

Research Paper

Differentiated and conflicting incentives across the sanitation value chain: the case of Sanergy in Nairobi

Mariam Zaqout ^{a,b,*}, Anna Mdee ^c, Dani Barrington ^d, Dorice Agol ^e and Barbara E. Evans ^a^a School of Civil Engineering, University of Leeds, Leeds, United Kingdom^b Current Address: The Bartlett School of Sustainable Construction, University College London, London, United Kingdom^c School of Politics and International Studies, University of Leeds, Leeds, United Kingdom^d School of Population and Global Health, The University of Western Australia, Perth, Australia^e Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, London, UK

*Corresponding author. E-mail: m.zaqout@ucl.ac.uk

 MZ, 0000-0001-6978-8252; AM, 0000-0002-8260-1840; DB, 0000-0002-1486-9247; DA, 0000-0001-5262-8092; BEE, 0000-0001-9815-3141

ABSTRACT

The challenge of achieving safely managed sanitation in low-income settlements in the context of rapid urban expansion in Nairobi is significant. National and county government plans for sanitation focus primarily on extending large-scale sewer systems, but in recent years, there has been increasing activity on non-sewered sanitation, particularly container-based sanitation (CBS) to potentially extend safely managed sanitation. Market-based CBS providers received extensive investment and promised to rapidly scale service delivery. Yet, progress has faltered, and scaling up is proving to be problematic. We apply a service characteristics analysis to examine the case of Sanergy, a CBS provider. Data are drawn from documents and stakeholder interviews. We demonstrate that misaligned incentives between stakeholders explain why extensive scaling up has (so far) failed to materialise. In particular, the creation of a self-sustaining faecal waste circular economy has proved to be elusive and highlights the need for the state to engage actively in sanitation provision as a public good.

Key words: incentives, market-based sanitation, political economy, public-private partnership, sanitation value chain

HIGHLIGHTS

- As market-based sanitation is increasingly promoted for low-income settlements, it is vital to assess its viability in the long-term.
- Understanding stakeholders' incentives towards funding sanitation through the lens of the service itself is crucial.
- Long-term resilience of sanitation services can only be achieved through collective agreement and partnership with all stakeholders involved.

INTRODUCTION

Kenya is a lower middle-income country that is rapidly urbanising. According to international definitions, in 2020, 33% of Kenya's population had access to at least basic sanitation (UNICEF/WHO 2021). The long-term sanitation goal for Kenya is sewerage sanitation across the country (NCWSC 2014). However, expanding sewer networks requires significant investments and is especially problematic in low-income settlements (LIS) with ambiguous and contested land ownership and control (van Welie *et al.* 2018; WSUP 2018; World Bank 2019).

In Nairobi, LIS residents have limited access to sewerage sanitation, despite being within the service area of the city sewer network operated by the Nairobi City Water and Sewerage Company (NCWSC), which covers 50% of the city according to the latest Shit Flow Diagram report for Nairobi (Dewhurst 2018). In 2009, the NCWSC created a department to support work in LIS, such as helping landlords to convert their pit latrines to pour-flush toilets and install connections to the sewer network (NCWSC 2022). However, progress is slow and hardly keeping pace with the growth of the city, in both formal and informal settlement areas (Fransen *et al.* 2024). Informal settlements in Kenya have become an experimental site for international NGOs selling novel non-sewered sanitation 'solutions' (Fischer *et al.* 2021). Such interventions often propose market-based

This is an Open Access article distributed under the terms of the Creative Commons Attribution Licence (CC BY 4.0), which permits copying, adaptation and redistribution, provided the original work is properly cited (<http://creativecommons.org/licenses/by/4.0/>).

logic and circular economy-based transformation. Yet they are heavily dependent on donor funding, are usually externally controlled, and are naive to local governance and politics. Mallory *et al.* (2022) explore this misalignment in relation to two container-based sanitation (CBS) social enterprises (Sanergy and Sanivation) and argue that there are fundamental mismatches in incentives and assumptions, which prevent these non-sewered sanitation ‘solutions’ from delivering promised transformation to sanitation conditions in Nairobi’s informal settlements. They argue critically that rhetorical and constitutional commitments by the Kenyan state to a human right to sanitation have little political traction in practice.

