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RESEARCH AND LEARNING FOR SANITATION IN SENEGAL

FINAL FINDINGS REPORT

JANUARY 2022

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech.

ACKNOWLEDGMENTS

This report was prepared by FSG. Rishi Agarwal led the analysis with essential participation from Subhash Chennuri and Abhishek Khanna (FSG).

The authors are immensely grateful to the many entrepreneurs promoting safe sanitation practices and services in Senegal who were generous with their time and shared details about their business and offered perspectives on sanitation markets. The authors would like to thank Ann Wessling and Dieynaba Dabo (USAID/ACCES), Massire Kare and Seynabou Dia (USAID/WASH-FIN, Senegal), Dieynaba Thiam-Ka (ex-USAID/WASH-FIN, Senegal) for facilitating meetings with entrepreneurs and invaluable thought partnership.

The authors would like to acknowledge the generous contribution and thought partnership of Xavier Preciado, Abdoulaye Boly, Salimata Massaly, and Leyfou Dabo from the USAID Mission to Senegal (USAID/Senegal). The authors thank the following individuals for their feedback on the report and methodology: WASHPaLS Project Director Morris Israel (Tetra Tech), WASHPaLS Research Advisor Dr. Mimi Jenkins, and Jesse Shapiro (USAID).

The authors express their gratitude to the Sanitation Directorate (Ministry of Water & Sanitation) and ONAS for their support, and local partners Moussa Diouf, Baboucar Casse, Ibrahim Diallo, Jean Birane Gning, and Mamadou Sonko for their assistance.

The authors would like to thank Anantya Chandra, Harshika Gupta, Meher Abrao, Niharika Mukerji, Rajgaurav Chaturvedi, Simran Sachdeva, and Umang Kapadia for their contributions to this document. Kashmira Ranji provided invaluable logistical and other support.

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Preferred citation: USAID. (2022). *Research and Learning for Sanitation in Senegal.* Washington, DC: USAID Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) Project.

Prepared for the United States Agency for International Development by the Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) project under Task Order number AID-OAA-TO-16-00016 of the Water and Development Indefinite Delivery Indefinite Quantity Contract (WADI), contract number AID-OAA-I-14-00068.

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CONTENTS

ACRONYMS AND ABBREVIATIONS

ABSA	Basic Sanitation and Water for Improved Health
ACCES	*Assainissement – Changement de Comportement et Eau pour le Senegal*
APROFES	*Association pour la Promotion de la Femme Senegalaise*
ANSD	National Agency for Statistics and Demography
BCC	Behavior Change Communication
CLTS	Community-Led Total Sanitation
CNP	Cash Net Profit
COGS	Cost of Goods Sold
FGD	Focus Group Discussion
FS	Fecal Sludge
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
GoS	Government of Senegal
GRET	*Groupe de Recherches et d'Echanges Technologiques*
IBT	Improved Basic Toilet
LV	*Latrine Ventilee* (Ventilated Latrine)
MBS	Market-Based Sanitation
MSW	Municipal Solid Waste
OD	Open Defecation
ONAS	Senegal National Sanitation Office
PAFA	Promotion of Improved Family Sanitation Program
PARC	Sludge Trucks Fleet Renewal Project
PEPAM	*Programme Eau Potable et Assainissement/ Millennium Water and Sanitation*
PP	Percentage Point
R&D	Research and Development
ROCE	Return on Capital Employed
SNAR	National Rural Sanitation Strategy
SSP	Sanitation Service Provider
Swiss-TPH	Swiss Tropical and Public Health Institute
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH-FIN	Water, Sanitation and Hygiene Finance
WASHPaLS	Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability
WHO	World Health Organization
WTP	Willingness to Pay

1.0 CONTEXT

Senegal has made significant strides toward adopting and providing hygienic and environmentally safe sanitation. Basic sanitation coverage has increased while open defecation (OD) levels have decreased. The capital city of Dakar is among the leading examples in the global South fostering public-private partnerships and innovations to increase safe fecal sludge management (FSM). Senegal has also embarked on developing the circular sanitation economy as a long-term solution to improve health and environmental outcomes.

However, to sustain progress, significant regional and income disparities in access to basic sanitation need to be resolved. To increase safe waste management nationally, growing private sector partnerships and infrastructure for FSM in urban markets outside of Dakar is essential. Senegal's circular sanitation economy is nascent, just as it is globally.

Against this backdrop, the USAID Mission to Senegal aims to support the development of a dynamic private sector by addressing the barriers to private sector participation in the circular sanitation sector. To inform the priorities for the Mission, the Government of Senegal (GoS), and other stakeholders, the Mission tasked the Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) project to conduct a two-part assessment across Senegal's sanitation value chain.

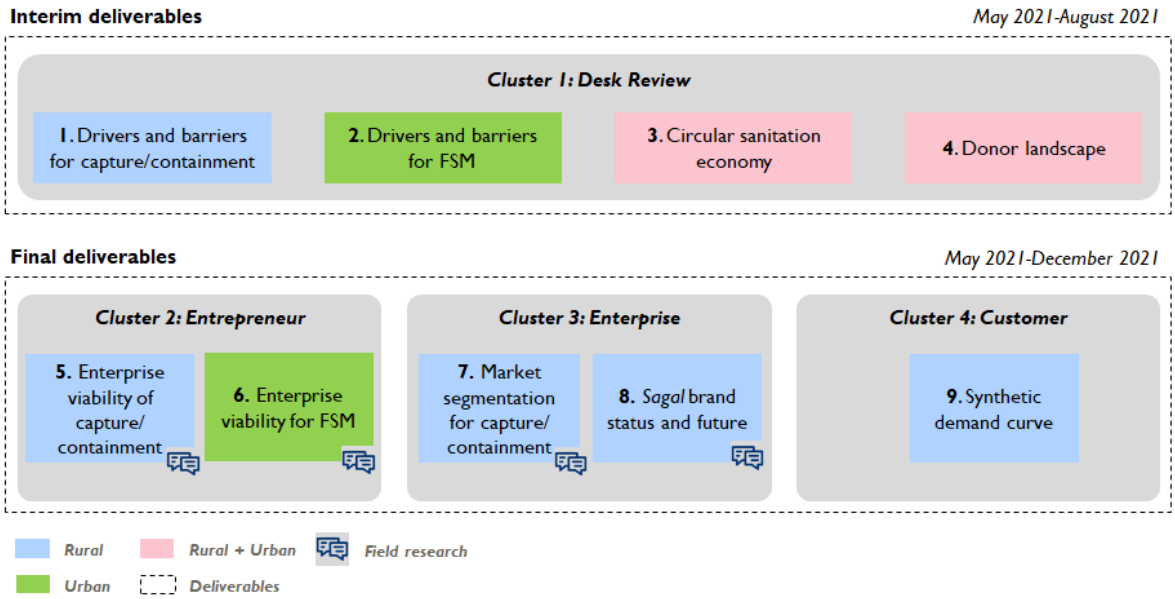
This report synthesizes the preliminary findings from Part 1 and additional findings from Part 2 of the assessment.

2.0 METHODOLOGY

2.1 APPROACH

WASHPaLS designed a two-part market-based assessment across the sanitation value chain by developing four clusters of activities:

Figure 1: Senegal Sanitation Market Assessment Phases 1 and 2 deliverables



Cluster 1 is a desk review to map the sanitation sector's landscape in Senegal, including scaling drivers and barriers for capture/containment and FSM markets, mapping donors and their activities, and identifying the potential of a circular sanitation economy.

Clusters 2 through 4 involve targeted research into specific issues identified by USAID/Senegal as critical for the development of the sanitation market. These were informed by learnings from Cluster 1:

- **Cluster 2** focuses on understanding sanitation entrepreneurs' incentives for continued participation in the market by analyzing the viability[1] of sanitation businesses serving the capture/containment and FSM markets.
- **Cluster 3** unpacks two key elements of the sanitation enterprise—analyzing the potential of leveraging the *Sagal* brand and segmenting the sanitation market into distinct and identifiable customer groups.
- **Cluster 4** contributes to market intelligence by estimating a demand curve for a sanitation product.

The desk review involved:

- Literature review of 80 documents spanning market studies, intervention literature, and policy;
- 32 interviews with key informants;
- 12 global analogs for fecal waste reuse models; and
- 19 documents and six interviews with experts on branding.

[1] Viability is a subjective measure of an enterprise's profit relative to a variety of explicit and implicit factors considered from an entrepreneur's perspective, such as minimum income expectations, income from other sources, level of investment and risk, among others.

The primary research involved:

- In-depth interviews with 34 sanitation businesses and value chain actors in seven regions, including nine *Sagal* sanitation enterprises supported by the USAID *Assainissement – Changement de Comportement et Eau pour le Senegal* (USAID/ACCES) program;
- Quantitative survey with 1,027 randomly sampled households and 312 *Sagal* customers; and
- In-depth focus group discussions (FGDs) with 84 households.

The contents of this report draw on all of the above activities except for the "Potential of the *Sagal* Brand" and the "Demand Curve Estimation," which were conducted to inform USAID's internal objectives. This report is based on supplementary documents corresponding to the above activities that contain detailed approaches, findings, and analyses.

2.2 ORGANIZATION OF THE FINDINGS

Early scoping research revealed that the state of markets at each stage of the sanitation value chain varied by the geographical setting, potentially raising the need to prioritize knowledge gaps and refine scope. The preliminary research and Part 2 of the assessment validate this perspective.

Containment markets (i.e., selling and purchasing toilets) are mature in urban and peri-urban regions of Senegal—while 68 percent of urban households have at least basic sanitation, 26 percent use limited sanitation—implying that the adoption and provision of improved toilets are well established (WHO/UNICEF, 2019). Rural Senegal's markets are relatively less mature, characterized by sizeable levels of OD and unimproved toilets, and limited private sector participation.

FSM markets (i.e., collection, transport, and treatment of fecal waste) are growing and evolving toward safe management practices. Senegal's urban markets are characterized by largely informal private sector sanitation service providers serving non-sewered households, complemented by existing and planned treatment infrastructure. The primary urban regions (i.e., Dakar, Thiès, and Saint-Louis) account for 71 percent of Senegal's urban population, and are relatively more advanced than secondary regions.[2]

The circular sanitation economy, particularly fecal waste reuse, is in a startup phase in Senegal, with experiments and innovations concentrated in Dakar. For instance, Delvic, a private sector concessionaire of several fecal sludge treatment plants (FSTPs), has piloted sales of compost from one of its plants while conducting R&D on other products (Delvic, key informant interview, July 23, 2021).

Given the relative stages of market evolution, the assessment team refined the geographic and sanitation value chain scope to identify where market development interventions are needed the most.

- In rural Senegal, addressing the containment challenge is a prerequisite and, arguably, a priority before targeting FSM in villages.
- In urban markets, access to improved sanitation through individual or shared toilets appears established while increasing both safe collection and safe disposal is the priority. Considering primary urban regions are relatively well documented and understood, the study team focused the assessment more on secondary urban regions.
- Fecal waste reuse models need prototyping and testing before replicating and scaling across urban markets with prerequisite collection and treatment infrastructure.

Accordingly, this report presents findings on the rural containment market, urban FSM market, and reuse market.

