis." *Electronic Journal on Information Systems in Developing Countries.* 20(4): 1-26.

Thompson, M. (2008). "ICT and development studies: Towards development 2.0." *Journal of International Development*. 20(6): 821-835.

Thompson, M., and Walsham, G. (2010). "ICT Research in Africa: Need for a Strategic Developmental Focus." *Information Technology for Development*. 16(2): 112-127.

Tukey, J. (1977). *Exploratory Data Analysis*. Reading, MA: Addison-Wesley.

Tversky, A., and Kahneman, D. (1974). "Judgments under uncertainty: heuristics and biases." *Science*. 185: 1124-1131.

United Nations Development Programme (UNDP). (2002). *Human Development Report*. Oxford University Press: New York.

UN-HABITAT (2003). *The Challenge of Slums: Global Report on Human Settlements*. London: Earthscan.

UN-HABITAT. (2011). *State of the World's Cities 2010/2011: Bridging the Urban Divide*. London: Earthscan.

Unwin, T. (2009). *ICT4D: Information and Communication Technology for Development*. Cambridge: Cambridge University Press.

Unwin, T. (2010). "ICTs, Citizens, and the State: Moral Philosophy and Development Practices." *Electronic Journal on Information Systems in Developing Countries*. 44(1): 1-16.

Van Ryzin, G. (2004). "Expectations, performance, and citizen satisfaction with urban services." *Journal of Policy Analysis and Management*. 23(3): 433-448.

WaterAid. (2008). *Why did City Water fail? The rise and fall of private sector participation in Dar es Salaam's water supply*. WaterAid - Tanzania. May 2008.

Waverman, L., Meschi, M., and Fuss, M. (2005). "The Impact of Telecoms on Economic Growth in Developing Countries." *Africa: The Impact of Mobile Phones*. Vodafone Policy Paper 3: 10-23.

Wesolowski, A., Eagle, N., Tatem, A., Smith, D., Noor, A., Snow, R., and Buckee, C. (2012). "Quantifying the Impact of Human Mobility on Malaria." *Science*. 338(6104): 267-270.

WHO/UNICEF. (2010). *Progress of Sanitation and Drinking-Water: 2010 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2012). *Progress on Drinking Water and Sanitation: 2012 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2013). *Progress on Sanitation and Drinking Water: 2013 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

Williamson, O.E. (1976). "Franchise Bidding for Natural Monopolies – In General and with Respect to CATV." *Bell Journal of Economics*. 7: 73-104.

Williamson, O. (1981). "The Economics of Organization: The Transaction Cost Approach." *American Journal of Sociology*. 87(3): 548-577.

Wong, A. (2008). "The Impact of Mobile Phones on the New Urban Poor: Leaving an Urban Footprint?" *Journal of Urban Technology*. 15(3): 25-38.

World Bank. (1997). *World Development Report 1997*. Oxford University Press: New York.

Zerah, M. (1998). "How to assess the quality dimension of urban infrastructure: The case of water supply in Delhi." *Cities*. 15(4): 285-290.

Chapter 2

Abdul-Muhmin, A.G. (2010). "Transaction size effects on consumers' retail payment mode choice." *International Journal of Retail and Distribution Management.* 38(6): 460-478.

AICD. (2010). "Africa's Infrastructure: A time for transformation." Washington, DC: World Bank and Agence Française de Développement.

Aker, J. (2010). "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger." *American Economic Journal: Applied Economics*. 2(3): 46-59.

Aker, J. (2011). "Dial A for Agriculture: A review of information and communication technologies for agricultural extension in developing countries*." Agricultural Economics*. 42: 631-647.

Alampay, E., and Bala, G. (2010). "Mobile 2.0: M-money for the BoP in the Philippines." *Information Technologies & International Development*. 6(4): 77-92.

Alegre, H., Baptista, J., Cabrera, E., Cubillo, F., Duarte, P., Hirner, W., *et al.* (2006). *Performance Indicators for Water Supply Services*. (2nd ed). London: IWA Publishing.

Altaf, M., Whittington, D., Jamal, H., and Kerry, V. (1993). "Rethinking rural water supply policy in Punjab, Pakistan." *Water Resources Research*. 29(7): 1943-1954.

Bannerjee, S., and Morella, E., (2011). *Africa's water and sanitation infrastructure: access, affordability, and alternatives*. Washington, DC: World Bank.

Banerjee, S., Skilling, H., Foster, V., Briceno-Garmendia, C., Morella, E., and Chfadi, T. (2009). "Ebbing Water, Surging Deficits: Urban Water Supply in Sub-Saharan Africa." *International Bank for Reconstruction and Development/The World Bank*.

Briscoe, J., De Castro, P., Griffin, C., North, J., and Olsen, O. (1990). "Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil." *World Bank Economic Review*. 4(2): 115-134.

Bounie, D., and Francois, A. (2011). "The economics of bill payments: an empirical analysis." *Applied Economics Letters*. 18(10): 961-966.

Casey, J., Kahn, J., and Rivas, A. (2006). "Willingness to pay for improved water service in Manaus, Amazonas, Brazil." *Ecological Economics*. 58(2): 365-372.

Dagdeviren, H., and Robertson, S. A. (2011). "Access to Water in the Slums of Sub-Saharan Africa." *Development Policy Review*. 29(4): 485–505.

Donner, J. and Escobari, M. X. (2010). "A Review of evidence on mobile use by micro and small enterprises in Developing Countries." *Development.* 22: 641–658.

Dutta, V., Chander, S., and Srivastava, L. (2005). "Public support for water supply improvements: Empirical evidence from unplanned settlements of Delhi, India." *Journal of Environment and Development*. 14(4): 439-462.

Essegbey, G., and Frempong, G. (2011). “Creating space for innovation – The case of mobile telephony in MSEs in Ghana.” *Technovation*. 31: 679-688.

Energy and Water Utilities Regulatory Authority (EWURA). (2011). *Water Utilities Performance Report for 2009/2010.* United Republic of Tanzania. Dar es Salaam, Tanzania: Government Printers.

Foster, T., Hope, R., Thomas, M., Cohen, I., Krolikowski, A., and Nyaga, C. (2012). “Impacts and implications of mobile water payments in East Africa.” *Water International*. 37(7): 788-804.

Gibbons, R. (2010). “Transaction Cost Economics: Past Present and Future?” *The Scandinavian Journal of Economics*. 112(2): 263-288.

Gonzalez-Gomez, F., Garcia-Rubio, M., and Guardiola, J. (2011). “Why Is Non-revenue Water So High in So Many Cities?” *International Journal of Water Resources Development*. 27(2): 345-360.

GSMA/Deloitte. (2012). *Sub-Saharan Africa Mobile Observatory 2012.* London: GSM Association.

Hancock, D., and Humphreys, D. (1998). "Payment transactions, instruments, and systems: A survey." *Journal of Banking and Finance.* 21: 1573-1624.

Hoaglin, D., Iglewicz, B., and Tukey, J. (1986). “Performance of some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 81: 991-999.

Hoaglin, D., and Iglewicz, B. (1987). “Fine tuning some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 82: 1147-1149.

Humphrey, D., and Berger, A. (1990). "Market failure and resources use: economic incentives to use different payment instruments." IN: Humphrey, D. (Ed.), *The US Payments System: Efficiency, Risk, and the Role of the Federal Reserve*. Pp. 45-86. Norwell, MA: Kluwer Academic Publishing.

Humphrey, D., Pulley, L., and Vesala, J. (1996). "Cash, Paper, and Electronic Payments: A Cross-Country Analysis." *Journal of Money, Credit, and Banking*. 28(4): 914-939.

Ivatury, G., and Pickens, M. (2006). “Mobile phone banking and low-income customers: Evidence from South Africa.” Washington, DC: Consultative Group to Assist the Poor (CGAP).

Jack, W., and Suri, T. (2011). “The Economics of M-PESA.” NBER Working Paper No. 16721.

Jensen, R. (2007). “The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector.” *The Quarterly Journal of Economics*. 122(3): 879-924.

Kayaga, S. (2002). *The influence of customer perceptions of urban utility water services on bill payment behaviour: Findings from Uganda.* PhD Thesis, WEDC, Loughborough University.

Kayaga, S., Franceys, R., and Sansom, K. (2004). "Bill payment behaviour in urban water services: empirical data from Uganda." *Journal of Water Supply: Research and Technology – AQUA*. 53(5): 339-349.

Kjellen, M. (2000). "Complementary Water Systems in Dar es Salaam, Tanzania: The Case of Water Vending." *International Journal of Water Resources Development*. 16(1): 143-154.

Kshetri, N., and Acharya, S. (2012). "Mobile Payments in Emerging Markets." *IT Professional*. 14(4): 9-13.

Mantel, B. (2000). "Why do consumers pay bills electronically? An Empirical Analysis." *Economic Perspectives*. Q-IV: 32-48.

Mas, I. (2009). "The Economics of Branchless Banking." *Innovations*. 4(2): 57-75.

Mas, I., and Morawczynski, O. (2009). "Designing Mobile Money Services Lessons from M-PESA." *Innovations: Technology, Governance, Globalization*, 4 (2): 77-91.

McGranahan, G., Satterthwaite, L., and Thompson, J. (2003). *Improving Access to Water and Sanitation: Rethinking the way forward in light of the Millennium Development Goals*. IIED: London.

Medhi, I., Gautama, S. N., and Toyama, K. (2009). "A comparison of mobile money-transfer UIs for non-literate and semi-literate users." *Proceedings of the 27th international conference on Human factors in computing systems*. Chicago: 1741.

Morawczynski, O. (2009). "Exploring the usage and impact of "transformational" mobile financial services: The case of M-PESA in Kenya." *Journal of East African Studies.* 3(3): 509-529.

Mu, X., Whittington, D., and Briscoe, J. (1990). "Modelling village water demand behaviour: A discrete choice approach." *Water Resources Research*. 26(4): 521-529.

