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How 'smart' are we with smart technology: comparison of water ATMs in Nairobi and Delhi

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ABSTRACT

New forms of decentralized water infrastructure with digital projects driven by private investment are being introduced in low-income urban neighborhoods in the global south with the aim of increasing the coverage of affordable and safe water. These 'smart' water-vending machines are gaining popularity to meet water demand in growing cities as they are low-cost, transparent, revenue generating and replicable. However, field evidence from Nairobi and Delhi shows that similar technologies implemented to solve similar problems in different geographical and social settings can have completely different outcomes. Smart technologies can offer better outcomes when the implementing agencies and policy makers make smart choices about implementation, setting aside utopian hype.

Key words: global south, smart technology, smart urbanism, urban poor, urban water infrastructure

HIGHLIGHTS

- Water ATMs in cities can be successful if they are socially and economically viable.
- Location of water ATMs is central to its success as it determines the scale of water sale.
- Water ATMs are not intrinsically pro- or anti-poor, and it can become pro-poor only with sound management.
- Their replicability cannot ignore the power and relevance of context because cities are complex and can enable, disrupt and resist the use of technologies.

INTRODUCTION

Water supply and distribution system issues have become central to discussions on improving access for the poor to safe and affordable water in the cities of the global south (GS), especially in the context of meeting the sustainable development goal (SDG) of universal coverage by 2030. Many postcolonial cities of the GS have inherited a legacy of fragmented urban water infrastructure, with pockets of inadequate and unserved service areas amidst the booming city. Many cash-strapped utilities trapped in the cycle of subsidy burden are moving away from the 'ideal' situation of standardized and uniform infrastructure (such as universal piped water networks in the global north; GN) to decentralized, heterogeneous and hybrid water systems. Along with municipal piped water supply, citizens are forced to access water from other parallel sources like public standpipes (both paid and free), public and/or private water tankers, wells, tube-wells, informal private water vendors etc.

With the growing influence of information and communication technologies (ICTs) on the nature, structure and enactment of urban water infrastructure, digital technologies are being used increasingly to experiment and launch hybrid water infrastructure in low-income areas as 'pro-poor intervention'. In this context, 'water ATMs' (WATMs), also known as 'any-time water kiosks', have gained attention in the past decade. They are digitally monitored, self-contained, automated water vending machines that store clean water and ensure access to water at nominal cost, with the help of digital payment via electronic cards. This 'technological innovation' is believed to have the potential to solve the problem of insufficient access to drinking water in underserved or unserved areas, by augmenting water infrastructure working in parallel with the municipal network. It is being introduced across cities in Kenya, Ghana, Tanzania, South Africa, India and Pakistan (Schmidt 2020).

STUDY CONTEXT

There is a natural tendency to juxtapose the promise of technology with socioeconomic deprivation (Philip *et al.* 2012). Neoliberal expectations of technological diffusion influence policy implementation (Kleine 2009), which goes well with promoting such technology-inspired development projects. In this context, adopting WATMs is seen as a win-win situation mainly because, first, modern views of planning that emphasize 'unity', 'control', and 'expert skills' (Dear 1995) use technology as a 'vehicle towards salvation in troubled times' (Aurigi & Odendaal 2020). So, 'this technology' that dispenses clean water at any convenient time and can control water use along with recouping cost must have the potential to solve the problem of water access in inadequately served areas of the GS. Secondly, 'technology use' and 'its innovation' is so pervasive that it has been associated with a strange 'placelessness' (Odendaal 2021). In other words, WATMs envisioned in Nairobi or New Delhi are expected to solve similar problems, irrespective of the complexity of the problem and heterogeneity of the places in which it is set up. Thirdly, WATMs suit the smart city (SC) discourse very well, and the sprawling megacities of the south can readily provide both a critical-mass market and a test bed for these technologies competing for 'smart urbanism' (SU).

