Social innovation: the bio-centre approach to water and sanitation infrastructure provision in Nairobi's informal settlement, Kenya

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Abstract

About 55% of the population in Nairobi live in informal settlements, which are often 'beyond the networks' in terms of water and sewerage provision. This means that the population occupying these settlements occupy both physical and institutional spaces outside the reach of the formal system of infrastructure networks. As a coping mechanism, deprived communities in Nairobi's large informal settlements namely, Kibera, Korogocho and Mathare are increasingly devising new strategies, technologies and institutional frameworks and servicing models intended to satisfy their existential needs, in the face of neglect by the state and conventional market mechanisms. The bio-centre approach is one such example of innovative mechanisms of survival that is rapidly gaining root in the Nairobi's low-income settlements. Using the case study approach, this paper analyses the bio-centre projects implemented in the three settlements with a view to interrogating the possibility for their recognition as viable alternative servicing models, given the exigencies of rapid urbanisation under severe resource constraints in Nairobi.

Key words: social innovation, water and sanitation infrastructure, community participation, informal settlement, Nairobi

1. Introduction

Inequitable access to clean water supply and adequate sanitation remains a critical development challenge for rapidly transforming cities of the global South. Despite various policy implementation over the past decades, the urban poor living in informal settlements continue to face challenges in accessing water and sanitation services. The persistent situation threatens huge investments usually sunk in the water sector (mainly by bilateral and multilateral financial aids) with the aim of improving access to these basic services, particularly for the poor households. For instance, the period 1981-90 was referred to as the international drinking water supply and sanitation decade, which saw significant funding by international organisations in support of water projects in the developing countries (WHO 1992; Bakker, Kooy et al. 2008). Following this, international financiers advocated privatization policies in the 1990s that supposedly was to improve efficiency of water utilities in delivery of water and sewerage services, with less direct involvement of the state in

provision of public services. Subsequently, the 2000 millennium declaration (Millennium Development Goals) was formulated and established target 7 that aimed to halve, by 2015, the proportion of population without sustainable access to safe drinking water and basic sanitation[1]. However, the internationally-driven approaches have since faced mixed reactions with a number of literature indicating failures in expansion of water and sewerage networks to poor households (Allen, Dávila et al. 2006; K'Akumu 2006; Prasad 2006; Kerf and Izaguirre 2007; Bakker 2010). For example, Allen et al. (2006) attribute this failure partly to:

> [A] legacy of decades of supply-led engineering approaches with high operating costs and under-utilized investment, unrealistically high standards of per capita service to formal areas of cities and *a general disregard for the needs of unregulated or "illegal" urban and peri-urban settlements'* (p.333, my emphasis).

The above mentioned approaches to provision of water services have been linked to the increasing inequalities among differentiated social-class in developing countries (Castro 2007; Miraftab 2007). The persistent lack of universal access to urban water and sewerage supply despite significant investments perhaps, is the reason for emergence of new approaches to provision of water services in the South. Developing states have proven inability to meet the internationally agreed targets for reducing the number of people with no access to clean water and adequate sanitation (Allen, Dávila et al. 2006; K'Akumu 2006). Bakker et al. (2008) attempt to explain the minimal access, if any, to networked water supply by the urban poor in the global South through the concept of 'governance failure'. In their argument, 'governance failure' occurs when institutional dimensions of water management and decision-making do not effectively take into account the poor's needs, resulting to 'disincentives for water utility to connect poor households and/or for poor households to connect to the network' (p. 1894). It is no wonder water supply networks in the South are not universal, and are provided by non-networked actors that include government, civil society and private sectors usually drawing on different sources of water and employing different technologies of water provision (Kjellén and McGranahan 2006; Bakker, Kooy et al. 2008).

The configuration of urban governance and socio-economic systems in most of the sub-Saharan Africa pose challenges in improving the appalling urban conditions (Kamete 2013). Conventional

