



Delft University of Technology

Evaluation of Business Models for Fecal Sludge Emptying and Transport in Informal Settlements of Kampala, Uganda

Singh, Shirish; Laker, Florence; Bateganya, Najib L.; Nkurunziza, Allan G.; Semiyaga, Swaib; Brdjanovic, Damir

DOI

[10.3390/w14182914](https://doi.org/10.3390/w14182914)

Publication date

2022

Document Version

Final published version

Published in

Water (Switzerland)

Citation (APA)

Singh, S., Laker, F., Bateganya, N. L., Nkurunziza, A. G., Semiyaga, S., & Brdjanovic, D. (2022). Evaluation of Business Models for Fecal Sludge Emptying and Transport in Informal Settlements of Kampala, Uganda. *Water (Switzerland)*, 14(18), Article 2914. <https://doi.org/10.3390/w14182914>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

Article

Evaluation of Business Models for Fecal Sludge Emptying and Transport in Informal Settlements of Kampala, Uganda

Shirish Singh ^{1,*†}, Florence Laker ^{1,2,†}, Najib L. Bateganya ³, Allan G. Nkurunziza ³ , Swaib Semiyaga ⁴ and Damir Brdjanovic ^{1,5}

¹ Department of Water Supply, Sanitation and Environmental Engineering, IHE Delft Institute for Water Education, Westvest 7, 2611 AX Delft, The Netherlands

² International Water Association, 1 Clove Crescent, East India, London E14 2BA, UK

³ Kampala Capital City Authority (KCCA), Plot 1-3 Apollo Kaggwa Road, Kampala P.O. Box 7010, Uganda

⁴ Department of Civil and Environmental Engineering, Makerere University, Sir Apollo Kaggwa Rd, Kampala P.O. Box 7062, Uganda

⁵ Department of Biotechnology, Faculty of Applied Sciences, Delft University of Technology, Van der Maasweg 9, 2629 HZ Delft, The Netherlands

* Correspondence: s.singh@un-ihe.org

† These authors contributed equally to this work.

Abstract: Various business models for fecal sludge emptying and transport have been developed to address challenges and their advantages have been documented; however, their evaluation has not been investigated. This study developed an evaluation framework, which was tested in informal settlements in Kampala for sustainable business models of fecal sludge emptying and transport. Through key informant interviews and stakeholder consultations, service delivery challenges from informal settlements in Kampala were identified and included in the framework, which were: high cost of emptying services, spillages, access to facilities, high operational costs and social stigma. The evaluation framework adopted six service criteria: Financial, Institutional, Environmental, Technological, Social and Scalability; these were further defined by fifteen service sub-criteria. The criteria were tested separately on eight business models—for mechanized (cesspool) and semi-mechanized (gulper) technologies. The key output of the evaluation framework (business model scorecard) revealed that two models (scheduled desludging and call center) for cesspool technology and three models (mobile transfer stations, scheduled desludging and call center) for gulper technology have high potential for service improvement in informal settlements. Scheduled desludging and mobile transfer stations can effectively optimize emptying services and subsequently reduce emptying charges, whereas the call center is critical for bridging service delivery.

Keywords: fecal sludge; emptying and transport; business models; informal settlements; evaluation framework; Kampala city



Citation: Singh, S.; Laker, F.; Bateganya, N.L.; Nkurunziza, A.G.; Semiyaga, S.; Brdjanovic, D. Evaluation of Business Models for Fecal Sludge Emptying and Transport in Informal Settlements of Kampala, Uganda. *Water* **2022**, *14*, 2914. <https://doi.org/10.3390/w14182914>

Academic Editor: Hongyu Ren

Received: 7 August 2022

Accepted: 14 September 2022

Published: 17 September 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

On-site sanitation systems (OSS) serve more than 2.7 billion people globally [1]. Approximately 80% of urban residents in Sub-Saharan Africa and over 90% in Kampala city rely on OSS, the majority of whom are in informal low-income settlements [2,3]. Indicator 6.2.1 (a) of the Sustainable Development Goals underscores the importance of “safely managed sanitation services”, i.e., Fecal Sludge Management (FSM) for OSS, focusing on the entire sanitation service chain, entailing containment; emptying and transport; treatment; disposal/re-use [4,5].

FSM services are a vital component of urban sanitation services in cities of many developing countries, with increasing recognition as part of the solution to complement off-site sanitation or sewerage services [5]. FSM services require safe emptying of containments and safe transport to treatment site(s), adequate treatment and/or safe disposal or end-use [6,7].

Typically, FSM services are the mandate of government but in recent times the private sector has taken an increased role in FSM service provision. Public–private partnership is necessary to ensure provision of quality and affordable FSM services to all, with the private sector taking lead in FSM service provision and government authorities providing regulatory oversight [1,8]. However, Fecal Sludge (FS) emptying and transport service provision is dominated by private operators who are informal and unregulated [1,5,9]. In addition, high housing density, lack of access to containments and lack of capacity to pay for emptying services hinder coverage and effective and quality provision of emptying services, particularly in informal settlements that host more than half of the urban population in Sub-Saharan Africa [1,9–12]. To address challenges of service delivery in informal settlements and meet sanitation needs of poor urban residents (who are unserved or underserved), there is a need for pragmatic approaches across the sanitation service chain that are effective, sustainable and affordable. This requires innovative solutions in service provision or business models beyond just advancement in emptying technology (mechanized and semi-mechanized) and infrastructure. Moreover, business models and technologies need to be scalable and appropriate to meet local demands of the FSM market [1].