Scholarship around SU has examined technologically advanced cities in the GN widely, and research on this theme is only beginning to emerge in the GS (Odendaal 2011; Datta 2015). This is surprising given the technological advancements that have taken place in the GS, ranging from high-tech, smartphone-based applications to low-tech, feature-phone-based platforms, especially in the water services sector (Hellström & Tröften 2010; Heymans *et al.* 2014; Krolikowski 2014; Sarkar 2019a, 2019b). Although WATMs are being adopted and have expanded over the past decade, there has been a lack of comparative analysis capturing the service delivery, operational efficiency, and access to services aspects, across utilities and in different urban contexts. New knowledge must be generated about the forms, dynamics, and impacts of WATMs in an internationally comparative context, to develop a nuanced understanding of how and why the impact of similar technologies varies across different 'urban spaces'.

In this study the impact of WATMs in low-income areas of Delhi and Nairobi was compared and contrasted, analyzing the challenges and opportunities posed in achieving their basic goal of providing water security to the urban poor. The goal is to broaden the conversation about urban technology development by placing it in a theoretical and transnational context, relying on dualisms such as safe vs improved water, paid vs free water, smart vs transparent technology, techno-centric vs holistic policy approach and efficient vs appropriate technology, using field evidence.

The study has two parts. The first is a theoretical enquiry into understanding smart technology as a 'problem-solving device', in the context of the emerging concepts of SC and SU. The second is an empirical enquiry into the actual functioning of the smart technology (WATMs) in a local context in low-income neighborhoods in Delhi and Nairobi. The analysis is built on field observations and structured interviews in 258 households in the Mathare slums in Nairobi and 233 households in the Matiyala resettlement colony in Delhi. For easy understanding, Mathare valley is referred to as Nairobi and Matiyala resettlement colony as Delhi throughout the paper. Households were categorized into different economic classes using a composite score of weighted assets instead of income. The arguments are based on exhaustive household schedules, participant observation, focus group discussions, and key informant interviews with slum residents and water industry experts.

UNDERSTANDING SMART TECHNOLOGY AS A 'PROBLEM-SOLVING DEVICE'

WATM initiatives have been called 'pop-up infrastructure' (Schmidt 2020) and 'new forms of decentralized, neighborhood solutions' (Sarkar & Choudhary 2020) that uses 'smart technology' (Sarkar 2019a, 2019b), with the aid of 'financial engineering' and 'automated management' of urban space (Kitchin & Dodge 2011). It is being pushed as a new tool of neo-liberalization planning (Sarkar & Choudhury 2020) and comes with a set of installation and uptake challenges (Narayanaswami 2018; Sarkar 2019a, 2019b).

Smart technology as a solution to problems

The media and policymakers love smart cities and smart technologies (Kaika 2017), and often characterize smart technology adoption as 'best practice' and 'replicable solutions' (Joss *et al.* 2017). Studies emphasise the technical, engineering, and economic dimensions of smart systems (Alawadhi *et al.* 2012) with a 'problem solving' focus, concerned with achieving optimal outcomes (Leydesdorff & Deakin 2011). The present-day generic concept of an SC began as an idea of technology as a solution assisted by telecommunications and cyberspace

(Graham & Marvin 2001). The SC narrative in academic literature is portrayed as an urban revolution in the making (Aurigi & Odendaal 2020) that suggests a comprehensive city-making through 'technological connection', where the 'modern infrastructure ideal' is characterized as 'seamless and efficient' (Graham & Marvin 2001). According to Odendaal (2021) 'the SC is an idealized amalgamation of data, pipes, ducts and people'. However, infrastructural experiences are too diverse and layered to conform to a single definition of smart.

Digital technology as the future of urban infrastructure growth

As a rising discourse at the interface of technological and urban networks, SU envisages ICT-driven societies with digitally controlled utility services and innovation as the primary driver for a future revolution in cities (Guma 2019). SU 'promises' flexibility, control, growth and transformation potential to reshape the future priorities of urban governments (Luque-Ayala & Marvin 2015; Guma 2019). Rolling out SU is fundamentally a political exercise because it operates through strategic economic interests. As a result, smart technologies are generally marketed as solutions to solve complex problems in cities' growing demand, which is inevitable due to unstoppable urbanization (Aurigi & Odendaal 2020). Cities in the GS experience massive migration, and services are cited as 'doomed' and 'out of control', while the cities are described as having 'lack of necessary scale of infrastructure' and 'limited resources' to expand infrastructure, and hence 'ill-equipped' to deal with 'more' demand. In order to deal with unstoppable city growth, urban governments need to become smarter. Equally, smart technology within SC initiatives also promises to make cities more 'efficient', 'sustainable' and 'livable' (GSMA Connected Living website 2020). The pursuit of smart technologies is also believed to lead towards sustainability frameworks (Kaika 2017) and help in achieving human development (Anand 2020), provided that technology diffusion takes place with effective urban governance (Moyer & Bohl 2019).