Mugabi, J., and Kayaga, S. (2010). "Attitudinal and socio-demographic effects on willingness to pay for water services and actual payment behaviour." *Urban Water Journal*. 7(5): 287-300.

Mugabi, J., Kayaga, S., Smout, I., and Njiru, C. (2010). "Determinants of customer decisions to pay utility water bills promptly." *Water Policy*. 12(2): 220.

Mugisha, S., and Brown, A. (2010). "Patience and action pays: a comparative analysis of WSS reforms in three East African cities." *Water Policy*. 12(5): 654.

Mwanza, D. (2005). "Promoting Good Governance Through Regulatory Frameworks in African Water Utilities." *Water, Science, and Technology*. 51(8): 71-79.

Padma, T. (2010). "Developing solutions." *Nature.* 466(7304): 6-7.

Porteous, D. (2006). *The enabling environment for mobile banking in Africa*. London: DFID.

Robinson, P., and Flatraaker, D. (1995). "Costs in the payments system." *Norges Bank Economic Bulletin*. 66: 207-216.

Schwartz, K., and Sanga, A. (2010). "Partnerships between utilities and small-scale providers: Delegated management in Kisumu, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C*. 35(13/14): 765-771.

Singh, B., Ramasubban, R., Bhatia, R., Briscoe, J., Griffin, C., and Kim, C. (1993). "Rural water supply in Kerala, India: How to emerge from a low-level equilibrium trap." *Water Resources Research*. 29(7): 1931-1942.

Tarfasa, S., and Brouwer, R. (2013). "Estimation of the public benefits of urban water supply improvements in Ethiopia: A choice experiment." *Applied Economics*. 45(9): 1099-1108.

Tukey, J. (1977). *Exploratory Data Analysis*. Reading, MA: Addison-Wesley.

Wafula, W. (2011). "NWSC to Save Billions in Mobile Payments." *Daily Monitor*. Accessed on 1 March 2013 from: http://www.monitor.co.ug/Business/-/688322/1108256/-/3r115b/-/index.html.

Wesolowski, A., *et al*. (2012). "Quantifying the Impact of Human Mobility on Malaria." *Science*. 338(6104): 267-270.

Whitesell, W.C. (1989). "The demand for currency versus debitable accounts." *Journal of Money, Credit, and Banking*. 21(2): 246-51.

Whittington, D., Davis, J., and McClelland, E. (1998). "Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda." *Water International*. 23(3): 134-145.

WHO/UNICEF. (2012). *Progress on Drinking Water and Sanitation: 2012 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2013). *Progress on Sanitation and Drinking Water: 2013 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

Williamson, O.E. (1979). "Transaction Cost Economics: The Governance of Contractual Relations." *Journal of Law and Economics*. 22(2): 233-261.

Williamson, O.E. (1981). "The Economics of Organization: The Transaction Cost Approach." *The American Journal of Sociology*. 87(3): 548-577.

Chapter 3

Ades, A., and Di Tella, R. (1997). "The new economics of corruption: a survey and some new results." *Political Studies*. 45(Special Issue): 496-515.

AICD. (2010). "Africa's Infrastructure: A time for transformation." Washington, DC: World Bank and Agence Française de Développement.

Aker, J. (2010). "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger." *American Economic Journal: Applied Economics*. 2(3): 46-59.

Aker, J. (2011). "Dial A for Agriculture: A review of information and communication technologies for agricultural extension in developing countries*." Agricultural Economics*. 42: 631-647.

Alampay, E., and Bala, G. (2010). "Mobile 2.0: M-money for the BoP in the Philippines." *Information Technologies & International Development*. 6(4): 77-92.

Anbarci, N., Escaleras, M., and Register, C. (2009). "The Ill Effects of Public Sector Corruption in the Water and Sanitation Sector." *Land Economics*. 85(2): 363-377.

Barr, A., Lindelow, M., and Serneels, P. (2009). "Corruption in public service delivery: an experimental analysis." *Journal of Economic Behaviour and Organization*. 72(1): 225-239.

Dagdeviren, H., and Robertson, S. (2011). "Access to Water in the Slums of Sub-Saharan Africa." *Development Policy Review*. 29(4): 485-505.

Davis, J. (2004). "Corruption in Public Service Delivery: Experience from South Asia's Water and Sanitation Sector." *World Development*. 32(1): 53-71.

Deininger, K., and Mpuga, P. (2005). "Does Greater Accountability Improve the Quality of Public Service Delivery? Evidence From Uganda." *World Development*. 33(1): 171-191.

Dill, B. (2010). "Public-public partnerships in Urban water provision: The case of Dar es Salaam." *Journal of International Development*. 22(5): 611-624.

Donner, J. and Escobari, M. X. (2010). "A Review of evidence on mobile use by micro and small enterprises in Developing Countries." *Development.* 22: 641–658.

Donovan, K. (2012). "Mobile Money and Financial Inclusion." In: Kelly, T., and Minges., M (eds.). *Information and Communication for Development 2012.* Washington, DC: World Bank.

Eisenhardt, K. (1989). "Agency Theory: An Assessment and Review." *Academy of Management Review*. 14(1): 57-74.

Elshorst, H., and O'Leary, D. (2005). *Corruption in the Water Sector: Opportunities for Addressing a Pervasive Problem*. Berlin: Transparency International.

Essegbey, G., and Frempong, G. (2011). “Creating space for innovation – The case of mobile telephony in MSEs in Ghana.” *Technovation*. 31: 679-688.

Foster, T., Hope, R., Thomas, M., Cohen, I., Krolikowski, A., and Nyaga, C. (2012). “Impacts and implications of mobile water payments in East Africa.” *Water International*. 37(7): 788-804.

Georgiadou, Y., Bana, B., Becht, R., Hoppe, R., Ikingura, J., Kraak, M., *et al*. (2011). Sensors, Empowerment, and Accountability: a Digital Earth view from East Africa. *International Journal of Digital Earth*. 4(4): 285-304.

GSMA/Deloitte. (2012). *Sub-Saharan Africa Mobile Observatory 2012.* London: GSM Association.

Hope, R., Foster, T., Krolikowski, A., and Cohen, I. (2011). *Mobile water payment innovations in urban Africa*. School of Geography and the Environment and Skoll Centre for Social Entrepreneurship at Säid Business School, University of Oxford, UK.

Hope, R., Foster, T., Money, A., and Rouse, M. (2012). “Harnessing mobile communications innovations for water security.” *Global Policy.* 3(4): 433-442.

Hutchings, M., Dev, A., Palaniappan, M., Srinivasan, V., Ramanathan, N., and Taylor, J. (2012). *mWASH: mobile phone applications for the water, sanitation, and hygiene sector*. Oakland, CA: Pacific Institute and Nextleaf Analytics.

Ivatury, G., and Pickens, M. (2006). “Mobile phone banking and low-income customers: Evidence from South Africa.” Washington, DC: Consultative Group to Assist the Poor (CGAP).

Jack, W., and Suri, T. (2011). “The Economics of M-PESA.” NBER Working Paper No. 16721.

Jain, A. (1998). *Economics of Corruption*. Mass: Kluwer Academic Publishers.

Jain, A. (2001). “Corruption: A Review.” *Journal of Economic Surveys*. 15(1): 71-121.

James, J., and Versteeg, M. (2007). "Mobile phones in Africa: how much do we really know?" *Social Indicators Research*. 84(1): 117-126.

Jensen, R. (2007). “The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector.” *The Quarterly Journal of Economics*. 122(3): 879-924.

Johnson, S., Kaufmann, D., and Zoido-Lobaton, P. (1998). “Regulatory discretion and the unofficial economy.” *American Economic Review*. 88: 387-392.

Kjellen, M. (2000). “Complementary Water Systems in Dar es Salaam, Tanzania: The Case of Water Vending.” *International Journal of Water Resources Development*. 16(1): 143-154.

Klitgaard, R. (1988). *Controlling Corruption*. Berkeley: University of California Press.

Kshetri, N., and Acharya, S. (2012). “Mobile Payments in Emerging Markets.” *IT Professional*. 14(4): 9-13.

Kyessi, A. (2005). "Community-based urban water management in fringe neighbourhoods: The case of Dar es Salaam, Tanzania." *Habitat International*. 29(1): 1-25.

Mauro, P. (1995). “Corruption and growth.” *Quarterly Journal of Economics*. 110: 681–712.

McGranahan, G., and Satterthwaite, D. (2006). *Governance and getting the private sector to provide better water and sanitation services to the urban poor*. IIED Human Settlements Discussion Paper Series. Theme: Water-2.

Morawczynski, O. (2009). “Exploring the usage and impact of “transformational” mobile financial services: The case of M-PESA in Kenya.” *Journal of East African Studies.* 3(3): 509-529.

Mwanza, D. (2005). “Promoting Good Governance Through Regulatory Frameworks in African Water Utilities.” *Water, Science, and Technology*. 51(8): 71-79.

Mugisha, S., and Brown, A. (2010). “Patience and action pays: a comparative analysis of WSS reforms in three East African cities.” *Water Policy*. 12(5): 654.

Padma, T. (2010). “Developing solutions.” *Nature.* 466(7304): 6-7.

Plummer, J., and Cross, P. (2006). “Tackling Corruption in the Water and Sanitation Sector in Africa: Starting the Dialogue.” *Water and Sanitation Program*. Washington, DC: World Bank.

Reinikka, R., and Svensson, J. (2011). "The power of information in public services: Evidence from education in Uganda." *Journal of Public Economics.* 95: 956-966.

Rose-Ackerman, S. (1978). *Corruption: A Study in Political Economy*. Ann Arbor, MI: Academic Press.

Schleifer, A., and Vishny, R. (1993). “Corruption.” *Quarterly Journal of Economics.* 108(3): 599-617

Stalgren, P. (2006). *Corruption in the Water Sector: Causes, Consequences, and Potential Reform*. Stockholm.