McLoughlin & Batley (2012) suggest that in seeking to understand the political nature of public and private investment in service provision, it is necessary to understand the characteristics of that service. This paper offers a novel application of the services characteristics approach to the case study of CBS (Sanergy) in Nairobi, to reveal the nature of differentiated incentives between stakeholders. We disaggregate this analysis across the sanitation value chain. In this way, we build on Mallory *et al.* (2022) in providing a more extensive explanation of incentives. We also contribute to the regime analysis of Van Welie *et al.* (2018) who characterise Nairobi as having a ‘splintered sanitation regime’, meaning that different sanitation service regimes (e.g. CBS) are not integrated in the formal sanitation regime. We suggest that a greater understanding of differentiated incentives might encourage more realistic discussions of routes to sanitation transformation for informal settlements. In particular, we seek to re-examine the role and responsibilities of the state (both national and at city level) in enabling improved sanitation for all.

METHODS

This study is based on a combination of (1) peer-reviewed publications; (2) grey literature about Sanergy, CBS, and the political economy (PE) of water and sanitation in Nairobi; and (3) semi-structured interviews with Sanergy staff, PE experts, and other stakeholders. We conducted a systematic search of peer-reviewed literature about Sanergy and sanitation in Kenya using Scopus, Web of Science, and Google Scholar in January 2021, in addition to resources of specialised websites such as Engineering for Change. The search resulted in 19 documents as well as recent three publications before submitting this manuscript.

We conducted a mix of online and in-person semi-structured interviews with the Sanergy staff (six interviews), PE and water, sanitation and hygiene (WASH) experts (five interviews), governmental organisations (three interviews), local NGOs (two interviews), and potential Sanergy customers and workers (four interviews in Mukuru), detailed in Appendix 1. The interviewing started in May 2021 and ended in March 2022. The interviewees were selected to discuss the key topics related to the service characteristics issues explained in the next section. The interviews covered (1) knowledge questions about the roles and responsibilities in providing sanitation, and (2) opinion and value questions to understand the interviewees’ perceptions regarding the dynamics between stakeholders. The sample size of the research participants was kept minimal to forgo the exploitive nature of research conduct. Similarly, expert interviews were intended to replace interviewing households since the study area has been subject to extensive research projects of which some are cited in this paper. Ethical approval was granted by the School of Social Science Human Research Ethics Committee at the University of Leeds (AREA 20-114). All the participants provided either verbal or written consent to take part in the study. We analysed the research data in two stages taking into account how Sanergy organised its services (the containment, collection, and transport are coupled together, and treatment is separated) across the sanitation value chain. First, we conducted inductive thematic analysis (demonstrated in Appendix 2) of both the literature and the interviews to develop an in-depth understanding of the institutional and economic features of Nairobi (Ulin Robinson & Tolley 2005). Second, we analysed each segment of Sanergy’s services using the service characteristics framework to investigate the key stakeholders’ roles: Sanergy, toilet users, Fresh Life (FL) operators, and the Nairobi City County. McLoughlin & Batley (2012) created the service characteristics framework that collates a set of service economic and institutional characteristics (Figure 1) and how those characteristics influence stakeholders’ incentives. We addressed four components of the framework: firstly, the nature of a good (characterised by rivalry¹ and excludability²) defines whether a good is a private, public, or in between; secondly, the market failure characteristics that influence the marketability of a service such as externalities and monopoly tendency; thirdly, the task-related characteristics that define the service provision arrangements; finally, the demand-related characteristics that impact or drive service demand and collective action such as territoriality. We did not systematically use all the concepts

¹ Rivalry occurs when consuming a good/service by an individual subtracts it from others.

² Excludability is the ability to deny non-payers access to a service.