Smart technology use to solve problems for targeted people and places

From the late 2000s, SU has been used as a tool to launch 'pro-poor' initiatives, particularly with the use of ICT innovations. These 'smart pro-poor' initiatives have attracted support and funding from the World Bank, Water and Sanitation Program (WSPWB), and UN-Habitat, and Water and Sanitation for the Urban Poor (WSUP). The smart tools seem to have given a smart option to utilities to shift from a standard form of service provision towards increasingly diverse, splintered and slightly differentiated modes, targeting specific populations. These modes work as 'assemblages', as they are targeted for specific urban niches within the cities (Graham & Marvin 2001). Although their funding and technological assistance come from multinational companies and private NGOs, their management and maintenance are gradually being transferred to the communities for whom they were deployed (Guma 2019).

Smart technology as a utopian hype

Although SCs might celebrate large-scale innovation and technical solutions to intractable spatial problems, infrastructure-led approaches have seldom delivered on these promises (Odendaal 2021). Spatial constraints do not simply disappear with broadened technology access but co-exist in a hybrid form (Graham 2008). Aurigi & Odendaal (2020) also call such 'technological solutions' a 'utopian hype', because technological products (infrastructural innovations that run on digital technology) need to be superimposed on and merged with elements of the existing environment, in both newly built towns and old cities that, in reality, are 'messy' (Rose 2017). As a result, some places remain isolated and underserviced even with the introduction of new technologies. In other words, technology cannot always solve access problems either, because it needs to be mediated through everyday social practices, livelihood strategies and socio-economic appropriation (Guma 2019), especially in increasingly fragmented cities and unequal societies.

Mora *et al.* (2017) argue that a 'corporate tech-driven' SC model has failed to account for the social and cultural challenges that SC developments pose. Some practitioners and scholars have also started to question the problem-solving powers of 'smart', by asking questions around democracy and citizenship (Townsend 2013; Halpern *et al.* 2013), drawing attention to and examining how smart rationalities and techniques alter the contemporary functioning of power, space, and regulation (Klauser 2013). Most 'technological fixing' seems to assume partial views of what the city is, and what its citizens do and need. Thus a 'holistic' and 'anthropocentric' interpretation of technological adoption and its opportunities is needed. The relationship between cities and technological evolution needs more textured understanding to build smart responses that take account of the urban spaces' structural parameters, as well as the local conditions that inform citizen-led responses (Aurigi & Odendaal 2020). Technological solutions do not always conform to the 'one-size-fits-all' concept and this is even more apparent in the GS (Odendaal 2021). Bolter & Grusin (1999) argue that 'smart' is more of a 'hi-tech endowment of the status quo' than a new movement supporting any major reinvention.

Research gaps in smart urbanism and smart technology studies

While urban studies have a long tradition of examining the interface between space and digital technologies critically (Graham & Marvin 2001; Graham 2002; Thrift & French 2002; Crang & Graham 2007), narratives and practices around notions of 'smartness' have largely been absent. However, understanding of the opportunities, challenges, and implications of SU is limited to a few fragmented case studies (Mahiznan 1999; Sarkar 2019a, 2019b; Sarkar & Choudhury 2020). There is little theoretical understanding or empirical evidence to assess the implications of this transformative phenomenon of smart technology use in urban spaces. SU currently lacks a critical perspective. The studies give unjustifiable emphasis on technological solutions without considering the social and political domains in which they are implemented and hence influence (Luque-Ayala & Marvin 2015). With such significant implications, the authors of studies must engage critically in understanding why, how, for whom and with what consequences SU is emerging in different urban contexts. Scholars have concerns about contemporary understandings of the city, and how studies have tended to neglect the material, technological and environmental dimensions (Monstadt 2009). Although digital technologies may offer the potential for change, they are fundamentally produced and operate under specific political rationalities and governmental techniques that currently remain beyond the reach of social science (Hudson 2011). In this context, experience of smart technology adoption in many GS cities can provide opportunities for a deeper and more rounded understanding of smart technology use for SU (Odendaal 2021).