[1] http://www.un.org/millenniumgoals/

planning practices have led to varied challenges that are experienced across the social, economic, cultural and political spheres (Albrechts 2002; 2004; 2005; Hillier 2011). Bureaucracy, inflexibility and lack of innovativeness have called for the need to seek more transformative spatial planning systems and practices (ibid.). The continued planning practice based on inappropriate approaches employed particularly in dealing with informal settlement issues have not yielded success in solving the complex urban challenges facing Southern cities (Roy 2005; K'Akumu and Olima 2007; Miraftab 2009; Watson 2009; 2012; Arabindoo 2011). It is for such reasons that Albrechts (2005) argues for creativity as a prerequisite for societies and planning in particular in responding to today's problems and challenges. Nevertheless, cities are increasingly becoming places of innovation particularly in governance relations and institutions despite being sites of crisis (González, Moulaert et al. 2010). Social organisations and local communities are increasingly becoming prominent entities through which they respond to alienation, deprivation and negotiate their presence in the city (Roy 2005; González, Moulaert et al. 2010; Arabindoo 2011; Watson 2012). It is such instances that may trigger social innovation as a conscious response to improve inclusionary dynamics (González, Moulaert et al. 2010). Social innovation thus becomes key in countering social exclusion, segregation, polarisation, fragmentation and marginalisation of communities, fostering social inclusion and social cohesion in cities (Gerometta, Haussermann et al. 2005; Moulaert, Martinelli et al. 2010).

Informal settlements in Kenya have faced many decades of neglect by the state and local planning authorities in infrastructure provision (Otiso 2003; Huchzermeyer and Karam 2006; K'Akumu and Olima 2007; Oyugi and Owiti 2007; Huchzermeyer 2008; Syagga 2011). Due to this neglect, crucial municipal infrastructure and services such as water and sanitation networks often lack in these settlements (ibid.). City authorities on the other hand are faced with diminishing resources for public expenditure and planning for the ever-increasing population (Oyugi and Owiti 2007; Majale 2008). Similar to other rapidly urbanising cities in Africa, Nairobi exhibit clear consequences of this neglect, with many informal settlements marooned beyond the infrastructure network. Nairobi's informal settlements currently host about 55% of the urban population (UN-Habitat 2014) who have to contend with little or no provision of water and sanitation services. Worse still, this proportion of urban population occupies a sheer 5% of the city's total residential land (Syagga 2011). Yet with rapid urban growth, more and more of the incoming population continue to find shelter in areas cut off from municipal mains. With such an upward trend of urbanization, the appalling situation is not

likely to change soon as informal settlements become inevitable feature of the 21st century in cities of the global South (Watson 2009; Roy 2011; Kamete 2013).

After decades of living in the margins of the city and beyond the infrastructure services, low-income communities in Nairobi are increasingly fashioning out socially innovative models of providing themselves with water and sanitation services in the face of neglect by planning authorities and conventional market mechanisms. Through strategic alliances with religious organisations, community based organisations and non-governmental organisation, communities are making significant contribution in supplementing the state in service provision within informal settlements (Huchzermeyer and Karam 2006). Drawing on the experience of Kibera, Korogocho and Mukuru informal settlements, this paper positions the utility of social innovation and active community engagement in the provision of basic socio-economic infrastructure services. In the three case settlements, communal self-help initiatives in bridging the water and sanitation service gap is increasingly becoming pronounced. Communities have recently mobilised themselves around non-conventional infrastructure technology dubbed as 'bio-centre' and cobbled up new institutional structures to aid in providing themselves with water and sanitation services. The institutional design and technological choices adopted in these new models of water and sanitation provision seem to correspond better with the daily needs of communities living in informal settlements, especially as they are more in tune with the socio-economic capacity of the beneficiaries. Many of the cases are emblematic of innovative collective infrastructure development. More importantly, they enhance social inclusion and cohesion built upon associational modes of reproduction.

The paper argues for recognition of these socially innovative community initiatives in infrastructure provision, especially in the face of resource constraints and rapid socio-economic changes in African cities. The community-led approach employed in the Nairobi's informal settlements is interrogated with an aim of testing its efficacy as a model for promoting bottom-linked infrastructure projects and inclusive urban development policies not only for Nairobi but for fast-growing contemporary African cities. The empirical work covers Kibera, Korogocho and Mukuru informal settlements in Nairobi, Kenya. The material draws from an ongoing field research that employs ethnographic fieldwork and in-depth interviews and focus group discussions with residents and project officials within the three settlements. Semi-structured interview with the Nairobi city planning authority and actively involved civil society actors constitute additional data for analysis.

