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(CASE STUDY)

Financial Acceptability Study of a Faecal Sludge Treatment Plant for Watercourse Purification in Mali

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Abstract

The sustainable management of faecal sludge is a major challenge for Malian cities facing rapid urbanization and limited access to collective sanitation systems. This study analyzes the financial acceptability of a faecal sludge treatment plant (FSTP) in Mali, using a techno-economic approach that integrates investment, operation, and maintenance costs, as well as the ability and willingness to pay of households and service operators. The results indicate that, under certain tariff and organizational assumptions, the FSTP can be financially acceptable and socially sustainable, provided that adequate institutional support and professionalization of stakeholders are ensured.

Keywords: Faecal sludge; Financial acceptability; Sanitation systems

1. Introduction

In developing countries, particularly in West Africa, urban sanitation relies mainly on on-site systems such as latrines and septic tanks. The management of faecal sludge generated by these facilities remains a technical, environmental, and economic challenge (Amzet, 2000; Sasse, 1998; Klingel et al., 2002). In Mali, more than 70% of urban households use non-collective sanitation facilities, making faecal sludge treatment a critical issue for public health and the protection of water resources (DNH, 2022; WHO, 1962).

Several studies have shown that the failure of faecal sludge treatment plants is often linked not to technical shortcomings, but rather to inadequate consideration of economic and financial aspects (Koné et al., 2012; Tayler, 2020). Indeed, a treatment facility that is technically efficient but financially unacceptable to users or operators quickly becomes non-functional (Kengne, 2006; Tadjouwa, 2016).

Financial acceptability is therefore a key determinant of the sustainability of faecal sludge treatment plants (FSTPs). It depends on household income levels, desludging costs, gate fees applied at the treatment plant, and the governance model adopted (Morel à l'Huissier; SOW, 2008). Studies conducted in Dakar, Ouagadougou, and Yaoundé have shown that financial balance can only be achieved through a combination of appropriate tariff structures, targeted subsidies, and effective regulatory mechanisms (DEME, 2008; Mahamane, 2014; Martine Koné, 2016).

This study fits within this framework and aims to assess the financial acceptability of a faecal sludge treatment plant in Mali, without questioning the initial theme, while strengthening scientific rigor through a clear structuring of results and discussions.

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2. Presentation of the Study Area

2.1. Urban and Geographical Context of Bamako

Bamako is the political and economic capital of Mali. Located along the banks of the Niger River, the city is characterized by rapid population growth and largely uncontrolled urban expansion. Its Sudano-Sahelian tropical climate, marked by a prolonged dry season and an intense rainy season, strongly influences sanitation practices and wastewater management.

The concentration of multi-storey buildings of the S+R+6 type along the river increases the challenges related to collective sanitation. In the absence of adequate sewerage networks, on-site sanitation systems dominate, leading to frequent desludging operations and uncontrolled discharges into the natural environment.

2.2. Institutional and Regulatory Framework

Mali has regulatory texts governing the management of wastewater and faecal sludge, notably decrees related to the protection of watercourses and the control of pollution. However, the effective enforcement of these regulations remains limited due to institutional, financial, and technical constraints.

3. Methodology

3.1. Socio-Economic Data Collection

A questionnaire-based survey was conducted among populations living along the Niger River and users of the targeted buildings. A non-probabilistic sampling method was adopted, allowing households present at the study sites at different times of the day to be interviewed in order to reduce selection bias.

3.2. Institutional Interviews

Interviews were carried out with the main institutions responsible for sanitation in Mali, including the National Directorate of Sanitation and Pollution and Nuisance Control (DNACPN), the National Directorate of Hydraulics (DNH), the National Agency for the Management of Wastewater Treatment Plants (ANGESEM), and the Niger River Basin Authority (ABFN). These discussions helped to better understand institutional constraints and strategic orientations in faecal sludge management.

3.3. Economic Analysis

The financial analysis is based on the estimation of:

- The investment cost of the faecal sludge treatment plant (FSTP);
- Operation and maintenance costs;
- Equipment depreciation;
- Users' financial contribution.

The individual contribution is calculated using the following equation:

$$Pay = \frac{A + I + C}{N_{users}} \qquad (Eq. 1)$$

where A represents depreciation, I the investment cost borne by the users, C the operation and maintenance costs, and $N_{(}users_{)}$ the number of beneficiaries.

4. Results

4.1. Assessment of Household Contribution

For the Faecal Sludge Treatment Plant (FSTP) implemented in Dioila in 2021, the total construction cost amounted to seventy-three million four hundred and nine thousand two hundred and fifty-four (73,409,254) FCFA, all taxes included.