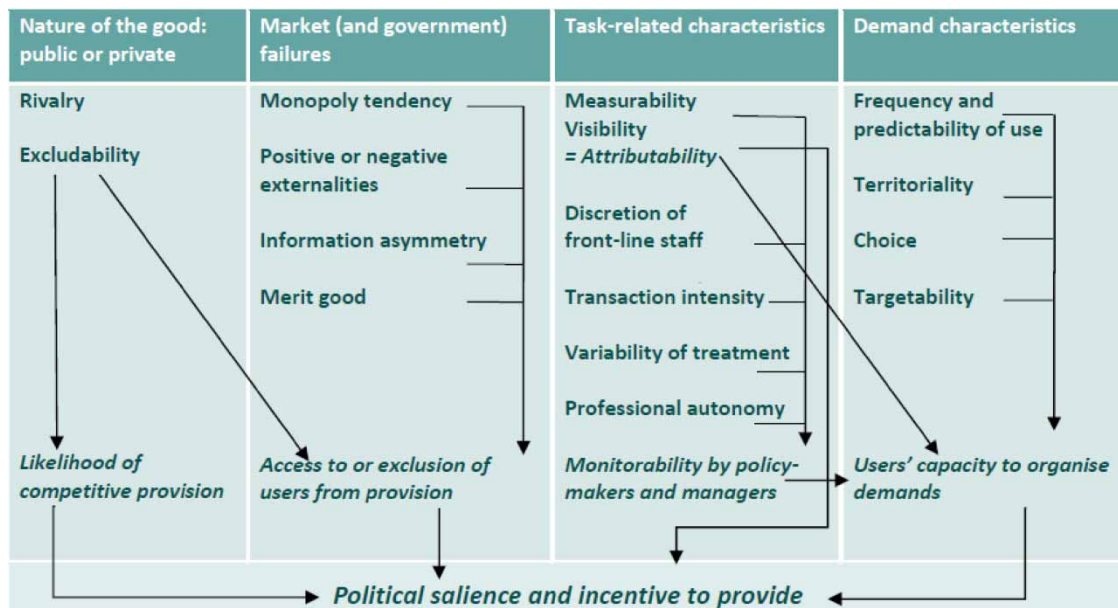


Figure 1 | The composite impact and relations between service characteristics (Batley & Harris 2014).

covered in the framework as we noticed that some characteristics are irrelevant to the case of Sanergy in our early thematic analysis. For example, territoriality is associated with people's capacity to organise themselves to demand basic services, which is not part of the interactions with Sanergy.

Case study description – Sanergy social enterprise

Sanergy is a self-portrayed 'social enterprise' that started operations in 2012 to deliver CBS service in LIS in Nairobi, Kenya. A social enterprise is a revenue-generating business that aims to achieve social, cultural, community economic, and/or environmental outcomes while generating revenue (The BC Centre for Social Enterprise 2022). Sanergy runs services that cover the containment, collection, transport, and treatment of faecal waste in Mukuru and Mathare in Nairobi (Auerbach *et al.* 2020). In 2020, Sanergy estimated its served population to be 132,000 persons per day through 3,300 toilets and handling a total of 12,000 tons of waste annually (Auerbach *et al.* 2020). Sanergy's model received recognition from development organisations such as the CBS Alliance (Auerbach *et al.* 2020). Nevertheless, investors were reluctant to fund/invest since it looked like 'a complicated venture' of profit and non-profit business models (Auerbach *et al.* 2020).

Sanergy has split its enterprise into two entities to appeal to different partners. The non-profit entity – FL – provides access to shared toilets – FL Toilets (FLTs) – and faecal sludge (FS) collection and transport for the serviced residents. The non-profit's work provides a rationale to philanthropic donors, of achieving social returns by providing affordable sanitation to the poor. The profit-generating company – Sanergy Limited – treats the collected FS and manufactures waste recovery products such as livestock feed and organic fertilisers. The potential returns on investments for the for-profit entity provides financial guarantees to attract private investments. At first, the Nairobi City County was hesitant about the appropriateness of the CBS³ technology used by Sanergy and only accepted it as an improved sanitation option 6 years after Sanergy's inception (World Bank 2019).

The FL initiative provides access to FLTs through FL operators (usually landlords) who are contracted by Sanergy. FLTs are onsite CBS systems. FLTs use urine-diversion to render the removal and transport of excreta in dense unplanned urban areas more easily (Auerbach 2016). Sanergy produces prefabricated toilets whose walls are assembled at the final location. Originally, FLTs could be bought, or leased on a monthly subscription, although only the subscription arrangement is now available. When leasing an FLT, the operator pays an 8.5 USD monthly subscription for renting the facility. The costs of

³ The technology has rapidly progressed to become recognised as a type of improved sanitation by the UN. However, the scaling of this technology has been slow.

FS collection and transport are covered by the subscription fee (Auerbach 2016). To promote uptake of FLTs, the Sanergy sales team raises awareness about sanitation and promotes the FLTs among the targeted communities. Upon securing interest, Sanergy and the new operator sign a franchise agreement to rent the facility and agree on the operation and maintenance arrangements and within 2 days, and then Sanergy installs the facility (Sanergy Staff #4). The customer support team provides training and operational support to the FL operators to ensure that they meet quality standards and how to access support from Sanergy (Sanergy Staff #5).