The paper is structured into five sections. After the introduction, the next section presents the theoretical underpinning social innovation. Social innovation is elaborated as an analytical concept applied in territorial development. Emphasis is laid on its three interrelated dimensions of content, process and empowerment. The third section presents the bio-centre story as narrated by research participants, highlighting the mobilisation and implementation processes involved in setting up the bio-centres. The fourth section analyses the community approach of bio-centre in provision of water and sanitation services through the lens of social innovation, interrogating its potential as a socially innovative strategy in tackling challenges of service provision in informal settlements. Finally, the paper concludes by drawing insights from the collective innovative infrastructure provision in the three cases, which I argue, can go a long way in reversing the exclusionary and neglect of informal settlements in infrastructure provision across cities in Kenya and beyond.

2. Social innovation: concept and meaning

Moulaert et al.(2005; 2007; 2010; 2013) espouse the concept of social innovation as an alternative analytical frame in urban socio-economic development policies particularly in anchoring urban change movements within their social and political contexts (cf. Drewe, Klein et al. 2008; MacCallum, Moulaert et al. 2009). As used in territorial development context, social innovation refers to creation of new ideas, models, practices and institutional frameworks by community members in order to satisfy societal needs not provided by the prevailing state and /or the market systems (Moulaert et al. 2010; 2013). Social innovation occurs when the mobilisation of social and institutional forces result in satisfaction of previously alienated human needs, empowerment of previously excluded social groups through creation of new capabilities, and changes the existing social and power relations towards a more inclusive and democratic governance system (Moulaert 2009; González, Moulaert et al. 2010). As an analytical concept, social innovation is used herein to frame how communities in informal settlements supplement the state and market mechanisms in providing themselves with basic infrastructure services following years of neglect or exclusion from formal/conventional infrastructure systems. The concept is useful in situating how communities living in informal settlements mobilise new forms of social organisation, informing and influencing larger institutions and policies while partnering with external actors, in seeking water and sanitation services.

At the core of social innovation, Moulaert et al. (2005) emphasize three interrelated dimensions. The first is the satisfaction of alienated human needs (content dimension). These human needs are not necessarily material forms but may include identity, recognition, equal opportunity and citizenship, which contributes to social, political and cultural inclusion (González, Moulaert et al. 2010). The revealing of human needs should however be backed by capability of social movements to meet the needs, through 'non-market' mechanisms steered by institutional frameworks emanating from the local context from within and beyond the confines of the state (Moulaert 2009). This dimension corresponds closely to the concept of governance beyond-the-state (Jessop 1998; Swyngedouw 2005). In governance beyond-the-state, the civil society and private actors play greater roles in policy making and providing basic services, which was previously the domain of national or local state's responsibility (Swyngedouw 2005). More often, the provision is done through self-organizing interpersonal networks, negotiated inter-organizational co-ordination and decentred, context-mediated inter-systemic steering (Jessop 1998, p.29). Here, governance entails management and co-ordination of interdependent/collective activities involving multiple stakeholders including the state, private and civil society (Jessop 1998; Healey 2003). The coordination of activities calls for new practices based on networks and partnerships (Newman 2001). This new approach has the potential to overcome the limitations of anarchic market mechanism that is based on pursuit of self-interest by capitalists, and top-down urban governance in an increasingly complex environment (Jessop 1998; Moulaert, Martinelli et al. 2005; Swyngedouw 2005). This can be possible when power rooted in particular institutions is diffused to more fluid, devolved and negotiated between partners (Taylor 2007).

The second dimension concerns with changes in social relations in local space in short, process dimension. The social transformation should lead to improvement of the governance system that regulates provision of services and establish new governance structures in order to satisfy societal needs (Moulaert 2009). It is important to note that social innovation is spatially negotiated between agents and institutions with a strong territorial affiliation, resulting to 'reproduction of place-bound and spatially exchanged identities and culture, and establishment of place-based and scale-related governance structures' (ibid. p. 12). Critical to the process dimension is the inclusion of previously deprived communities in (re)production activities priming active community participation (Moulaert, Martinelli et al. 2005). Feted for its emancipatory potential of change (Scott-Cato and Hillier 2010), social innovation places emphasis on community collective initiatives in mobilizing new forms of

social organisation, but also advocating for participation within and without the state, thereby triggering changes in local institutional and governance structures (Moulaert 2009). Viewing community participation as a spatial practice, the process encompasses power relations and construction of citizenship that permeates public engagement sites (Cornwall 2002; 2004; 2008; Gaventa 2004; Cornwall, Robins et al. 2011). Such spheres of participation opens up new spaces and opportunities for significant participation of excluded communities in policy making and decision making that affects them (Swyngedouw 2005; Cornwall and Coelho 2007; Moulaert, Martinelli et al. 2007; Taylor 2007). In the process, communities shape the decision making contrasting their past position as passive recipients of policies (Cornwall and Gaventa 2000). This enhances democracy and improves effectiveness and equity of public policy as the community communicates and negotiates with other actors from the state and private (Cornwall and Coelho 2007; Cornwall 2008).

