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Financial sustainability in municipal solid waste management – Costs and revenues in Bahir Dar, Ethiopia ☆

Christian Riuji Lohri *, Ephraim Joseph Camenzind [1], Christian Zurbrügg [1]

Eawag: Swiss Federal Institute of Aquatic Science and Technology, Department of Water and Sanitation in Developing Countries (Sandec), Überlandstrasse 133, P.O. Box 611, 8600 Dübendorf, Switzerland

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ABSTRACT

Providing good solid waste management (SWM) services while also ensuring financial sustainability of the system continues to be a major challenge in cities of developing countries. Bahir Dar in northwestern Ethiopia outsourced municipal waste services to a private waste company in 2008. While this institutional change has led to substantial improvement in the cleanliness of the city, its financial sustainability remains unclear. Is the private company able to generate sufficient revenues from their activities to offset the costs and generate some profit?

This paper presents a cost-revenue analysis, based on data from July 2009 to June 2011. The analysis reveals that overall costs in Bahir Dar's SWM system increased significantly during this period, mainly due to rising costs related to waste transportation. On the other hand, there is only one major revenue stream in place: the waste collection fee from households, commercial enterprises and institutions. As the efficiency of fee collection from households is only around 50%, the total amount of revenues are not sufficient to cover the running costs. This results in a substantial yearly deficit. The results of the research therefore show that a more detailed cost structure and cost-revenue analysis of this waste management service is important with appropriate measures, either by the privates sector itself or with the support of the local authorities, in order to enhance cost efficiency and balance the cost-revenues towards cost recovery. Delays in mitigating the evident financial deficit could else endanger the public-private partnership (PPP) and lead to failure of this setup in the medium to long term, thus also endangering the now existing improved and currently reliable service.

We present four options on how financial sustainability of the SWM system in Bahir Dar might be enhanced: (i) improved fee collection efficiency by linking the fees of solid waste collection to water supply; (ii) increasing the value chain by sales of organic waste recycling products; (iii) diversifying revenue streams and financing mechanisms (polluter-pays-, cross-subsidy- and business-principles); and (iv) cost reduction and improved cost-effectiveness.

We argue that in a PPP setup such as in Bahir Dar, a strong alliance between the municipality and private enterprise is important so that appropriate solutions for improved financial sustainability of a SWM system can be sought and implemented.

1. Introduction

Solid waste management (SWM) often represents a significant proportion of the total recurrent municipal budget in cities of low- and middle income countries (Scheinberg et al., 2010). Despite the high financial burden, the local authorities often struggle to provide adequate and reliable services for all. According to the World Bank and USAID, it is common for municipalities in developing countries to spend 20–50% of their available municipal budget on SWM, which often can only stretch to serve less than 50% of the population (Henry et al., 2006; Memon, 2010). Public sector inefficiencies and continuously increasing cost has led local authorities to analyze if this service can better be provided by the private

Abbreviations (see Fig.1): ANRS, Amhara National Regional State; BDU, Bahir Dar University; FfE, Forum for Environment; GIZ, German Agency for International Cooperation; GOs, Governmental Organizations; SBPD, Sanitation, Beautification and Park Development; SME, Small & Medium Enterprise; UNDP, United Nations Development Programme; UNEP, United Nations Environmental Programme; WB, World Bank.

* Corresponding author. Tel.: +41 58 765 54 20; fax: +41 58 765 53 99.
E-mail addresses: christian.lohri@eawag.ch (C.R. Lohri), ephraimcamenzind@hotmail.com (E.J. Camenzind), christian.zurbruegg@eawag.ch (C. Zurbrügg).
[1] Tel.: +41 58 765 52 86; fax: +41 58 765 53 99.

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sector (Massoud and El-Fadel, 2002). Increasingly public–private partnerships (PPP) have emerged as an alternative to improve municipal solid waste service performance at lower costs (Cointreau et al. 2000; Zhu et al., 2007; Abdrabo, 2008). But even with a new partnership approach the financial aspects of municipal SWM remain critical for ensuring sustainability of the system. This concerns budgeting, cost accounting, financial monitoring and evaluation aiming at recovering sufficient money to cover recurrent operational expenditures of the collection service as well as to stock up capital for new investments or large maintenance. These methods are too seldom employed and the municipality rarely knows the actual cost of providing the service (Bartone et al., 1990; Diaz et al., 1999; Schübeler, 1996; Wilson et al., 2012). While external capital may often be needed for major investments, the recurrent costs should by preference be covered by a combination of user fees, and local taxes, but some degree of cross-subsidization and/or financing out of governmental sources may be needed to ensure equitable access to service (Schübeler, 1996; Wilson et al., 2013). However, before taking any strategic decision on how to proceed, it is, as a first step, indispensable to establish a full understanding of the current costs for provision of the services and the respective revenues (Hoornweg et al., 2005). Typically total costs are underestimated by up to 50% (Coffey and Coad, 2010). To safeguard financial sustainability it is important that all short-term as well as long-term financial costs are taken into account and that procedures are in place for obtaining regular revenues to cover these costs. The lack of specific financial monitoring and analysis of data is one of the major barriers for not being able to sustain any envisaged improvement of the SWM system (Hanrahan et al., 2006; Zurbrügg et al., 2007; Parthan et al., 2012). This study aims at filling this gap by analyzing cost and revenues of the private waste company in Bahir Dar and pointing out options on how financial sustainability can be improved in SWM of developing countries.