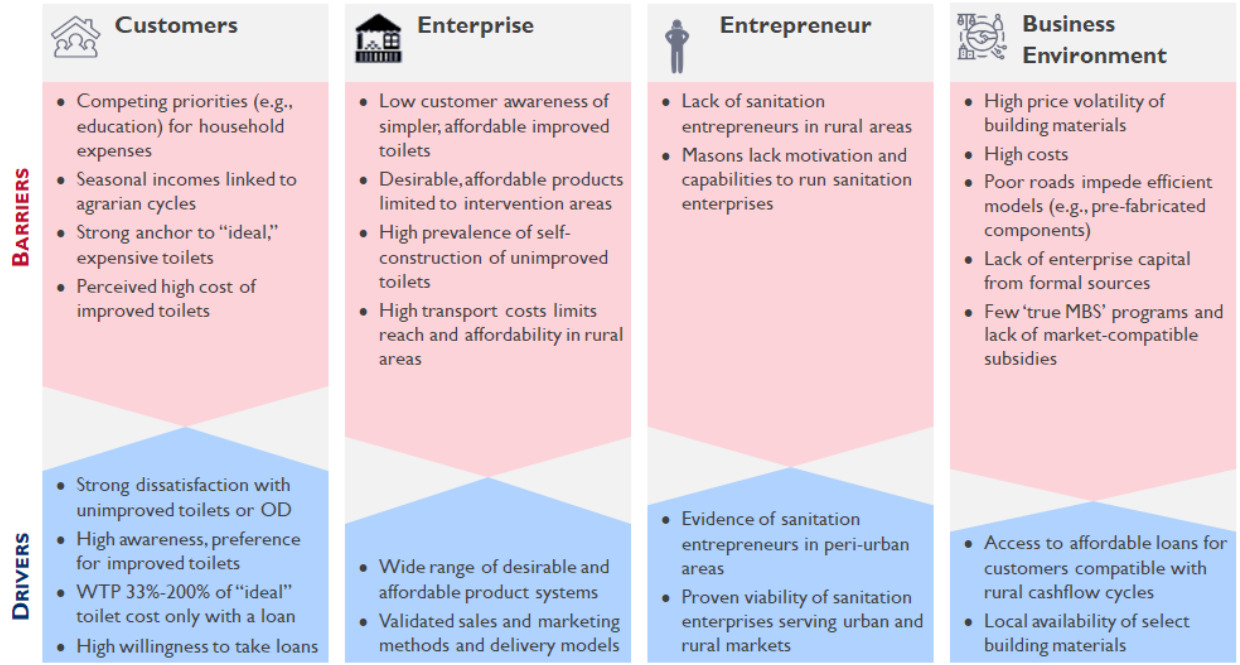
[2] Secondary regions that have lower urban population levels, collectively represent only 29 percent of Senegal's urban population, have few to no FSTPs, a relatively lower level of urbanization (26 percent as compared to 77 percent for the primary regions); and some regions are experiencing rapid growth in urbanization.

3.0 KEY FINDINGS

3.1 RURAL CONTAINMENT

High latent demand for improved toilets exists but is impeded by entrenched perceptions about "ideal" products and their cost, which can be addressed by replicating and scaling peri-urban sanitation enterprises serving rural markets.

Figure 2: Drivers and barriers for rural containment

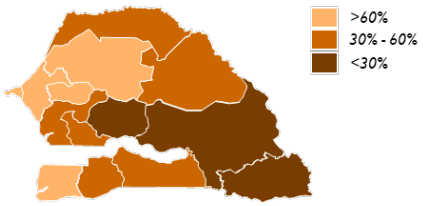


Note: Drivers and barriers based on preliminary findings and primary research
Acronyms: WTP: Willingness to pay

3.1.1 HIGH LATENT DEMAND FOR IMPROVED TOILETS, BUT FULFILLMENT IS IMPEDED BY PERCEIVED UNAFFORDABILITY AND LOW AWARENESS OF AFFORDABLE PRODUCT OPTIONS

Senegal has achieved significant improvement in rural basic sanitation coverage; 45 percent of households own improved basic toilets.[3] But, a sizeable share of households, about 21 percent, still practice OD. Practices vary widely across geographies and household income levels (Figure 3). Within households, women influence the adoption of hygienic behavior because the responsibility for domestic hygiene and cleanliness rests on them (USAID/ACCES, key informant interview August, 2021). They often partake in hygiene and sanitation behavior change communications within their communities (USAID, 2020). Despite their influence in sanitation-related decisions, men, who typically head a

Figure 3: Improved basic sanitation coverage by region



Source: WHO/UNICEF Joint Monitoring Programme WASH Data, 2019

[3] Improved Basic Toilet: Sanitation facilities that hygienically separate excreta from human contact and are not shared with other households.

household, make the final purchase decision (GRET, Hydroconseil, 2018).

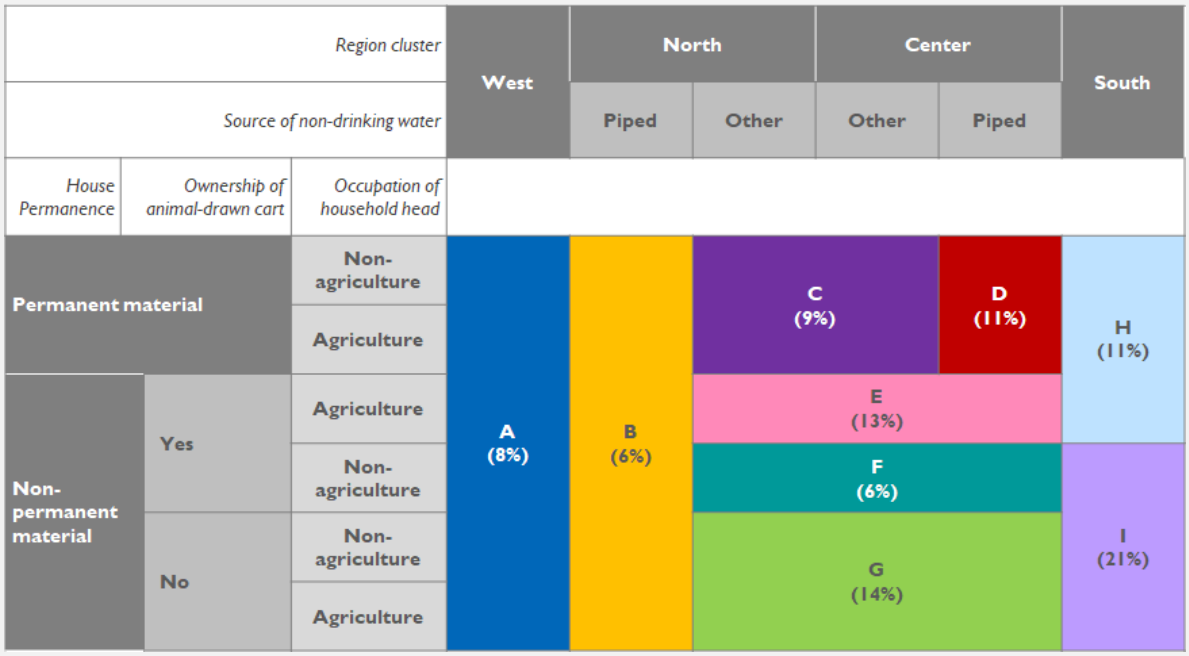
Households' sanitation behavior and propensity to adopt improved basic toilets will likely differ significantly within regions or income levels. We identified nine customer segments (Box 1) based on awareness of improved basic toilets, affluence, and the ability to pay for toilets to get a nuanced understanding of households.

Box 1: Segmentation of rural households in Senegal

To segment customers, the assessment team identified variables that are most likely to predict significant statistical differences in household behavior against key drivers of investment in individual, improved toilets. Ultimately, the team selected four segmentation variables that predicted differences in these drivers:

- *Source of non-drinking water*: Indicates access to public infrastructure and facilities that reflect connectivity to markets. Piped water includes piped connections to dwellings and standpipes because these sources are built/maintained with public investment and indicate better infrastructure than those with "other" sources built with private investment.
- *House permanence*: Use of permanent materials for the roof and walls of a house indicates affluence and access to building materials and construction-related service providers.
- *Ownership of animal-drawn cart*: Indicates an affordable means to transport building materials and affluence as well.
- *Occupation of household head*: Indicates affluence within regional clusters. For instance, non-agricultural workers in the west are likely better off than those in the south.

Note: Regions have been clustered into West (Dakar, Thiès), Center (Diourbel, Fatick, Kaolack, Kaffrine), North (Matam, Saint-Louis, Louga) and South (Ziguinchor, Sédhiou, Kolda, Tambacounda, Kédougou) using the classification followed by the Demographic and Health Surveys.



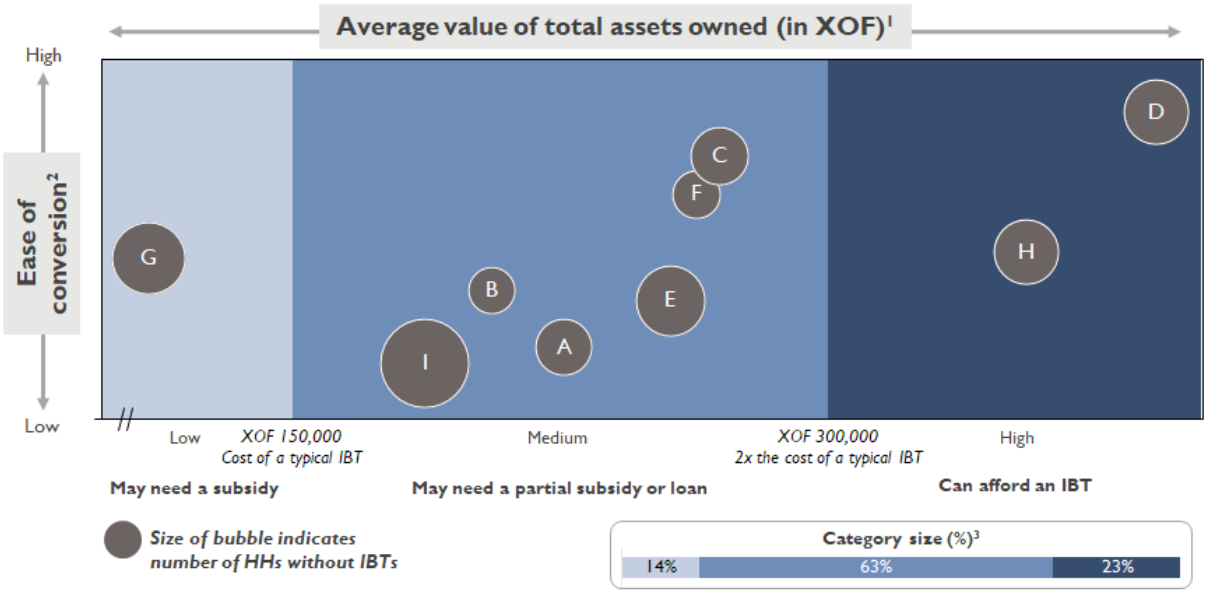
Source: FSG analyses of Swiss-TPH household survey dataset (2015)

Note: Percentages in parentheses indicate the proportion of households in each segment out of total households in Senegal without improved basic toilets. Labels A-I are unique identifiers for each segment.

Households within a segment are largely homogenous in terms of toilet purchase behaviors and sanitation profile. However, when compared across segments, households in each segment differ in their purchase behavior and sanitation profile. The compendium of findings provides further details on the segmentation methodology and is available upon request from the USAID Mission to Senegal.

The segmentation analysis showed that two out of nine segments (D and H), consisting of 23 percent (rounded value) of all households in Senegal without improved toilets, have a high ability to pay for improvements. The ability to pay is determined by their "distance" from other segments and the average value of their assets relative to twice the price of a typical improved basic toilet (Figure 4). We deliberately consider expensive improved basic toilets (IBT) because across segments, most households' perceptions are anchored to their "ideal" toilet, which is expensive and influences their buying behavior and propensity to purchase improved toilets. Figure 4 also shows many customer segments, accounting for 63 percent of all households without improved toilets, may require financing or soft loans to pay the full price of an IBT upfront. Segment G, accounting for 14 percent of all households without improved toilets, consists of the least affluent customers that have neither taken loans nor can they afford loans, and require full subsidy.

Figure 4: Ease of conversion, average value of assets (XOF), and market size by segment



Source: FSG analyses of Swiss-TPH household survey dataset, 2015 (Swiss TPH, ISED, 2015))

Notes:

1. *Average total asset value for households within the segment (in XOF); assets considered included appliances (e.g., furniture, mobile phone, TV) and vehicles.*
2. *Ease of Conversion: Composite metric created by combining three appropriateness tests: awareness about general and improved sanitation benefits, involvement in category, willingness to pay.*
3. *Proportion of households that are in each category, out of the total population of households without IBTs.*

Households in rural Senegal are motivated to construct toilets by their strong desire for respect from community members. Toilets are seen as a source of pride and respect, signaling that owners have the means to make significant purchases. Their position within the community increases in value once they acquire a toilet. While owners see a direct benefit for their households, they also reap respect from guests and visitors. Privacy and safety also factor into buying decisions, especially among female household members. Households also report a high awareness of benefits from constructing and using toilets, including better health.

However, households appear to focus on constructing their "ideal" toilet, which may be significantly more expensive than simpler, more affordable improved toilet options. "Ideal" toilets are typically described as a lined pit, water closet/commode or squatting pan, tiled concrete floor and walls, and roof. They also appear to lack awareness of more affordable options or incremental upgrades as a pathway to their ideal toilet. Households perceive modern, improved toilets as expensive and beyond their means. Price perceptions are influenced by information gathered from family and friends, masons, and general assumptions. Perceived costs range from XOF 500,000 (USD 864) to XOF 1,300,000 (USD 2,247) for the ideal toilet.

