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Market driven approach for faecal sludge treatment products

N. Andriessen, L. Schoebitz, M. Bassan, S. Bollier & L. Strande (Switzerland)

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Inadequate management and treatment of faecal sludge continues to pose risks for public and environmental health. Given the variability of faecal sludge and location-specific nature of solutions, it is difficult to decide on treatment objectives and performance goals for treatment. The Market Driven Approach was developed as a quantitative methodology to determine which faecal sludge treatment products have the highest market potential in a defined location. This methodology provides a way to compare treatment products based on their real value for resource recovery. This paper discusses the results and lessons learned from field-testing in five cities across Africa and South-East Asia.

Introduction

For the 2.7 billion people that are using on-site sanitation technologies worldwide, the safe collection, transport and treatment of the resulting faecal sludge is of utmost importance (Strande, et al., 2014). Unfortunately, dumping of untreated faecal sludge directly into the environment occurs frequently, which poses a serious risk for public and environmental health. Thus, for adequate protection of public and environmental health, solutions for faecal sludge management are essential. Acknowledgement of the importance of solutions for faecal sludge management is relatively new, and is rapidly gaining attention and making advances.

The characteristics of faecal sludge are different from wastewater in many aspects (i.e. variability, solids, organic matter, stability) (Strande, et al., 2014). For this reason, design principles for wastewater treatment cannot simply be transferred to faecal sludge treatment. For engineers designing faecal sludge treatment, there are limited good-case-practice examples on well-designed treatment facilities. Moreover, due to the variability of faecal sludge, direct transfer of treatment design from other locations results in under- or overdesigned treatment facilities. Furthermore, frequently standards do not yet exist for faecal sludge treatment, or are not enforced. As a result, it is not necessarily clear what treatment objectives and performance goals should be designed for, and there is a need for guidance materials.

Diener et al. proposed that designing for treatment needs to start from a resource recovery perspective (2014). This includes the possible treatment products of faecal sludge treatment, and to what extent they can be marketed, to ensure treatment produces resources with optimal value. If these products are identified, then treatment performance goals can be determined appropriately. Presented in Figure 1 is an engineering design approach to design and selection of faecal sludge treatment. This approach first considers treatment products and markets to determine treatment objectives, to ensure the level of treatment is adequate for the intended enduse (Strande, et al., 2016). The approach also considers inflow quantities and characteristics of faecal sludge, and all other enabling factors included in a planning approach. A resource recovery approach to determine treatment goals can potentially: offset disposal costs of treated sludge; reduce annual operating costs; stimulate sustainable operation of the treatment plant, as the operator must meet customer demand; and prevent treatment producing products with no market value. With the number one goal always being protection of public health, an approach such as this would aid in the sustainable design of faecal sludge treatment.

To help fill these gaps, the Market-Driven Approach (MDA) was developed as a decision making tool, and provides a method to determine quantifiable and comparable market values of treatment products, which is globally applicable. This paper presents the developed method, and the results from field testing it in five cities in Africa and South-East Asia.

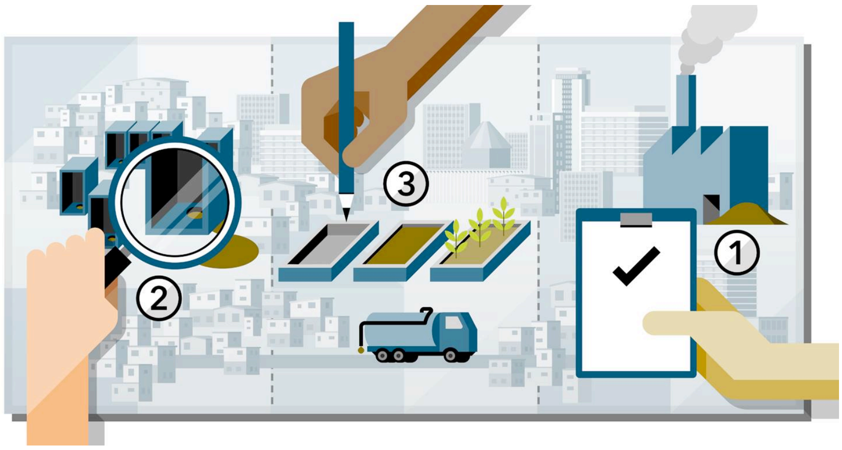

Figure 1. Engineering design approach

Source: (Strande et al., 2016)