Tanzi, V., and Davoodi, H. (1997). “Corruption, public investment, and growth.” *International Monetary Fund*. Working Paper 97/139. Washington, DC: IMF.

UN-HABITAT. (2011). *State of the World's Cities 2010/2011: Bridging the Urban Divide*. London: Earthscan.

WaterAid. (2008). *Why did City Water fail? The rise and fall of private sector participation in Dar es Salaam's water supply.* WaterAid - Tanzania. May 2008.

Wei, S.-J. (1999). “Corruption in economic development: Beneficial grease, minor annoyance, or major obstacle?” *World Bank Policy Research Working Paper 2048*. Washington, DC: The World Bank.

Wesolowski, A., Eagle, N., Tatem, A., Smith, D., Noor, A., Snow, R., and Buckee, C. (2012). “Quantifying the Impact of Human Mobility on Malaria.” *Science*. 338(6104): 267-270.

WHO/UNICEF. (2010). *Progress of Sanitation and Drinking-Water: 2010 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2012). *Progress on Drinking Water and Sanitation: 2012 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2013). *Progress on Sanitation and Drinking Water: 2013 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

Chapter 4

Addo-Yobo, F.N., Njiru, C., and Sohail, M. (2006). "Determinants of households' intention to pay for improved water services: an application of the theory of reasoned action." *Journal of Water Supply: Research and Technology - AQUA*. 55(6): 419-425.

AICD. (2010). "Africa's Infrastructure: A time for transformation." Washington, DC: World Bank and Agence Française de Développement.

Aker, J. and Mbiti, I. (2010). "Mobile phones and economic development in Africa." *The Journal of Economic Perspectives*. 24(3): 207-232.

Andaleeb, S., Siddiqui, N., and Khandakar, S. (2007). "Patient satisfaction with health services in Bangladesh." *Health Policy and Planning*. 22: 263-273.

Balbo, M. (1993). "Urban planning and the fragmented city of developing countries." *Third World Planning Review*. 15(3) 23-35.

Bannerjee, S., and Morella, E., (2011). *Africa's water and sanitation infrastructure: access, affordability, and alternatives*. Washington, DC: World Bank.

Bernhardt, K.L., Donthu, N., and Kennett, P.A. (2000). "A Longitudinal Analysis of Satisfaction and Profitability." *Journal of Business Research*. 47(2): 161-171.

Bitner, M.J., and Hubbert, A.R. (1994). "Encounter Satisfaction versus Overall Satisfaction versus Quality." Pp 72-94 in *Service Quality: New Directions in Theory and Practice*. Roland T. Rust and Richard L. Oliver (Eds.). London: Sage.

Carvalho, C., and Brito, C. (2012). "Assessing Users' Perceptions on how to Improve Public Services Quality." *Public Management Review*. 14(4): 451-472.

Deichmann, U., and Lall, S. (2007). "Citizen feedback and delivery of urban services." *World Development.* 35(4): 649-662.

Dill, B. (2010). "Public-public partnerships in Urban water provision: The case of Dar es Salaam." *Journal of International Development*. 22(5): 611-624.

Donkor, E. (2013). "The Effect of Customer Satisfaction on Water Utility Business Performance." *Technical Report TR-2013-2.* Institute for Integrating Statistics in Decision Sciences. George Washington University. Washington, DC.

Fattahi, P., Kherikhah, A., Sadeghian, R., Zandi, S., and Fayyaz, S. (2011). "An evaluation model for measuring customer satisfaction levels in a water supply domain: case study - water supply in Hamedan." *Water Policy*. 13: 490-505.

Foster, T., Hope, R., Thomas, M., Cohen, I., Krolikowski, A., and Nyaga, C. (2012). "Impacts and implications of mobile water payments in East Africa." *Water International*. 37(7): 788-804.

Gupta, S., and Zeithaml, V. (2006). "Customer Metrics and Their Impact on Financial Performance." *Marketing Science*. 25(6): 718-739.

Hoaglin, D., and Iglewicz, B. (1987). “Fine tuning some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 82: 1147-1149.

Hoaglin, D., Iglewicz, B., and Tukey, J. (1986). “Performance of some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 81: 991-999.

Helgesen, O. (2006). "Are Loyal Customers Profitable? Customer Satisfaction, Customer (Action) Loyalty, and Customer Profitability at the Individual Level." *Journal of Marketing Management*. 22(3/4): 245-266.

Heskett, J.L., Sasser Jr., W.E., and Schlesinger, L.A. (1997). *The Service Profit Chain: How Leading Companies Link Profit and Growth to Loyalty, Satisfaction, and Value.* New York, NY: Free Press.

Homburg, C., Koschate, N., and Hoyer, W.D. (2005). "Do Satisfied Customers Really Pay More? A Study of the Relationship between Customer Satisfaction and Willingness to Pay." *Journal of Marketing*. 69(2): 84-96.

Im, T., and Jong Lee, S. (2011). "Does Management Performance Impact Citizen Satisfaction?" *The American Review of Public Administration*. 42(4): 419-436.

Jack, W., and Suri, T. (2011). “The Economics of M-PESA.” NBER Working Paper No. 16721.

Jaglin, S. (2002). “The right to water versus cost recovery: participation, urban water supply and the poor in sub-Saharan Africa.” *Environment and Urbanization*. 14(1): 231-245.

James, O. (2009). "Evaluating the Expectations Disconfirmation and Expectations Anchoring Approaches to Citizen Satisfaction with Local Public Services." *Journal of Public Administration Research and Theory*. 19(1): 107-123.

James, O. (2011). "Managing Citizens' Expectations of Public Service Performance: Evidence from Observation and Experimentation in Local Government." *Public Administration.* 89(4): 1419-1435.

Jermais, J. (2009). "Investigating the impacts of customer satisfaction on firm performance." *Gadjah Mada International Journal of Business*. 11(3): 341-359.

Kayaga, S., Calvert, J., and Sansom, K. (2003). "Paying for water services: effects of household characteristics. *Utilities Policy*. 11: 123-132.

Kayaga, S., Franceys, R., and Sansom, K. (2004). “Bill payment behaviour in urban water services: empirical data from Uganda.” *Journal of Water Supply: Research and Technology – AQUA*. 53(5): 339-349.

Kjellen, M. (2000). “Complementary Water Systems in Dar es Salaam, Tanzania: The Case of Water Vending.” *International Journal of Water Resources Development*. 16(1): 143-154.

Kjellen, M., and McGranahan, G. (2006). "Informal Water Vendors and the Urban Poor." *Human Settlements Discussion Paper Series - Water 3.* International Institute for Environment and Development. London: IIED.

Kooy, M., and Bakker, K. (2008). “Splintered Networks: The colonial and contemporary waters of Jakarta.” *Geoforum*. 39: 1843-1858.

Kshetri, N., and Acharya, S. (2012). “Mobile Payments in Emerging Markets.” *IT Professional*. 14(4): 9-13.

Kyessi, A. (2005). "Community-based urban water management in fringe neighbourhoods: The case of Dar es Salaam, Tanzania." *Habitat International*. 29(1): 1-25.

Lewis, B., and Pattinasarany, D. (2009). "Determining citizen satisfaction wiht local public education in Indonesia: The significance of actual service quality and governance conditions." *Growth and Change*. 40(1): 85-115.

Mas, I. (2009). “The Economics of Branchless Banking.” *Innovations*. 4(2): 57-75.

Mittal, V., Anderson, E.W., Sayrak, A., and Tadikamalla, P. (2005). "Dual Emphasis and the Long-Term Financial Impact of Customer Satisfaction." *Marketing Science*. 24(4): 544-555.

Morawczynski, O. (2009). “Exploring the usage and impact of “transformational” mobile financial services: The case of M-PESA in Kenya.” *Journal of East African Studies.* 3(3): 509-529.

Mugabi, J., and Kayaga, S. (2010). “Attitudinal and socio-demographic effects on willingness to pay for water services and actual payment behaviour.” *Urban Water Journal*. 7(5): 287-300.

Mugabi, J., Kayaga, S., Smout, I., and Njiru, C. (2010). “Determinants of customer decisions to pay utility water bills promptly.” *Water Policy*. 12(2): 220.

Mugisha, S., and Brown, A. (2010). “Patience and action pays: a comparative analysis of WSS reforms in three East African cities.” *Water Policy*. 12(5): 654.

Mwanza, D. (2005). “Promoting Good Governance Through Regulatory Frameworks in African Water Utilities.” *Water, Science, and Technology*. 51(8): 71-79.

Myburgh, N., Solanki, G., Smith, M., and Lalloo, R. (2005). "Patient satisfaction with health care providers in South Africa: The influences of race and socioeconomic status." *International Journal for Quality in Health Care*. 17(6): 473-477.

Oliver, R.L. (1980). "A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions." *Journal of Marketing Research*. 17: 460-469.

Oliver, R.L. (1999). "Whence Consumer Loyalty?" *Journal of Marketing*. 63(SI): 33-44.

Roch, C.H., and Poister, T.H. (2006). "Citizens, Accountability, and Service Satisfaction." *Urban Affairs Review*. 41(3): 292-308.

Russ, L.W., and Takahaski, L.M. (2013). "Exploring the Influence of Participation on Programme Satisfaction: Lessons from the Ahmedabad Slum Networking Project." *Urban Studies*. 50(4): 691-708.

Rust, R.T., and Oliver, R.L. (1994). *Service Quality: New Directions in Theory and Practice*. London: Sage.

Solo, T.M. (1999). "Small-scale entrepreneurs in the urban water and sanitation market." *Environment and Urbanization*. 11(1): 117-132.

Taylor, S. A., and Baker, T.L. (1994). "An Assessment of the Relationship Between Service Quality and Customer Satisfaction in the Formation of Consumers' Purchase Intentions." *Journal of Retailing*. 70(2): 163-178.