The third dimension of social innovation is an increase in the socio-political capability and access to resources (empowerment dimension). Here, the state and civil society remain crucial in emancipating deprived communities, through strengthening community's capacity for satisfaction of societal needs (González and Healey 2005). To achieve community empowerment, social innovation encompasses both social and political rationale (Moulaert, Martinelli et al. 2005). Whereas the social rationale concerns with promotion of inclusion into various societal spheres, the political aspect emphasizes voicing by groups that have traditionally been absent from politics and local politico-administrative system (ibid.). The success of social innovation however is structured by the social and political systems at hand (Moulaert 2009). For realisation of such result, the relationship and responsibilities among complex alliances of actors must be reconfigured towards a more networked-horizontal operational horizons across permeable institutional boundaries and an expanded public domain vision (Cornwall 2004; Swyngedouw 2005). The range of actors should therefore recognise their interdependences and be representative of the interests and knowledge relevant to the community's issues at hand (Booher and Innes 2002). Only then can the community's access to socio-political resources be reinforced, enhancing their satisfaction of unfulfilled human needs (Moulaert et al. 2010; 2013). The bio-centre project implemented in Kibera, Korogocho and Mukuru, to which we now turn our focus exemplify strong features of social innovation, eventually answering to the water and sanitation needs of communities living there.

3. Community bio-centres: a socially innovative strategy for water and sanitation provision?

Nairobi hosts many informal settlements dotting the city's landscape. Among the major informal settlements in the city include: Kibera (infamous for being the largest informal settlement in Africa), Korogocho (the fourth largest informal settlement in Nairobi) and Mukuru (second largest informal settlement in Nairobi).