THE STUDY AREAS

Delhi, India's capital, is one of the world's fastest-growing megacities. The city incorporates more than one million households in 6,343 slums (Census of India 2011). Only 40% of the 83% of its slum households with access to safe water have home connections. Residents in low-income areas depend mostly on public standpipes that are shared between 10 and 30 households, with typical daily water supply for only 1–2 hours, and taking between 30 minutes and 3 hours daily to fetch water (USAID and SWN 2016).

Nairobi, Kenya's capital, is sometimes referred to as Africa's 'Silicon Valley' because smart technology innovations and approaches find wide application ranges in urban service delivery systems (Poggiali 2017). Urban planning modes that still follow colonial blueprints reinforce patterns of hegemonic accumulation, segmentation, and control (Myers 2015), with 60% of the city's population living in pockets of inadequate infrastructure provision, mostly low-income informal settlements (Gerlach 2008). Less than 5% of the 20% of the population with access to safe water in low-income areas have piped water connections at home (NCWSC 2017).

Both Nairobi and Delhi record perpetual water scarcity due to rising demand, inefficient infrastructure, weak municipal institutions, low operating efficiency and poor water utility staff performance (Zérah & Llorente 1999; NCWSC 2011; Sarkar 2019b). Apart from being covered by the municipal water supply network, residents in low-income neighborhoods depend on parallel provisions such as bores, wells, illegal cutting off pipes from the mains, water tankers (both private and municipal) and informal vendors, as well as buying and borrowing water from neighbors and employers (Truelove 2011; Sarkar 2019b). None of these sources have assured water supplies since vandalizing, bypassing, and/or tampering with water pipes remain common problems (Guma 2019; Sarkar 2019a).

To address these issues, both cities opted for decentralized digital infrastructure in the form of WATMs. In Delhi, WATMs were set up by the private company Sarvajal in 2012, in six low-income neighborhoods on a for-profit basis. At present there are five WATMs in Matiyala village resettlement colony, where the primary survey for this study was undertaken. These WATMs sell water treated by reverse osmosis, either at the treatment unit or through vending machines across the settlement. Sarvajal is responsible for setting up water kiosks on land allotted by Delhi Urban Shelter Improvement Board (DUSIB). The capital cost of the treatment and dispensing units, as well as their operating and maintenance costs, are borne by Sarvajal, who draw on groundwater free of charge. The WATMs are managed by salaried staff of Sarvajal.

WATMs were first time established in urban Kenya in Nairobi in the Mathare valley informal settlement in 2015, as a public private partnership between Nairobi City Water and Sewerage Company (NCWSC) and Grundfos Lifelink, a Danish water engineering company. The WATMs are managed by self-help groups chosen from the community and given an official contract by NCWSC. Managers are given a digital master ATM card that allows them to fill water credits at 40% profit, i.e., water worth Ksh. 140 (1.4 USD) is bought with water credit of Ksh. 100 (1 USD). Initially the WATMs were designed to draw water from the public network, but water tankers from NCWSC fill the WATMs' overhead tanks due to low pressure and lack of supply.

The WATMs work with smart cards ('*Water Cards*') that include an electronic chip with a radio frequency identification device. When the cards are swiped on the WATM screen, water is dispensed and can be collected by customers in their own vessels.

RESULTS AND DISCUSSION

Field evidence

Paid vs free water

WATMs, although claimed to be 'pro-poor', are not free. Cost recovery is not only a goal, efficient and sufficient revenue generation is a prerequisite for survival and expansion. However, as a charitable and social enterprise, prices must be set at lower, more competitive rates than existing sources that function already. Table 1 gives a comparison of WATM water prices in Delhi and Nairobi.