Tukey, J. (1977). *Exploratory Data Analysis*. Reading, MA: Addison-Wesley.

Tversky, A., and Kahneman, D. (1974). "Judgments under uncertainty: heuristics and biases." *Science*. 185: 1124-1131.

Van Ryzin, G. (2004). "Expectations, performance, and citizen satisfaction with urban services." *Journal of Policy Analysis and Management*. 23(3): 433-448.

Van Ryzin, G., and Charbonneau, E. (2010). "Public Service Use and perceived Performance: An Empirical Note on the Nature of the Relationship." *Public Administration*. 88(2): 551-563.

Vasquez, W.F., Trudeau, J., and Fransceschi, D. (2011). "Can user perception influence the quality of water services? Evidence from Leon, Nicaragua." *International Review of Administrative Sciences*. 77(3): 481-503.

WaterAid. (2008). *Why did City Water fail? The rise and fall of private sector participation in Dar es Salaam's water supply*. WaterAid - Tanzania. May 2008.

Westlund, A.H., Gustafsson, C., Lang, E., and Mattson, B. (2005). "On customer satisfaction and financial results in the Swedish real estate market." *Total Quality Management and Business Excellence*. 16(10): 1149-1159.

WHO/UNICEF. (2012). *Progress on Drinking Water and Sanitation: 2012 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2013). *Progress on Sanitation and Drinking Water: 2013 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

Yeung, M.C.H., and Ennew, C.T. (2000). "From customer satisfaction to profitability." *Journal of Strategic Marketing*. 8(4): 313-326.

Yu, S.H. (2007). "An Empirical Investigation on the Economic Consequences of Customer Satisfaction." *Total Quality Management and Business Excellence*. 18(5): 555-569.

Zeithaml, V.A., Berry, L., and Parasuraman, A. (1993). "The Nature and Determinants of Customer Expectations of Service." *Journal of the Academy of Marketing Science*. 21(1): 1-12.

Chapter 5

Balbo, M. (1993). "Urban planning and the fragmented city of developing countries." *Third World Planning Review*. 15(3) 23-35.

Bardasi, E., and Wodon, Q. (2003). "Who pays the most for water? Alternative providers and service costs in Niger." *Economics Bulletin*. 9(20): 1-10.

Boland, A. (2007). "The trickle-down effect: Ideology and the development of premium water networks in China's cities." *International Journal of Urban and Regional Research*. 31(1): 21-40.

Collignon, B., and Vezina, M. (2000). *Independent Water and Sanitation Providers and African Cities: Full Report of a Ten-Country Study.* Water and Sanitation Program. Washington, DC: World Bank.

Coutard, O. (2002). "Premium Network Spaces: A Comment." *International Journal of Urban and Regional Research*. 26(1): 166-174.

Coutard, O. (2008). "Placing splintering urbanism: Introduction." *Geoforum*. 39(6): 1815-1820.

Dagdeviren, H., and Robertson, S. (2011). "Access to Water in the Slums of Sub-Saharan Africa." *Development Policy Review*. 29(4): 485-505.

Dill, B. (2010). "Public-public partnerships in Urban water provision: The case of Dar es Salaam." *Journal of International Development*. 22(5): 611-624.

Donkor, E. (2013). "The Effect of Customer Satisfaction on Water Utility Business Performance." *Technical Report TR-2013-2.* Institute for Integrating Statistics in Decision Sciences. George Washington University. Washington, DC.

Dos Santos, S., and LeGrand, T. (2013). "Is the Tap Locked? An Event History Analysis of Piped Water Access in Ouagadougou, Burkina Faso." *Urban Studies*. 50(6): 1292-1310.

Drangert, J.O., Okotto-Okotto, J., Okotto, L., and Auko, O. (2002). "Going Small When the City Grows Big: New Options for Water Supply and Sanitation in Rapidly Expanding Urban Areas." *Water International*. 27(3): 354-363.

Foster, T., Hope, R., Thomas, M., Cohen, I., Krolikowski, A., and Nyaga, C. (2012). "Impacts and implications of mobile water payments in East Africa." *Water International*. 37(7): 788-804.

Gandy, M. (2006). "Planning, anti-planning, and the infrastructure crisis facing metropolitan Lagos." *Urban Studies*. 43(2): 371-396.

Graham, S. (2000). "Constructing Premium Network Spaces: Reflections on Infrastructure Networks and Contemporary Urban Development." *International Journal of Urban and Regional Research*. 21(1): 183-200.

Graham, S. (2002). “On Technology, Infrastructure, and the Contemporary Urban Condition: A Response to Coutard.” *International Journal of Urban and Regional Research*. (26)1: 175-182.

Graham, S., and Marvin, S. (2001). *Splintering Urbanism: Networked Infrastructures, Technological Mobilities, and the Urban Condition*. London: Routledge.

Hoaglin, D., and Iglewicz, B. (1987). “Fine tuning some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 82: 1147-1149.

Hoaglin, D., Iglewicz, B., and Tukey, J. (1986). “Performance of some resistant rules for outlier labelling.” *Journal of the American Statistical Association.* 81: 991-999.

Hope, R., *et al*. (2011). *Mobile water payment innovations in urban Africa*. School of Geography and the Environment and Skoll Centre for Social Entrepreneurship at Säid Business School, University of Oxford, UK.

Hope, R. *et al*., (2012). “Harnessing mobile communications innovations for water security.” *Global Policy.* 3(4): 433-442.

Jaglin, S. (2002). “The right to water versus cost recovery: participation, urban water supply and the poor in sub-Saharan Africa.” *Environment and Urbanization*. 14(1): 231-245.

Kariuki, M., and Schwartz, J. (2005). *Small-scale Private Service providers of Water Supply and Electricity: A Review of Incidence, Structure, Pricing, and Operating Characteristics*. World Bank Report Number WPS3727. Washington, DC: World Bank.

Kayaga, S., and Franceys, R. (2007). "Costs of urban utility water connections: Excessive burden to the poor." *Utilities Policy*. 15(4): 270-277.

Kayaga, S., Franceys, R., and Sansom, K. (2004). “Bill payment behaviour in urban water services: empirical data from Uganda.” *Journal of Water Supply: Research and Technology – AQUA*. 53(5): 339-349.

Keener, S., Luengo, M., and Banerjee, S. (2010). "Provision of Water to the Poor in Africa: Experience with Water Standposts and the Informal Water Sector." *Policy Research Working Paper 5387*. Washington, DC: World Bank.

Kjellen, M. (2000). “Complementary Water Systems in Dar es Salaam, Tanzania: The Case of Water Vending.” *International Journal of Water Resources Development*. 16(1): 143-154.

Kooy, M., and Bakker, K. (2008). “Splintered Networks: The colonial and contemporary waters of Jakarta.” *Geoforum*. 39: 1843-1858.

Krolikowski, A. (2013). "Mobile-Enabled Payment Innovations and Financial Sustainability in Tanzania's Urban Water Sector." *Unpublished Thesis*

Kshetri, N., and Acharya, S. (2012). “Mobile Payments in Emerging Markets.” *IT Professional*. 14(4): 9-13.

Kyessi, A. (2005). "Community-based urban water management in fringe neighbourhoods: The case of Dar es Salaam, Tanzania." *Habitat International*. 29(1): 1-25.

Listening to Dar. (2012). *Access to Water - Report 15*. Twaweza. Accessed: 17 May 2013. <http://listeningtodar.org>.

Mashauri, D., and Katko, T. (1993). "Water Supply Development and Tariffs in Tanzania: From Free Water Policy Towards Cost Recovery." *Environmental Management*. 17(1): 31-39.

Mugabi, J., and Kayaga, S. (2010). "Attitudinal and socio-demographic effects on willingness to pay for water services and actual payment behaviour." *Urban Water Journal*. 7(5): 287-300.

Mugabi, J., Kayaga, S., and Smout, I. (2007). "Why water utility customers don't pay their bills promptly." *Water Utility Management International*. 2(2): 17-19.

Mugabi, J., Kayaga, S., Smout, I., and Njiru, C. (2010). "Determinants of customer decisions to pay utility water bills promptly." *Water Policy*. 12(2): 220.

Mugambe, R.K., Tumwesigye, N.M., and Larkan, F. (2013). "Barriers to accessing water, sanitation, and hygiene among people living with HIV/AIDS in Gomba and Mpigi districts in Uganda: a qualitative study." *Journal of Public Health*. 21(1): 29-37.

Nnaji, C.C., Eluwa, C., and Nwoji, C. (2013). "Dynamics of domestic water supply and consumption in a semi-urban Nigerian city." *Habitat International*. 40: 127-135.

Ozpryszko, M., Huang, H., Soderlund, K., and Schwab, K. (2009). "Data gaps in evience-based research on small water enterprises in developing countries." *Journal of Water and Health*. 7(4): 609-622.

Sansom, K., and Bos, A. (2008). "Utility and non-state water service provision for the urban poor." *International Journal of Water*, 4(3/4): 290-303.

Schwartz, K., and Sanga, A. (2010). "Partnerships between utilities and small-scale providers: Delegated management in Kisumu, Kenya." *Physics and Chemistry of the Earth, Parts A/B/C*. 35(13/14): 765-771.

Solo, T.M. (1999). "Small-scale entrepreneurs in the urban water and sanitation market." *Environment and Urbanization*. 11(1): 117-132.

Stoler, *et al*. (2012). "When urban taps run dry: Sachet water consumption and health effects in low income neighborhoods of Accra, Ghana." *Health and Place*. 18: 250-262.

Thompson, J., Porras, I., Wood, E., Tumwine, J., Mujwahuzi, M., Katui-Katua, M., and Johnstone, N. (2000). "Waiting at the tap: changes in urban water use in East Africa over three decades." *Environment and Urbanization*. 12(2): 37-52.

Tukey, J. (1977). *Exploratory Data Analysis*. Reading, MA: Addison-Wesley.