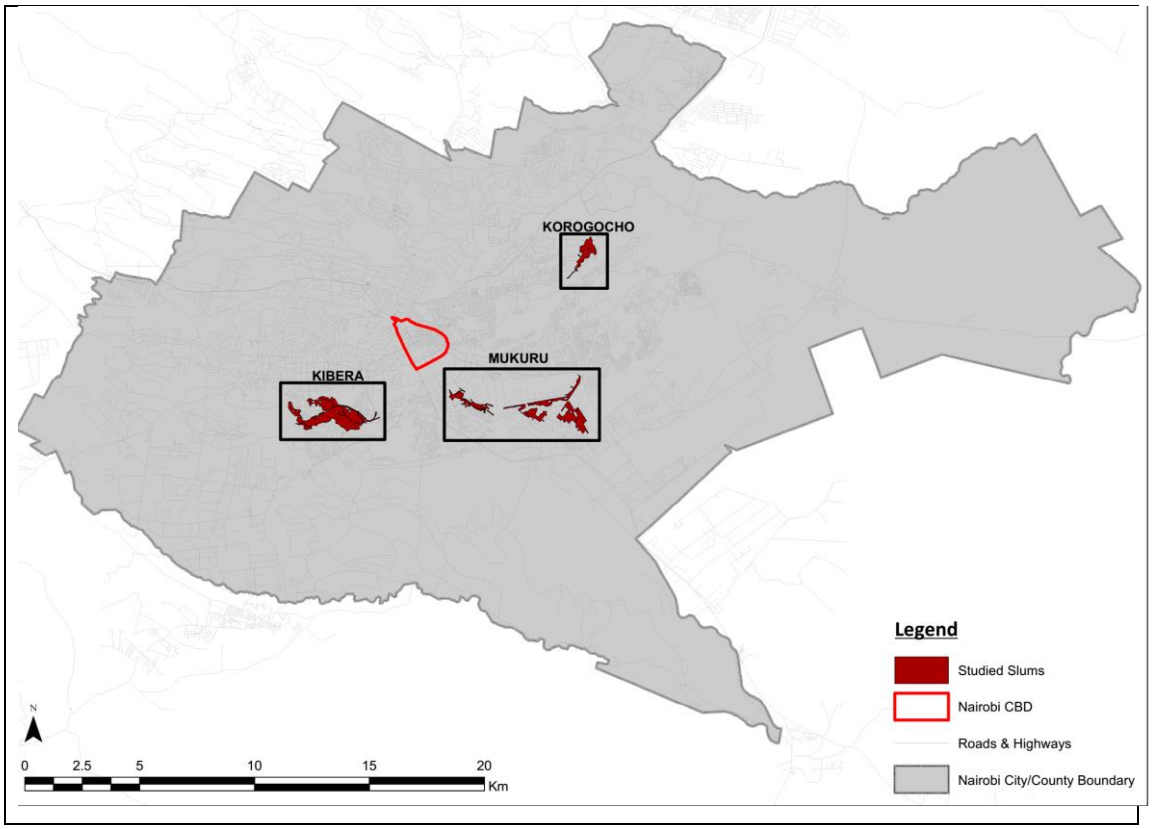

Figure 1: Location of Kibera, Korogocho and Mukuru settlements within Nairobi

These settlements sit on public land without tenure security, a factor that significantly explains poor living conditions with minimal or no basic infrastructure services provision by state planning authorities. The settlements are densely populated with semi-permanent building structures usually measuring 10 by 10 metres. The population consist of heterogeneous communities from multi-ethnic backgrounds. Owing to the high rents in planned settlements, majority of people seeking better opportunities in the city find themselves in such settlements, compromising their living conditions as they try to make ends meet.

After decades of marginalisation by public utilities in water and sewerage infrastructure and service provision, communities in the three informal settlements formed community based organisations

(CBOs) and self-help initiatives that sought partnership with other civil society groups to strengthen their water and sanitation agenda. In 2007, communities in Kibera, Korogocho and Mukuru entered into a collaboration with Umande Trust (UT)—a human rights-based organisation that supports community-led plans and actions in transforming water and sanitation services in Kenya's urban centres[2]. The collaboration between the communities and Umande Trust was meant to help organised groups in pioneering the implementation of bio-centres within their settlements. Umande Trust mainly offered technical support throughout the process besides acting as the link between the communities and other key stakeholders such as the Nairobi Water and Sewerage Company (NWSC), Athi Water Service Board (AWSB), and international donors and NGOs. In August 2007, Umande Trust signed a Memorandum of Agreement (MoA) with AWSB to oversee the implementation of twenty bio-centre projects by communities in the three settlements to benefit about 350,000 residents (Binale 2011). Through the extended partnership involving the communities, Umande Trust, Nairobi Water and Sewerage Company and the Athi Water Service board, the communities benefited from project funding of the French Development Agency (AFD) through AWSB under the framework of the Nairobi Water and Sewerage Emergency Physical Investments Project.

Bio-centres are conceptualised to provide a wide range of crucial services to communities they serve using water and sanitation as entry points, therefore serving as multipurpose projects. More specifically, a bio-centre is a three-storey building that comprises of a bio-digester at the basement, a water kiosk, toilets and bathrooms at the ground floor and a community centre at the top floor (fig. 2). The implementation of bio-centres in the selected settlement entailed a number of processes and activities. With assistance of Umande Trust, communities carried out initial research, training and awareness. Competitively selected community members from different registered CBOs formed the technical and operating group that received training from Umande Trust's technical team. Selected members were trained on construction, operation, maintenance and management of the facilities. Trained members were to assist in successive training of the rest of the community. The technical and operating team carried out a series of awareness workshops within their settlement during the project period. Initial research was conducted to determine the scale and location of a bio-centre, including space availability to put up the facility. Critical attributes

[2] http://umande.org/about/

of water and sanitation services such as: sources, availability, cost and distance constituted important data for planning of a new bio-centre within a settlement.

Using gathered data from the field survey and research complemented by feedback from members during awareness sessions, the trained team designed bio-centres befitting specific site characteristics. As basic requirements, each bio-centre consisted of an underground dome-shaped waste digester, bathrooms and toilets equally shared between male and female users, and an additional floor space for communal purposes. Upon a commonly agreed design by community members, the trained team installed the bio-gas system and constructed the bio-centres with supervision of the Umande Trust's technical team, through hands on-the-job training. To ensure efficient running of the bio-centres, appointed individuals were stationed at each site to manage and monitor daily activities as well as collect small fees from external users accessing any of the range of services offered at a bio-centre.

Figure 2: A bio-centre project in Nairobi. Source: Umande Trust 2014

4. Appraising the community bio-centre approach to water and sanitation provision in Nairobi's informal settlements

Having presented the bio-centre narrative, this section employs the three dimensions of social innovation introduced earlier. As the dimensions are interrelated, the delineations herein are not

mutually exclusive. Nonetheless, the heuristics afforded by them are useful in structuring the discussion.