Table 1 | Comparative prices of water across various sources in Nairobi and Delhi

	Water Price (per 20 liters per jerry can)	
Source	**Nairobi**	**Delhi**
WATMs	50 cents (USD 0.005)	INR 4 to 7.50 (USD 0.054 to 0.10)
Standpipes	Ksh. 2 to 10 (USD 0.02 to 0.10)	free
Vendors	Ksh. 2 to 50 (USD 0.02 to 0.50)	INR 30 to 70 (USD 0.41 to 0.95)

Source: Collected and computed from field survey by the author.

In Nairobi, WATMs are the cheapest source of water available. The WATM prices differ in the two cities because of the processing charges. In Delhi, water is treated by reverse osmosis at the treatment works before being sold. In Nairobi, the water is same as that in the city mains. Considering household water expenses, however, Nairobi residents pay much more because every drop of domestic water used must be paid. In Delhi, most water for domestic use by the poor is procured free from community standpipes. The introduction of WATMs has given Delhi's residents the choice of buying cheaper, treated drinking water, which was previously available only as bottled water sold by private water vendors. The difference is that private water vendors give door to door service, while the residents must carry their own water if they buy from the WATMs.

Besides free standpipe water, Delhi's local government also offers 20,000 kiloliters (20 m^3) of water free every month to all metered households supplied by the utility. In this local and national context, a culture developed in which water is assumed to be a free good, and citizens do not pay for either water or its services (Sarkar 2019b). Many customers demanded free water when WATMs first appeared in Bhubaneshwar, Odisha, India (Schmidt 2020). The South Asia Network on Dams, Rivers and People (SANDRP) claimed that 'ATMs are essentially a way of privatizing water supply' (The Hindu 2018). Charging for water, even at the subsidized prices offered by WATMs, is also criticized as a form of commodification by scholars in India (Sarkar & Choudhary 2020), but this is not a view held in Africa.

Since the early 1990s, payment for water at standpipes has become common in most African cities, and citizens pay between about USD 0.40 and 1.00 per m^3 (Water Utility Partnership for Capacity Building (WUP) Africa *et al.* 2003). The free standpipes were withdrawn gradually in African cities, even from the low-income areas. With growing utility deficits, cost recovery became mandatory for all water service provisions, so, over more than three decades, the urban poor have been paying for water and doing so has been assimilated into their culture. While no respondents asked for 'free water', all lamented its rising cost, and the unreliable, erratic price hikes by standpipe owners and private vendors, especially at times of scarcity when there is a lack of supply from the mains. In this context, the WATMs have definitely made water 'affordable' if not free.

In Delhi, the standpipes functioned on cross subsidies and supply was rationed highly. Water subsidies are earmarked for low-income areas and only a fixed amount of water is dispensed from a specific number of taps in a specific amount of time. Since this water subsidy has been fixed over the years, the volume of water discharged free remains constant. With increasing population, per capita water availability has thus declined. Irrespective of the subsidy burden and revenue loss to the utility, local governments do not wish to charge for water for fear of losing elections. The politics of 'free water' have been the biggest game changer in Delhi elections. It is clear that the political ideology of the ruling party in government has determined who paid for this water. WATMs are always set up in collaboration with the municipal water departments concerned with providing services to meet the needs of those they serve. People pay for the transport, treatment and supply of water, and not for the water per se.

Safe vs improved water

The UN defines safe water as 'water that is free from micro-organisms, chemical substances and radiological hazards that constitute a threat to a person's health' (UNDESA 2005). Improved drinking-water sources are defined as 'those that are likely to be protected from outside contamination, and from fecal matter in particular, like household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collection' (WHO undated). 'Safe water' is defined as treated water from individual connections and shared public standpipes, protected dug wells (covered wells), rainwater collection, boreholes, and protected springs. In other words, safe water from improved sources may not necessarily be 'safe'.

In this context, therefore, WATMs in Nairobi can be said to provide 'improved water', as the source is the municipality pipelines, while water from WATMS in Delhi is 'safe' as it is treated before being sold. Although determining water quality from the WATMs was beyond the study's scope, residents were asked about their perception of water quality. Around 43% respondents in Nairobi noted that neither the tankers nor the WATM tanks are ever cleaned, which raises suspicions about water quality. Running water from the standpipes was perceived as safer than the stored water of the WATMs. However, the majority of respondents felt that water is safe as 'it looks and tastes good', and it is at least covered unlike the water sold by private vendors.