The contracted operators must own the land or have formal access (e.g., allotment by the government). Sanergy can assist operators to approach the county government to get the allotment (Sanergy Staff #3). The credit team assesses an operator's ability to pay for the service. The FL operators have access to interest-free financing from Kiva (online micro-lending platform) to cover the upfront payment (Sanergy Staff #3). Sanergy recruits and contracts FL operators with four different models: commercial public toilets, institutional toilets such as schools, residential toilets managed by landlords, and in-home Fresh Fit toilets for use by individual families (Auerbach 2016; World Bank 2019).

The price charged to the toilet users is left to FL operators to decide but is generally similar to the fees charged by non-FLT providers for toilet/latrines use to make it a competitive option (Sanergy Staff #6). Landlords do not explicitly pass on the cost to their tenants but provide the service to retain tenants (Sanergy Staff #6). Each FLT typically serves four families or 34 people. Besides constructing FLTs, Sanergy also offers a service to convert existing pit latrines to FLTs which is more expensive than constructing FLTs from scratch, but targets a bigger market (World Bank 2019).

Sanergy employs a logistics team to run the collection, transport, and treatment operations. The logistic team replaces the full containers of the FLTs with empty ones and transports the full containers to a transfer station using a truck or tuk tuk (a three-wheeler vehicle) (World Bank 2019). The faeces are then consolidated in large drums at the transfer station (one drum per 10 toilet containers) and then transported by exhauster trucks to the treatment plant. The urine is collected and dumped into nearby sewers since it is currently not financially viable to reuse it. The collection and transport of the containers was initially daily, but it was changed in 2016 to improve efficiency and adapt with the demand patterns of the FLTs.

Sanergy operates a treatment plant on land leased from the government. The treatment uses aerobic composting to produce organic fertiliser and biomass briquettes. Besides treating FS, Sanergy also collects organic waste from various institutions (including slaughterhouses, hotels, and public offices) to increase the yield of their products. The demand for the organic fertilisers was low since the chemical fertilisers were cheaper and more socially acceptable, which required Sanergy to increase their marketing efforts.

RESULTS

This section presents the dynamics and incentives associated with each segment of Sanergy's services broken down as: FLTs, FS collection and transport, and FS treatment and waste recovery products.

Fresh Life toilets

The technical features of the FLTs make it a club good since Sanergy and the landlord operators exclude users who are not part of the served housing while it remains a non-rival good. However, for each stakeholder, the nature of the good is different. In Nairobi LISs, the landlord monopolises toilet provision. Tenants use whatever facility their landlord provides. For that reason, users are not involved in the choice of provider or the selection of an FLT, its hygiene, or maintenance. Tenants only pay a marginal cost bundled along with rent (or a negligible cost if they were already living in the compound when the FLT was installed). So, for the users, FLTs become simply a monopolistic or choice-restricted provided service.

By contrast, the FLT is a private good for the landlords since they can choose one of a range of toilet types offered in a free market. Buying or subscribing for a toilet generates additional income (through raising the rent, or at least retaining tenants, and collecting entry fees in some cases) so it has monetary value for the landlord. The FLTs are marketed to the landlords, who are often required to provide a toilet in the vicinity of their housing blocks as per their tenancy agreement with the tenants. There are no quality or service-level standards for the landlord to abide by, so a landlord would only choose the FLT if it were cheaper or more convenient to *him/her* than other options. In addition, landlords do not want to pass additional costs onto their tenants who might not be willing to pay for higher quality services taking into account their other competing needs (Grinnell College 2014). The other options on the market (e.g., shared pit latrines) are mostly cheaper since non-FLT operators offer the facility but do not necessarily include safely managed FS collection and transport. Consequently, Sanergy offers FLTs at a subsidised rate to compete for landlords' demand (Sanergy Staff #6).

FS collection and transport

The FS collection and transport is, in theory, a private good since non-payers can be excluded easily, and it is a rival since a truck or a tuk tuk can only collect a limited amount of FS in each trip. However, Sanergy's current business model made this service a public good. The FS collection and transport service is coupled with the FLT service and provided free of charge to the FL operators who are obliged by their contract with Sanergy to coordinate with the logistics team to collect the FS. For owners and operators of pit latrines, the FS collection and transport service is offered for a subsidised fee to compete with other emptying services (Sanergy Staff #4). A pit latrine owner suggested that these operators tend to only empty their facility when it is nearly full (14 October 21), which implies that there is no regular/planned collection from non-FLT toilet operators and the currently limited potential to recruit more subscribers beyond the FLTs.