In Kampala, most of the FS emptying and transport service is provided by the private sector and is largely rudimentary, informal and unregulated. There are mainly two types of FS emptying and transport technologies: (i) cesspool (140 in number) and gulper (15 in number). Cesspool is a mechanized FS emptying and transport technology encompassing a pump for emptying, which is collected in a tank with varying sizes ranging from 2 to 15 m³ and transported through a vehicle (usually a truck). Gulper is a semi-mechanized technology encompassing a gulper to empty FS, which is collected in 200 L barrels and transported using tricycles and vehicles.

Various business models have been developed to address challenges and meet demands for FS emptying and transport and these include: transfer stations, franchise, non-profit, call center, incentivized, licensing and scheduled desludging. Some of the business models documented with advantages to service authority/regulator, service provider and service user include: revenue maximization through optimization of emptying services; cost reduction and increased coverage due to reduction in travel distance; possibility of reduction in emptying fees/charges; environmental protection through safe disposal of sludge. Some examples are: (i) mobile transfer stations reduced transport distance by 12 km per trip in Addis Ababa, Ethiopia; (ii) the call center reduced emptying fees by 14% and increased volume of sludge delivered to treatment plant in Senegal; (iii) scheduled desludging reduced emptying fees and improved business operations in the Philippines [4].

Apart from advantages of various models, including application in an informal settlement, little is known about evaluation and the optimized selection of models. Therefore, there is a need for evaluating potential business models that could result in decreased expenditure for households while remaining profitable to the private sector. This will ensure inclusivity, affordability and accelerating the sanitation service, particularly in informal settlements in the city. The main objective of this study was to develop an evaluation framework for assessing business models of FS emptying and transport that can potentially be applied in informal settlements.

2. Materials and Methods

2.1. Study Area

This study was conducted in two informal low-income settlements/parishes of Kanyanya and Lukuli in Kampala with high population densities of 10,058 people/km² and 8228 people/km², respectively [13]. In addition to high population densities, they are characterized by high housing density, high poverty levels, frequent flooding, a high water table and high prevalence of unimproved and poor-quality sanitation facilities [9,12,14]. High housing density limits access to mechanized cesspool trucks to empty all OSS [12], and low capacity to pay for emptying services renders the FS emptying service unaffordable for poor urban residents whose average daily income is approximately USD 2 [9].

2.2. Approach and Methodology

The study sought to develop a framework for the evaluation of business models against a set of service delivery criteria. The framework was contextually developed, taking into consideration service delivery challenges in informal settlements of Kampala city. To develop service criteria for assessing business models, anonymized primary data was collected from community respondents (landlords and tenants), cesspool and gulper entrepreneurs, and key informants ranging from policy makers, regulators, development partners to researchers, so as to structure and contextualize the framework (Supplementary materials S1). Primary data collection methods used were: focus group discussions (FGDs), in-depth interviews (IDIs), key informant interviews (KIIs) and observations. A total of four FGDs (cesspool entrepreneurs; gulper entrepreneurs; households in Kanyana; households in Lukuli parishes), six IDIs (staff and owners of cesspool and gulper businesses) and 10 KIIs (Representatives, Kampala Capital City Authority—KCCA; Principal Health Inspector, National Environment Management Authority—NEMA; FSTP staff, National Water and Sewerage Corporation—NWSC; Sanitation focal person, Deutsche Gesellschaft fuer Internationale Zusammenarbeit—GIZ; Country Director, Water for People—WFP; Chairperson of Cesspool and Gulper Associations and Researcher, Makerere University) were conducted. Secondary data collection involved the desk review of the City Service Delivery Assessment (CSDA) tool and user guide for the City-Wide Inclusive Sanitation and Financial, Institutional, Environmental, Technological and Social (FIETS) sustainability approach [5,15–17]. The service criteria were scored and weighted, and the overall score for business models were determined. Business models with high scores (high potential for service improvement) were considered appropriate and sustainable for informal settlements. The data collection methods used in the study might be subjected to socio-economic and personal biases, which have been minimized by conducting stakeholder workshops and sharing/discussing the findings.

2.3. Evaluation Framework

For developing the evaluation framework, five service criteria were adopted from the FIETS sustainability approach, which aims to accelerate and ensure quality water, sanitation and hygiene (WASH) service delivery [17], as well as a criterion on scalability. Each service criterion was defined by a set of sub-criteria that were adopted with modifications from a study by Rao [4] and contextualized to local conditions of informal settlements in Kampala City. The service sub-criteria for FEITS included: business profitability; emptying costs/fees; subsidy; cost recovery, public private partnership; legislation/regulation; functionality of service chain; environmental protection; public health safety; adaptability to local context; responsiveness; mixed technology adoption; equity/inclusion; social inclusion.

2.3.1. Service Criteria: Scoring and Weighting (Input)

Data collected through KIIs, IDIs and FGDs with relevant stakeholders was used to define and score sub-criteria of the framework. Each sub-criterion was scored following CSDA tool score values of 0, 0.5 and 1, and summed up to score for each service criterion. For example, there are four sub-criteria for “financial” service criterion: (i) business profitability; (ii) emptying costs/fees; (iii) subsidy; (iv) cost recovery. The weightage for each service criterion was determined by dividing its score by overall score for all six service criteria. As there are four sub-criteria for “financial” service criteria as described earlier, it could score a maximum of 4 and as there are six service criteria (fifteen sub-criteria) with a maximum score of 15 for each business model, the weightage of “financial” service criteria is calculated as $4/15$, i.e., 27%. Therefore, a service criterion with a higher number of service sub-criteria had more weightage and was ranked high in terms of its importance in assessing business models compared to other service criteria. The study used a traffic light reporting system to score the service criteria and business models (Figure 1). Each score value was color coded, i.e., 1 was color coded green for a high score; 0.5 was color coded orange for a moderate score; 0 was color coded red for a low score. The color codes help to visualize the scores for the service criteria and corresponding (overall) score of the business models [15].