Nevertheless, the water quality concerns are valid, since it is being used for drinking. In most GS cities, it is customary to 'treat' piped water before drinking as there is a high risk of water-related diseases. Some scholars feel that WATMs can compete with the booming demand for water, especially bottled water, due to municipalities' inability to provide safe drinking water (Sarkar 2019b).

'Pro-poor' vs accessed by the poor

In both cities studied, the official rationale for setting up WATMs was to serve the urban poor, particularly prioritizing poor residents who do not have in-house connections. The reality is quite contrary (Table 2). While the very poorest mostly bought water from Nairobi's WATMs, the richest among the poor did so in Delhi.

Table 2 | Water coverage: who and how many people use WATMs

	Household Economic Classes			
Class	**Poor**	**Lower**	**Middle**	**Upper**
Nairobi	18.8%	43.8%	25%	12.5%
Delhi	6.8%	22.0%	16.9%	54.2%

Source: Collected and computed from field survey by the author.

Without private connections at homes, all water for domestic use must be carried home in Nairobi, where all WATMs were clustered along the main roads. Most peoples' homes were located in the riverbeds and valleys. Women and girls generally collect water in the undulating terrain of the Nairobi slum, and it is a difficult task for them to carry water for all their domestic needs. As a result, the relatively better off always chose a water source at a convenient distance from their homes, the poorest opted for the cheapest option to save money.

More than 80% of survey respondents were unhappy with the inconvenient location of WATMs. Municipality staff clarified, in interview, that there were no vacant spaces within the slum for WATM placement, also, the expensive digital machines are safer on main roads, where public surveillance is better. In fact, it was observed that the roads inside the slum are narrow and inaccessible for water tankers servicing the WATMs.

In Delhi, poorer residents drank free water available from standpipes and did not want to pay for water even if it was 'treated'. They were ready to take the risk of drinking 'not so safe' water to avoid spending money. The few relatively richer families bought water from WATMs as it was cheaper than bottled water (Table 1) and saved them the hassle of boiling or buying costly home potable water treatment devices. Only 20% of households surveyed reported boiling water before drinking, including for children and the elderly when they fell sick. Unsurprisingly, water sold through Delhi's WATMs is generating much less revenue than expected (Sarkar 2019b). At present the WATMs are located in the resettlement colonies, where the utility has provided private connections in most households in addition to free community standpipes. Were the WATMs in neighborhoods that had no private connections, demand would have been greater.

Hence, it is clear that to serve the poor, WATM location is as important as the price of the water sold. The price must be calculated taking into consideration the opportunity cost of carrying and procuring water from the source, the availability of alternative sources, and the customers' cultural and social mindset.

Flexible vs reliable

A unique selling point of WATMs is 'reliable water' and, in fact, another name for them is 'all time water machines'. The reality is quite different. Around 32% of Delhi respondents surveyed and 57% in Nairobi complained of unreliable supplies from the WATMs. Most complained that, although the WATM was technically open 24 hours a day, it often contained no water to buy.

In Delhi, several managerial issues with respect to topping up credit in the smart card and multiple unaddressed customer grievances remain as challenges. Although there was great initial enthusiasm among Nairobi slum residents when the WATMs were being installed, later on, they remained empty because of irregular filling with water. The WATMs also remained dry and unreliable due to illegal siphoning of water from their tanks by cartels. Moreover, since the water vending and card swiping machines are powered by electricity, they stopped working whenever there was a power cut. (There were frequent power cuts in the slums.)

In an interview, the managing director of NCWSC said, '*It is very important that we are able as a utility to generate revenue where nobody thought we would be able to generate revenue*' (https://www.grundfos.com/cases/find-case/water-atms-offer-low-priced-water-to-nairobis-poorest-residents.html). The question is, if the WATMs can generate revenue, why are they not reliable and running at full capacity? There is no doubt that there is ample demand for water. The utility bears the cost of production, distribution, and collection of WATM cards, and of electricity to run the machines. Additional costs arise from the fuel and manpower to run the tankers to fill the WATM tanks. So, in effect, the WATMs are probably not generating as much revenue as estimated and claimed by the government, and thus not operating optimally.