My nephew constructed a toilet with a sink and everything – the kind I want. He told me it cost over XOF 1 million.
- Resident, rural Saint-Louis

We do not believe traditional toilets with a hole and wood are secure enough for adults, let alone children who can fall into the hole. We'd rather go to the bush.
- Resident, rural Kaolack

Households make product choices depending on the combined desire to acquire an ideal toilet and the perceived affordability of their ideal toilet. Households in segments with a higher proportion of OD may perceive modern improved toilets to be too expensive and are not satisfied with the safety and durability of unimproved toilets.

Figure 5: Examples of self-constructed traditional toilets

Source: USAID/ACCES project

Those who desire toilets but could not afford improved toilets construct unimproved (traditional) toilets with pits covered with wooden planks, zinc sheets, sand, and superstructures made from straw. They do not hire masons and self-construct toilets. Households that construct improved toilets are comfortable opting for toilet designs without several of their desired features (e.g., tiled floor, deeper pits) but still choose washable floors built with permanent materials (e.g., cement) that are well within their financial reach.

With the exception of segment G, all households are only willing to pay for an ideal toilet if they get a loan. Taking loans into account, households are willing to pay between 33 percent to 200 percent (median: 113 percent) of their perceived cost of improved toilets. All but one segment are willing to pay more than 100 percent, where the excess amount represents the loan interest they are willing to pay. The implied interest suggests that many households seek low annual interest rates (e.g., 1–2 percent). They also desire repayment schedules linked to the rural agricultural cycle (e.g., annual installments around the harvest season), smaller installments (e.g., XOF 10,000–15,000 or USD 17-26), or less onerous terms related to repayment frequency and default. The priority accorded to toilets in household budgets is mixed. Some segments, especially women, prioritize children's education over constructing toilets.

Households such as those in segment G lack the financial capacity to purchase toilets even with a loan and require full subsidy. The relatively low share of the population requiring subsidy contrasts with Senegal's long history of employing sanitation subsidies as a development approach. Even in recent years (i.e., 2015 onward), subsidies feature as an approach in all but one market-based sanitation (MBS) program (i.e., USAID *Assainissement – Changement de Comportement et Eau pour le Senegal* or

USAID/ACCES). In this context, literature and key informant interviews highlight the risk of households deferring investment in toilets with the expectation of receiving a subsidy.

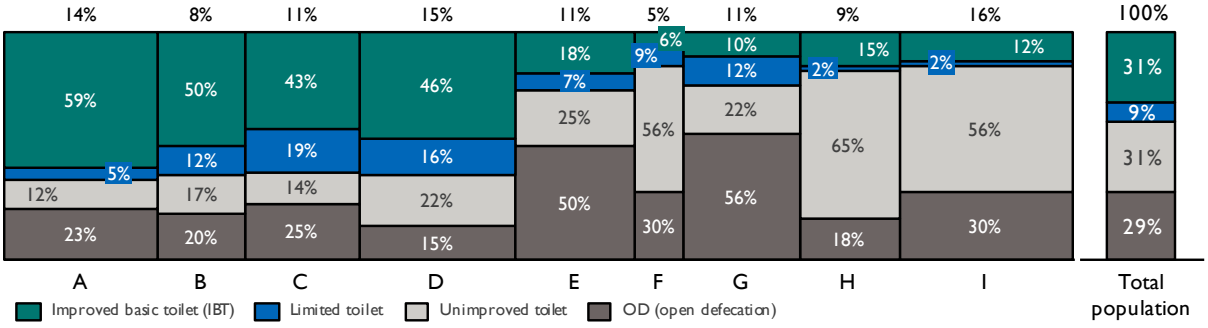
Table 1: Programmatic approach (stated) adopted by government and donor-funded programs since 2015

Name of program	Approach		
	MBS	CLTS/ BCC	Subsidy
ACCES – USAID	✓	✓	
Basic sanitation and water for improved health (ABSA) – GRET	✓	✓	✓
PAFA – GRET, Eau Vive	✓	✓	✓
PASEPAR – Republic of Belgium	✓		✓
PEPAM		✓	✓
Senegal Rural Water and Sanitation Project – World Bank	✓	✓	✓
Senegal Urban Water and Sanitation Project – World Bank			✓
SNAR	✓	✓	✓

Implementation program of the GoS *Grants funded by donors*

The proportion of households exhibiting contrasting choices of toilets in each segment manifests in the stark differences observed in the share of sanitation facility type among the different customer segments. Segments A-D have a higher propensity to invest in improved basic toilets despite differences in affluence. Segments E and G differ in affluence but are characterized by a preference for OD, while segments F, H, and I prefer constructing unimproved toilets.

Figure 6: Sanitation facility type by customer segment and total population (n=1,503, 2015)



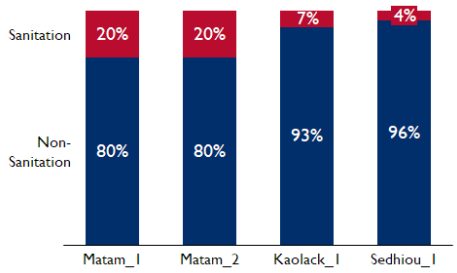
Source: FSG analyses of Swiss-TPH household survey dataset (2015)
Notes:
1. *Percentages in bars indicate the share of segment population.*
2. *Percentages above bars indicate the share of the total population.*

Overall, rural sanitation markets for toilets in Senegal benefit from high latent demand for improved toilets. Activating demand will require interventions to improve information flow for raising awareness of more affordable toilet designs and the incremental upgrade path to constructing toilets. Product innovations, including re-engineering, could also be leveraged to fulfill households' product preferences while addressing affordability constraints. Households can also be supported with innovative loan products that are compatible with rural cash-flow patterns, or soft loans with favorable terms to address liquidity constraints. In the next section, we examine if the supply-side of sanitation markets address any of these challenges.

3.1.2 RURAL MASONS LACK THE INCENTIVE AND CAPABILITIES TO ADDRESS CUSTOMERS' NEEDS

Rural masons are the primary actors in constructing improved toilets in Senegal and follow the same process to construct a toilet as other masonry jobs. They respond to customer queries by providing information (e.g., design), materials required, and costs. Customers procure the materials in one go or gradually whenever they have funds, and hire other laborers such as pit diggers and brick makers before masons build the toilet.

Figure 7: Sanitation and non-sanitation business share of total revenue (2020)



Source: FSG interviews with masons

Constructing toilets is profitable for masons. They earn a profit after deducting expenses such as apprentices' wages and transport to customers' sites from the amount charged to customers. Masons we interviewed reported profit margins of 32 percent to 53 percent. However, building toilets is a minor source of income (Figure 7), and such jobs are rare compared to other masonry jobs (e.g., home improvement, construction). More often than not, they build toilets as part of larger home construction or improvement projects than as a standalone job/product. As such, sanitation alone does not weigh heavily on their business decisions.

By virtue of their bespoke, built-to-order business model, masons lack the capabilities required to address the critical barriers to customers' adoption of improved toilets. They typically offer 1-2 designs (e.g., circular or rectangular pit, circular or square slab with a drop hole or ceramic toilet pan, vent pipe in some instances, and superstructure if customers demand it), and prices vary significantly. For instance, two masons in Sédhiou offered toilets that cost the customer approximately XOF 68,000 (USD 118) and XOF 364,000 (USD 629), including the mason's labor and raw materials. Customers also face cost overruns. On the other hand, customers desire more affordable improved toilet options. The mason business model is reactive instead of proactive. An active sales market is generally characterized by organic information sharing and product marketing, which, if adopted as a feature in the sanitation market, would spur more customers to purchase toilets. (USAID, 2021; USAID, 2018). In general, customers do not trust masons. Distrust stems from issues like delays in completing jobs, overcharging, and cost overruns. At the same time, customers do not have an alternative resource available.

3.1.3 VIABILITY AND SCALABILITY OF *SAGAL* AGGREGATOR MODEL

Sagal is a sanitation brand and enterprise model developed by the USAID/ACCES project as a one-stop-shop delivery model to sell toilets. *Sagal* enterprises address several of the mason model's shortcomings along with barriers preventing customers from adopting improved toilets. They offer a range of products at different price points to meet diverse customer preferences and budgets. These include upgrades to existing unimproved toilets (XOF 10,000–56,000, USD 17-97), single-pit latrines (XOF 48,000–150,000, USD 83-259), and double-pit latrines (XOF 130,000–230,000, USD 225-398).[4] Prices vary across regions and among enterprises in a region, but each enterprise has fixed prices for its products.

Sagal enterprises actively sell toilets by employing commissioned sales agents and advertising on radio and social media to raise customer awareness about their affordable product options. They also simplify the purchase process by purchasing and transporting required materials to customers' homes and supervising construction by a rural mason partner to ensure they meet time and quality commitments.

[4] Prices for SaTo pan and SaTo pan with slab (upgrades), and partially or fully lined pit toilets sourced from *Sagal* enterprise interviews; prices exclude the superstructure.

The entrepreneur's role as a focal point managing and coordinating sales, procurement, and labor lends itself to female entrepreneurship. The team interviewed three female-led *Sagal* enterprises that also employ women sales agents, but we did not learn about female masons. Among the three is the *Association pour la Promotion de la Femme Sénégalaise* (APROFES), which began operating *Sagal* as a social enterprise in 2021. In spite of early days, APROFES is confident of generating sales at scale through its network of female members spread across rural areas.

The Sagal enterprise model can be viable. While the scale and profitability of interviewed enterprises vary, a few in the assessment sample generated high sales and/or had high profit margins.

Figure 8: Revenue and gross profit (XOF million), 2020

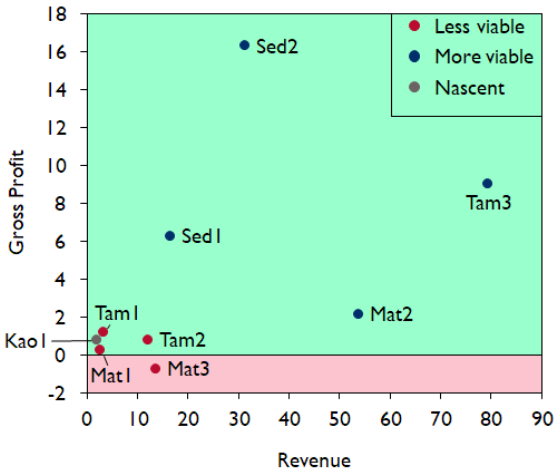
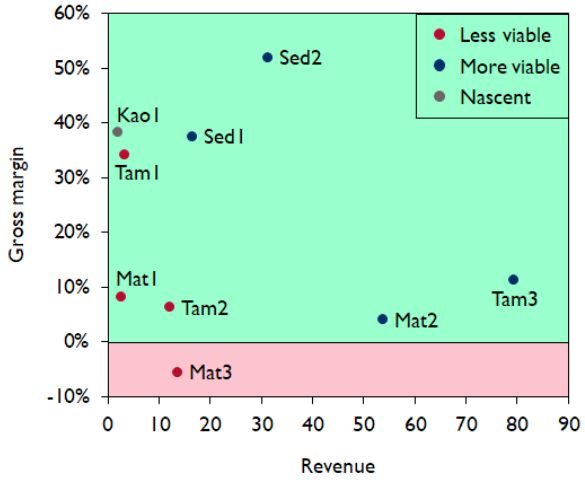


Figure 9: Revenue (XOF million, 2020) and gross margin (%)



Source: FSG analyses of profit & loss statements of 9 sanitation enterprises interviewed

Notes:

1. *Gross profit: Revenue less expenses for labor, raw materials, and transport of raw materials from suppliers.*
2. *Gross margin: Gross profit expressed as a percentage of revenue indicating the share of price charged to the customer that the enterprise retains after deducting core production expenses incurred to construct a toilet.*

Analysis of the differences in performance among several enterprises revealed four profit drivers—number of toilets sold, price, costs, and product mix. Enterprises with high sales volumes actively managed a salesforce of agents to get orders, and they also advertised regularly. Price management tactics included cross-subsidizing rural customers by charging a premium to urban customers or offering rural customers the option to contribute labor for pit digging, a sizeable share of costs. The higher cost base for some enterprises was a function of higher raw material usage, a factor that is within an enterprise's control, and variance in prices for sand and gravel as dictated by local market factors. The product mix (i.e., the proportion of total sales constituted by high-margin vs. low-margin products) played a significant role. Two products accounted for more than 75 percent of sales and profits for most enterprises. Enterprises with a product mix favoring low-margin products such as discounted toilets or upgrades realized lower profits. The profit drivers and underlying factors suggest that less viable enterprises can alter their strategies and business practices to improve scale and viability.

