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Can Mobile-Enabled Payment Methods Reduce Petty Corruption in Urban Water Provision?

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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.

KEYWORDS: Urban water services, corruption, mobile money, Africa, Tanzania

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 recently achieved the Millennium Development Goal (MDG) drinking water target in 2012, 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 (2000) suggests that political interference and poor billing and payment collection systems are primary contributors to service

deficiencies in Dar es Salaam. 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 (2006) identify administrative corruption in payment systems as a primary source of corruption in Africa, 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. The first section 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. The paper then 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 then described, 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.

CORRUPTION AND MOBILE TECHNOLOGY IN THE WATER SECTOR

Corruption in the urban water sector

The urban water sector has been traditionally 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 members of utility staff enjoy significant levels of discretionary power (Stalgren, 2006). Klitgaard (1988; from Stalgren, 2006) presents an institutional perspective that positions corruption as a function of monopoly power, discretionary power, and transparency or accountability. 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 favours 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 changing the context 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 (2004) 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. 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.

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[1] 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. Penetration[2] rates in 2002 stood at 3.6% in Kenya, 1.7% in Tanzania, and 1.5% in Uganda. By 2012, these proportions 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 services (Aker, 2011). These studies show that the 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[3]-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 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 customers 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 [US$0.09]. Applications of mobile communication technologies in the urban water sector enhance availability of, and access to, information and may therefore diminish the prevalence of corruption.

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

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

[3] GPRS (General Packet Radio Service) 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'.

THEORETICAL FRAMEWORK: AGENCY THEORY AND PRINCIPAL-AGENT FRAMEWORKS

Agency theory and its specific focus on principal-agent relationships are 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 oversight of agent behaviour is difficult or cost-prohibitive (Eisenhardt, 1989). Contractual relationships between principals and agents are primary units of analysis within agency theory. Each actor 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 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 et al., 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 1. Visual representation of a conceptual framework detailing the relationship between the principal-agent framework and water utility performance.
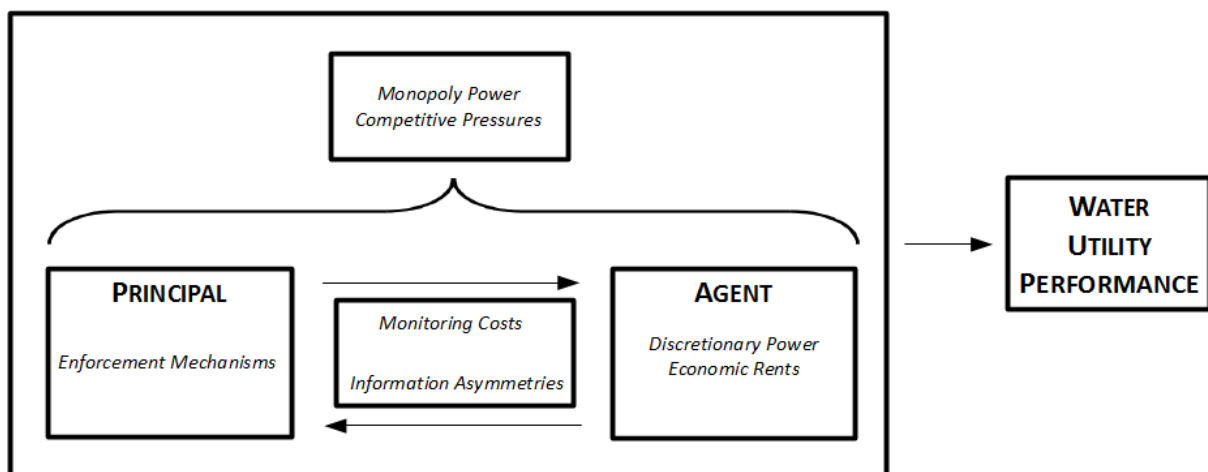
Source: Author

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.

METHODS, DATA COLLECTION, AND ANALYTICAL APPROACH

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 (Zain, now Airtel Tanzania), and a third-party Tanzanian technology company (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 (Vodacom's M-PESA and Airtel Money from Airtel Tanzania) and wireless point-of-sale networks (Selcom Wireless Pay Points). One additional mobile money service (Tigo's TigoPesa) and another wireless point-of-sale network (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 water transactions made with money using mobile phones 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 fee if they pay their water bills using mobile phones via Airtel Tanzania. Comparisons of adoption of these methods and descriptions of the financial relationships between water utilities and telecommunication 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 obtaining water services.