Colour code	Input	Output/Overall score	Result of overall score
	0	Lower value ($< 33\%$)	Business model has low potential for service improvement in informal settlements
	0.5	Middle value ($> 33\%$ and $< 67\%$)	Business model has moderate potential for service improvement in informal settlements
	1	Higher value (67%)	Business model has high potential for service improvement in informal settlements

Figure 1. Color coding for input, output and overall score of the framework.

The evaluation framework (service criteria and scores) was collectively validated by relevant stakeholders in a workshop, participated in by representatives from water utility, city authority, development partners, WASH International Non-Governmental Organizations (INGOs) and research institution/academia. The eight business models evaluated were mobile transfer station, franchise, non-profit, call center, licensing, incentivized disposal, scheduled desludging and discreet collection and treatment (current model in Kampala city). These were assessed and scored separately for cesspool and gulper technologies since the mode of service delivery is different for each technology.

2.3.2. Business Model Scorecard (Output)

The key output of the evaluation framework is a business model score card. The score for each service criterion was determined by summing up scores attained in each sub-criterion and dividing it by the maximum score for that criterion. For example, sub-criteria for the “financial” service criterion for the cesspool “call center” business model scored 1 for business profitability; 0.5 for emptying costs/fees; 0.5 for subsidy; 1 for cost recovery, with a total score of 3. The output score of the “financial” service criterion is then calculated by dividing it by the maximum score that the criterion could attain, which is 4, i.e., 75% ($3/4$). To determine lower, middle and higher values for each criterion, so as to allow for color coding, the score was divided into three bands. If a criterion score was less than 33% (one-third), it was coded red (lower). A score between 33% and 67% (one-third and two-thirds) for a criterion was coded orange (middle), and a criterion score greater than 67% (two-thirds) was coded green (higher) (Figure 1). The overall score for each business model was the sum of the attained scores from all service criteria divided by the maximum score that the model could attain. For example, the cesspool “call center” business model scored 3 (75%) in financial, 2 (67%) in institutional and legal, 1.5 (75%) in environmental and public health, 3 (100%) in technological, 1.5 (75%) in social and 1 (100%) in scalability. The overall score of the business model is 12 and dividing it by the maximum score, i.e., 15, the overall score is 80% ($12/15$). Similarly, to determine lower, middle and higher values for the business model, and to allow for color coding, the same steps mentioned for the service criteria was followed.

3. Results and Discussion

3.1. Evaluation Framework: Service Criteria and Sub-Criteria

Findings from primary data collected from community respondents in informal settlements, cesspool and gulper entrepreneurs and key informants revealed service delivery gaps/challenges that were used to contextualize and define the evaluation framework. The study categorized service gaps as demand and supply challenges, where demand challenges represent client perspectives and supply challenges represent service provider perspectives. Based on the findings, the study adopted six criteria, namely: financial, institutional and legal, environmental and public health, technological, social, and scalability, and fifteen sub-criteria for the evaluation framework (Table 1 and further elaborated in subsequent sub-sections).

Table 1. Service criteria and sub-criteria of evaluation framework (adapted from [3,4,9,17]).

Service Criteria	Sub-Criteria	Maximum Score	Weightage (%)	Rationale
Financial	Business profitability	1	27%	Business model should increase business profitability to entrepreneurs through revenue gains or reduced operational costs.
	Emptying costs/ fees	1		Business model should reduce emptying costs/fees so that service is affordable to users of on-site sanitation facilities.
	Subsidy	1		Subsidy or external support from government/donors is not required for operation of business model.
	Cost recovery	1		Full operating costs are recovered from revenues.
Institutional and Legal	Public–private partnership (PPP)	1	20%	Legal and regulatory framework that supports public–private partnership is required to ensure provision of quality and affordable FSM services.
	Legislation/regulation	1		Close monitoring of service providers for regulatory compliance implies weakness in the business model to promote safe emptying and transport of FS.
	Functionality of FSM/sanitation service chain	1		Business model promotes linkage between all components of FSM/sanitation service chain: households in informal settlements frequently empty toilet facilities; service providers collect and dispose FS at designated treatment sites; treatment sites receive and adequately treat all FS received.
Environmental and public health	Environmental protection	1	13%	Safe collection should translate into safe disposal of FS so as to ensure environmental and public health protection and safety. These criteria align with mandates of main regulators of FSM in Kampala city, i.e., KCCA, NEMA, NWSC.
	Public health safety	1		
Technological	Adaptability to the local context	1	20%	Business model promotes use of technologies that address service challenges in informal settlements, particularly accessibility of sanitation facilities and desludging of facilities containing solid wastes and thickened sludge.
	Responsiveness	1		Business model promotes timely response in service provision.
	Mixed technology adoption	1		Availability of mixed technology options allows technology selection by clients in informal settlements and is influenced by factors such as affordability, toilet types, ease of access, etc.
Social	Equity/inclusion	1	13%	Business model promotes inclusiveness in emptying service provision so that urban poor communities in informal settlements are not left behind in sanitation service delivery.
	Social stigma	1		Business model addresses the problem of social stigma that is associated with provision of FS emptying services.
Scalability	Scalability	1	7%	Scalability of business model to other informal settlements. It is to be noted that not all informal settlements are homogeneous in characteristics.
Total		15	100%	

3.1.1. Demand Challenges

High cost of emptying: Clients in both parishes cited the high cost of emptying as a challenge when it comes to the full emptying of their pit latrines or septic tanks, in particular, when clients have to frequently empty pits or tanks and do not have the capacity to pay for full emptying as an emptying fee is associated with the volume. This is similar to findings of other studies that proposed emptying charge reduction so that services are affordable [3,18]. The “emptying costs/fees” formed a sub-criterion and was used to formulate the indicator question: “Does the business model reduce emptying costs to households”? Therefore, scoring the business model against this criterion would ensure that it addresses the challenge of the high cost of emptying cited by clients in the informal settlements.