Transport is the most significant challenge cited by enterprises because it limits their reach and the affordability of their products in rural markets. Enterprises hire transport for sales (e.g., village meetings), deliver raw materials to customer sites, and supervise construction by their partner masons. Low-price, low-margin products like upgrades become expensive for customers situated far from the entrepreneur's base. If enterprises absorb transport costs instead of charging extra from rural customers, their profit margins erode significantly.

Figure 10: Increase in prices for 3 times the distance typically served by a sample enterprise

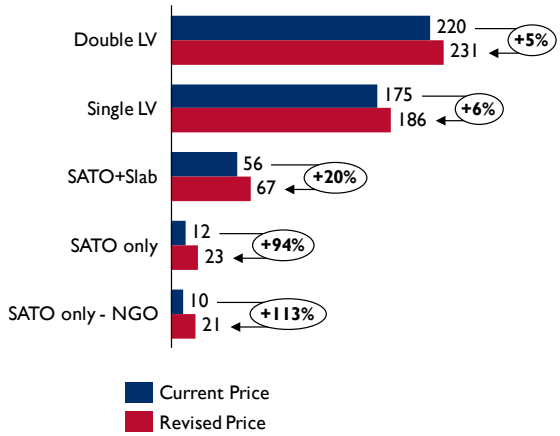
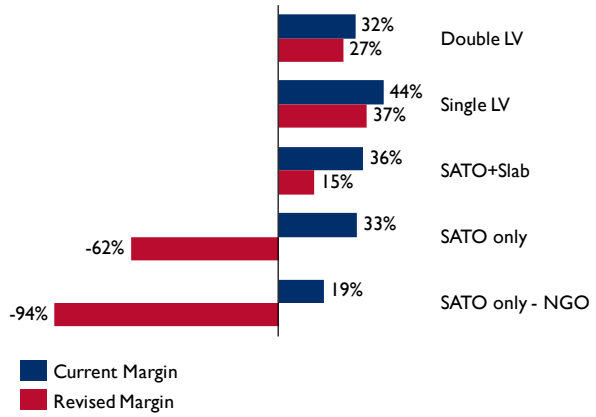


Figure 11: Change in gross margins for a sample enterprise absorbing additional delivery costs



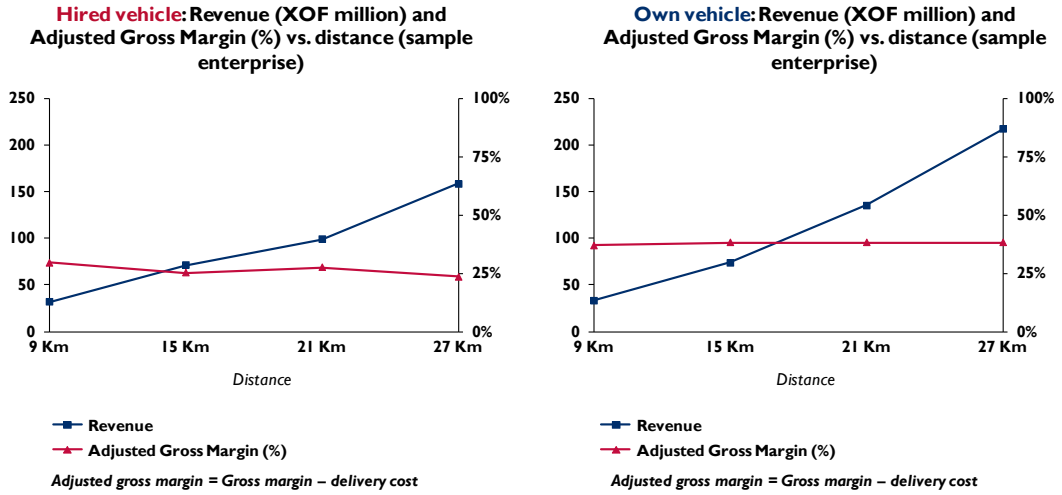
Note: Revised price inclusive of additional delivery charges.

Most enterprises are keen to purchase a vehicle to reduce transport costs. To test the potential cost-effectiveness of owning a vehicle, the assessment team developed two scenarios comparing the change in revenue and costs when using hired vs. own transport over longer distances. Purchasing a delivery vehicle shows promise in expanding *Sagal* enterprises' reach in rural markets while maintaining gross margins. In both scenarios, revenue increased because enterprises gained access to a wider market. However, gross margins declined with the use of hired vehicles while remaining fairly constant for owned transport (Figure 12). The prime difference was in fuel costs. Fuel costs were 24 times lower for the vehicle owned by the test enterprise as compared to that of rented vehicles. The assessment team corroborated its findings by comparing hired transport costs for other enterprises in the sample.

Purchasing a vehicle involves a tradeoff because the enterprise incurs depreciation and must seek a loan to make the purchase. Depreciation and the interest on the loan lower the enterprise's net profit. Although depreciation is a non-cash cost often ignored by entrepreneurs, they should factor into decision-making along with interest costs to holistically assess the purchase of a vehicle. The team modeled these costs and assessed their impact on net profit for two sample enterprises, including the enterprise analyzed above. Enterprises that extend their reach into new rural markets stand to benefit from higher net profits even after factoring in depreciation and interest costs. However, enterprises that already serve distant customers and pass on delivery costs will not benefit because their net profit will reduce. Their market and revenue will remain the same while they incur a cost (the vehicle) that depreciates in value and may be supplemented by interest costs. The impact is based on estimates by entrepreneurs for new vehicles. Purchasing a second-hand vehicle is plausible that could lower depreciation and interest costs while increasing maintenance costs, but entrepreneurs did not have this information.

Owned transport benefits female entrepreneurs in particular. Those interviewed by the team expressed a strong desire for a vehicle (with financial assistance) to travel more frequently and cover more rural areas. Reliance on hired transport or a male relative to accompany them is constraining, especially if they plan to travel long distances or spend an entire day visiting villages.

Figure 12: Change in revenue and gross margin with distance for hired vs. own transport



Source: FSG scenario analyses for a sample enterprise

Notes:

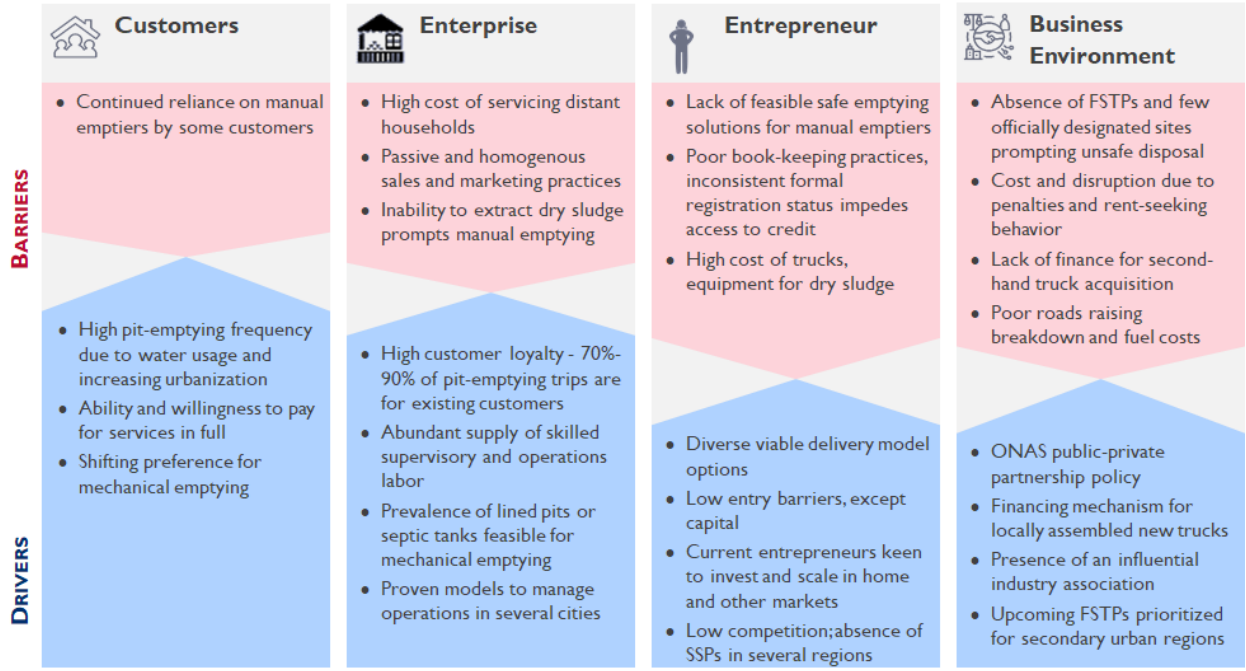
1. *Adjusted gross margin refers to gross profit less transport delivery costs expressed as a percentage of revenue.*
2. *Cost of hired transport is XOF 1,667 (USD 3) per km and cost of own transport is XOF 67 (USD 0.1) per km based on enterprises interviews.*
3. *Change in revenue estimated by extrapolating the enterprise's current number of customers per square kilometer in rural areas and assuming the sales of products with a positive adjusted gross margin only, i.e., products whose margins fall below 0 due to transport costs.*

The *Sagal* model demonstrates an opportunity to serve rural markets by raising customer awareness about affordable improved toilets. Interventions to replicate or scale the model across rural markets will improve basic sanitation coverage. Factoring transportation concerns into decision-making is a significant challenge for sanitation and for construction. Loan products that ease the cost of transportation may help mitigate entrepreneurs' transportation concerns.

3.2 URBAN FSM

Scaling existing, viable sanitation service providers and encouraging new entrants complemented by the development of treatment infrastructure can significantly improve safe FSM in secondary urban regions.

Figure 13: Drivers and barriers for urban FSM



Note: Drivers and barriers based on preliminary findings and primary research focusing on secondary urban regions.
Acronyms: SSP: Sanitation service provider; FSTP: Fecal sludge treatment plant; ONAS: L'Office National de l'Assainissement du Sénégal.

3.2.1 HIGH LATENT DEMAND FOR PIT EMPTYING SERVICES

On average, more than 50 percent of Senegalese households empty latrine pits once or twice a year, a high for Western Africa and perhaps among the highest rates globally (Mbeguere, et al., 2011; USAID; Burt, Sklar, & Murray, 2019). According to SSPs and a local WASH expert interviewed, pits are emptied at higher rates because they fill quickly, as a result of the population's predominant preference to use water for anal cleansing compared to alternative materials (e.g., paper, leaves) used in other contexts. Moreover, climate change factors such as increased frequency and intensity of rainfall and higher flood propensity also contribute to pits filling up quickly and driving a higher frequency of pit emptying. In coastal regions and low-lying areas, rising sea and groundwater levels warrant more frequent pit emptying to prevent leakages and groundwater contamination.

> *Kaolack has a problem with rising ground water. You see houses being constructed on plots surrounded by water. 60% of my customers empty pits twice a month. They don't have another option – SSP Kaolack*

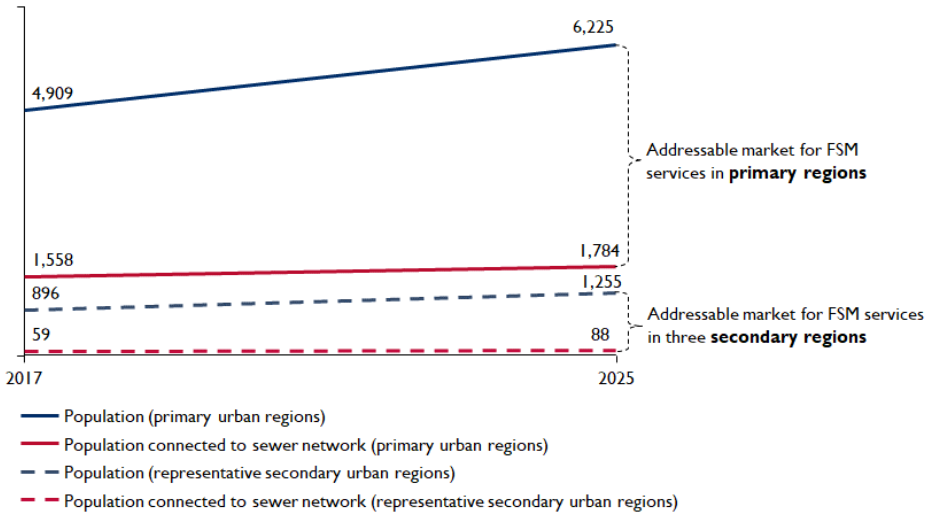
3.2.2 THE PRIVATE SECTOR LEADS THE SUPPLY OF FECAL WASTE COLLECTION AND TRANSPORTATION SERVICES

Urban Senegal, excluding Dakar, lacks sewerage networks. Even in Dakar, only 30 percent of households have a sewered toilet (ANSD/ICF, 2019). Therefore, fecal waste collection and transport is dominated by the private sector. Sanitation service providers (SSPs) provide mechanical and manual pit emptying services. SSPs typically service toilets with septic tanks or lined pits. Most non-sewered

toilets/households have septic tanks or other lined substructures. In secondary urban markets, the prevalence of septic tanks ranges from 55 to 67 percent, while the prevalence in primary urban markets ranges from 79 to 85 percent (ANSD/ICF, 2019).[5]

A sizeable customer base, both in volume and frequency, contributes to high recurring demand for SSPs. The assessment team projects demand for SSPs' services to continue steadily, if not grow over time, due to urbanization outpacing sewer connections (Figure 14) and the government's proposed changes to its safe FSM strategy. The Ministry of Water and Sanitation plans to shift its priorities from increasing sewer coverage to supporting private sector SSPs (ONAS & Ministry of Water and Sanitation, 2021).