The Dar es Salaam Water and Sewerage Corporation (DAWASCO) is a publicly 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 increased 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 over 65% of the urban population is estimated to live 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 a reliable service, compared with 100% at independence in 1961 (WaterAid, 2008). Scholars have described the city's water obstacles as a product of deficient financial resources, political interference, petty corruption, poor billing and payment systems, and alternative service options used 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.

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 et al., 2009), analyses of large data sets (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.

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. Respondent affiliations are detailed in Table 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 was piloted in June 2012. Survey responses include information on geographic location and housing quality, socio-economic variables, demographic variables, assets/expenditures, use of mobile phones, payment methods and preferences, payment behaviours, service satisfaction, disconnections/ reconnections, alternative sources of water, community supply behaviours, and use of SMS billing reminders. Responses numbered 1097 and customers were invited to share their thoughts on the performance of the water utility. Customers were surveyed during one billing cycle and the questionnaire was administered at physical payment locations randomly selected from a stratified sample of 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. This generated a stratified sampling frame that included water offices, banks, and wireless pay points. Water utility customers using the selected payment locations 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 the relative influence of each payment method over competitive pressures, monopoly power, discretionary power, economic rents, enforcement mechanisms, information asymmetries, and monitoring costs. Relative rankings of 'Very High', 'High', 'Intermediate', 'Low', and 'Very Low' are used to illustrate how each payment instrument moderates corruption-related forces in relation to the others.

Table 1. Affiliations of respondents participating in interviews.

Institution	No. of respondents
Water utility	12
Mobile network operators	6
Water committees	5
Ministry of Water	4
Banking institutions	3
Third-party integrators	3
Municipal water officers	3
Water authority	2
Water regulator	2
Civil society	2

EVIDENCE AND ANALYSIS

An overview of the billing and payment process for each payment method is found in Table 2, and the proportions of socio-economic and demographic characteristics of customers who use and do not use mobile-enabled payment instruments are summarised in Table 3. These summaries were assembled from interviews with key actors as described in Table 1. Each sub section 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.

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 primary provider of water bill payment services and directly collected all water-related transactions before the introduction of mobile-enabled payment instruments in 2009. DAWASCO operates 14 water offices throughout its serviced area that act as central clearing houses for bill payments, customer inquiries, and offices for managerial and operational staff. Payment data for 2011 show that these offices collected 92.2% of all water-related transactions and an average of 39,495 payments per month (Table 4). The year 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).

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

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 visits to utility office	Utility staff – customer visits to utility office	Pay point operator – balance inquiry via SMS	Customer – balance inquiry via SMS

Table 3. Demographic and socio-economic comparison of users (n = 112) and non-users (n = 504) of mobile-enabled payment methods.

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%
Monthly expenditures* (US$)	Food	188	188
	School	34	38
	Transport	25	38
	Mobile phones	25	21
	Electricity	25	25

Source: Utility customer survey data.

Note: Variables marked with an asterisk (*) are reported as the median of all values.

A cashier working for the water utility stated that the use of mobile-enabled methods has created "noticeable declines in the number 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 to the growth of water payment collection.

Table 4. Comparison of four payment methods for monopoly power.

Payment method	Providers (No.)	Locations (No.)	Payments (%)*	Payments (No.)*
Water office	1	14	92.2	39485
Bank branch	4	53	<1	18
Wireless pay point	2	2000+	6.3	2698
Mobile money	3	10,000+	1.6	702

Source: Author; Dar es Salaam Water and Sewerage Corporation. Variables marked with an asterisk (*) are reported as mean monthly values in 2011.

Monopoly powers enable an entity to be the sole provider of a particular good or service, and the existence and growing use of non-utility payment service providers illustrates that there is no longer a monopoly on payment services in Dar es Salaam (Table 4). 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,[4] transport methods, waiting times, geographic extent, open hours per week, and water sector perspectives (Table 5). Water offices are found in only 13 of the 73 wards in Dar es Salaam (i.e. neighbourhoods) and are open for approximately 45 hours each week from Monday to Saturday. A majority (52%) of customers take public transport to make payments at the water office, and the median waiting 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 median waiting time of 5 minutes. Payment of money via mobile phones can be made at any time during the week (168 hours) and wireless pay points are open for approximately 105 hours per week.