Methodology

The MDA methodology (Schoebitz, et al., 2016) provides a method to quantify the market attractiveness of faecal sludge treatment products. Market attractiveness is comprised of the market volume and market growth (Figure 2). Given the lack of existing markets for faecal sludge treatment products, the methodology uses substitute products as proxies to determine the market attractiveness of the potential treatment products. Substitute products are currently existing (and used) products that could be replaced by faecal sludge products. For example, charcoal could be replaced with faecal sludge briquettes, therefore, charcoal is a substitute product. Market volume is calculated by multiplying the number of units sold per substitute product (market size) with existing prices, resulting in the volume of the potential market in US$/year. However, faecal sludge treatment products will never have exactly the same characteristics as existing substitute products (e.g. faecal sludge briquettes with lower calorific value than existing briquettes, or lower acceptance or usage of treatment products). To prevent over- or under-estimation, an adjustment factor is included in the methodology to adjust for the differences (positive and negative) between the treatment product and the proxy used. The adjustment factor consists of qualitative components (i.e. social acceptability of the new faecal sludge product, switching costs, quality) that are scored according to their importance in the specific location. The adjustment factor then gives an indication whether the market volume of the faecal sludge treatment product is (much) lower or higher than the calculated market volume of the substitute product. In addition to market volume, market growth is determined, which is the predicted growth of the sector of the substitute product. This is estimated from extrapolating historical growth data. Market attractiveness is then plotted by combining market volume and market growth for each substitute product (Figure 3). The resulting graph serves as the basis to evaluate the most attractive faecal sludge treatment product. Table 1 provides an overview of the steps in the MDA methodology. For clarity, an example is provided for each step from implementation in Kampala, Uganda. Applying the MDA methodology required two key assumptions: 1) adequate supply of untreated faecal sludge for the market; and 2) ability to produce the faecal sludge treatment products in the required quality and quantity. For complete details, the method can be downloaded free of charge at www.sandec.ch/fsm_tools.

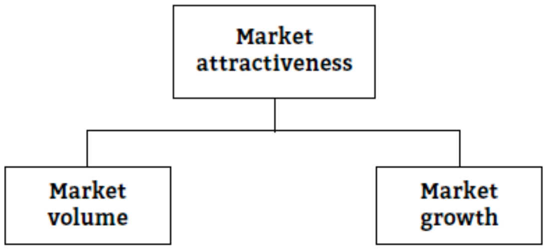

Figure 2. Break-down of market attractiveness as used in the MDA methodology

Source: (Schoebitz et al., 2016)

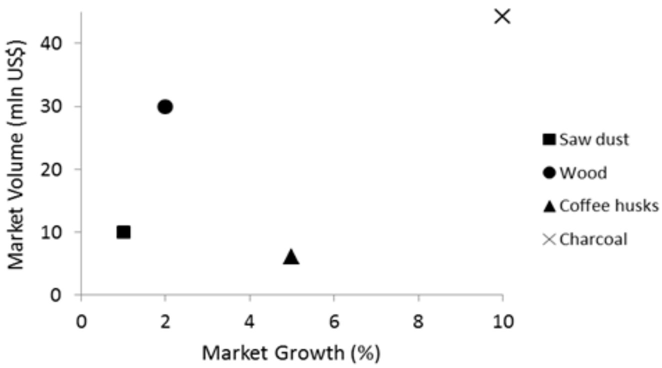

Figure 3. Graph of market attractiveness of faecal sludge for the treatment product solid fuel
Source: (Schoebitz et al., 2016)

The method was field-tested in five cities of varying location and size:

- Kampala, Uganda, 2014. A large city in East-Africa (population 1.5 million (Uganda Bureau of Statistics, 2014)).
- Son La, Bac Ninh, and Ba Ria, Vietnam, 2015. Three mid-size, peri-urban cities in Asia (urban population 66,515, 92,118, and 69,293 respectively (Bassan, et al., 2015). Bignona, Senegal, 2015. A rural town in West-Africa (population 44,783 (Guinko, 2015)). The field-test in Bignona included Tenghory Transgambienne, the adjacent town and district.