Figure 14: Projected urban population ('000) compared to population connected to sewers ('000)



Sources: ANSD population projections for 2017 and 2025, ONAS, 2017

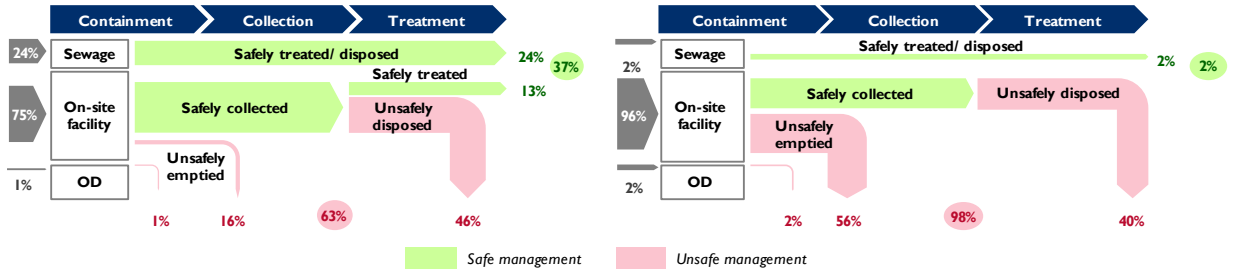
3.2.3 SECONDARY URBAN REGIONS HAVE HIGH UNSAFE COLLECTION AND DISPOSAL LEVELS

Though demand for pit emptying services is high, the corresponding rate of safe waste collection and safe waste disposal is low. Mechanical pit emptying service providers and disposal infrastructure are available to varying degrees in the country's primary and secondary urban regions. The majority of SSPs in Senegal are concentrated in primary urban regions. The *Association des Acteurs de l'Assainissement du Sénégal (AAAS)* or Senegal's pit emptiers' association's records and SSP interviews indicate that approximately 235 of 277 mechanical pit emptying trucks operate in primary regions. Of the 42 trucks operating in secondary urban regions, 65 percent operate in the twin cities of Mbacké and Touba. Availability of FSTP exhibits a similar pattern. The primary urban regions of Dakar, Thiès, and Saint-Louis rely on eight FSTPs, while only three FSTPs serve Mbacké and Touba in the Diourbel region.

WASHPaLS' analyses of fecal sludge production, collection, and disposal volumes indicate high levels of safe waste collection in primary urban regions but significantly lower levels in secondary urban regions. Sewerage and mechanical pit emptiers collect 83 percent of fecal sludge generated in primary regions, and manual emptiers collect 16 percent, most likely from households in densely populated settlements inaccessible by trucks. By contrast, only 40 percent of fecal waste is collected safely in secondary urban regions.

[5] Primary urban: Dakar, Thiès, Saint-Louis; representative secondary urban: Kaolack, Tambacounda, and Ziguinchor.

Figure 15: Shit flow diagram estimates for three primary urban regions—Dakar, Thiès, Saint-Louis—and three representative secondary urban regions—Kaolack, Tambacounda, Ziguinchor



Source: FSG Analyses

Safe fecal waste disposal levels are low in both primary and secondary urban regions, indicating sizeable gaps between the amount of fecal sludge generated and the amount that reaches treatment plants. Interviews with SSPs offering mechanical emptying services suggest they comply with regulations and dispose of waste safely where FSTPs are present.

When they dispose of unsafely, they cite several reasons. Most secondary urban regions lack FSTPs, and official disposal sites that do exist are on open land without any form of treatment. Other barriers include closed FSTPs under maintenance or long waiting times. SSPs may also engage in illegal dumping to avoid long trips or paying tipping fees at FSTPs, but this information is not reported. Manual emptying also contributes to unsafe disposal because emptiers either bury fecal waste on-site or discard it in the street.

Increasing safe FSM poses different challenges in primary and secondary urban regions. In primary urban regions, unsafe collection is largely limited to areas inaccessible by mechanical emptiers. Secondary urban regions, however, have a long way to go to increase safe emptying service provision, considering that few SSPs and trucks operate in these markets. The assessment team posits that increasing safe emptying service provision requires three levers—scale existing SSPs, facilitate new entrants, and transition manual emptiers to safe collection methods.

Reducing unsafe disposal requires infrastructure provision, responding to SSPs' incentives to practice safe disposal, and reducing manual emptying. The government's plans to install FSTPs in 23 cities, of which 87 percent are in secondary urban markets without existing FSTPs (ONAS, 2017), will contribute to safe disposal levels. The assessment team, therefore, prioritized secondary urban markets (i.e., three secondary region groups with similar contexts—Matam-Tambacounda, Ziguinchor, Diourbel-Kaolack, and one primary region—Thiès) to answer the following questions:

a) Are existing SSPs viable and can they scale?
b) Can new SSPs enter the market?
c) Can manual emptiers transition to safe management practices?
d) What barriers and incentives determine SSPs' choice between safe and unsafe disposal practices?

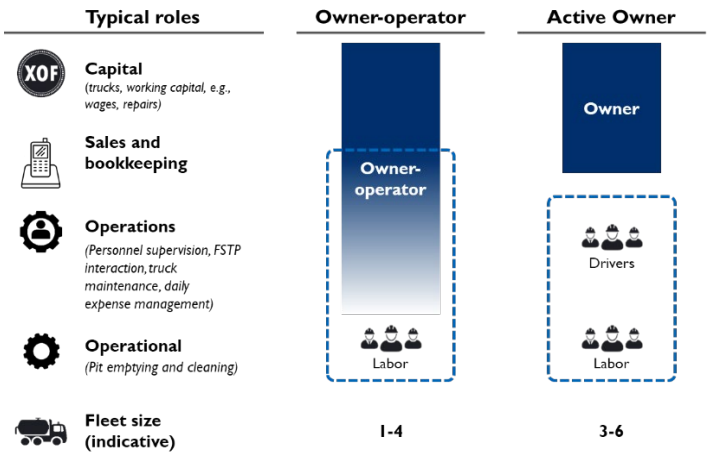
3.2.4 LEVER 1: SCALING SSPS WITH SECOND-HAND TRUCKS

Delivery model landscape

According to the AAAS records, small SSPs (1–2 trucks) and medium SSPs (3–4 trucks) serve secondary urban regions, and unlike primary urban regions, they do not have large SSPs (i.e., 5 or more trucks). The majority of entrepreneurs were either fully dependent on or derived the bulk of their income from pit emptying services. The assessment team observed two delivery models differentiated primarily by the role and extent of the entrepreneur's involvement in the business:

- **Owner-operator:** Run by owners who not only finance truck acquisition but also partake in day-to-day sales and operations alongside a team of one driver and one or more helpers per truck. They manage sales via phone, negotiate and schedule visits with customers, supervise sludge emptying, and manage daily expenses such as fuel, disposal fees, and daily wages or cash bonuses. Owner-operators typically have small SSPs and rely on the driver of the second truck to manage the enterprises' activities except for sales.
- **Active owner:** Entrepreneurs finance truck acquisition, actively manage sales via phone, and schedule visits to customers for pit emptying. While some participate in the day-to-day operations described above, two out of five medium SSP entrepreneurs delegate operations to a supervisor or truck drivers. In such cases, their employees collect fees from customers and deduct trip expenses before remitting the trip or day profits (customers' fees *less* trip expenses) to entrepreneurs.

Figure 16: Illustration of two delivery models

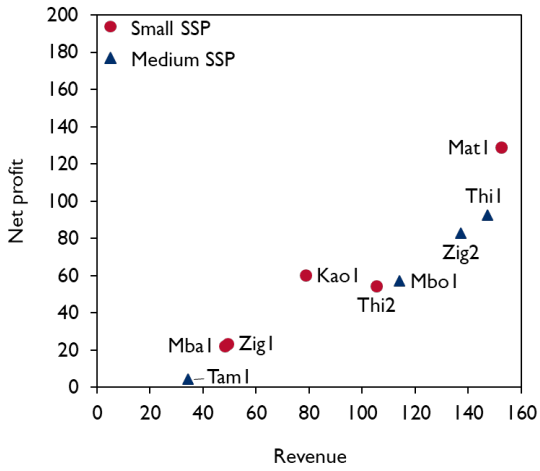


Financial performance and profit drivers

Existing SSPs in secondary urban regions are profitable (Figure 17). They are profitable at the unit level, i.e., revenue less direct expenses per trip. They are also profitable at a business level after fully accounting for all costs, including depreciation of trucks, which many entrepreneurs do not consider because it is a non-cash cost[6].

Analyses of the factors differentiating the financial performance[7] between two SSPs operating in the same or similar contexts revealed that fleet size is the key profit driver. Prices and costs influence an enterprise's ability to generate higher profits to a lesser extent. Fleet size increases SSPs' ability to cater to more customers while mitigating inherent system failures like vehicle breakdowns, a problem all SSPs experience. Increased fleet size does not correspond with a proportionate

Figure 17: Revenue and net profit (n=9, 2020, XOF million)



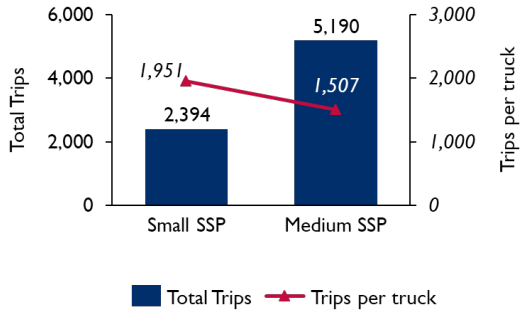
Source: FSG Analysis

[6] Depreciation is an accounting method for expensing long-term assets (e.g., production equipment) that does not entail the enterprise making a cash payment. In this method, the cost of a long-term asset is spread over its useful life because its value is "expended" or "consumed" over multiple years, unlike other expenses that are incurred during the year.

[7] Analyses of the difference in gross profits of two SSPs

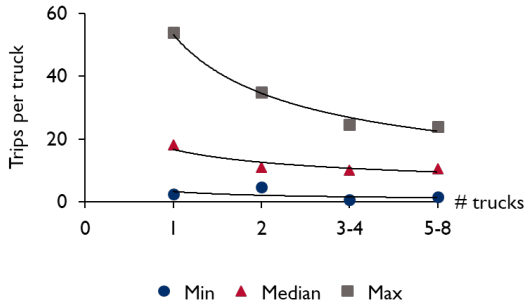
increase in trip volumes. Instead, medium SSPs realized fewer trips per truck than small SSPs with fewer trucks, a trend experienced by SSPs operating in primary urban regions (Figure 18 and Figure 19).

Figure 18: Median annual total trips and trips per truck (2020)



Source: FSG Analysis

Figure 19: Trips per truck (2019)



Source: WASH-FIN SSP Survey, 2019

Sales and marketing practices are generally the same and largely passive. All SSPs display their phone number on trucks. They also write down their phone number outside customers' premises or leave business cards so customers have it handy or can refer neighbors or their networks. The passive marketing approach stems from the SSP's business model. Existing and repeat customers make up 70 percent of the market for small SSPs and 90 percent of the market for medium SSPs.