UN-HABITAT (2003). *The Challenge of Slums: Global Report on Human Settlements*. London: Earthscan.

UN-HABITAT. (2011). *State of the World's Cities 2010/2011: Bridging the Urban Divide*. London: Earthscan.

WaterAid. (2008). *Why did City Water fail? The rise and fall of private sector participation in Dar es Salaam's water supply.* WaterAid - Tanzania. May 2008.

WHO/UNICEF. (2012). *Progress on Drinking Water and Sanitation: 2012 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

WHO/UNICEF. (2013). *Progress on Sanitation and Drinking Water: 2013 Update*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

Zerah, M. (1998). "How to assess the quality dimension of urban infrastructure: The case of water supply in Delhi." *Cities*. 15(4): 285-290.

Zuin, V., *et al*. (2011). "Water supply services for Africa's urban poor: the role of resale." *Journal of Water and Health*. 9(4): 773-784.

Chapter 6

Angrist, J., and Krueger, A. (2001). "Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments." *Journal of Economic Perspectives*. 15(4): 69-85.

Baker, J. (2000). *Evaluating the Impact of Development Projects on Poverty.* Washington, DC: World Bank.

Davis, J. (2004). "Corruption in Public Service Delivery: Experience from South Asia's Water and Sanitation Sector." *World Development*. 32(1): 53-71.

Heeks, R. (2009). "The ICT4D 2.0 Manifesto: Where next for ICTs and International Development." Development Informatics Group, University of Manchester. *IDPM Working Paper No. 42*. Available at: http://www.sed.manchester.ac.uk/idpm/research/publications/wp/dl/dl_wp42.htm

Hope, R., *et al*. (2011). *Mobile water payment innovations in urban Africa*. School of Geography and the Environment and Skoll Centre for Social Entrepreneurship at Säid Business School, University of Oxford, UK.

Mugabi, J., Kayaga, S., Smout, I., and Njiru, C. (2010). "Determinants of customer decisions to pay utility water bills promptly." *Water Policy*. 12(2): 220.

Zanello, G., and Massen, P. (2012). "Strengthening citizen agency and accountability through ICT: An extrapolation for Eastern Africa." *Public Management Review*. 13(3): 363-382.

APPENDICES

Survey Questionnaire – DAWASCO Customers

Aaron Krolikowski, Doctoral Student
+255(0)656 608 206
aaron.krolikowski@ouce.ox.ac.uk

Enumerator: _____

Project: ***Mobile-enabled Payments for Water Services in Dar es Salaam, Tanzania: Innovations, Impacts, and Implications***

Date: D D M M Y Y Location of Survey: District | Ward | Street

---

1) Introduce yourself and smile.

2) Ask: "Do you have a DAWASCO connection?" ☐ YES ☐ NO

3) Introduction – Good morning/afternoon, I am part of a research team coordinated by the University of Oxford in the United Kingdom. We would like to learn more about why you and your family choose different options to pay for water services in Dar es Salaam. We are using this survey with 1200 individuals and households. *You are being invited to participate in this research because you are a DAWASCO customer.* This survey should take approximately 10-15 minutes and will provide important information that will hopefully be used to improve water services in Dar es Salaam. This research has been approved by DAWASCO and the Tanzania Commission for Science and Technology (COSTECH).

4) Please ensure that the respondent understands that:
   1. They will remain anonymous and that their answers will be confidential.
   2. They can refuse to answer any questions and that they can stop the survey at any time.
   3. This research is for a doctoral thesis. Copies of this thesis will be available at DAWASCO, DAWASA, and the Ministry of Water.
   4. This research has been approved by the University of Oxford, the United Republic of Tanzania (COSTECH), and DAWASCO.
   5. Take time to answer any questions individuals might have.

5) Once you have answered their questions, mark this box to ensure respondent agrees to participate: ☐ YES, I AGREE

Part 1.1 – Residence of Respondent

1. Municipality of Residence

- ☐ Ilala
- ☐ Kinondoni
- ☐ Temeke

- ☐ Don't Know
- ☐ No Answer

2. Ward of Residence

_____

- ☐ Don't Know
- ☐ No Answer

3. Mtaa of Residence

_____

- ☐ Don't Know
- ☐ No Answer

Part 1.2 – Housing (House with DAWASCO Connection)

4. Who owns the house?

- ☐ Myself/Spouse
- ☐ Relatives
- ☐ Rented
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

5. Who holds the lease for the land?

- ☐ Myself/Spouse
- ☐ Relatives
- ☐ Rented
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

6. How long have you resided at the house?

Years: _____

Months: _____

- ☐ Don't Know
- ☐ No Answer

7. What is the roof material?

- ☐ Tiles/Shingles
- ☐ Cement
- ☐ Metal
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

8. What is the floor material?

- ☐ Tile/Wood/Carpet
- ☐ Cement
- ☐ Metal
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

Part 1.3 – Respondent Information

9. What is your sex?

- ☐ Male
- ☐ Female
- ☐ Other: _____
- ☐ No Answer

10. What is your age OR the year you were born?

_____

☐ No Answer

11. What is your marital status?

- ☐ Never Married
- ☐ Married
- ☐ Divorced
- ☐ Widowed
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

12. What is your highest level of COMPLETED education?

- ☐ Primary
- ☐ Secondary
- ☐ University
- ☐ Vocational
- ☐ None
- ☐ Don't Know
- ☐ No Answer

13. What type of PAID job do you have?

- ☐ Full Time
- ☐ Part Time
- ☐ Study
- ☐ Self Employed
- ☐ Unemployed
- ☐ Don't Know
- ☐ No Answer

14. How many adults regularly live/eat/sleep in the house?

_____

☐ Don't Know
☐ No Answer

15. How many children regularly live/eat/sleep in the house?

_____

☐ Don't Know
☐ No Answer

Part 2.1 – Mobile Phone Use

16. Do you own a mobile phone?

- ☐ Yes
- ☐ No
- ☐ No Answer

17. How many other people in your family own a mobile phone?

_____

☐ Don't Know
☐ No Answer

18. If you do not use a mobile phone, why do you not? [DO NOT PROMPT]

- ☐ No Need for Mobile Phone
- ☐ Handset is too Expensive
- ☐ Phone Service is too Expensive
- ☐ I Do Not Trust the Technology
- ☐ I Do Not Know How to Use
- ☐ Borrow from a Friend/Neighbour
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

Part 2.2 – Operator(s) and Service Provider(s)

19. Do you use Vodacom services?

☐ Yes ☐ No

19a. How much do you spend per week on Vodacom services?

_____

☐ Don't Know
☐ No Answer

19b. Which services do you use?

☐ Talk ☐ Pay Bills*
☐ Text/SMS ☐ Don't Know
☐ Send Money ☐ No Answer
☐ Receive Money ☐ Other: _____

***19c. Which bills do you pay using this service?**

☐ Electricity ☐ Taxes
☐ DSTV ☐ No Answer
☐ Exam Fees ☐ Other: _____

20. Do you use Airtel services?

☐ Yes ☐ No

20a. How much do you spend per week on Airtel services?

_____

☐ Don't Know
☐ No Answer

20b. Which services do you use?

☐ Talk ☐ Pay Bills*
☐ Text/SMS ☐ Don't Know
☐ Send Money ☐ No Answer
☐ Receive Money ☐ Other: _____

***20c. Which bills do you pay using this service?**

☐ Electricity ☐ Taxes
☐ DSTV ☐ No Answer
☐ Exam Fees ☐ Other: _____

Part 2.2 – Operator(s) and Service Provider(s) (Continued)

21. Do you use Tigo services?

☐ Yes ☐ No

21a. How much do you spend per week on Tigo services?

_____

☐ Don't Know
☐ No Answer

21b. Which services do you use?

☐ Talk ☐ Pay Bills*
☐ Text/SMS ☐ Don't Know
☐ Send Money ☐ No Answer
☐ Receive Money ☐ Other: _____

***21c. Which bills do you pay using this service?**

☐ Electricity ☐ Taxes
☐ DSTV ☐ No Answer
☐ Exam Fees ☐ Other: _____

22. Do you use Zantel services?

☐ Yes ☐ No

22a. How much do you spend per week on Zantel services?

_____

☐ Don't Know
☐ No Answer

22b. Which services do you use?

☐ Talk ☐ Pay Bills*
☐ Text/SMS ☐ Don't Know
☐ Send Money ☐ No Answer
☐ Receive Money ☐ Other: _____

***22c. Which bills do you pay using this service?**

☐ Electricity ☐ Taxes
☐ DSTV ☐ No Answer
☐ Exam Fees ☐ Other: _____

Part 3.1 – DAWASCO Water Supply

23. What is your DAWASCO account number?

_____
- ☐ Don't Know
- ☐ No Answer

24. How much did you spend on your last DAWASCO bill?

TZS: _____
- ☐ Don't Know
- ☐ No Answer

25. Where is your tap located?
- ☐ In the House
- ☐ In the Yard
- ☐ Other: _____
- ☐ No Answer

26. Do you have water storage tanks?
- ☐ Yes*
- ☐ No
- ☐ No Answer

***26a. How many litres do the tanks hold?**

_____
- ☐ Don't Know
- ☐ No Answer

27. What do you use DAWASCO water for?
- ☐ Drinking
- ☐ Washing/Bathing
- ☐ Cooking
- ☐ Garden
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

28. Do you have a water meter?
- ☐ Yes
- ☐ No
- ☐ No Answer

Part 3.2 – Paying Your DAWASCO Bills

29. How do you usually pay your DAWASCO bills?
- ☐ DAWASCO Office
- ☐ Bank
- ☐ Mobile Money
- ☐ DAWASCO Website
- ☐ Pay Point (Selcom/MaxMalipo)
- ☐ No Answer
- ☐ Other: _____

30. Who usually makes the payment?
- ☐ Male Head of Household
- ☐ Female Head of Household
- ☐ Other: _____
- ☐ No Answer