Table 1. An overview of steps in the MDA methodology, together with an example from implementation in Kampala, Uganda for the faecal sludge treatment product solid fuel

Step	Activity	Example from Kampala, Uganda
1	Review list of potential faecal sludge treatment products.	A list of 11 treatment products that can be made from faecal sludge was compiled based on literature research (e.g. . dried sludge as a solid fuel, biogas, liquid effluent as reclaimed water, black soldier fly larvae as protein source for animal feed)
2	Identify potential product application.	As a solid fuel: briquettes, pellets and powder.
3	Identify substitute products.	Charcoal, firewood, coffee husks, sawdust.

4	Define geographic boundaries.	The boundaries of Kampala City Corporation.
5	Identify market participants (producers/customers).	Included industries using solid fuel (e.g. brick factories), and charcoal wholesalers.
6	Calculate Market Volume.	Approximately 73 million US$ (presented in results and discussion section).
7	Assess Adjustment Factor.	The Adjustment Factor was set to 0.6 for charcoal, based on conducted interviews.
8	Calculate Adjusted Market Volume.	Approximately 74 x 0.6 = 44 million US$
9	Assess Market Growth.	10% for charcoal, based on historical data and interviews.
10	Graph Market Attractiveness.	See Figure 3.

Results and discussion

Field testing

In Kampala, ten treatment products were identified and evaluated: dried sludge as a solid fuel, biogas as a liquid fuel, dried sludge as a soil conditioner, black soldier fly larvae as protein, liquid effluent as reclaimed water, electricity, plants from drying beds as animal fodder, dried sludge as building materials, dried sludge as a fertilizer (with added nutrients), and fish grown on effluent. The treatment products with the most market potential were solid fuel and protein, with market volumes of 44 million US$/year and 8.2 million US$/year respectively. The other eight treatment products had a significantly lower market volume and market attractiveness compared to solid fuel and protein (approximately one order of magnitude less than protein). The market attractiveness for the treatment product solid fuel is illustrated in Figure 3. In Kampala, people currently use sawdust, wood, coffee husk, and charcoal as a solid fuel, which were identified as the substitute products in the methodology. The market attractiveness of charcoal as a solid fuel is highest, because the combined market growth (x-axis) and market volume (y-axis) are the highest. Marketing of faecal sludge briquettes in Kampala as a potential supplement for charcoal is just getting started (Kiwana & Naluwagga, 2016; Ward et al., 2017). These results confirm the need for on-going research to optimize treatment, products, and to fully exploit the market for faecal sludge briquettes.

In Son La, Bac Ninh and Ba Ria, the treatment products dried sludge as a fertilizer (with added nutrients), black soldier fly larvae for protein, and dried faecal sludge as solid fuel could be quantitatively assessed and compared. In Son La, the highest market volume was fertilizer at 141 million US$/year. In Bac Ninh, fertilizer had the largest market volume at 143 million US$/year. In Ba Ria, the largest market volume was also fertilizer at 190 million US$/year. Protein had the second largest market volume due to the high density of aquaculture in the region at 4.5 million US$/year. In Vietnam, market growth was assessed (through interviews) by identifying if the trend was positive, negative or neutral, as opposed to in Kampala and Bignona, where market growth was defined by the methodology as a number (percentage). The results from Vietnam were comparable to these produced by the method, and could be adapted in the future, especially when adequate information is not available. In general in Vietnam, cultural acceptance of resource recovery from faecal sludge was found to be high, and based on these results an enabling environment to allow for the production and sale of fertilizer or soil amendment from faecal sludge should be developed.

In Bignona, the treatment products dried sludge as soil conditioner, dried sludge as solid fuel, biogas, liquid effluent as reclaimed water, plants from drying beds as animal fodder, black soldier fly larvae as protein, dried sludge as fertilizer, fish grown on effluent and electricity were assessed. The treatment products with the highest potential were soil amendment and animal fodder, with market volumes of 80,000 US$/year and 550,000 US$/year respectively. The other treatment products were negligible in comparison. The social acceptance of using faecal sludge treatment products was very low, and thus the market volume had to be adjusted significantly. These results indicate that even if there is a significant market volume, cultural acceptance is a strong indicator for the potential for resource recovery from faecal sludge.