SSPs with more trips are more likely to undertake shorter trips that enable quicker turnaround to service more customers in a day. Two SSPs with relatively higher profits than their peers serve distant customers by scheduling their trips on the same day, thereby reducing fuel costs.

Prices tend to be homogenous in a given market and vary primarily by truck capacity, but are often negotiated. The majority of SSPs charged XOF 20,000–25,000 (USD 35-43) per trip. SSPs factor distance into the pricing for customers situated away from SSPs' base cities by charging a premium. The majority of SSPs also tend to charge the same rate to households as they do to commercial and institutional clients, although medium SSPs are more likely to charge higher prices overall. When communities celebrate religious festivals, SSPs are sometimes contracted to provide additional or different services and their pricing alters accordingly. Of the nine SSPs surveyed by the assessment team, five of them participate as sub-contractors to empty pits during religious festivals like the *Magal* in Touba. Though special occasions might call for an increase in services, the assessment team found that the price realized per trip is typically lower than the SSP's standard rate. Nevertheless, these SSPs believe that servicing the Senegal National Sanitation Office (ONAS) contracts for religious festivals is a duty. It is also considered a good business choice because religious festivals guarantee 10–17 days' worth of trips.

Fuel and labor account for the bulk of costs incurred by SSPs. Fuel costs are largely beyond the SSPs' control, but the fuel economy of their second-hand, aged trucks (median: 2 km per liter of diesel) is in line with that of new trucks (2–3 km per liter). Though evidence shows the fuel economy (i.e., distance traveled by the truck per liter of fuel) is roughly equivalent, SSPs believe second-hand trucks are inefficient. Labor costs for drivers are typically range-bound at XOF 90,000–100,000 (USD 156-173) per month, paid as fixed salaries, while the majority of helpers are casual laborers paid on a per day or per trip basis to manage costs. However, the wide variance in daily wages and the practice of daily bonuses for drivers and helpers have a sizeable impact on profits realized. SSPs with relatively lower labor costs per trip were more likely to pay only salaries or low bonus levels relative to salaries.

According to a USAID Water Sanitation and Hygiene Finance (WASH-FIN) survey conducted in 2019, maintenance and breakdown of second-hand trucks are among SSPs' top challenges. However, for a top-of-mind challenge, entrepreneurs' recall or estimates for the frequency and typical costs of breakdowns is low. Entrepreneurs' estimates for maintenance and breakdown-related costs amount to seven percent

(median) of total costs. Breakdowns also appear manageable because entrepreneurs either replace trucks to avoid escalating costs or undertake regular maintenance to pre-empt breakdowns.

SSPs can scale by purchasing second-hand trucks

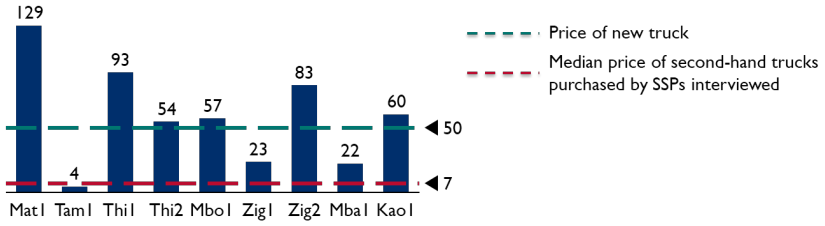
SSPs are keen to expand their fleet to grow their business in their home markets, while a few also want to deploy trucks in other secondary urban regions. All SSPs experience demand in excess of their capacity leading them to either turn down business or, in some instances as in Mbacké-Touba, pass it on to a competitor. Historically, the median cost of trucks acquired by SSPs is XOF 7 million (USD 12,100) and they estimate new second-hand trucks will cost approximately XOF 20 million (USD 34,570).

In addition, SSPs want to capture the dried sludge market, which would require purchasing a different type of truck. Currently, customers turn to manual pit emptiers to clear dry sludge. However, a truck equipped with a hydraulic excavator, priced as high as XOF 30 million (USD 51,850), would enable SSPs to service more customers and gain a competitive advantage over manual pit emptiers.

In some cases, entrepreneurs are actively collecting funds to purchase a second-hand truck. In other cases, they cite the lack of finance for second-hand trucks as an impediment to their growth plans. Assuming SSPs rely on financing truck acquisition from profits, however, the assessment team finds that most SSPs can afford second-hand trucks in the XOF 7–20 million (USD 12,100–34,570) range. It is likely that SSPs estimate expendable funds lower than the assessment team because they have identified plans to allocate their profits for compensation, other business needs that are variable and not fixed, or diversification.

Nevertheless, the profit levels also suggest that acquiring new trucks, estimated at XOF 50 million (USD 86,400) instead of second-hand trucks, is a challenge. New trucks are expected to improve fuel efficiency and costs, lower maintenance costs, and break down less frequently. SSPs that on average travel longer distances per trip believe that new trucks can increase the number of trips per day because they travel at higher speeds and can function longer before needing to cool down. In general, all SSPs are a part of the AAAS (the pit emptiers' association) and believe that new truck acquisition is possible only through financing and procurement mechanisms set up by stakeholders such as ONAS and the USAID WASH-FIN project in partnership with the association. They are highly critical, however, of inequity within the association, citing that Dakar-based SSPs tend to corner all benefits, including access to new trucks.

Figure 20: Net profit vs. price of new trucks[8] and median price second-hand trucks (XOF million, 2020)



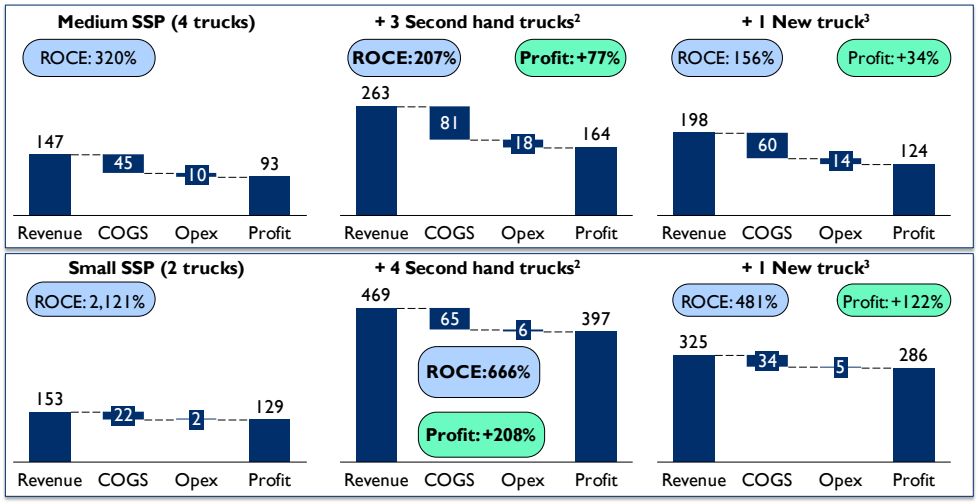
Source: FSG Analysis

Entrepreneurs' preferences for purchasing new instead of second-hand trucks are mixed—some believe the advantages justify the expense while others have the opposite view and cite quicker recovery of investment from second-hand trucks. The assessment team evaluated the financial case for purchasing new or second-hand trucks by developing scenarios for two sample SSPs—one medium and one small

[8] XOF 50 million estimated from Sludge Trucks Fleet Renewal Project (PARC) budget of XOF 2 billion for 40 new trucks and SSP interviews

SSP—and measuring the return on capital employed (ROCE)[9] and growth in net profit. In both cases, investing the same amount in several second-hand trucks instead of one new truck generated higher returns and profit growth. The difference can be explained through assumptions made about the advantages of a new truck. One example is to estimate the trip capacity at 150 percent and fuel and maintenance costs at 80 percent compared to second-hand trucks. Higher fuel efficiency and lower maintenance costs should not alter the results because a new truck is unlikely to complete the same number of trips in a day as several second-hand trucks.

Figure 21: Fleet expansion scenarios of second-hand trucks vs. new truck (XOF million, 2020) for two sample SSPs



Source: FSG Analyses

Notes:

1. *Investment amount of XOF 51 million (USD 88,150) for medium SSP and XOF 50 million (USD 86,400) for small SSP toward purchasing several second-hand trucks or one new truck where price per second-hand truck is assumed as approximately XOF 16 million (USD 27,650).*
2. *Plus three second-hand trucks: Assumed same number of trips per day per truck as the current fleet, total trips for commercial and institutional clients and ONAS kept constant.*
3. *Plus one new truck: Assumed trip capacity is +150 percent of current, second-hand trucks due to speed and lesser instances of cooling periods; fuel cost and maintenance is 80 percent; and insurance premium is 300 percent compared to that of second-hand trucks.*
4. *Acronyms: COGS: Cost of Goods Sold is the sum of labor, fuel, disposal fees and/or penalties, and chemicals costs; 2. Opex: Operating expenses is the sum of depreciation, administrative staff salaries, marketing, maintenance, breakdown, insurance, safety equipment, utilities, and office rent costs.*

However, the case for purchasing new or second-hand trucks needs to be examined on a case-by-case basis because financial models vary from one SSP to another. Variables such as current maintenance costs, fuel economy, and average distance traveled per trip influence the choice between new and second-hand trucks. Moreover, due consideration must be given to other non-financial factors such as ease of operations (e.g., availability of spare parts), regulations (e.g., vehicle age, emission levels), and vehicle fitness and safety.

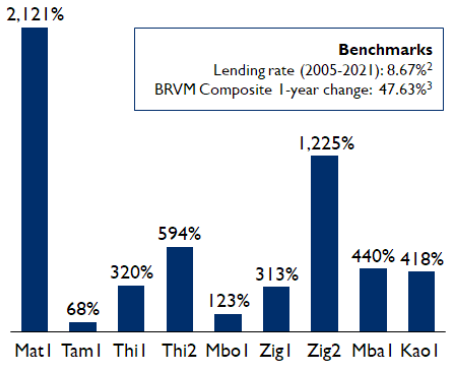
The assessment team observed that current levels of returns are high to begin with because SSPs employ a low amount of assets and working capital, which together constitute "capital employed." The average value of assets, i.e., trucks, tends to be low because the value of many trucks has fully depreciated, and SSPs do not maintain other assets of significant value, such as office space. Working capital is also low because expenses for fuel, disposal fees, daily wages, salaries, etc., are paid after collecting fees from customers (i.e., they have a positive working capital cycle).

[9] ROCE: Net profit/capital employed (i.e., sum of average value of assets during the year and working capital); SSPs working capital is assumed zero because the bulk of expenses are funded from customer fees on any given day, SSPs do not set aside funds for salaries, which are paid at the end of a month, and other expenses such as insurance.

3.2.5 LEVER 2: EASE OF SSP ENTREPRENEURSHIP

The high cost of trucks, even second-hand trucks, is cited as a key barrier to the expansion of existing SSPs and new entrants. Interviews with a pit emptiers' association representative and SSPs paint a picture of the challenges facing entrepreneurs who want to enter the secondary urban regions and increase the overall market supply of safe emptying services. Entrepreneurs include individuals with existing businesses that have surplus capital for investment, or Senegalese expatriates investing in businesses at home. Examples of the former include two SSPs the assessment team interviewed who invested proceeds from their other businesses to start and grow the SSP business. Two other SSPs interviewed had silent profit-sharing partners abroad who provided seed capital to purchase trucks while the local partners manage the business and periodically repatriate funds as returns. Potential entrants could be attracted by demonstrating the significantly high returns generated by SSPs (68 percent to 2,121 percent with median returns of 418 percent) when compared with benchmarks such as the commercial bank lending rate or investing in equities in Senegal.