Spillage of FS: Some of the community respondents indicated that while using gulper technology to empty their latrines, there are spillages that leave areas dirty and unsightly, with high risk to public health safety and environmental pollution. This was used to define two sub-criteria, one on environmental protection, scoring the business model against an indicator question: “Does the business model address environmental pollution issues and concerns”? and the second on public health safety, scoring the business model against an indicator question: “Does the business address public health safety issues and concerns”? The FIETS sustainability approach explains that WASH interventions interact with the wider context of the natural environment, including people’s livelihood [17].

3.1.2. Supply Challenges

Difficulty in accessing sanitation facilities: Respondents cited this challenge, which hinders effective service provision in informal settlements. This is mainly attributed to the high density of housing units, which limits access, especially by large cesspool trucks. The problem is further compounded by poor siting and design of latrines and septic tanks. These were used to define the sub-criteria on: adaptability of technologies to the local context, responsiveness and adoption of mixed technologies for emptying and transport of FS.

High operational costs: Cesspool and gulper entrepreneurs cited this as a challenge that affects their business operations and consequently reduces revenue and profit margin. Fuel and personnel costs contributed the most to high operational costs. This finding was used to define the sub-criterion on cost recovery, scoring each business model against an indicator question: “Are FS emptying and transport service providers able to cover their full operating costs due to revenue gains in the form of user charges”?

Social stigma: Service providers, especially gulper operators, cited stigma as a challenge in providing emptying services. This is due to the nature of their work, which is considered a “dirty” job in the society [19]. This finding was used to define the sub-criterion on social stigma. Scoring each business model against the indicator question: “Does the business model address social stigma issues”? revealed the importance of this sub-criterion in ensuring social sustainability of the business model.

3.1.3. Institutional, Legal and Regulatory Challenges

Key informants indicated that there are existing policies and regulations that are relevant for FSM in the city. These include: KCCA Act, 2010; The Public Health Act 1935 (Cap.281); The Local Government Act 1997 (Cap 243); The National Environment (Waste Management) Regulations S.I. No 52/1999; The Local Governments (Kampala City, Uganda) (Sanitation of Building Sites) Byelaws; The Public Private Partnership Bill 2012. These laws/regulations can be used to regulate emptying services; enable licensing and certification; enforce standards; engage the private sector; formulate specific byelaws at lower urban councils [18]. However, to address challenges within current laws and regulations, such as lack of standards for sanitation facilities and city level byelaws for FSM, the city council approved the Kampala Sewage and Faecal Sludge Management Ordinance, and minimum standards for OSS, which are currently under review. The study

revealed some challenges that are still affecting effective emptying and transport services, for example, gulper operators are currently not considered for licensing by NEMA due to technological challenges that pose high environmental pollution and public health risks. Public–Private Partnerships, for example, through service level agreements, can only be achieved provided the FS emptying and transport operators are registered entities.

3.2. Existing Business Models for FS Emptying and Transport in Kampala City

This study revealed four business models that are operational in Kampala city. In the first model, service providers operate in a free market business environment with limited regulation. Each stakeholder has a responsibility within FSM; households pay emptying fees to private service providers to empty and transport FS to public utility FSTP that charges a discharge fee for disposal and treating FS. However, there are challenges with this model, such as high emptying fees since there is no structured pricing guidelines, and unrestricted service boundaries, which has led to inequitable selection of clients and inefficiency in service delivery. This study described this model (which is the main model in operation) as a “discreet collection and treatment” model, as similarly described by Strande [20]. The discreet collection and treatment model is complemented by three other business models (mobile transfer station, call center and licensing models) that have not been fully scaled. The mobile transfer station model was initially piloted in five parishes and managed by an INGO in collaboration with KCCA within the concept of a non-profit model and integrated with scheduled emptying. There are two 5 m³ mobile transfer tanks designed with aims of reducing transport distance, promoting bulk transportation and disposal of FS so as to reduce operational costs for gulper entrepreneurs and consequently the emptying cost borne by households. However, the current pricing (USD ~10 per 180 liter barrel) by gulper operators has rendered the services unaffordable for urban poor. In addition, there are high risks to environmental pollution and public health safety right from the point of desludging to the discharge into transfer tanks. The call center model (established in 2016) provides FSM services with the objective of linking customers to service providers. Service providers are tracked through a GIS tracking application installed on their phones. Licensing is a process regulated by three public authorities, i.e., NWSC, responsible for registration for discharge of FS at treatment plant; KCCA, responsible for operational licensing and provision of Environmental Services Certificate; NEMA, responsible for transportation licensing and enforcement of environmental standards. Due to the weak regulation of service providers, only 8 out of 30 registered private operators have been licensed. This could possibly explain unregulated pricing and unrestricted service boundaries affecting service delivery especially in informal settlements. Detailed description of the business models, challenges and opportunities are provided in Table 2.

3.3. Alternative Business Models for Improving Service Delivery in Informal Settlements

The study analyzed alternative business models for FS emptying and transport that could potentially be applied to improve service delivery in informal settlements of Kampala city. The business models were categorized as: (i) business models for FS emptying and transport (transfer station, franchise and non-profit models) and (ii) business models that link emptying, transport and treatment (call center, incentivized disposal, licensing and scheduled desludging sanitation tax models). The pros and cons of business models in relation to their adequacy for application in informal settlements have been discussed in Table 3.