The adjustment factor was assessed differently in all three countries. In Uganda, it was assessed based on the method, which resulted in quantitative results for market attractiveness. In Vietnam, the adjustment factor was evaluated based on the three factors: enabling environment of local government; industries interested in substituting faecal sludge products; and willingness to pay at customer level. In contrast to the other cities, in Bignona, Senegal, the components of the adjustment factor were only used as guidelines for asking qualitative questions, because adequate information was not available in the rural context. With just a qualitative adjustment factor, it was difficult to arrive at a final number for market attractiveness, and so final market attractiveness became a qualitative ranking of treatment products, rather than a comparison between actual values.

Lessons learned

The field-testing was conducted in cities of various sizes and types, to observe the reliability of the method in different contexts. The MDA methodology was more readily adhered to in middle and larger-sized urban and peri-urban areas, because information was available from the formal economy to define the market volume, and there was better access to sources of official information. In smaller, rural areas, the challenge can be reduced by carefully identifying only the relevant treatment products for that specific area in the beginning (step 1), as was done in Vietnam.

The adjustment factor is a quantitative method to correct the existing market volume to a realistic approximation of a faecal sludge market. As the field-test in Vietnam showed, it is a challenge to find drivers that can be applied globally to all locations. This was identified as a weakness in the method. The adjustment factor has been adapted based on the field experiences, and as it implemented more often in the future, it can continue to be refined. In addition, for implementation in rural areas, the adjustment factor can be simplified to a qualitative assessment.

One of the biggest challenges of implementing the MDA methodology is that currently many markets are in the informal sector (e.g. charcoal). This means that there is no official data about the size of the markets, which is a challenge, as the methodology is reliant on those numbers. However, with cross-checking of data, it was found that the method in its present form is able to give a good indication of the informal sector. Furthermore, as economies and sectors become more formalized, it will also become easier to find the required numbers.

It is recommended that the implementation of the MDA methodology is carried out by a professional with knowledge of the local context, and ideally, who speaks the local language. Depending on the size and context of the city, the professional skills of the implementer, their level of experience and available time, it is estimated that the assessment takes between 3 weeks and 3 months.

At this stage, the technologies to produce many faecal sludge products are still in development. As technologies for faecal sludge treatment are further developed and implemented, and hence markets for faecal sludge products further develop, it will become easier for decisions and market estimations for faecal sludge treatment products to be made more accurately.

The MDA methodology can provide a quantitative way to evaluate and compare market potentials so that decisions can be backed up with numbers and not only assumptions. Quantitative values are a very persuasive tool, as many industries and policy makers want to know the real economic value of a product before they invest in it.

Conclusion

The MDA methodology provides a way that potential markets for faecal sludge treatment products can be quantitatively determined and compared. These results are derived based on market attractiveness, and not on engineering or treatment technology factors. This information then needs to be incorporated into a comprehensive planning approach to evaluate how it can be used as one design variable in deriving final decisions. Resource recovery can offset costs in a sanitation service chain, but cannot be expected to fund the entire service chain. As an additional benefit, gathering data on the substitute products contributes to the fundamental understanding of the local context, and deriving long-term, sustainable solutions.

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Contact details

Nienke Andriessen is a scientific project manager and Linda Strande is a senior scientist/group leader of the Management of Excreta, Wastewater and Sludge group at Eawag: the Swiss Federal Institute of Aquatic Science and Technology in Sandec: Sanitation, Water and Solid Waste for Development.

Nienke Andriessen
Überlandstrasse 133
8006 Dübendorf
Switzerland
Tel: +41 (0)58 7655082
Email: nienke.andriessen@eawag.ch
www.sandec.ch

Linda Strande
Überlandstrasse 133
8006 Dübendorf
Switzerland
Tel: +41 (0)58 765 5553
Email: linda.strande@eawag.ch
www.sandec.ch/fsm_tools