In general, safely managed FS collection and transport services have little or no market value because users are only interested to pay for the basic collection (private good) that does not necessarily include safe transport (a public good). This is why the government heavily subsidises sewerage sanitation (Dodane *et al.* 2012). Sanergy manages collection and transport under their non-profit entity, along with the FLT facilities, as it contributes to their non-profit mandate to extend affordable and safely managed sanitation for LIS. Service providers (including landlords) offering competing services to Sanergy in Nairobi settlements only use FS collection and transport services when the pit is full and becoming unfunctional, which keeps costs low and is possible because there are no regulations or law enforcement to encourage regular emptying. This lack of regulation also means that even when toilet operators pay for the service (by non-Sanergy providers), it is usually a minimal fee to remove the sludge and dump it nearby without safe disposal. In Nairobi's LIS, users are not expected to pay for FS collection and transport, nor do they have an incentive to do so; transporting the waste to treatment is a purely public good offering little personal benefit. For these reasons, Sanergy bundles the FS collection and transport with the toilet in the contract with FL operators, because Sanergy values FS collection and transport as part of their social mandate as well as the economic value for manufacturing waste recovery products.

Faecal sludge treatment and waste recovery

The FS treatment infrastructure is a natural monopoly that requires high capital costs that the private sector cannot afford to provide without subsidies. It is a public good with positive externalities, and in a free market, the private sector would underfund it. In theory, the Nairobi City County would provide the treatment service since it affects public health and the environment (Arrow 1951). However, there is no evidence that the county would provide enough of these treatment plants. For this reason, Sanergy runs their FS treatment and waste recovery business under the Sanergy Limited Company.

The sale of waste recovery products to local farmers is the only potential revenue stream for the treatment service. Sanergy does not collect treatment fees from the waste generators since the treatment does not have any private value for them (whether the waste is treated is not of private value to them, only that it has left their premises). In most contexts, citizens do not willingly pay for a public good such as FS treatment; they would potentially pay if the government enforced regulations and taxes for individuals to cover it (Sadoff *et al.* 2003). The imposition of treatment fees would require the intervention of a regulatory body.

So, for the treatment plant to increase production, Sanergy must increase FS collection. Currently, the sale of the waste recovery products does not recover the operation costs, and Sanergy fills this gap from their philanthropic donors who, like Sanergy, value the positive externality of safely treating and disposing of waste. Even though the treatment segment produces a marketable good (the waste recovery products), it is still a public good that would require large subsidies to remain financially viable. Table 1 summarises the key stakeholders' incentives to contribute to the three elements of Sanergy's services and how it would theoretically incentivise them to contribute to it.

DISCUSSION

In this section we reflect on three service characteristics to explain the mismatch of incentives among stakeholders to fund sanitation.

The nature of a good spectrum

The nature of a good, along with other factors, dictates who provides the service. Some services in the sanitation value chain are naturally public goods such as the FS treatment and disposal because the provider would incur extra costs to exclude non-payers from use (non-excludable) and using it does not subtract it from others (non-rival) (Ostrom & Ostrom 1980; Harner

Table 1 | Stakeholders' incentives towards contributing to Sanergy's services

Service	FLT	FS collection and transport	FS treatment and waste recovery
User	(+/-) Club good (-) Positive externalities (-) Regulated monopoly ^a	(-) Public good (-) Positive externalities (-) Regulated monopoly ^b	(-) Public good (-) Positive externalities (-) Natural monopoly
Landlord	(+) Private good (-) Positive externalities (+) No monopoly	(+) Private good (-) Positive externalities (-) Regulated monopoly	(-) Public good (-) Positive externalities (-) Natural monopoly
Sanergy	(+) Private and public good (+) Positive externalities (-) No monopoly	(+) Private and public good (+) Positive externalities (+) Regulated monopoly	(+) Private and public good (+) Positive externalities (+) Natural monopoly
Nairobi City County	(-) Club good (+) Positive externalities (-) No monopoly	(+) Public good (+) Positive externalities (+) Regulated Monopoly	(+) Public good (+) Positive externalities (+) Natural monopoly

Note: (+): Positive incentive to pay/fund; (-): Negative incentive to pay/fund.

^aUsers are only allowed to use the facility that their landlord decides to provide.

^bSanergy monopolises the FS collection and transport for FLTs.

The bold text signifies positive incentives.

et al. 1986). Due to the non-excludability and non-rivalry of public goods, the market fails to provide it which requires that the state subsidise it. In this study, we have seen that Sanergy attempts to market the treatment segment as a private good open for private investments by focusing on its waste recovery segment through its for-profit entity to appease private investors. Nevertheless, this segment is still a public good and the financial returns of the sale of waste recovery products are not guaranteed, which may eventually lead to failure unless the state intervenes. Farmers' acceptability and uptake of waste recovery products is still low in Kenya because of the uncertain impacts on crop yield and the disgust of using fertilisers made from human waste (MoWS #2).