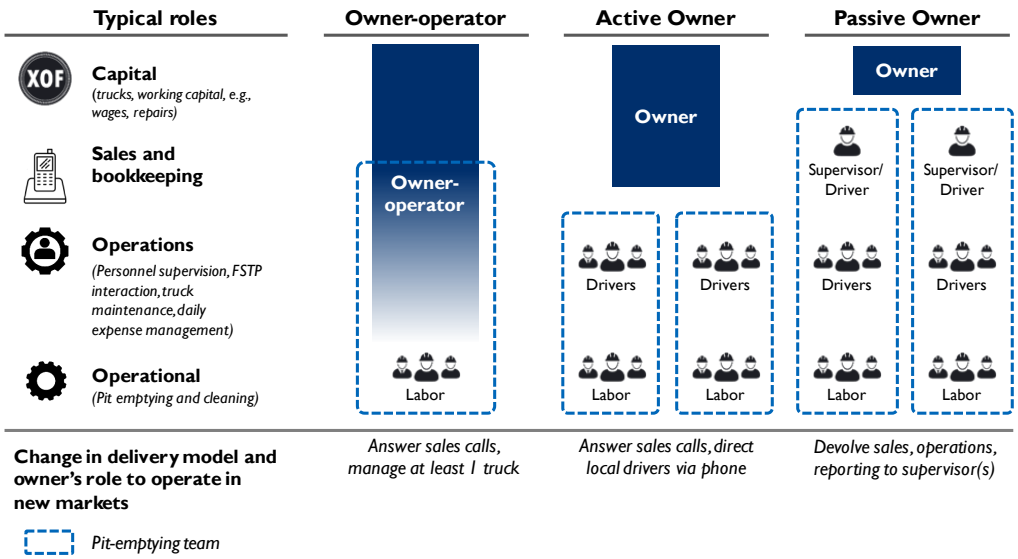
Figure 22: Return on Capital Employed (ROCE, %, 2020)



Source: FSG Analysis

Assuming entrepreneurs are incentivized to launch SSPs, they can opt for a passive, "hands-off" owner model by hiring supervisors to manage operations. Entry barriers cited by existing SSPs appear low and can be addressed. Existing entrepreneurs believe new entrants risk failure because they do not know the business. However, by their own admission, management and operations are straightforward. Further, they easily acquire or replace labor with necessary skills such as supervision, driving, and operating equipment.

Figure 23: SSP delivery models



Existing SSPs also believe new entrants will find customer acquisition challenging because households tend to call existing operators who have served them satisfactorily. Existing sales and marketing

practices, described earlier, are passive and largely involve ensuring phone numbers are visible or easily available for customers when they require the service. New entrants could pursue active strategies such as distributing flyers and visiting cards, or offer limited-time discounts at launch or during peak pit-emptying season (i.e., the rainy season).

Entrepreneurs who adopted the "active owner" model, relying on supervisors or drivers to remit profits daily, cited staff underreporting collections as a risk. They address this challenge by permitting the display of their phone number only to keep track of sales and reconcile with daily reports and profits received from the staff. Similarly, new entrants can centralize sales queries at a phone number they control to track sales and monitor collections.

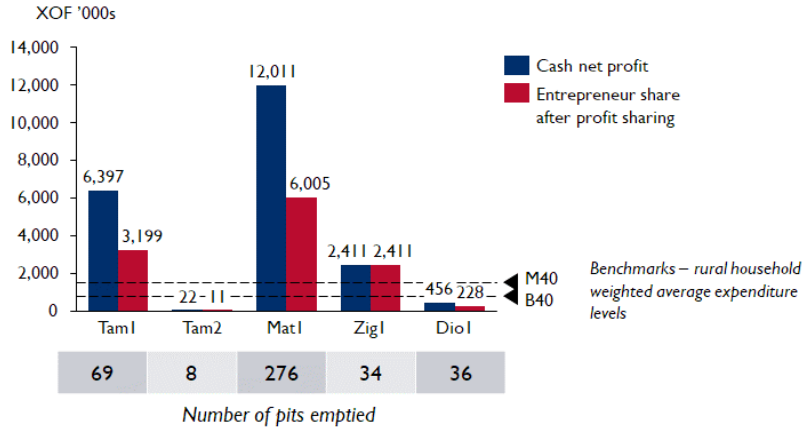
3.2.6 LEVER 3: SOLUTIONS FOR MANUAL EMPTIERS

Manual emptiers interviewed by the field team are uniquely positioned to extract dry sludge. All but one manual emptier dealt with wet and dry sludge, while one manual emptier only extracted dry sludge. They consider their service as complementing mechanical pit emptiers and see their relationship as collaborative. In fact, some manual emptiers claimed that either customers or mechanical SSPs call them to remove sludge leftover by vacuum trucks and clean the pit.

Some emptiers have experienced a gradual reduction in pit emptying jobs. They believe several factors are at play. For one, customers increasingly prefer mechanical emptying for fear of government penalties. Emptiers also report that there is increased competition in the field from individuals who work temporarily as freelance manual pit emptiers. Competition is difficult to measure because the ban on manual emptying disincentivizes advertising.

Their viability, assessed by examining financial performance and the number of pits emptied, exhibits wide variance (Figure 24). Some manual pit emptiers make incomes lower than the annual expenditure levels of the bottom two quintiles of rural households. On the other hand, manual emptiers report robust business (e.g., Tam1 and Mat1 in Figure 24) and charge sizeable fees to remove dry sludge. For instance, Zig 1 in Figure 24 charges XOF 125,000 (USD 216) compared to XOF 20,000–25,000 (USD 35–43) for mechanical emptying because they get only 2–3 jobs per month.

Figure 24: Annual cash net profit (CNP) of manual emptiers (XOF '000s, 2020), entrepreneurs' CNP, and benchmarks to evaluate vulnerability.



Source: FSG Analysis
Notes:
CNP = Cash net profit (net profit plus depreciation [a non-cash expense not considered by many entrepreneurs]); B40 = Bottom 40 percent of rural households (first two quintiles) by expenditure; M40: Middle 40% of rural households (next two quintiles) by expenditure; rural households adopted as benchmarks because urban household expenditure data was unavailable.

Manual pit emptiers desire solutions for safer waste collection and are willing to invest with or without financing, depending on their income and savings.[10] However, they see several challenges to adoption, primarily the limited ability of semi-mechanical solutions to extract dry sludge, which would necessitate manual emptying practices. Other challenges include new expenses such as renting or purchasing a vehicle to transport sludge for safe disposal, fuel and disposal fees, increased risk of police harassment, and risk of semi-mechanical equipment damaging pits or triggering a collapse.

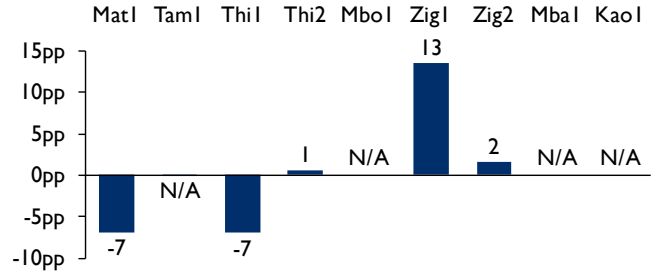
Transitioning manual emptiers to safer practices will require solutions to extract sludge without risking direct contact or exposure to feces. Given that several SSPs who offer mechanical emptying want to invest in hydraulic excavators, manual emptiers are likely to face more competition in the longer term and may need assistance to adopt other livelihoods.

3.2.7 SSPS DESIRE SAFE DISPOSAL INFRASTRUCTURE

SSPs dispose of waste illegally when FSTPs, if present in their market, are closed for maintenance or their sites are saturated. In urban regions without FSTPs, SSPs have no choice but to dispose of waste in officially designated or illegal sites, often open grounds situated away from populated areas. For instance, SSPs in Ziguinchor collaborated to negotiate a disposal site with a nearby commune. SSPs also resort to illegal dumping when customers are located far from their home markets or disposal sites. However, they claim such instances are far and few between because the majority of their customers are located in their home market. The lack of disposal infrastructure is among SSPs' top challenges because they are often fined by the hygiene police or other authorities, and penalties vary greatly. Frequent penalization also leads to business disruption and costs.

All SSPs interviewed desire FSTPs or officially designated disposal sites and are willing to pay disposal fees between XOF 1,200–2,100 (USD 2–4) per trip. They are motivated by potential savings, estimating that disposal fees will cost less than paying penalties. Per entrepreneurs' estimates of penalties incurred, the amount is a small share (2–3 percent) of COGS.[11] The impact of paying disposal fees instead of penalties on the net profit margin (i.e., net profit expressed as a percentage of revenue) is mixed (Figure 25). The benefit of paying disposal fees is relative to the penalty amounts incurred, which vary significantly from one SSP to another. In Figure 25, Zig1 appears to be an exception because it estimates the potential site of an FSTP in the city will significantly reduce its average trip distance and fuel costs resulting in a net profit margin gain of 13 pp. Similarly, Zig2 estimates fuel savings but to a lesser extent. However, excluding fuel cost reductions, consistent with other SSPs, the net profit margins of Zig1 and Zig2 will reduce by 0pp and -2 pp, respectively. Notwithstanding the financial benefit (or lack thereof), SSPs value conducting business without the uncertainty and disruption caused when penalized.

Figure 25: Change in net profit margin due to tipping fees replacing fines and equivalent (pp, 2020)



Source: FSG Analysis
Note: pp refers to percentage point or the difference between two percentages (e.g., 25% - 20% = 5 percentage points)

[10] Manual emptiers were shown the Gulper semi-mechanical emptying solution as an example to understand willingness to adopt, ability to pay, and potential benefits and challenges.
[11] COGS is the sum of labor, fuel, disposal fees and/or penalties, and chemicals costs.

SSPs benefit from a favorable business environment in large part due to ONAS' public-private partnership approach, which encourages private sector operators to enter the market. Interventions such as designating the bulk of new FSTPs to secondary urban regions and the Sludge Trucks Fleet Renewal Project (PARC) for access to new, locally assembled trucks, among others, address SSPs' key challenges faced. However, the configuration of wastewater treatment plants set up in secondary cities recently that prioritized sewerage networks and excluded SSPs is a challenging precedent considering the majority of households, even in Dakar, rely on on-site systems.

Considering the low competition in secondary urban regions and customers' preferences shifting toward mechanical emptying, stakeholders need to identify interventions to increase the presence of mechanical SSPs in these markets. Increasing entrepreneurs' market participation combined with infrastructure development will contribute significantly to enhancing safe FSM across urban Senegal.

3.3 URBAN REUSE

The fecal sludge reuse market is at a nascent stage and has the potential to grow from XOF 11 million (USD 19,012) to XOF 350 million (USD 605,000), but it requires solving critical challenges.

3.3.1 PILOT FECAL SLUDGE REUSE MODELS IN DAKAR

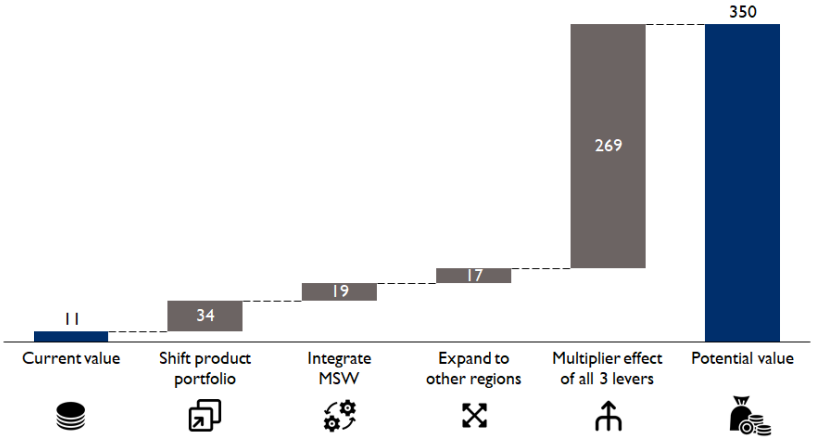
Dakar accounts for 39 percent of the fecal sludge generated in urban Senegal, and FSTPs are currently transforming approximately 50 percent (270,000 m^3 annually) of the sludge received into compost. The model is at a pilot stage. Delvic, the FSTP operator, has developed a compost production process but has not yet set up a sales and distribution model. Currently, farmers purchase compost on-site and transport it at their own cost from the FSTP, which suggests sale is limited to the FSTPs' catchment area. The field team estimates fecal sludge-derived compost sales at XOF 11 million annually, which represents approximately 0.1 percent of the total fertilizer market in Senegal (West African Fertilizer Association, 2019).

While the production and sale of compost are at a pilot stage, local organizations such as Delvic are also considering biogas and treated water.

3.3.2 CHANGES TO ENHANCE REUSE MARKET POTENTIAL

The assessment team's analysis shows that the market potential for fecal sludge reuse can increase by up to 32 times (Figure 26) through three levers. Implementing all three will yield the greatest impact.

Figure 26: Annual market value of FS reuse (XOF million)



Source: FSG Analysis
Note: Detailed calculations can be found in the supplemental deck on the circular sanitation economy.