31. Who usually provides money for the payment?
- ☐ Male Head of Household
- ☐ Female Head of Household
- ☐ Other: _____
- ☐ No Answer

32. How often do you make payments?
- ☐ Monthly
- ☐ Weekly
- ☐ Daily
- ☐ Other: _____
- ☐ No Answer

33. Do you have to save money to pay your DAWASCO bill each month?
- ☐ Yes
- ☐ No
- ☐ No Answer

34. Have you ever missed a DAWASCO payment?
- ☐ Yes*
- ☐ No
- ☐ No Answer

***34a. If Yes, why did you miss the payment?**
- ☐ Not Enough Time to Travel
- ☐ Not Enough Time to Wait
- ☐ Not Enough Money to Pay
- ☐ Not Enough Money to Travel
- ☐ Forgot to Pay
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

Part 3.2 – Paying Your DAWASCO Bills (continued)

35. How long do you wait at the payment location?

Minutes: _____
☐ Don't Know
☐ No Answer

36. How do you travel to make your DAWASCO payments?

☐ Personal Car
☐ Motorbike
☐ Bicycle
☐ Dalla Dalla
☐ Bajaji
☐ Taxi
☐ No Answer
☐ Other: _____

37. How long does it take to travel to the payment location (one way)?

Minutes: _____
☐ Don't Know
☐ No Answer

38. How much does it cost to travel to the payment location (one way)?

TZS: _____
☐ Don't Know
☐ No Answer

39. Do you pay other bills at the same location?

☐ Electricity
☐ DSTV
☐ Exam Fees
☐ Taxes
☐ No Answer
☐ Other: _____

Part 3.3 – Payment Methods

40. In the past 12 months, have you paid at a DAWASCO Office?

☐ Yes ☐ No* ☐ No Answer

41. Which office do you usually pay at?

_____
☐ Don't Know
☐ No Answer

42. Why do you pay using this method? [DO NOT PROMPT]

☐ Availability of other DAWASCO services
☐ Payment securely applied to account
☐ Not aware of other payment options
☐ To avoid queues/waiting
☐ Payment immediately credited to account
☐ I have always paid this way
☐ Most convenient location
☐ No Answer
☐ Other: _____

***43. Why do you not pay using this method? [DO NOT PROMPT]**

☐ Poor Customer Service
☐ Inconvenient Location
☐ Long Queues/Waiting
☐ I Do Not Trust DAWASCO
☐ No Answer
☐ Other: _____

44. In the past 12 months, have you paid at a bank?

☐ Yes ☐ No* ☐ No Answer

45. Which bank do you pay at?

☐ CRDB ☐ Barclays ☐ Other: _____
☐ NMB ☐ Bank of Africa ☐ No Answer

46. Why do you pay using this method? [DO NOT PROMPT]

☐ Availability of other bank services
☐ Payment securely applied to account
☐ Not aware of other payment options
☐ To avoid queues/waiting
☐ Payment immediately credited to account
☐ I have always paid this way
☐ Most convenient location
☐ No Answer
☐ Other: _____

***47. Why do you not pay using this method? [DO NOT PROMPT]**

☐ Poor Customer Service
☐ Inconvenient Location
☐ Long Queues/Waiting
☐ No Bank Account
☐ No Answer
☐ Other: _____

Part 3.3 – Payment Methods (Continued)

48. In the past 12 months, have you paid a pay point?
- ☐ Yes
- ☐ No*
- ☐ No Answer

49. Which pay point do you usually pay at?
- ☐ Selcom Wireless — Location: _____
- ☐ MaxMalipo — Location: _____

50. Why do you pay using this method? [DO NOT PROMPT]
- ☐ Availability of other Pay Point services
- ☐ Payment securely applied to account
- ☐ Not aware of other payment options
- ☐ To avoid queues/waiting
- ☐ Payment immediately credited to account
- ☐ I have always paid this way
- ☐ Most convenient location
- ☐ No Answer
- ☐ Other: _____

***51. Why do you not pay using this method? [DO NOT PROMPT]**
- ☐ Poor Customer Service
- ☐ Inconvenient Location
- ☐ I Do Not Trust the Service
- ☐ I Am Not Aware of Option
- ☐ No Answer
- ☐ Other: _____

52. In the past 12 months, have you paid using mobile money?
- ☐ Yes
- ☐ No*
- ☐ No Answer

53. Which service do you usually pay with?
- ☐ Vodacom M-Pesa
- ☐ NMB Mobile
- ☐ Airtel Money
- ☐ No Answer

54. Why do you pay using this method? [DO NOT PROMPT]
- ☐ Availability of other mobile money services
- ☐ Payment securely applied to account
- ☐ Not aware of other payment options
- ☐ To avoid queues/waiting
- ☐ I have always paid this way
- ☐ Most convenient location
- ☐ No Answer
- ☐ Other: _____

***55. Why do you not pay using this method? [DO NOT PROMPT]**
- ☐ Poor Customer Service
- ☐ Inconvenient Location
- ☐ I Do Not Trust the Service
- ☐ I Do Not Own a Mobile Phone
- ☐ No Answer
- ☐ Other: _____

Part 3.4 – Satisfaction with DAWASCO Water Supply

56. If you turn on DAWASCO tap, do you know water will flow every time?
- ☐ Yes, Always
- ☐ Yes, Most Times
- ☐ Never Know
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

57. How long is water available in your DAWASCO tap?

Days/Week: _____

Hours/Day: _____
- ☐ Don't Know
- ☐ No Answer

58. How do you rate the taste of this water?
- ☐ Good
- ☐ Acceptable
- ☐ Poor
- ☐ No Answer
- ☐ Other: _____

59. What tastes are in the water?
- ☐ Salty
- ☐ Chemicals
- ☐ Metal
- ☐ No bad taste
- ☐ No Answer
- ☐ Other: _____

60. How do you rate the smell of this water?
- ☐ Good
- ☐ Acceptable
- ☐ Poor
- ☐ No Answer
- ☐ Other: _____

61. What smells are in the water?
- ☐ Salty
- ☐ Chemicals
- ☐ Metal
- ☐ No bad smell
- ☐ No Answer
- ☐ Other: _____

62. Overall, how would you rate your DAWASCO water supply?
- ☐ Excellent
- ☐ Good
- ☐ Acceptable
- ☐ Poor
- ☐ No Answer
- ☐ Other: _____

Part 3.5 – DAWASCO Connection/Disconnections

63. How much did it cost to be connected to the DAWASCO water supply?

TZS: _____
- ☐ Don't Know
- ☐ No Answer

64. How did you make this payment?
- ☐ DAWASCO Office
- ☐ Bank
- ☐ Pay Point
- ☐ M-Pesa/Airtel Money/TigoPesa/Z-Pesa
- ☐ No Answer
- ☐ Other: _____

65. Did you borrow money for the connection?
- ☐ Yes
- ☐ No
- ☐ No Answer

66. If you need 150,000/-, are you able to borrow it from friends/family?
- ☐ Yes
- ☐ No
- ☐ No Answer

67. Has your water supply been disconnected in the past year?
- ☐ Yes
- ☐ No
- ☐ No Answer

68. Why was your water supply disconnected?
- ☐ Late Payment
- ☐ DAWASCO Error
- ☐ Voluntary Choice
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

69. How long was your water supply disconnected?
- ☐ Some Days
- ☐ One Week
- ☐ Some Weeks
- ☐ Month
- ☐ No Answer
- ☐ Other: _____

70. How much did it cost to be reconnected?

TZS: _____
- ☐ Don't Know
- ☐ No Answer

Part 4 – Alternative Sources of Water

71. Have you used any of the following sources for drinking water in the past 12 months?
- ☐ Neighbour's DAWASCO Tap
- ☐ DAWASCO Kiosk
- ☐ Well/Borehole
- ☐ Tanker Truck
- ☐ Cart Vendor
- ☐ Rainwater
- ☐ Bottled Water [Uhai / Kilimanjaro]
- ☐ River/Stream/Lake
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

72. Source 1 – _____
How much does this water cost?

TZS: _____ PER Litres: _____
- ☐ Don't Know
- ☐ No Answer
- ☐ Don't Know
- ☐ No Answer

73. Source 1 – How do you pay for this water?
- ☐ Cash
- ☐ M-Pesa/Airtel Money/TigoPesa
- ☐ No Answer
- ☐ Other: _____

74. Source 1 – How do you transport this water?
- ☐ Delivered to House
- ☐ By Hand/Head
- ☐ Cart
- ☐ Personal Car
- ☐ Bicycle/Motorbike
- ☐ No Answer
- ☐ Don't Know
- ☐ Other: _____

75. Source 1 – How long does it take to travel to this water source?

Minutes: _____
- ☐ Don't Know
- ☐ No Answer

76. Source 1 – What do you use this water for?
- ☐ Drinking
- ☐ Washing/Bathing
- ☐ Cooking
- ☐ Garden
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

Part 4 – Alternative Sources of Water (Continued)

77. Source 2 – _____

How much does this water cost?