4.1 Process dimension: transforming social relations

Community participation was the central cog in satisfying the water and sanitation needs of the three communities. Active engagement of community members through the entire process was not only internally beneficial to the communities, but was useful in transforming social relations with external partners. The communities overcame the complex social relations usually tied to ethnicity and political support lines that for long has divided members amongst themselves. Instead, communities mobilised their members to form local organised groups comprising of youth groups, women group and self-help groups drawing like-minded members from different ethnic and political groups. This kind of organisation enabled them to collaborate with other partners in a more structured way. For instance, Umande Trust only entered into collaboration with vetted organised groups, which are officially registered and have group constitution governing their membership and activities. The partnership between Umande Trust and these community groups was cemented through signing of a memorandum of understanding that clearly defined their engagement and roles in implementing the project. More importantly, as a long-term partner, Umande Trust acted as a liaison between the groups, local administration, the Nairobi Water and Sewerage Company, donors and financial institutions.

Despite the long stringent relationship between planning authorities responsible for utility provision and communities residing in informal settlement, the cases analysed herein demonstrate that active community participation can improve local governance for service provision. The communities engaged the Nairobi Water and Sewerage Company—a utility company responsible for provision of water and sewerage services in Nairobi—to connect the bio-centres to the municipal water mains. Although the city authorities have been hesitant in extending their supply network to informal settlements, the highly organised and zeal exhibited by the community compelled them to consider their proposal. Concomitantly, Umande Trust helped the communities to negotiate with NWSC basing their argument from a human rights perspective in reminding the authority of the constitutional rights of every citizen to have access to clean and adequate sanitation (GOK 2010) and therefore, the city authority has a role to play towards this realisation. After long deliberations, the NWSC found the project feasible and considered the communities' proposal as one of the

projects to be funded under the rubrics of the Nairobi Water and Sewerage Emergency Physical Investments Project, which had been set up to help in realisation of the 2015 MDGs target. This development led to the signing of a memorandum of agreement between the NWSC and Umande Trust on behalf of the community (Binale 2011). The MoA prescribed terms of reference for implementation of twenty bio-centres within Kibera, Korogocho and Mukuru settlements to benefit 365,000 residents. This partnership was valuable in supporting the communities to access funds and approvals for implementation of bio-centres within their respective settlements. As a result, the social relations between the communities and city authorities transformed, promoted inclusivity and social justice in city infrastructure governance.

Internal community mobilisation and member participation in the day-to-day activities strengthened community bond and solidarity. At the preliminary stages of project initiation, the communities organised various awareness workshops facilitated by Umande Trust. These workshops brought together all stakeholders including the NWSC and local administration officers. The workshops created a platform for stakeholder mobilisation and mounting support for the new project in the interest of the general public. It is during such forums that residents collectively identified their water and sanitation needs among other socio-economic issues. The communities were strategic by involving crucial partners early into the process such as the NWSC and the local administration officials to garner their political good will and win their trust. More importantly, the presence of the local administration in the forums was useful in guiding site selection for implementation of the bio-centres. Owing to the complexities of land tenure coupled with limited space for development within the densely formed settlements, the communities needed the support of local administrators in resolving conflictual issues arising from land related matters. In the long run, the communities were able to secure sites where facilities were to be constructed. The local setting of these forums not only allowed greater participation of locals within reach, but depicted the squatters' real life conditions that contributed to a shared problem definition, necessitating speedy launching of the project.

Yet another aspect of community participation is seen in the designing of the bio-centres. Community members expressed their desires on how they wanted their bio-centre to be planned and determined number and type of facilities to be included in the plan. The communities' desires were interpreted and incorporated into a final plan, prepared with technical assistance from

Umande Trust's architects. Eventually, a three-storey structure with distributional functions across the different levels was adopted by the communities. Although there are minor design variations across the three settlements, it was unanimously specified that each bio-centre should contain: water points, bathrooms and toilet facilities, rental spaces, community hall, bio-digester and a kitchen. The design process of the bio-centres demonstrate a co-production venture that provided the community with deliberative opportunities (Healey 2003), which interacted with the place dynamics, eventually shaping the design of bio-centres according to community needs and site restrictions. The planning approach employed in these settlements can be said to be 'innovative, emancipatory and transformative' (Albrechts 2012, p. 46) in dealing with the practical needs of the community.