Lever 1: Reorient the planned product portfolio toward relatively higher value and easier to implement reuse products

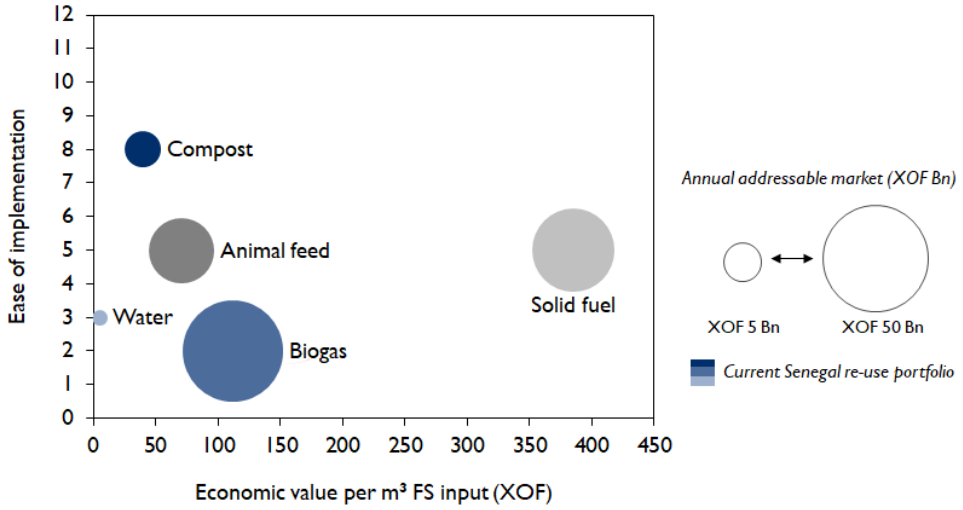
Analysis of reuse models across the global South show that while compost and biogas are the most common products, treated water for reuse is rare. In addition, solid fuel (briquette) and animal feed are two other reuse products produced in the global South. Neither are currently being explored in Senegal.

The field team analyzed potential reuse products in Senegal (Figure 27) using three parameters—economic value per unit of fecal sludge processed, ease of implementation, and the addressable market. The team's analysis concluded that compost, animal feed, and briquette are the most promising products. By contrast, Senegal's planned portfolio by local actors includes compost, treated water, and biogas.

Compost, trialed in Dakar, has low unit economic value but a relatively reasonable addressable market. It is also the easiest model to implement because of its low capital and minimal labor and energy requirements. Notably, early trials show some degree of acceptance by small-scale farmers in Senegal, which is often a challenge for products derived from fecal sludge (Delvic, key informant interview July 23, 2021; (Diener, et al., 2014).

Animal feed and briquettes have higher economic values and larger addressable markets than compost. But implementation requirements for these two products are higher than compost because the production processes need more capital and consume more energy. Acceptance by end-users needs testing, especially for animal feed. Insights can be drawn from global precedents, which show that animal feed is a viable substitute for traditional reuse products in Senegal. Animal feed has higher protein content than commonly-used feed products, while briquettes can be a lower-cost substitute for charcoal, which is expensive in Senegal.

Figure 27: Estimated economic value per unit of fecal sludge processed (XOF per m3), ease of implementation, and annual addressable market (XOF billion) of select fecal reuse products



Source: FSG Analysis
Note: Ease of implementation is a composite qualitative score of ease of production, distribution, and customer acceptance; detailed calculations can be found in the supplemental deck on the circular sanitation economy. XOF 5 Bn = USD 8.6 Mn, XOF 50 Bn = USD 86.4 Mn

While biogas also has a large addressable market in terms of usage as a domestic fuel, production yield is a severe barrier in Senegal. Sludge retention times in septic tanks, which are predominant in urban Senegal, render it unsuitable for generating biogas. Retention time in septic tanks stabilizes sludge, generates methane, and much of the readily degradable organic matter required to generate biogas is lost (Diener, et al., 2014); (Alison Parker and Miriam Otoo, key informant interviews August 20, 2021).

Finally, deriving treated water from fecal sludge has the least potential because the process lacks global precedent. Although a relatively easier production process, acceptance of the practice by external users is nonexistent.[12]

Irrespective of the product portfolio composition, sales and distribution models need to be designed and evaluated because their costs can fundamentally alter the costs and ease of implementation. User acceptance will also need to be evaluated to understand the potential for scale.

[12] Refers to users other than FSTPs who may consume reuse products (e.g., biogas, water) in their operations.

Lever 2: Integrate municipal solid waste streams to increase production quantity and improve quality

Most urban reuse models (e.g., compost, biogas, and solid fuel production) integrate municipal solid waste streams, specifically organic waste, which has higher total solid content compared to fecal sludge. The total solid content in waste determines the quantity of output (Ddiba, Andersson, Rosemarin, Schulte-Herbrüggen, & Dickin, 2022). Therefore, integrating one or more solid waste streams with fecal sludge boosts reuse product quantity while simultaneously improving product quality, i.e., nutrient or energy content. For instance, the assessment team estimates that compost and solid fuel volumes can increase by 1.8 times while animal feed volumes can more than treble.

> *Focus on mixing waste streams, and not relying only on fecal sludge, has allowed us to scale-up our output products*
> *– Sanergy, Kenya*

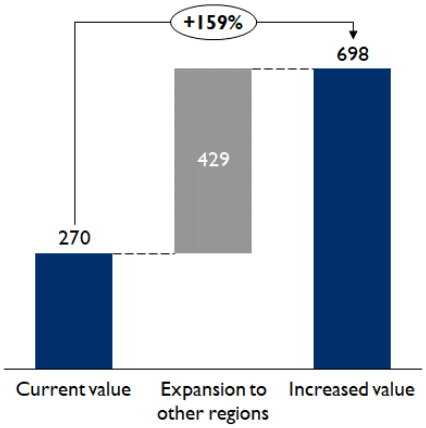
Senegal features enabling factors to integrate waste streams. Municipal solid waste generates more than the amount of organic waste needed to mix with the total fecal sludge produced in urban Senegal. While SSPs and municipalities need to set up partnerships to direct organic waste to existing and new FSTPs, several SSPs are interested in adding solid waste collection to their businesses. Integrating municipal solid waste with fecal sludge, instead of reusing only fecal sludge, can increase costs, but literature on the potential impact on cost is limited. One study from 2002 indicated that capital cost per unit of input of fecal sludge could increase by 1.1 times due to the amount of additional land and equipment needed to process it (Steiner, 2002). Operating costs per unit input of fecal sludge might increase by 3.5 times due to the additional cost of segregating organic from other solid wastes. The study also identified potential increases in other costs such as labor and utilities (Steiner, 2002). Segregation of solid waste is the main driver of this increase, accounting for about 50 percent of the change in operating costs. Solid waste segregation is, therefore, an important problem to be defined and resolved. One option is to implement source segregation at the household level. Alternatively, segregated organic waste can be procured from hotels, vegetable markets, and other commercial organic waste producers, a practice pursued by a reuse facility in Devanahalli, India.

Lever 3: Expanding reuse in cities other than Dakar can scale the value of reuse products

Dakar has high rates of safe waste collection, and despite a significant volume not reaching FSTPs, the supply of fecal sludge to FSTPs exceeds their capacity. Nearly 50 percent of sludge is not transformed into compost at FSTPs due to a lack of capacity (Delvic, key informant interview, July 23, 2021). The current utilization at the FSTPs in Dakar is 270 percent and there is little room to expand due to constrained land availability.

Other cities in Senegal have under-utilized FSTPs or new FSTPs with capacity that exceeds supply. By the field team's estimates, the market potential for reuse products can double by transforming fecal sludge in urban Senegal outside of Dakar (Figure 28). Increasing the quantity of sludge received by new or upcoming FSTPs and increasing the output of reuse products will require systemic interventions to increase safe collection and disposal.

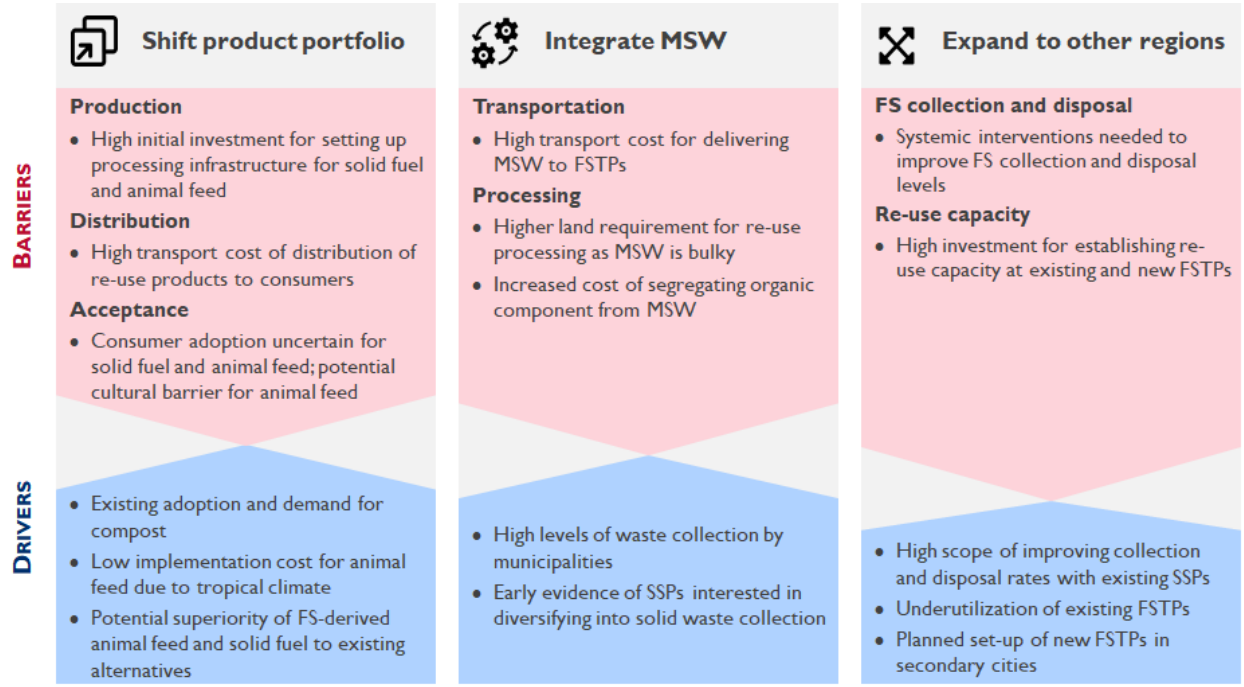
Figure 28: Increase in FS under re-use ('000 m3)



Note: Detailed calculations can be found in the supplemental deck on the circular sanitation economy.

3.3.3 ADDRESSING KEY BARRIERS TO REALIZING CIRCULAR SANITATION

Figure 29: Driver and barriers to realizing the potential of circular sanitation economy



Acronyms: FS: Fecal sludge; MSW: Municipal solid waste; SSP: Sanitation service provider; FSTP: Fecal sludge treatment plant

Developments in Senegal and global examples of fecal sludge reuse models offer several starter ideas to implement the three levers and catalyze Senegal's nascent circular sanitation economy.

1. **Shifting the product portfolio** (from compost, water, and biogas to compost, solid fuel, and animal feed) will require testing the technical feasibility of producing solid fuels and animal feed in Senegal. Distribution models involving commercial enterprises (e.g., agriculture inputs value chain for animal feed, solid fuel suppliers for briquettes) could be explored to deliver reuse products to end-users. Demand for solid fuel and animal feed through willingness-to-pay studies can inform acceptance levels by end-users and improve estimates of market size.
2. **Integrating municipal waste streams** requires evaluation of existing solid waste collection systems and how they can be diverted to FSTPs and segregated for organic waste. Alternatively, or as a complementary source, SSPs expressing interest in diversifying into solid waste collection could be leveraged. The issue of waste segregation can also be resolved by procuring organic waste directly from large-scale generators such as restaurants, produce markets, and food processors.
3. **Expanding to regions** outside Dakar requires continued systemic interventions to increase safe FSM. Minimizing FSTPs' investment risk can be achieved by granting subsidized land, tax breaks, and other such policy levers. Other mechanisms such as mandatory procurement by the government and the public sector (e.g., the use of compost in gardens) can help assure FSTPs a certain level of demand and act as a demonstration for other potential customers.

The starter ideas and the fledgling state of fecal sludge reuse models make clear that many other potential opportunities exist, and experimentation and innovation are needed to validate fecal sludge reuse models. They also highlight that developing a circular sanitation economy is a long-term effort, requires steady capital, and is a multi-sectoral effort involving actors beyond sanitation market systems. Building consensus among the public, private, and development sectors will be critical to replicate the partnerships and progress in the broader safe FSM.

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