TZS: _____ ☐ Don't Know ☐ No Answer

PER

Litres: _____ ☐ Don't Know ☐ No Answer

78. Source 2 – How do you pay for this water?

- ☐ Cash
- ☐ M-Pesa/Airtel Money/TigoPesa
- ☐ No Answer
- ☐ Other: _____

79. Source 2 – How do you transport this water?

- ☐ Delivered to House
- ☐ By Hand/Head
- ☐ Cart
- ☐ Personal Car
- ☐ Bicycle/Motorbike
- ☐ No Answer
- ☐ Don't Know
- ☐ Other: _____

80. Source 2 – How long does it take to travel to this water source?

Minutes: _____
☐ Don't Know
☐ No Answer

81. Source 2 – What do you use this water for?

- ☐ Drinking
- ☐ Washing/Bathing
- ☐ Cooking
- ☐ Garden
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

Part 5 – Water Users in the Community

82. Have you shared your piped water with non-family members in the past 12 months?

- ☐ Yes
- ☐ No
- ☐ No Answer

83. Who do you share with?

- ☐ Neighbours
- ☐ Local Business
- ☐ Water Vendors
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

84. How many users do you have per day?

_____
☐ Don't Know
☐ No Answer

85. How much do you charge per large (20L) bucket?

TZS: _____
☐ No Answer

86. How do users pay?

- ☐ Cash
- ☐ M-Pesa/Airtel Money/TigoPesa
- ☐ No Answer
- ☐ Other: _____

87. How often do users pay?

- ☐ Pay as you go
- ☐ Weekly
- ☐ Monthly
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

88. How do you store the money you collect?

- ☐ At Home
- ☐ Bank Account
- ☐ Don't Know
- ☐ M-Pesa/Airtel Money/TigoPesa/Z-Pesa
- ☐ No Answer
- ☐ Other: _____

Part 6 – SMS Billing Reminders

89. Do you receive DAWASCO billing reminders via text message (SMS)?

- ☐ Yes
- ☐ No
- ☐ No Answer

90. If yes, how often do you receive these reminders?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

91. If not, why do you not use this service?

- ☐ Does not own a mobile phone
- ☐ Does not share number with DAWASCO
- ☐ Is not aware of this service
- ☐ Has shared number, no reminders
- ☐ No Answer
- ☐ Other: _____

92. Are you satisfied with receiving bills this way?

- ☐ Yes
- ☐ No
- ☐ No Answer

93. Do you use your mobile phone to check your DAWASCO balance?

- ☐ Yes
- ☐ No
- ☐ No Answer

94. If yes, how often do you use this service?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

95. If no, why do you not use this service?

- ☐ Does not own a mobile phone
- ☐ Is not aware of this service
- ☐ Does not trust service
- ☐ Does not know how to use service
- ☐ No Answer
- ☐ Other: _____

96. How much does this service cost per use?

TZS: _____

- ☐ Don't Know
- ☐ No Answer

Part 7 – Water-Related Assets and Expenditures

97. Do you have any of the following?

- ☐ Flush Toilet
- ☐ Refrigerator
- ☐ Freezer
- ☐ Washing Machine
- ☐ Television
- ☐ Internet Cable Connection
- ☐ Internet Modem Connection
- ☐ Kitchen/Bathroom Sink
- ☐ Solar Panels
- ☐ Personal Computer
- ☐ I do not own any of these items
- ☐ Don't Know
- ☐ No Answer
- ☐ Other: _____

98. Do you treat your DAWASCO water?

- ☐ Yes
- ☐ No
- ☐ No Answer

99. If yes, how do you treat your DAWASCO water?

- ☐ Boil
- ☐ Chemicals
- ☐ Filter
- ☐ Other: _____
- ☐ Don't Know
- ☐ No Answer

100. What type of transportation do you own?

- ☐ Personal Car
- ☐ Motorbike
- ☐ Bicycle
- ☐ Dalla Dalla
- ☐ Bajaji
- ☐ Taxi
- ☐ No Answer
- ☐ Other: _____

101. How much do you spend on electricity?

TZS: _____

- ☐ No Answer
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Yearly

Part 7 – Water-Related Assets and Expenditures (Continued)

102. How much do you spend on school fees?

TZS: _____
☐ No Answer

☐ Daily
☐ Weekly
☐ Monthly
☐ Yearly

103. How much do you spend on transportation?

TZS: _____
☐ No Answer

☐ Daily
☐ Weekly
☐ Monthly
☐ Yearly

104. How much do you spend on healthcare?

TZS: _____
☐ No Answer

☐ Daily
☐ Weekly
☐ Monthly
☐ Yearly

105. How much do you spend on food?

TZS: _____
☐ No Answer

☐ Daily
☐ Weekly
☐ Monthly
☐ Yearly

"This is the end of our survey. Thank you very much for your time and participation.

Please feel free to ask any further questions you might have."

Questions for Enumerators

What language was the survey conducted in?

☐ Kiswahili
☐ English
☐ Arabic
☐ Other: _____

How would you rate the quality of information collected?

☐ Excellent
☐ Good
☐ Acceptable
☐ Poor

How would you rate the respondent's understanding of the questions?

☐ Excellent
☐ Good
☐ Acceptable
☐ Poor

Notes:

SAMPLE INTERVIEW GUIDE (DAWASCO)

DAWASCO AREA OFFICES –

AREA MANAGER
BILLING/PAYMENT OFFICER
METER READER

*INTERVIEW TOPICS & POTENTIAL QUESTIONS**

INTRODUCTION

- Please introduce yourself, stating your position and the responsibilities of your post.
- How long have you been working for DAWASCO?
- Do you use a mobile phone in your work?
- How has your work changed since using the mobile phone?

IMPACT OF MOBILE PAYMENTS

- Do you use mobile money (M-PESA/Airtel Money/TigoPesa/ZPesa) in your job?
- Do you know any customers who use mobile money to pay their DAWASCO bills?
- Have there been any challenges in using this new payment method?
- Have you ever helped anyone make a payment this way?
- Has the use of mobile money had positive impacts?
- Has the use of mobile money had negative impacts?

IMPACT OF PAY POINTS

- Do you use pay points (Selcom/MaxMalipo) in your job?
- Do you know any customers who use pay points to pay their DAWASCO bills?
- Have there been any challenges in using this new payment method?
- Have you ever helped anyone make a payment this way?
- Has the use of pay points inside and outside of DAWASCO offices had positive impacts?
- Has the use of pay points inside and outside of DAWASCO offices had negative impacts?

REMAINING CHALLENGES

- What are the major challenges you face in your job?
- How can mobile money and pay points be used in a better way?
- What are the major challenges facing DAWASCO?
- Can mobile money and pay points be used to help reduce these challenges?

ANY OTHER QUESTIONS?

**Note: These questions and topics are not exhaustive and only signal the type of information I hope we will discuss.*

CONTACT DETAILS:
Aaron M. Krolikowski
+255 (0)753 222 651
aaron.krolikowski@ouce.ox.ac.uk

Appendix: Coding and Categorization of Qualitative Data Related to Petty Corruption

Topic	Key Themes	Water Office	Bank Branch	Pay Point	Mobile Money
Monopoly Powers	Proportion of transactions	92.2% (39485)	<1%	6.3% (2698)	1.6% (702)
	Number of service providers	1 payment service provider	4 payment service providers	2 payment service providers	3 payment service providers
	Number of service provider locations	14 locations		> 2000 locations	> 10000 agent locations
Competitive Pressures	Reconciliation period	8 hours	7 Days	Immediate	Immediate
	Transport method	Public Transport	Personal Car	Walk/Public Transport	N/A
	Median wait	10 minutes	7 minutes	5 minutes	N/A
	Number of wards	13 wards	29 wards	73 wards	73 wards
	Open hours	45 hours/week	37 hours/week	105 hours/week	168 hours/week
	Respondent Comments	Meter Reader 2: Reconciliation period for M-PESA payments takes 2-3 months; even if people pay there is not an immediate change in the account Area Manager 2: Mobile money saves people time for travel, people can pay at any time Area Manager 2: Selcom pay points are used in the payment office when there is a large queue and during network problems as a substitute for the utility billing system Area Manager 2: Customers are often available and have the money to pay, but they do not want to move to the office Area Manager 2: Using pay points effects payment Area Manager 3: Pay point payments are used at the utility office when the utility billing system is down. They are used once or twice per month Area Manager 3: Selcom pay points are everywhere and there are usually some within walking distance throughout the city Area Manager 3: Using pay points means that customers might be more willing to pay bills. When the bill is 3000 and it costs 5000 to make a payment, some customers may wait multiple months to pay. Some might be more likely to forget to pay at all in the long run.			

		Area Manager 3: Utility payments are reconciled at the end of the day, pay points are immediately applied, mobile money payments are immediately applied Cashier 2: It is hard for some people to go to far-away banks or utility offices to pay, and now they give up completely since no option helps or works at all times Cashier 2: Using Selcom pay points, people can now pay on Sundays and public holidays, and they allow for continuation of payments when power is out or network is down Billing Officer 1: Mobile money payments reduce queues and helps customers to not waste time or money for travel and waiting costs Billing Officer 1: Selcom pay points are used in the office when electricity and the network is down Billing Officer 1: Utility reconciliation is no more than 8 hours, mobile money and pay point reconciliation are no more than 1 day Commercial Officer 1: Mobile money has immediate reconciliation, pay point payments are on the account immediately . When paid at a utility office, the bill is not changed until the end of the day Commercial Officer 2: Pay point machines are used in the water office when there are network or electricity issues, this allows customers to not have to pay during working hours Cashier 3: I use the pay point machine every day for different reasons, especially when the power is out, the network is down, or if there are large queues Cashier 3: it used to be that the utility would lose payments for the day if the power was out or the network was down, Selcom pay points prevent this by still allowing payments in down times Billing Officer 2: We use Selcom pay points when the utility network is down Ministry Official 2: Mobile money payments are good for the billing and collection system and can generate more payments from customers Ministry Official 3: "People are willing to pay their bills every money if they have a more user-friendly system. Mobile technologies make the entire system more user-friendly, if not more efficient."