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 payment via mobile

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[4] Reconciliation period refers to the time interval between the date of payment and the date when that payment is reflected in customer accounts.

phones and wireless pay points, 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 one point to another in the city. The ability to pay at any time with pay points in particular was discussed by multiple respondents, who emphasised Sundays, holidays, non-working hours, power outages, and internal network failures as new periods of time that were now open to water-related transactions. One official at the Ministry of Water summarized the benefits of the new payment instruments by saying "[m]obile 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: customers and utility personnel commonly criticised pay point receipts for being too similar to retail receipts 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".

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

Payment method	Reconciliation period	Transport method	Median wait (minutes)	Number of wards	Open hours (hours/week)
Water office	8 hours	Public	10	13	45
Bank branch	7 days	Personal car	7	29	37
Wireless pay point	Immediate	Walk	5	73	105
Mobile money	Immediate	N/A	10 (at agent)	73	168

Source: Author; Utility Customer Survey Data.

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 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 short travelling distances, standing in stark contrast to the utility's 14 water offices, which require costly travel and longer waiting 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 "[s]ometimes, 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 computerised billing system. One cashier noted the cumbersome process required to change payment information when an error is 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". Regarding complaints made about the utility, customers said they sometimes felt "taken advantage of" and "helpless" when interacting with meter readers and also used the words "dishonest" and "lazy" to describe them. 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 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 information on payments. Discretionary power held by commercial managers is derived from their ability to revise revenue reports and modify information on payments, although there was no evidence to suggest that this was occurring illicitly. Bank employees, pay point operators, mobile money agents and 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 that 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.

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

Variable	Element	Water office	Bank branch	Wireless pay	Mobile money

		point			
Monopoly power	No. of services	Low	Intermediate	Intermediate	High
	Locations	Low	Intermediate	High	High
	Share of payments	Declining	No change	Rising	Rising
Competitive pressure	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)	Teller (Low)	Operator (Low)	Network Operator (Low)
		Cashier (Intermediate)	Manager (Low)		
		Office Manager (High)			
Economic rents	Source	Bill payments			
		Bank deposits	Bill payments	Bill payments	Bill payments
		Connections, etc			
	Captured by	Utility staff	Bank staff	Pay point operators	Mobile network operators
Enforcement mechanisms	Probability of being bought	Low	High	High	High
	Sanction *(Likelihood)*	Employment termination (Low)	Employment termination (High)	Contract termination (High)	Employment termination (High)
		Criminal charge (Low)	Criminal charge (Intermediate)	Criminal charge (Intermediate)	Criminal charge (Intermediate)
Monitoring costs	Mechanism *(Cost)*	Paper receipt (Low)	Paper receipt (Intermediate)	Paper receipt (Intermediate)	SMS receipt (High)
		Record-keeping (High)	Record-keeping (Intermediate)	Record-keeping (Low)	Record-keeping (Low)
Information asymmetries	Information held by	Utility	Bank/Utility	Utility	Utility
	Availability of information	Low	Intermediate	High	High
	Cost to access information	High	High/High	Intermediate	Low

Source: Author.

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 over 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 cannot 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 [US$31.25[5]]. Sadly, sometimes only 45,000 shillings [US$28.13] 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 official of the Ministry of Water pointed out – "[t]hings like M-PESA are making the supply chain shorter for customers and [the water utility]. The process is now very easy 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 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.

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: "[m]y 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.

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[5] The conversion rate from Tanzanian Shillings to United States Dollars used in this paper is US$1.00:TZS1600.

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 6). For payments made via water offices, employees who 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 who 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 generate electronic transaction records and customers receive a confirmation SMS from the mobile money service provider that a payment has 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 has been made. Cashiers from across DAWASCO's offices stated that mobile money confirmations are hard to locate after a specific time period, emphasising 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 an 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 refers to the ability of principals to maintain effective oversight of their agent's actions and are analysed by comparing the relative cost of mechanisms used to this end (Table 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 recognisable 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 receipts generated at places like groceries. 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 constitute 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 information on payment 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 these payment data requires customers to physically visit a utility office to request for 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 greater availability of information on payments 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 organization 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. 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 items 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 members of 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 to all parties.

DISCUSSION AND CONCLUSIONS

The introduction of mobile money and wireless pay points in Dar es Salaam has reduced opportunities for petty corruption in the payment of water bills. Increases in the adoption, number, geographic proximity, and temporal availability of alternative payment services are 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 are 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, and also empowers many citizens to collectively monitor and share information regarding the activities of water services providers.[6] 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 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 multidimensional, 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.

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

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