Smart vs transparent

Traditionally, the urban water sector has been perceived as a spot for petty to grand corruption (Davis 2004). Monopolies are common in payment services due to reduced competitive pressures to recuperate revenue and fixed water staff salaries. Petty corruption is common in the billing and payment – e.g., informal transactions and kickbacks by individuals for falsified meter readings; expediting of repair work and new connections; avoiding disconnection; as well as cover-up for installation or ignoring illegal connections (Davis 2004; Krolikowski 2014; Sarkar 2019b, 2021). It has been claimed that smart technologies have the potential to enable innovation in efficiency and transparency in urban infrastructure, particularly with the information-enhancing properties of mobile technologies and related payment innovations (Hope *et al.* 2012).

The WATMs' prepaid digital payment systems have definitely led to transparent billing systems for water sold in both cities. Moreover, with prepaid delivery, there are no additional metering or billing costs. There is less interaction between the utility staff and customers, because, as for standpipes, there is no cash handling between officers and kiosk managers.

Although there is no corruption with regard to water charge payment, other kinds occur. In Nairobi, WATMs face stiff competition from standpipes and private water vendors, who are alleged to sabotage WATM water sales. Cartels running standpipes and informal water vendors often cut municipal pipes, to create artificial shortages to push up demand and increase prices. Vendors also steal water from WATM tanks and sell it at higher prices. Due to illegal pipe-cutting, water pressure remains low and water tankers need to fill WATM tanks. The utility staff accepted, in interview, that WATMs remain dry due to illegal water siphoning, but could not comment on why such offenders were dealt with very gently. With the utility's tankers being late and unreliable, collusion between utility staff and the water cartels cannot be ruled out completely.

Another major concern raised by respondents was the rampant corruption and nepotism in contracting of WATMs to private groups. Either kinship connection or heavy kickbacks were associated with such contracts. Technocratic solutions are often subjected to disengagement and contestation, caught up in the politics and micro-politics of low-income neighborhoods presenting 'unique power dynamics' (Guma 2019).

With fixed salaries, managers in Delhi are not bothered about water sales. Most respondents complained about absent and indolent staff, who were apathetic about customer complaints. Repeated visits were needed to recharge the water cards, which could only be done by these managers. Many people reported dissatisfaction because of their inability to use WATMs as staff were not available to recharge their cards on time. Although illegal pipe-cutting was common in Delhi, it did not affect WATM functioning because they use groundwater.

Environment-friendly vs polluting

Locally, WATMs are often given an environmental rationale in terms of reducing the use of single-use plastic water bottles (Sarkar 2019b; Schmidt 2020). If the full socio-environmental cycle of smart technologies is traced, however, a better picture is gained of how 'sustainable' such technologies really are. The water treatment units in Delhi's WATMs extract only 50–65% of the treated water for use. The rest is discharged either to open drains or back into aquifers, where it further contaminates the groundwater because of the high TDS content (Paliwal 2013). Moreover, WATMs are pumping groundwater in an area already demarcated as a dark zone, where water abstraction exceeds recharge. Groundwater depletion can have negative effects on other users. In this context, Kaika (2017) mentions that in many cases smart technologies cannot be the solution because they are part of the problem.

Smart technology vs smart citizens

When smart technologies are put forward as efficient and seamless problem-solving devices, it is assumed automatically that the citizen who can afford and access all sorts of hi-tech gadgetry, must be smart and conversant with mobile technology, and willing and expecting to interact with advanced data feeding and reporting systems. McDermont (2005) observed that 'low awareness and skills with technology' among people can be one of the greatest hindrances for digital infrastructure success. Since water collecting is done mainly by women, WATMs can be successful in low-income areas if women have access to and an acceptable level of skill with the technology. In Delhi, water card recharge was available through registered mobile numbers only and, in most cases, women had neither a personal cell phone nor the technological literacy to add credit to the cards. They depended completely on men in their families who had the registered mobile. The men would make multiple visits to the WATMs to get hold of the manager to recharge the card, hindering capacity use of the technology. The problem was not observed in Nairobi as credit recharge was done with the help of M-Pesa, a mobile-based payment service. Anybody could help in recharging water cards, either at the kiosks or with mobile money transfer.