On the contrary, Sanergy presents the FS collection and transport as a mix of public and private goods by providing it free of charge to the FL operators (landlords) and at a subsidised fee for non-FL operators through the non-profit entity. Such a service is traditionally provided by independent sanitation workers in the context of LIS as a private good. *Dodane et al.* (2012) and *Daudey* (2018) suggest that the collection and transport of FS from onsite sanitation should be eligible for state subsidies as its equivalent in offsite sanitation (sewer networks) is highly subsidised by the state. However, this is not the case in Kenya even though sewer users pay significantly more than those who use onsite sanitation. Such bias usually occurs because the provider of the sewer network is affiliated with/or owned by the state (*Daudey* 2018). Reluctance to subsidise Sanergy's services is fuelled by the ownership dilemma of the service by Sanergy. Three key informants argued that the Nairobi City County (NCC) is asset-oriented and would require ownership of the infrastructure to fund it which is against Sanergy's approach (WASH Expert #1; WASH Expert #4 NCWSC staff). For the containment segment (FLT), Sanergy kept it a club good since it is non-rivalrous between the users but excludes non-payers. Nevertheless, for landlords, who are the potential customers of Sanergy, the FLT is a private good since they do not share it with other landlords.

In the three segments, we showed how for the users (households) the nature of a sanitation good aligns with the inherent nature of the infrastructure used (e.g., shared container-based facilities, FS treatment plants) in terms of excluding non-payers and its rivalrous nature. The users' incentives did not change the economic nature of sanitation for them since the landlords make decisions about sanitation provision on behalf of them.

Subsidising externalities

Delivering safely managed sanitation services create positive externalities such as improved public health and environmental protection. Externalities are associated with public goods such as large-scale FS treatment plants. As summarised in *Table 1*, positive externalities run through the three segments of the sanitation value chain in the case of Sanergy, which some readers might argue are not public goods in nature. Indeed, the service level that Sanergy claims to provide exceeds the service level (the private or public good aspect) that the served community would pay for (as represented by the negative signs in *Table 1*) taking into account their competing spending priorities such as food and housing. A study on LIS in Nairobi showed that people's transition to improved sanitation is slower than their transition to improved water and solid waste services and

the relapse to unimproved sanitation is faster than their relapse to unimproved water and solid waste services (Iddi *et al.* 2021).

Externalities, by definition, involve benefits/costs to a third party that are not reflected in the price (Hyman 2011). Subsequently, the private sector would under-provide services with high externalities and the state would step in to fix market failure by subsidising those externalities (Arrow 1951). Although Sanergy claims to be an enterprise, it does provide the service, despite its high externalities, by subsidising their services from its philanthropic grants. In other words, Sanergy mimics the role of the state by internalising the service's externalities. Nevertheless, depending on philanthropic grants to do so does not guarantee long-term viability of this model. The NCC heavily subsidises the segments of sewer-based sanitation that are public goods with positive externalities. However, they show little interest in funding the commensurate segments of Sanergy's service despite their incentives being well aligned as shown in Table 1.

Monopolising sanitation

Services that require large-scale initial investments such as FS treatment plants pose entry barriers to small providers and require monopolistic provision (Samuelson 1948). Ultimately, the provider would monopolise the service and benefit from the economy of scale to minimise cost per unit production. Sanergy was able to provide the FS treatment segment despite its monopoly tendency thanks to its investors and access to land from the government. However, the potential of scaling it is questionable.

First, scaling FS treatment and waste recovery depends on monopolising or at least scaling prior elements of the sanitation value chain (FLT and FS collecting and transport). However, those two segments, particularly in onsite sanitation, are not natural monopolies, nor do they have obvious economies of scale since people are not connected to a network and can opt into different arrangements (Debaere & Kapral 2021). Indeed, Mallory *et al.* (2022) argue that scaling CBS would incur more costs because of its high operational transactions. Moreover, current cost recovery is low, which is potentially due to the mismatch between the interests of the provider and the customer regarding the service level and its cost. The financial viability of Sanergy's business model could also be a key reason behind the low cost recovery, which is beyond the scope of this paper.