Table 2. Analysis of existing business models in Kampala.

Business Model	Model Description/Mode of Operation	Challenges	Opportunities
Discreet collection and treatment model	- FS emptying and transport services dominated by private sector - Cesspool and gulper operators provide services in unregulated free FSM market - Public authorities, i.e., KCCA, NEMA and NWSC provide regulatory oversight	- Unregulated service provision, thus, not all clients are served - Large part of the city underserved, particularly informal settlements - Non-binding tariff guidelines, thus, customers are highly charged	- Large untapped market in informal settlements that hosts 60% of the city's population and with 90% of population reliant on on-site sanitation - Planned construction of decentralized fecal sludge treatment plants that will reduce transport costs and consequently emptying fees
Call center model	- Objective is to bridge the gap in service delivery - Call center is managed by KCCA - There is no payment of any fee by service providers to the call center	- Tracking becomes a challenge when phone is switched off - There is limited data captured in the system that limits adequate service evaluation through the call center	Upscaling of the model to ensure all service providers are registered with the call center
Mobile transfer tank	- Managed by Gulper Association of Uganda - Two mobile transfer tanks (5 m³ each) currently stationed at a distance from the FSTP to receive FS from gulper operators	- Lack of tipping provision for FS delivered by gulper operators in Lubigi FSTP - High operational costs and consequently emptying fees due to long distance to FSTP	- Growing low-income informal population and neighborhoods and standardization of containment facilities (large market size) - Construction of small, fixed transfer tank of 32 m³ capacity at FSTP
Licensing model	- Process begins with compulsory registration of cesspool and gulper entrepreneurs with their respective associations - An introductory letter from each member association is a key requirement to be registered by NWSC that allows a truck to dispose FS at FSTP - NWSC issues a recommendation letter for endorsement by KCCA upon payment of annual operating license fees - KCCA issues environmental services certificate - Lastly, NEMA conducts final inspection and issues license to qualified service providers	- Only 8 out of 30 registered entities are currently licensed by NEMA - Only 12 have been awarded environmental services permits by KCCA - Gulper operators are not eligible for licensing by NEMA due to environmental and public health safety concerns, such as spillage of FS during emptying (due to current gulping technology in use) transportation and disposal at transfer tanks	- Leveraging existing strong coordination and collaborative platform so as to harmonize service level standards by all regulators - Kampala sewage and fecal sludge management ordinance shall complement existing licensing measures so as to improve service delivery.

Table 3. Analysis of alternative business models for FS emptying and transport in informal settlements adapted from [4,18,20].

Business Model	Description/Mode of Operation	Pros	Cons
Business models for FS emptying and transport			
Transfer station model Case example from Bangladesh, Zambia, Malawi	• Intermediary disposal solution prior to final disposal of fecal sludge • Applicable where semi-mechanized and manual emptying exists; where pits are inaccessible by trucks and where treatment plants are located far from desludging sites • Two types: Fixed transfer stations (underground holding tanks) and mobile transfer stations that can be moved from one location to another	• Reduces time and transport costs for operators • Possible to reduce emptying costs to households due to reduced operational costs • Increases number of pits/septic tanks emptied due to reduced distance to treatment plant • Reduces indiscriminate fecal sludge disposal	• Likely (fixed transfer stations) to be expensive for poor households • Requires subsidy from government
Franchise model Case example from South Africa- Amanz' abantu Services (Pty) Ltd., Eastern Cape Province, South Africa	• Management by a large company (public and private) • Franchisor and franchisee operate on contractual arrangement • Franchisor aims to achieve economies of scale through larger market base • Franchisee limited in operation and meets all emptying operational costs • Applicable to both manual and mechanical emptiers • Franchisor can provide financial assistance to franchisee	• Facilitates thorough coverage of FS market (including low income informal settlements) due to decentralized contact points	• May not reduce emptying costs to households • May not reduce operational costs for private emptiers • Does not necessarily reduce indiscriminate disposal of FS
Non-profit model Case example from Mozambique and Bangladesh	• Operated by NGOs with grants from donors • Aim to create awareness, improve, institutionalize and regulate FS emptying and transport operations • Target entrepreneurs involved in manual emptying services • Operation based on two-phased approach: (i) NGO owns and operates emptying service, mobilizes and trains informal emptiers; (ii) NGO hands over operations to trained entrepreneurs • Initially, NGO may provide necessary capital free or as interest-free loans from donor funds • In the long term, NGO engages with local financing entities to bridge possible financing gaps	• Equity (target underserved communities, i.e., low-income informal settlements) • Possibility to legalize manual emptying services	• Requires subsidy • Does not reduce emptying costs to households • Does not reduce emptying operational costs

Table 3. Cont.

Business Model	Description/Mode of Operation	Pros	Cons
Business models linking emptying, transport and treatment			
Call center model Case example from Senegal—ONAS Call Center	• Call center links customers to vacuum truck operators • Payment of fixed annual fee (can double as license or permit) • Competitive bidding process • Lowest bidder awarded the contract • Two forms of payment (direct to private operator/call center or fixed sanitation tax)	• Possible reduction in emptying costs to households as prices are usually negotiated • Likely to increase business profitability through additional revenue gains	• Clients without mobile phones may not benefit from the call center service
Incentivized disposal model	• Provides financial incentives to truck operators • Objective to eliminate illegal disposal of FS • Truck operators not charged disposal fees but paid fixed price by treatment plant • Can be developed by incorporating other models like licensing and sanitation tax	• Likely to increase business profitability through reduced operational costs	• Requires subsidy • Does not reduce emptying costs to households
Licensing model	• Private operators issued license/permits by relevant public authority • One-time or annual payment of license/permit fees • Public authority sets operational standards and monitors regulatory compliance by tracking operators	• Likely to reduce emptying cost to households	• Does not reduce cost of emptying operations • Does not increase business profitability
Scheduled Desludging Sanitation Tax model	• Operation of model based on two key aspects: (i) collection of sanitation tax from owners of on-site sanitation systems either as a percentage of property tax or surcharge on water bills; (ii) mandatory scheduled desludging of pits/tanks • Scheduled desludging can be contracted to private sector	• Optimization of emptying services—increased number of pits/septic tanks emptied and trips made • May reduce emptying costs to households	• Sanitation tax may be expensive to low income households • Challenge of availability of households at time of desludging