4.2 The content dimension: meeting societal needs

As observed earlier, the state and planning institutions failed to provide water and sanitation infrastructure services to people living in informal settlements. Furthermore, the market mechanisms eschew informally developed areas due to fear of loss of their investments as such areas do not present stable ground for long-term investment. In the absence of sanitation services, communities resorted to open defecation and/or defecated into paper bags that are thrown into clogged drainages on narrow walkways commonly referred as 'flying toilets' synonymous with life in Nairobi's informal settlement (Huchzermeyer and Karam 2006; Binale 2011; UmandeTrust 2014). To meet their sanitation needs, the community embraced the bio-centre technology that not only provide toilet and bathroom facilities but has a bio-digester component, which turns human waste into clean gas as well as liquid fertilizer. Apart from supplementing household's cooking energy, excess bio-gas generated from the bio-centre is used to heat water for showers installed within the centre. Some of the bio-gas project support school feeding programmes, contributing to societal development. The sanitation technology adopted therefore offers a cost-effective way of managing wastes in the settlements while at the same time promoting environmentally friendly waste management practices.

It is widely acknowledged that communities living in informal settlements pay more to access water services. With accessibility defined by cost, distance, time and water quality, the bio-centre prove to maximise on these critical attributes of water services. Previously, residents in the three case settlements relied on buying water from vendors who sourced water from illegally connected pipes,

which often lie in open drains filled with raw sewer, posing threats of water contaminating in case of broken pipes. However, in implementing the bio-centre projects, the communities sought permission of the Nairobi Water and Sewerage Company to make connection to the municipal water mains. The NWSC approved the communities' request and supplied each bio-centre with its water, which is billed per capita volume on monthly basis. The communities have in addition invested in storage tanks to help in continuous running of the bio-centres owing to the inconsistent water supply by the public utility. A water kiosk stationed at the ground floor sells water to community members at a constant price of 3ksh per 20 litre container. The bio-centres offer affordable water service compared to other water vendors who charge up to 20ksh per 20 litres jerry on bad days (Binale 2011; UmandeTrust 2014a), which is considered exorbitant. Furthermore, the quality of water from these vendors is of questionable standards, adding to preference by communities to fetch water from controlled water supply at bio-centres. To bridge distance coverage, the bio-centres are planned to serve a radius of 60 metres and located on major streets and within densely settled sections, enhancing accessibility within the settlements.

The idea of a multipurpose project not only answered the communities' water and sanitation needs but created multiple socio-economic opportunities revolving around the bio-centre. The 'business-cum-communal venture' approach of the bio-centres met other communities' needs in varied ways. For instance, the incorporation of a bio-gas project produces relatively cheaper cooking energy that assist members in their domestic meal preparations. Other community members can use the kitchen facilities installed at the centres to prepare their meals at a small fee. Since the bio-gas produced from these centres exceed domestic use, the excess gas is sold to commercial enterprises and nearby institutions such as schools and health centres, earning income in the process. The bio-digester project promotes use of renewable energy contributing to a shift from commonly used wood fuel, charcoal and kerosene to bio-gas for cooking. The renewable source of energy is more efficient and reduces carbon emissions besides alleviating pressure on forests. The liquid fertilizer, which is a by-product from the bio-digester process is sold to agricultural institutes in the city and self-help groups practicing urban agriculture, generating income to the communities. As earlier mentioned, the communities created an extra floor space, which provides rental spaces for other businesses and events. More importantly, the communal hall incorporated in the bio-centre has become the communities' foci acting as a meeting place for community groups

and members to discuss current issues, enhancing dialogue, social cohesion and integrations in the multi-ethnic settlements.

4.3 Community empowerment

The bio-centre project has had significant socio-economic impact in the settlements where they were implemented. Evaluation of the projects by a private consultant showed that bio-centres have evidently reduced the flying toilet menace in the selected settlements, resulting to better waste disposal methods that contributes to the environmental well-being of the societies (UmandeTrust 2014). In addition, connections are made to other on-site pit latrines to the bio-digesters for maximum production of bio-gas and waste management. Up to date, more than 60 bio-centres have been implemented in Kibera, Mukuru and Korogocho (ibid.). More importantly, the bio-centre concept has spread to other settlements across the country such as Kisumu city where more bio-centres are being implemented and co-managed by community based organisations. As a result, there is notable reduction of water-related diseases such as typhoid and diarrhoea within the vicinity of bio-centres due to improved water services in the settlements and sensitization on proper waste management practices. Figure 3 below shows an attempt to map the distribution of bio-centres within Kibera settlement.