		Ministry Official 3: "Now the customers pay every 2 or 3 months, but they would pay more often if it were easier to do so. I would pay every month if I could do it right near my house." Bank 3: Using mobile payments, customers save time and money, particularly in terms of transport costs MNO 3: Mobile money agents have increased to approximately 22,000 country wide, with 25% of these in Dar es Salaam Third Party 2: There are 1500 points of sale in Dar es Salaam, and this is projected to increase to over 2000 by the end of the year Third Party 2: Utility offices have started using pay points due to their reliability MNO 2: Mobile money payments are integrated with the utility billing system after approximately 2 minutes Bank 1: Number of transactions is small because there is not yet a mobile channel (just as easy to pay at the water office) [March 2012 - 21 payments; April 2012 - 17 payments] Bank 3: Mobile banking allows unbanked individuals to receive cash transfers and withdraw the transfers from the ATM network. Bank 3: 2012 is the first full fiscal year for NMB bill payments Bank 3: Between January and April 2012, there were 307 water payments that totaled 8,710,542 shillings. In May 2012, this has already grown to 60 payments and 1.5 million shillings Bank 3: Currently, there are no utility payments happening at physical bank branches Bank 1: Mobile channel currently in testing, people will be able to bank from home instead of coming all the way to town
Discretionary Power	Action of receiving payment	Cashier 2: Sometimes there is fake money and I have no machine to detect this Cashier 2: I sometimes give too much money as change, and I need a money counter to fix this Billing Officer 1: During disconnection exercises, pay point machine is used to allow people to pay. Meter readers direct customers to nearby pay points to pay bills.

		Commercial Officer 2: Meter readers are not allowed to collect money Area Manager 2: Sometimes the meter readers will negotiate with customers to prevent them from being disconnected. Cashier 3: I am responsible for receiving payments Third Party 2: The utility did not have the IT capabilities at the time to accept electronic payments, so we worked with them to develop a new billing and payment system MNO 2: When the utility did not have the IT facilities to handle the payment system, they outsourced these functions to a third-party company
	Other powers related to water	Meter Reader 2: Other responsibilities include meter reading, ensuring clients receive bills, encouraging payments, disconnections Meter Reader 2: Meter readers have the most customer interaction Meter Reader 2: I sometimes disconnect customers because the new balances [paid with mobile money] are not reflected Meter Reader 2: I do not teach customers how to use M-PESA to pay bills. There are others who are supposed to do this. Cashier 2: Responsible for giving receipts, taking money to the bank each day, preparing daily reports Billing Officer 1: Other responsibilities include data entry of customer information, meter readings Billing Officer 1: Meter readers sometimes don't go to the meters and can often bring back false information Commercial Officer 1: Other responsibilities include collections of bills, deal with customer complaints, fix targets, daily reports, control meter readings, supervise meter readers Cashier 3: I am also responsible for preparing daily reports and taking cash to the bank each day Billing Officer 2: I am responsible for new accounts, meter exchanges, cleaning databases, meter

		installation, customer adjustments, posting meter readings and bills, and editing customer details Billing Officer 2: Meter readers need to see if a bill has been paid if they are going to disconnect Ministry Official 2: If a customer has a complaint with a meter reader, they are instructed to pay first and complain later Bank 3: Some employees [of the utility] are dishonest and collaborate with customer to access illegal connectivity. Many are just lazy. MNO 2: Field-based utility employees were threatening to disconnect customers because they did not have paper receipts MNO 5: Utility meter readers working on bill collection and disconnections have begun using mobile money to begin a side business of making payments themselves. Those who do not use mobile money can pay the agents cash and they will make the payment at that moment. They may charge a premium, but this prevents disconnection
Economic Rents	Money in transaction	Area Manager 3: Mobile money payments prevent petty theft by cashiers and others Cashier 2: Sometimes there is fake money and I have no machine to detect this Cashier 2: I sometimes give too much money as change, and I need a money counter to fix this Cashier 3: I have to round to the nearest 100 shillings because the bills come out as exact amounts that don't allow for easy change Cashier 3: There is no change when customers pay using mobile money MNO 3: The transition to mobile payment options will become bigger when customers accept the abstract concept of electronic cash. "Citizens are requiring time to become sensitised to the concept of electronic cash. This is very new for most of the population." MNO 2: Using mobile money and making payment funds electronic leads to resistance from utility employees. There is less money going around in the group and thus fewer opportunities for corruption, theft, and collusion with other people. MNO 5: Utility meter readers working on bill collection and disconnections have begun using mobile

		money to begin a side business of making payments themselves. Those who do not use mobile money can pay the agents cash and they will make the payment at that moment. They may charge a premium, but this prevents disconnection
	Movement of funds from client to utility account	Area Manager 3: If the account is in arrears, the customer might give them 50,000 shillings. Sadly, sometimes only 45,000 shillings can back it back to the office. Area Manager 3: I like it when people pay with M-PESA. IT prevents petty theft by the cashiers if they need to borrow money and it means that the money from one day can't be stolen from our office at night if the bank closes before the cashiers can make the deposit. Area Manager 3: There is the threat of theft of daily balances being stolen from utility offices at night Third Party 2: There is a 3% commission we receive from all pay point payments. The utility receives the other 97% MNO 2: The utility receives mobile money payments and pay point payments in the form of e-money. When the utility requests to cash out this e-money, a payment is made via electronic transfer from the MNO account to the utility account. The utility is not changed to withdraw the money from its mobile money account. Ministry Official 2: Things like mobile money are making the supply chain shorter for customers and the water utility. The process is now very easy for customers. MNO 5: The customer pays the 200 shilling transaction fee for the bill payment, and the utility pays a commission to intermediaries
Enforcement Mechanisms	Probability of being caught	Billing Officer 1: Errors are difficult to rectify when we are using the pay point machines Commercial Officer 1: One of my biggest challenges is managing the meter readings. I give targets for the day, but they can 'cook' the data by estimating consumption without actually reading the meter. Or sometimes the meter reader might negotiate a payment plan with the customer, but my meter readers are human beings and most of them have worked here for a long time. I cannot punish them for these things. Commercial Officer 2: When there are errors with mobile money payment information, this creates difficult situations and there are large efforts to get the money back. MNO 2: We make it very difficult for any of the money to go missing. This is an advantage of having

		electronic payments. Third Party 1: Of course people can steal the money, but if it is a pay point they are stealing from themselves. It is different than stealing from the utility.
	Severity of sanctions	Commercial Officer 1: One of my biggest challenges is managing the meter readings. I give targets for the day, but they can 'cook' the data by estimating consumption without actually reading the meter. Or sometimes the meter reader might negotiate a payment plan with the customer, but my meter readers are human beings and most of them have worked here for a long time. I cannot punish them for these things. MNO 3: An employee would be fired if we found out they were stealing money from our company. Third Party 2: Pay point contracts are terminated immediately if there are legal questions. Third Party 2: Employees that are found to be engaged in illegal activity are reported to the police.
Monitoring Costs	Receipts	Area Manager 3: There is a need for physical proof of payment; customers prefer to have hard copies as physical evidence of payments Area Manager 3: Utility staff prefer physical proof to track the payment - electronic payment are currently difficult to track Cashier 2: When customers come to the utility offices for an inquiry, they complain that they do not have any receipts Cashier 2: Commercial assistants are still disconnecting houses when they visit, because receipts cannot be located and produced Cashier 2: I would rather have customers use receipt-based methods because there is proof of payment and threat of disconnection is less Cashier 2: People prefer the large [utility] invoices because it has all the detailed information in case of problems Billing Officer 1: Mobile money issues include a lack of receipt and many customers do not know how to use the option Billing Officer 1: The SMS sent to customers can be lost

		Billing Officer 1: Sometimes the pay point receipt does not come out of the machine Commercial Officer 1: For mobile money payments, the receipt is an issue - hard to find messages often from long time ago Commercial Officer 1: Selcom pay point receipts are too small and there is not enough information, but the receipt from the utility is big and detailed Commercial Officer 2: When paying with mobile money, customers are supposed to receive 2 SMS messages. One from the phone company and one from the utility. We need both. Commercial Officer 2: Selcom pay point receipts are difficult to use because they are often faded Commercial Officer 2: If people were using mobile money system correctly, receipts would be less needed Cashier 3: Over time the pay point receipt ink fades, this is a problem because there may be a need for the receipt if there are longer-term issues Third Party 2: The pay point generates a paper record of payment for the customer Third Party 2: There is a need for a physical receipt for payments, and this encourages customer use of pay points MNO 2: Customers receive two records in SMS form, one from the MNO and one for their utility balance MNO 5: Customers receive a follow up SMS from our company informing them of the mobile money balance. They do not receive one from the utility.
	Record Keeping	Cashier 2: When there are issues with the bills, I need a better system for adjusting bills when there has been an error Billing Officer 1: Errors are difficult to rectify when we are using the pay point machines Commercial Officer 2: When there are errors with mobile money payment information, this creates difficult situations and there are large efforts to get the money back.

		MNO 2: When a payment is made, the money is moved and the MNO creates an electronic file as a record of payment MNO 2: Customers receive two records in SMS form, one from the MNO and one for their utility balance
Information Asymmetries	Who holds transaction info	Cashier 3: Most people come to the utility offices to complain or to inquire about a bill MNO 2: The third-party pushes the file to the utility, which reduces the balance owed on an individual water bill Third Party 2: We keep a record of all the payments made using mobile money or a pay point. The phone companies also have a record of the mobile money payments. MNO 5: Customer payments are made in real time and the utility balance is updated automatically
	Accessibility of info	MNO 2: We charge 150 shillings for customers to access a balance inquiry. This is cheaper than going to the utility to ask. The only other method to check balances is to travel to the utility office and wait in a queue. Third Party 2: Customers can easily check their account balance from home or at a pay point CSO 1: Meter readers in Dar have just been creating confusion with customers. They know they can use the SMS messages to see a customer has paid, but they choose not to. CSO 2: Our organization believes that people can create more agency for themselves if they have comparative information. Electronic payments allow this to happen.
	Cost to access info	Cashier 3: Most people come to the utility offices to complain or to inquire about a bill Third Party 2: There is a 150 shilling charge for balance inquiries. This is half of a one-way ride on a dalla dalla MNO 2: We charge 150 shillings for customers to access a balance inquiry. This is cheaper than going to the utility to ask. The only other method to check balances is to travel to the utility office and wait in a queue. MNO 5: Balance inquiries are free for our customers.