Second, Sanergy builds the case of scaling the service on the potential to receive result-based financing from the NCC, which is unlikely, considering their views on CBS (Auerbach *et al.* 2020). Representatives from the Ministry of Water, Sanitation, and Irrigation and from Sanergy highlighted the government's institutional support through licencing, but there has been little financial backing (e.g., subsidies, loans). The government and its partners perceive Sanergy as a short-term venture due to their technology. As one interviewee puts it, *'if we have enough good services [sewerage network], then we can enforce sewerage through policies, but for now ... we are co-existing with Sanergy, and other service providers and I don't know for how long'* (13 August 2021).

Sanergy acknowledges that their work is not in line with the government's aim to extend sewerage and it is only a transitional point to ensure that LIS have access to sanitation. van Welie *et al.* (2018) described the diverse sanitation services in Nairobi as a splintered regime; it has multiple sanitation services that meet different needs and preferences, but those services fail to align with each other. Currently, the CBS technology does not fit with sewer-based sanitation (for example, public flush toilets are better fit to sewer-based sanitation since both are water-borne technologies). Therefore, if Sanergy is interested to scale the service, it is vital to illustrate how it functions within the wider service delivery endorsed by Nairobi City County including its long-term ambition to extend sewer-based sanitation (NCWSC 2014).

CONCLUSIONS

We have interrogated Sanergy's sanitation services in LIS in Nairobi, Kenya, to understand the prevailing incentives to fund it. There is a mismatch between the cost of the provided service and its affordability, which hinders scaling the service. Whether the goal is sewer-based sanitation, CBS, or other infrastructure, providing equitable and sustainable services require financial commitments to fill the gap between service cost and users' capacity and willingness to pay. Services, across the sanitation value chain, constitute different types of economic goods. The containment segment is mostly a private or a club good while the treatment segment is a public good. The different types of goods can dictate stakeholders' willingness to contribute to the service. In addition, the will to internalise the externalities (e.g., improving public health and environmental protection) of delivering sanitation, which is an attribute of public goods, varies among stakeholders based on

their financial capacity and values. Therefore, scaling a certain type of sanitation service requires understanding and aligning stakeholders' incentives to contribute to it throughout the sanitation value chain.

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.