Figure 3: Distribution of community bio-centres within Kibera settlement

Community members and self-help groups benefited from capacity building and training schemes undertaken in collaboration with Umande Trust. For instance, Umande Trust offered training on leadership and governance; design, operation and maintenance of bio-centres; entrepreneurial skills; savings and credit systems; and hygiene education. A notable outcome of the training is the start of new businesses by members who previously did not have a form of earning a living. Some members have joined hands to start small projects at the bio-centre site such as fish farming using treated water from the bio-centre, tailoring, shoe repair, cyber café and retail shops. The bio-centre provides rental spaces that house such business, giving opportunities for community development. Some of the spaces is used as community library. In addition, the bio-centres offer community courses and access to internet that empowers the communities in accessing training material for environmental issues and micro-credit information. Employment opportunities have also been created through the creation of a site manager and caretaker positions to help in the day-to-day running of the facilities. More importantly, communities that have benefited from bio-centres contribute 10% of the net-income into a saving facility, which boosts individual member's savings and enables members to draw credit from this savings facility at a small interest. The savings kitty is further supplemented with funds from the government and non-governmental organisations in support of putting up new bio-centres due to growing demand for better water and sanitation services.

As earlier mentioned, not only do these centres provide basic services of water, toilets and bathrooms but also house income generating activities run by self-help groups. Groups have come up with innovative ways of collecting money from users using the beba pay card system. The beba pay card is an innovative cashless system that allows clients to load money using mobile money (Mpesa) into special cards. The cards are swapped in a smart phone which deducts the cost of service used at the bio-centre and instantly deposits the money in the group's account. Immediately, a client receives a confirmation message of the payment transaction. This technology has reduced the hustle and risk of handling bulky cash. More importantly, the beba pay card has improved transparency and accountability in the management of finances collected from the project. To encourage communities to use the card system, the service charge is lowered by one shilling. Where the card system is not yet used, monies collected is deposited into a group's bank account and book records are kept at the site to allow auditing. The business cum venture of the bio-centres have proved to be profitable with groups recording good returns from services offered.

Apart from acting as servicing projects, bio-centres have become feasible business ventures for low-income communities, improving their living standards.

5. Conclusion

This paper has highlighted how communities living in informal settlements of Nairobi are mobilising alternative ways of servicing their settlements with water and sanitation infrastructure. This is after decades of neglect by the state and prevailing market mechanisms in providing them with basic socio-economic infrastructure and services. As seen, this marginalisation has resulted into a spatial infrastructure pattern that exacerbates urban inequalities and denies the poor of their citizenship rights to clean water and adequate sanitation. The paper therefore argues for more inclusive infrastructure systems that promotes equitable service provision for all urban settlements.

The paper has identified a number of innovative features of the bio-centre projects implemented in Kibera, Korogocho and Mukuru. More prominently is the active community participation in the designing, implementation and management of the bio-centres. The bio-centre initiatives corresponds to the concept of social innovation, which as earlier expounded advocates for active engagement of marginalised communities in processes pertaining their welfare; community empowerment; and access to resources ordinarily not available to disenfranchised groups. Social innovation has therefore been a useful analytical framework in understanding the process involved in providing water and sanitation projects in the three case settlements.

As the cases demonstrate, through community organisations such as those of self-help groups, communities are able to forge partnerships that reinforces their access to socio-political resources in realising alienated societal needs. Whereas it might have been difficult for the public utility to extent their infrastructure lines into the settlements, the selected cases demonstrate that local communities can trigger changes in the urban infrastructure governance to promote inclusivity and social justice in service provision. Active engagement by communities can therefore greatly contribute towards transformation of institutional and governance structures, which lead to social and economic improvement of deprived communities and areas.

The foregoing cases exemplify how sustainable solutions can be reached through a bottom-linked and community-led process. Local communities are therefore capable of constructing novel and

pragmatic solutions that contributes to long-term community development. As observed, through active community participation, neglected residents of informal settlements have been empowered through provision of improved water and sanitation services using the bio-centre approach. The example of bio-centres can go a long way in solving complex issues of infrastructure provision to low-income settlements especially in rapidly transforming cities, where most of the population reside in informally developed settlements. Notwithstanding, the local planning authorities and state organs remain critical in public infrastructure provision and perhaps engaging more with city residents could potentially improve the living conditions of informal settlements.

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