3.4. Business Model Scorecard

Business model scorecards for cesspool and gulper are discussed separately. Scoring (analysis) of the transfer station model was limited to gulper because of its appropriateness in the context of the informal settlement. The mobile transfer station model has been piloted and proven to be most applicable where smaller emptying equipment and semi-mechanized and manual emptying technology, such as gulper, exists [4].

3.4.1. Cesspool

For the business model scorecard for cesspool (Figure 2), scheduled desludging, call center and discreet collection and treatment models were coded green, which indicated a high score in the financial criterion. This could be attributed to higher revenue gains resulting from an increased number of informal settlement dwellers served, and high emptying fees, as for the case of the discreet collection and treatment model. However, licensing and non-profit models were coded red as revenue maximization and cost reduction is not the primary objective of these models. Regarding the institutional and legal criteria, the licensing model was the only model coded green because it is the only business model that does not require close monitoring of service providers for regulatory compliance, provided that there is a functional tracking system in place. There were no business models that presented a high risk to environmental and public health as all models were coded orange, except for the licensing and call center models that were coded green. All business models concerning the technological criterion were coded either orange or green and, thus, could be adapted and promoted in informal settings. Licensing and discreet collection and treatment models were coded red for the social criterion because they do not necessarily promote equity in service provision and effective coverage of the FS market. All business models could be scaled-up to other informal settlements, however, non-profit and discreet collection and treatment models might pose some challenges. The non-profit model is donor-dependent and, therefore, requires consistent donor funding or subsidies to increase coverage in FS emptying services to other informal settlements that are underserved. This may create a ‘dependency syndrome’ among service providers and service users, which may not be sustainable in informal settings. The discreet collection and treatment model is defined by an unrestricted geographical boundary of operation, which has left a large part of the city, particularly informal settlements, underserved.

Service criteria	Business model						
	Franchise (Zoning)	Scheduled desludging	Licensing	Incentivised disposal	Call center	Non-profit	Discreet collection and treatment
Financial	63%	75%	25%	50%	75%	13%	75%
Institutional and Legal	67%	67%	83%	67%	67%	50%	50%
Environmental and public health	50%	50%	75%	50%	75%	50%	50%
Technological	67%	67%	50%	83%	100%	83%	50%
Social	75%	75%	25%	50%	75%	75%	25%
Scalability	100%	100%	100%	100%	100%	50%	50%
Over all	67%	70%	53%	63%	80%	50%	53%

Figure 2. Business model scorecard for cesspool (Supplementary material S2).

The overall score on the business model scorecard (Figure 2) revealed that two business models have the green color code—the call center and scheduled desludging models at 80% and 70%, respectively. Both models, therefore, have high potential for service improvement in informal settlements. The rest of the business models were coded orange and, therefore, have moderate potential for service improvement in informal settlements.

3.4.2. Gulper

As with cesspool, licensing and non-profit models were coded red for the financial criterion (Figure 3). Regarding the institutional and legal criteria, the mobile transfer station and licensing models were the only models coded green because mobile transfer station was operational within an existing legal and regulatory framework and was able to safeguard interests of multiple stakeholders along FSM, whereas the licensing model, as it might not safeguard the interests of all stakeholders, could be implemented within the existing legal and regulatory framework without close monitoring by regulators. In contrast with cesspool, all business models were coded red for the environmental and public health criteria. This is mainly attributed to the high risk associated with the use of current gulper technology, right from the point of desludging FS to the final disposal at the treatment plant. Alike for cesspool, all business models were coded orange and green for the technological criterion with the highest score for the call center. This signifies that these business models are able to address technological aspects of service provision in informal settlements. Licensing was the only model coded red for the social criterion. For the scalability criterion, non-profit and discreet collection and treatment business models were coded orange and the rest coded green, thus, could easily be scaled to other informal settlements in the city.

Service criteria	Business model							
	Transfer station	Franchise (Zoning)	Scheduled desludging	Licensing	Incentivised disposal	Call center	Non-profit	Discreet collection and treatment
Financial	88%	63%	88%	25%	63%	75%	13%	63%
Institutional and Legal	83%	67%	67%	83%	67%	67%	67%	50%
Environmental and public health	25%	25%	25%	25%	25%	25%	25%	25%
Technological	83%	83%	83%	50%	83%	100%	83%	67%
Social	75%	75%	75%	25%	50%	75%	75%	50%
Scalability	100%	100%	100%	100%	100%	100%	50%	50%
Over all	77%	67%	73%	47%	63%	73%	50%	53%

Figure 3. Business model scorecard for gulper (Supplementary material S3).

The overall scorecard (Figure 3) revealed that three models, i.e., mobile transfer station, scheduled desludging and call center models scored high and were coded green, thus, have high potential for service improvement in informal settlements. All other models were coded orange, thus, have moderate potential for service improvement. Of all the business models, the mobile transfer station model had the highest overall score (77%).