Techno-centric vs holistic policy approach

There is a general assumption in urban planning history that techno-centric approaches enable 'efficiency' and 'progress' (Odendaal 2021), and so the immense demand for city services can be counter-balanced by the 'soft utopia of smart-fixing' (Odendaal 2021) because it is 'efficient'. In the last few years these 'techno-centric' approaches have begun to be questioned as only a short-term fix for a deep-rooted, complex problem. 'Holistic policy' approaches are advocated instead. WATMs are seen as 'compensation' for delayed fulfilment of state infrastructure promises. In this context, Schmidt (2020) argues, 'While not providing equality in public service provision, the state claims WATMs as a means towards that end'. Digital technologies are used as a 'short-term remedy' for 'drinking water pipes at homes'. However, promoters of WATMs applaud digital technology as it has provided at least a viable alternative to delayed, large-scale, piped water infrastructure that requires time and huge investment. Big investments in social capital infrastructure are indeed a problem for many insolvent utilities, and even private investment is low in the water services sector due to low returns and long payback periods (Bakker 2010).

Some believe that, in the garb of an SC pitch for providing water assisted by digital technology, the state is able to 'hide its gross failure' in not completing state sanctioned drinking water projects (The Sentinel 2018). Although digital machines definitely offset the 'unscrupulous practice' of arbitrary price hikes by private retailers, the delays and denials of state in providing holistic infrastructure are part of shifting accountability for promised infrastructure development away from the state. If this techno-centric approach is successful it will provide not only a solution to a complex problem but also new explanations of the 'moral state'.

One basic requirement will remain the same, irrespective of the goal and the location of the WATMs. WATMs require water. Water will be provided by the state, whether from the municipal mains or groundwater.

CONCLUDING REMARKS

Solutions for complex issues – even 'smart technologies' – require contextually embedded responses, to be viable and socially sustainable. To replicate such similar smart solutions as WATMs in different spaces, some common considerations needs to be understood by both policymakers and technology providers.

Service providers must assess cost and revenue effects before introducing WATMs and compare the impacts of other options. WATM location is central to their success because it determines adequate scale of water sales for its economic viability. Localities are needed where demand is high, and other affordable and safe water sources are not adequately available. The machines must be accessible and close to where customers reside, to minimize water transport difficulties.

WATMs require water. WATMs' ability to provide reliable water depends on a network with adequate pressure, reliability of supply, the machines themselves, and their installation and maintenance. Other important factors in water sales are convenient credit purchase points, and technology access and literacy among customers. The technology's relative expense does not remove the need for sound management ensuring reliable supply and fixing operating problems, which will offer prospects of healthier cash flows and more revenue to fund expansion.

When utilities choose WATMs to deliver water to low-income households at a social tariff, early consultation is necessary with higher-level decision-makers about recovering costs. This demands robust regulation. WATMs do not currently operate within regulatory frameworks. They are often (mis)used by water vendors, who buy water from WATMs and resell it at a profit. Clear goals must be set with specific beneficiary targets and the extent of subsidy to be allocated.

The aim of the paper's message is honesty and objectivity: WATMs do not offer a miracle cure. It is neither pro- nor anti-poor and cannot replace sound management. Unless careful assessments are made and effective management systems installed, WATMs will fail like many other donor-dependent projects implemented without a sound understanding of the socio-cultural context. Irrespective of the WATMs' 'placelessness', the suitability of a smart technology cannot diminish the power or relevance of context, because cities are naturally complex, and can enable, disrupt, resist and translate technology use. Giving scarce attention to local values, culture, knowledge and space can make the machine-space rigid, blunt, and insensitive (Sassen 2011). Thus, when modern technologies are introduced, they must be understood in the context of their geographical spaces, which will contribute to rethinking urban spaces in a more socially sustainable and intelligent light.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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