With regard to sanitation, the beneficiaries' contribution to the operation and maintenance of the newly tested facility in Dioila can be estimated based on several considerations, including:

- The monthly contribution to be paid on the basis of 2,000 beneficiaries (number of users, N_{users}) involved in the experiment over a period of ten years;
- The only marketable by-product, namely compost obtained from the drying beds, whose revenues will be used to purchase treatment equipment; and
- The investment cost, which will not be charged at 100% of the project cost but limited to 3%, thanks to financial support from the pepa-giz funding agency.

4.2. Operation and Maintenance Costs

Table 1 Operation and Maintenance Costs of the FSTP

Title	**Basis**	**Ten Year Amount**
Civil works	0,5% of investment/5 Years	731 552,6
Electricity	1 200 000 over 10 Years	1 200 000
Piping	1% of' investment/5 Years	1 463 105
Personnel (drivers and guard)	250 000FCFA/Month	15 000 000
Equipement	3% of investment/5 Years	4 389 316
TOTAL		**22 783 973,3**

Depreciation

The depreciation is summarized in the table below:

Table 2 Depreciation of the FSTP

Depreciation				
Equipement	Lifespan (Year)	Purchase Price (F CFA)	Annual Depreciation	Ten-Year Depreciation
Vacuum trucks and carts	10	15 000 000,0	1 500 000	15 000 000
TOTAL				15 000 000

4.3. Calculation of the Individual Financial Contribution

In accordance with Equation 1, it is calculated using the following relation:

- Where A is the depreciation, I is the investment (taken at 3% by the users), C represents the operation and maintenance costs, and N_users is the number of users.
- Thus, the monthly payment per individual over 10 years (i.e., 10 × 12 months) will be: Pay = 166.57 FCFA/month
- The monthly financial contribution can be rounded to 170 FCFA per individual.

This monthly rate, which corresponds to approximately 1,700 FCFA per average family (10 people), is highly affordable compared to the rate established for the maintenance of mini-sewer systems implemented by the AEA, which charged 1,000 FCFA per individual per month.

4.4. Financial Acceptability of the FSTP

The results show that for a total investment cost estimated at 73,409,254 FCFA (all taxes included), the portion borne by users can be limited to 3% thanks to donor support. Operation and maintenance costs over ten years amount to approximately 22.8 million FCFA, while the depreciation of major equipment is estimated at 15 million FCFA.

Based on a sample of 2,000 users involved in the Dioila pilot experiment, the average monthly contribution per individual is approximately 170 FCFA. This amount is significantly lower than the contributions observed in urban mini-sewer systems, reinforcing the financial acceptability of the facility.

Socio-economic surveys indicate that most households accept a desludging fee between 1,700 and 2,000 FCFA/m^3, whereas desludging operators find it difficult to integrate high charges at the entrance of the treatment plant.

Financial analysis indicates that budgetary balance can be achieved, provided there is a minimum annual treatment volume and a partial investment cost subsidy mechanism.

5. Discussion

The analysis, based on the diffusion of innovation theory, highlights several factors favorable to the adoption of the FSTP:

- **Relative advantage:** reduced costs and limited environmental impacts;
- **Compatibility:** alignment with local sanitation practices;
- **Relative simplicity:** technology is locally accessible and manageable;
- **Testability:** successful experimentation at the Dioila pilot site;
- **Observability:** visible benefits on effluent quality and compost production.

These elements confirm that the FSTP represents a socially and economically acceptable innovation.

Compared to the Sotuba wastewater treatment plant, the FSTP has fewer negative impacts on biodiversity and aquatic ecosystems. Although some visual and olfactory nuisances remain, they are manageable and significantly lower than the effects observed in conventional, poorly adapted systems.

The unit costs obtained are comparable to those observed in other African cities (DEME, 2008; Klingel et al., 2002). The predominance of operation costs confirms the need to optimize technological choices and the organization of the facility.

The observed ability to pay remains limited, which aligns with the conclusions of SOW (2008) and Tayler (2020). A uniform tariff could exclude part of the households, highlighting the importance of cross-subsidization mechanisms or targeted subsidies.

Financial viability strongly depends on the institutional framework and the plant's utilization rate. Similar experiences in West Africa show that local government involvement is decisive for ensuring the sustainability of FSTPs (Kengne, 2006; Tadjouwa, 2016).

6. Conclusion

The study demonstrates that the faecal sludge treatment plant under consideration can be financially acceptable in the Malian context, provided that tariffs are appropriately set, a sufficient volume of sludge is treated, and institutional support is ensured. Sustainable improvement in faecal sludge management thus requires an integrated approach combining rigorous economic analysis, effective local governance, and user awareness.

The low contribution required from users, combined with environmental and health benefits, favors its social acceptance.

However, long-term success of this type of facility requires (i) strengthening sector governance, (ii) increased user awareness and (iii) continuous adaptation of financial models to local socio-economic realities.

Thus, the FSTP appears as a relevant lever for sustainably improving urban sanitation in Mali.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed

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