3.5. Assessing the Most Feasible Business Model(s)

Business models that scored high have high potential for service improvement. It is imperative to note that business models scored differently for each criterion and sub-

criterion, for both cesspool and gulper, which could be explained by the difference in the mode of service between cesspool and gulper. Each business model has its strengths/pros and weaknesses/cons for a particular criterion, as evident from different scores attained by each business model for the six service criteria. For example, where a business model had low potential for service improvement for one service criterion, that gap could be complemented by another model that had high potential for service improvement, for that particular criterion. Based on the final output of business model scorecards, the study revealed that two models (scheduled desludging and call center) for cesspool and three models (mobile transfer stations, scheduled desludging and call center) for gulper have high potential for service improvement in informal settings and, thus, the most appropriate business models for informal settlements.

3.5.1. Scheduled Desludging

The scheduled desludging model has benefits for all stakeholders along the FSM and has the potential to improve functionality of the service chain. This can enable informal settlement dwellers to adequately plan for desludging of their sanitation facilities as opposed to emptying their pit latrines or septic tanks when they are over-flowing. This will reduce the risk of environmental pollution as a result of not emptying fecal matter into streams during the rainy season [21] as well as public health risks associated with exposure to contaminated FS. To service providers, this model improves their business operations as they are likely to increase their profit margin through additional revenue gains [4] from economies of scale resulting from an increased number of clients served and trips made. To the city authority, the business model will ensure city-wide coverage of services, i.e., no one is left behind whilst supporting efforts to eliminate manual emptying and enforcing standards in latrine and septic tank construction so that it is easier to regulate and plan for scheduled emptying. To the NWSC/treatment plant, this model has a positive impact on the quality of FS delivered to the treatment plant [8] as well as for the adequate planning of treatment of FS generated in the city. To NEMA, it enhances effective monitoring of service providers to ensure compliance with waste transportation regulations. With the support of local leaders and community activation teams in each informal settlement, emptying schedules can be locally arranged, as was piloted with mobile transfer stations [22].

3.5.2. Call Center Model

This model has high potential for service improvement in informal settlements of Kampala city and plays a critical role in bridging service delivery. The uniqueness with this model is that it is not restricted to only FSM service provision and, thus, has enhanced service delivery in various sectors through services such as public health, revenue and licensing related calls. This model offers a negotiating platform with informal settlement dwellers, which increases access to emptying services with a possibility of reduction in emptying costs that are normally negotiated. To service providers, there is the possibility of being increasingly client-based as opposed to searching for clients. To the city authority, the model enhances monitoring and evaluation of service provision. In the case of informal settlements in Kampala, the call center will complement other business models whereby its role may change as and when necessary and may also vary for every business model. For scheduled desludging, a broadcasting role may suffice, whereby a mobile phone short messaging service (SMS) code can be designed so that clients can capture all the information about their facilities that require emptying and send it to the call center that will contact service providers to offer services on scheduled dates. However, this will require prior and intensive mobilization and sensitization of clients by contact persons in each area.

3.5.3. Mobile Transfer Station

The mobile transfer station is, undoubtedly, a sustainable business model for gulper operators as it has high potential for service improvement in informal settlements. Financially, this business model has potential to increase profitability to entrepreneurs due to

reduced travel distance translating into reduction in fuel costs [4]. To clients, this model has high potential to reduce emptying costs by approximately 40% [22]. Previous studies have recommended implementation of this model along with scheduled desludging for effective operation [4].

4. Conclusions

The applicability and effectiveness of a business model may vary from context to context. The evaluation framework, therefore, provides a holistic and sustainable approach for assessing business models for a given context. Development of the framework (service criteria and sub-criteria), as contextualized for Kampala city local conditions, could be tailored to address service delivery challenges in any given context.

The heterogeneity of informal settlements requires use of mechanized and semi-mechanized emptying technologies and, thus, the need to assess business models for each technology separately. Testing of the framework revealed that there is no one-size-fits all business model for fecal sludge emptying and transport. Integration of the mobile transfer station, call center and scheduled desludging models for cesspool and gulper would be most appropriate in ensuring inclusiveness, affordability and profitability, and, ultimately, sustainable service delivery in Kampala city.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/w14182914/s1>, S1: Data collection guide and informed consent; S2: Cesspool—input scoring service criteria and output business model scorecard; S3: Gulper—input scoring service criteria and output business model scorecard.

Author Contributions: Conceptualization, S.S. (Shirish Singh), F.L., N.L.B., A.G.N. and D.B.; methodology, S.S. (Shirish Singh) and F.L.; validation, S.S. (Shirish Singh) and F.L.; formal analysis, S.S. (Shirish Singh) and F.L.; investigation, S.S. (Shirish Singh) and F.L.; writing—original draft preparation, S.S. (Shirish Singh) and F.L.; writing—review and editing, S.S. (Shirish Singh), F.L., N.L.B., A.G.N., S.S. (Swaib Semiyaga) and D.B.; supervision, S.S. (Shirish Singh), N.L.B., A.G.N. and D.B.; project administration, N.L.B., A.G.N. and D.B.; funding acquisition, D.B. All authors have read and agreed to the published version of the manuscript.

Funding: The study was a part of the MSc research supported by the ‘Accelerating the Impact of Education and Training of Non-Sewered Sanitation’ project financed by the Bill and Melinda Gates Foundation (OPP1157500).