REFERENCES

- Arrow, K. J. 1951 *Alternative approaches to the theory of choice in risk-taking situations*. *Econometrica* **19** (4), 404–437. <https://doi.org/10.2307/1907465>.
- Auerbach, D., Rosenberg, R., Poulet, I. & Kibuthu, S. 2016 Broken pumps and promises. In: *Broken Pumps and Promises: Incentivizing Impact in Environmental Health* (Thomas, E. A., ed.). Springer. <https://doi.org/10.1007/978-3-319-28643-3>.
- Auerbach, D. *et al.* 2020 It does not take a unicorn: how cities can attract private sector participation in addressing the urban sanitation crisis [version 1; not peer reviewed]. *Gates Open Res* **2020**, 4, 23. <https://doi.org/https://doi.org/10.21955/gatesopenres.1116588.1>.
- Batley, R. & Harris, D. 2014 Analysing the politics of public services: a service characteristics approach (Shaping Policy for Development, Issue April). <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8913.pdf>
- Daudey, L. 2018 *The cost of urban sanitation solutions: A literature review*. *Journal of Water Sanitation and Hygiene for Development* **8** (2), 176–195. <https://doi.org/10.2166/washdev.2017.058>.
- Debaere, P. & Kapral, A. 2021 *The potential of the private sector in combating water scarcity: The economics*. *Water Security* **13**. <https://doi.org/10.1016/j.wasec.2021.100090>.
- Dewhurst, R. 2018 *SFD Thinking: SFD Creation Process and Impacts: Case of Nairobi, Kenya*. Available from: <https://www.the-star.co.ke/news/2018/07/06/most->
- Dodane, P., Mbéguère, M., Sow, O. & Strande, L. 2012 *Capital and operating costs of full-scale fecal sludge management and wastewater treatment systems in Dakar, Senegal*. *Environmental Science and Technology* **46** (7), 3705–3711. <https://doi.org/10.1021/es2045234>.
- Fischer, K., Kokko, S. & McConville, J. 2021 *No legitimacy: A study of private sector sanitation development in the Global South*. *Environmental Innovation and Societal Transitions* **38** (August 2020), 68–78. <https://doi.org/10.1016/j.eist.2020.11.006>.
- Fransen, J., Hati, B., van Stapele, N., Kiriro, S. & Nyumba, R. 2024 *Resilience pathways of informal settlements in Nairobi: Stasis, decline, adaptation, and transformation*. *The European Journal of Development Research*. <https://doi.org/10.1057/s41287-023-00605-w>.
- Grinnell College 2014 *Sanergy Q&A (YouTube Video)*. Available from: <https://www.youtube.com/watch?v=UyEb7rLQqcg> (accessed 24 November 2020).
- Harner, H., Hamel, P., Harris, A. & Smith, J. 1986 Where have all the midnight dumpers gone? 191st National Meeting - American Chemical Society, Division of Environmental Chemistry, pp. 155–158.
- Hyman, D. N. 2011 *Public Finance: A Contemporary Application of Theory of Policy*, 10th edn. South-Western Cengage Learning, Mason, OH.
- Iddi, S., Akeyo, D., Bagayoko, M., Kiwuwa-Muyingo, S., Chikozho, C. & Kadengye, D. T. 2021 *Determinants of transitions in water and sanitation services in two urban slums of Nairobi: A multi-state modeling approach*. *Global Epidemiology* **3**. <https://doi.org/10.1016/j.gloepi.2021.100050>.
- Mallory, A., Mdee, A., Agol, D., Hyde-Smith, L., Kiogora, D., Riungu, J. & Parker, A. 2022 *The potential for scaling up container-based sanitation in informal settlements in Kenya*. *Journal of International Development* 1–15. <https://doi.org/10.1002/jid.3639>.
- McLoughlin, C. & Batley, R. 2012 *The Effects of Sector Characteristics on Accountability Relationships in Service Delivery*, Working paper 350. London. <https://doi.org/10.2139/ssrn.2209074>.
- NCWSC 2014 *Nairobi City Water and Sewerage Company Strategic Plan 2014/15–2018/19*. Nairobi. Available from: https://www.nairobewater.co.ke/wp-content/uploads/2021/02/SP_popular_version-1.pdf (accessed 12 March 2024).
- NCWSC 2022 *Nairobi Sanitation OBA Project – Sanitation Connections in Informal Settlements*. Available from: <https://www.nairobewater.co.ke/nairobi-sanitation-oba-project-sanitation-connections-in-informal-settlements/> (accessed 16 June 2022).
- Ostrom, E. & Ostrom, V. 1980 Public Economy Organization and Service Delivery. In *Elinor Ostrom and the Bloomington School of Political Economy Volume 3, A Framework for Policy Analysis* (D. H. Cole & M. McGinnis, eds.). Lexington Books, Lanham, MD.
- Sadoff, C., Whittington, D. & Grey, D. 2003 *Africa's International Rivers: An Economic Perspective*. World Bank Group, Washington, DC. <http://documents.worldbank.org/curated/en/476721468741625220/Africas-international-rivers-an-economic-perspective>.
- Samuelson, P. 1948 *Economics*, 1st edn. McGraw-Hill, New York.
- World Bank Group, Washington, DC. <http://documents.worldbank.org/curated/en/476721468741625220/Africas-international-rivers-an-economic-perspective>
- The BC Centre for Social Enterprise 2022 *Social Enterprise – Do Definitions Matter?* Available from: <https://www.centreforsocialenterprise.com/what-is-social-enterprise/> (accessed 14 May 2022).

- Ulin, P. R., Robinson, E. T. & Tolley, E. E. 2005 *Qualitative Methods in Public Health: A Field Guide for Applied Research*, 1st edn. Jossey-Bass, Thousand Oaks, CA. <https://doi.org/10.4135/9781483384511>.
- UNICEF/WHO 2021 *Progress on Household Drinking Water, Sanitation and Hygiene (2000–2020): Five Year into the SDGs*. World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF), Geneva.
- van Welie, M. J., Cherunya, P. C., Truffer, B. & Murphy, J. T. 2018 *Analysing transition pathways in developing cities: The case of Nairobi’s splintered sanitation regime*. *Technological Forecasting and Social Change* **137** (February), 259–271. <https://doi.org/10.1016/j.techfore.2018.07.059>.
- World Bank 2019 *Evaluating the Potential of Container-Based Sanitation: Sanergy in Nairobi, Kenya*. World Bank, Washington, DC.
- WSUP 2018 *A Journey of Institutional Change: Extending Water Services to Nairobi’s Informal Settlements*. Water & Sanitation for the Urban Poor, London. <https://wsup.com/wp-content/uploads/2018/10/10-2018-A-journey-of-institutional-change-Extending-water-services-to-Nairobi%E2%80%99s-informal-settlements.pdf>.

First received 22 December 2023; accepted in revised form 19 June 2024. Available online 1 July 2024