Institutional Review Board Statement: The study was approved by the Research Ethics Committee of IHE Delft Institute for Water Education (IHE-RECO 2022–332; 30 March 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available at <https://ihedelftrepository.contentdm.oclc.org/digital/collection/masters2/id/107309/rec/1> (accessed on 7 August 2022).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Cairns-Smith, S.; Hill, H.; Nazarenko, E. *Urban Sanitation: Why a Portfolio of Solutions Is Needed*; The Boston Consulting Group: Boston, MA, USA, 2014. [CrossRef]
2. Morella, E.; Foster, V.; Banerjee, S.G. Climbing the Ladder: The State of Sanitation in Sub-Saharan Africa. In *Africa Infrastructure Country Diagnostic*; AICD: Abidjan, Côte d’Ivoire, 2008.
3. Schoebitz, L.; Niwagaba, C.B.; Strande, L. SFD Report Kampala, Uganda. 2016. Available online: https://www.susana.org/_resources/documents/default/3-2593-7-1478269444.pdf (accessed on 22 June 2020).
4. Rao, K.C.; Kvarnström, E.; Di Mario, L.; Drechsel, P. *Business Model for Fecal Sludge Management*; Resource Recovery and Reuse Series 6; International Water Management Institute (IWMI); CGIAR Research Program on Water, Land and Ecosystems (WLE): Colombo, Sri Lanka, 2016; 80p. [CrossRef]
5. Ross, I.; Scott, R.; Blackett, I.; Hawkins, P. *Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas*; Summary Report (English); Water and Sanitation Program (WSP): Washington, DC, USA, 2016.

6. Klingel, F.; Montangero, A.; Kone, D.; Strauss, M. *Fecal Sludge Management in Developing Countries—A Planning Manual*; Swiss Federal Institute for Environmental Science & Technology (EAWAG); Department for Water and Sanitation in Developing Countries (SANDEC): Duebendorf, Switzerland, 2002.
7. Medland, L.S.; Scott, R.E.; Cotton, A.P. Achieving Sustainable Sanitation Chains through Better Informed and More Systematic Improvements: Lessons from Multi-City Research in Sub-Saharan Africa. *Environ. Sci. Water Res. Technol.* **2016**, *2*, 492–501. [\[CrossRef\]](#)
8. Chowdry, S.; Kone, D.D. *Business Analysis of Fecal Sludge Management: Emptying and Transportation Services in Africa and Asia*; Bill & Melinda Gates Foundation: Seattle, WA, USA, 2012.
9. Nkurunziza, A.G.; Bateganya, N.L.; Byansi, J.Z.; Rokob, J.; Busingye, J. *FSM Innovation: Leveraging FSM to Close the Urban Sanitation Loop in Kampala. FSM Innovation Case Studies—Case Studies on the Business, Policy and Technology of Faecal Sludge Management*; Bill & Melinda Gates Foundation: Seattle, WA, USA, 2017.
10. Jones, P. Formalizing the informal: Understanding the position of informal settlements and slums in sustainable urbanization policies and strategies in Bandung, Indonesia. *Sustainability* **2017**, *9*, 1436. [\[CrossRef\]](#)
11. Murungi, C.; van Dijk, M.P. Emptying, Transportation and Disposal of faecal sludge in informal settlements of Kampala Uganda: The economics of sanitation. *Habitat Int.* **2014**, *42*, 69–75. [\[CrossRef\]](#)
12. Semiyaga, S. Dewatering as a Critical Step in Urban Slum-Based Faecal Sludge Management. Ph.D. Thesis, Makerere University, Kampala, Uganda, 2017.
13. KCCA. *Sanitation Mapping for Kampala City*; Kampala Capital City Authority: Kampala, Uganda, 2017.
14. Katukiza, A.Y.; Ronteltap, M.; Niwagaba, C.B.; Foppen, J.W.A.; Kansime, F.; Lens, P.N.L. Sustainable sanitation technology options for urban slums. *Biotechnol. Adv.* **2012**, *30*, 964–978. [\[CrossRef\]](#) [\[PubMed\]](#)
15. Blackett, I.; Hawkins, P. *City Service Delivery Assessment for Citywide Inclusive Sanitation—Tool and User Guide*; Inclusive Sanitation in Practice: UK, 2019. Available online: <https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3700#> (accessed on 16 June 2020).
16. Peal, A.; Evans, B.; Blackett, I.; Hawkins, P.; Heymans, C. Fecal sludge management (FSM): Analytical tools for assessing FSM in cities. *J. Water Sanit. Hyg. Dev.* **2014**, *4*, 371–383. [\[CrossRef\]](#)
17. WASH Alliance International. FIETS Sustainability Approach (The Five Principles of Sustainability). Available online: <https://wash-alliance.org/our-approach/sustainability/> (accessed on 16 June 2020).
18. KCCA. *Kampala Faecal Sludge Management—Improving Faecal Sludge Management for On-Site Sanitation in Kampala City, Uganda*; Kampala Capital City Authority: Kampala, Uganda, 2014.
19. Anh, T.H.; Koottatep, T.; Polprasert, C. Business model analysis for faecal sludge collection and transport services in Thailand and Vietnam. *J. Water Sanit. Hyg. Dev.* **2018**, *8*, 556–567. [\[CrossRef\]](#)
20. Strande, L.; Roneltap, M.; Brdjanovic, D. *Fecal Sludge Management: Systems Approach for Implementation and Operation*; IWA Publishing: London, UK, 2014.
21. Kulabako, N.R.; Nalubega, M.; Thunvik, R. Study of the impact of land use and hydrogeological settings on the shallow groundwater quality in a peri-urban area of Kampala, Uganda. *Sci. Total Environ.* **2007**, *381*, 180–199. [\[CrossRef\]](#) [\[PubMed\]](#)
22. Mawejje, M.N.; Asimwe, J.; Achiro, B.; Nimanya, C. Piloting of a mobile faecal sludge transfer tank in 5 divisions of Kampala City. In Proceedings of the 41st WEDC International Conference: Transformation towards Sustainable and Resilient Wash Services, Nakuru, Kenya, 9–13 July 2018.