Bahir Dar, a city with 220,000 inhabitants in northwestern Ethiopia, is one of the fastest growing cities in the country (UNEP, 2010a). If the current annual population growth rate of 6.6% continues, the city population will double in 11 years. Thus the need for adequate SWM is unquestionable and well acknowledged by the municipality (Mekete et al., 2009). In 2008 the local government was approached by a newly formed private waste company, who offered to take over the services of waste collection, transport and disposal. The municipality acknowledged that despite high expenses, it had not been able to achieve sufficiently satisfying services, resulting in low collection coverage. Hence it agreed to outsource their main SWM activities by contracting the private waste company. Excluded from this new arrangement were tasks which remain the duty of the municipality. These are monitoring of service provision and quality control, which remained the responsibility of the public sector, the City Administration. As a consequence of this organizational setup, obvious improvements in city cleanliness have been achieved (UNEP, 2010b). Nevertheless a major challenge remains to ensure that this partnership can endure, whereby one important factor is the degree of financial sustainability, i.e. that ongoing expenditures for providing the service can be sufficiently recovered through an efficient but equitable revenue system.

The research conducted in Bahir Dar was guided by the question if the private company is able to generate sufficient revenues from their activities to offset the costs and generate some profit. Or in other words, how financially sustainable the current system is and if necessary, where and how it can be improved. This paper presents a delineation of the institutional and organizational structure and presents and discusses the results of the financial assessment. In conclusion, based on the data available, some recommendations are proposed how the current financial aspects might be improved.

2. Methodology

Methods used for this research involve qualitative as well as quantitative approaches, and are briefly summarized as follows:

- Document and literature analysis: On one hand literature on financial assessments in SWM related to the low- and middle-income country context, on the other hand documents directly or indirectly related to the SWM situation in Bahir Dar.
- Participatory observations concerning the SWM situation in Bahir Dar and its surroundings to understand the system setup.
- Material flow analysis with secondary data sources (Brunner and Rechberger, 2004) involving a system description for solid waste flows in Bahir Dar which was then depicted in a process (and material) flow diagram (Rodic et al., 2010).
- Stakeholder identification and assessment (Schmeer, 1999) delineating the institutional and organizational structure, as well as assessing the influence, interest and attitude situation.
- Semi-structured interviews with a wide range of stakeholders to obtain information on staffing, infrastructure, costing and working conditions.
- Information obtained through the interviews were cross-checked with the objective to reassess gaps and divergences of information. Reassessment questions were based on issues of divergences.
- Analysis of disaggregated costs into SWM activities (process cost accounting) and of revenues into sources.

The financial assessment and cost-revenue analysis was restricted to the activities of the private waste company, aiming at understanding the financial sustainability of this main service provision stakeholder in the SWM system of Bahir Dar. Other financial flows and important stakeholders such as the informal collection and recycling sector were not included in this analysis due to limited availability of data. Two cost categories were distinguished in the analysis, up-front investment costs – also called capital expenditures (Capex) – and operational expenditures (Opex). Capex are business expenses to create future benefit such as acquisition of assets like infrastructure, machinery, equipment or upgrading of existing facilities so their value as an asset increases. Expenditures required for the day-to-day functioning of the business like salaries, maintenance and small repairs fall under the category of Opex. This includes the annual depreciation of infrastructure and equipment by 20%, a figure used by the private waste company. Back-end costs (long term costs and externalities) were not considered in this analysis, since these costs are generally difficult to quantify and are most often completely neglected in the budgets by the responsible authorities, e.g. the budgeting for site closure or post-closure care, environmental pollution mitigation costs, etc. All monetary values are listed in US Dollars (USD), whereby 1 USD is 17 ETB (as of April 2011). To understand the processes and events that led to the current situation or context historical narratives, timelines and time trend analysis were used which were integrated as questions for the semi-structured interviews. Nevertheless the quantitative financial data collected represents only a snapshot in time and covers the 2-year period from July 2009 to June 2011.The site visit, interviews, and data collection occurred in Bahir Dar from April to July 2011. Analysis was conducted conjointly with data collection but then extended further over a period of one year after the site visit.

3. Results and discussion

3.1. The SWM system in Bahir Dar

The classification of stakeholders according to Scheinberg et al. (2010) into providers, users and external agents is used here to present the different stakeholders, functions and their inter-linkages in the SWM system of Bahir Dar (Fig. 1). Arrows depict either different service functions (waste collection, recycling, etc.) support functions (financial, research) or regulatory and legal functions (e.g. national regulation and legislation). A more detailed description of the stakeholders involved is depicted in the interest-power matrix in Lohri et al. (2013).

The SWM system of Bahir Dar has undergone some major organizational and institutional changes in the past years. In 2008 the municipality of Bahir Dar outsourced the main municipal solid waste management activities (collection and transportation to the dumpsite) to a private waste management company. What led to this decision cannot be exactly determined post-ante. There is however evidence from conducted interviews that the private company was able to make an excellent case on how they intended to improve the service at lower cost. With this, they were able to convince the political and public decision-makers to embark on this venture. Furthermore, there is also some indication from interviews that the global trend in devolution of urban services to the private sector (Oteng-Ababio, 2010) had influenced the decision-makers to pursue this strategy for Bahir Dar. This private sector participation approach was however not the result of a tender with various bidders, but rather the result of a proposition by one private waste company and a political decision to allocate the task to this company. The private waste company, with its entrepreneurial leadership seems convinced that providing this service for the city and accessing the value in waste can generate profit for the company. Excluded from the private contract agreement are activities related to industrial, health care, construction and demolition waste management as these are not considered part of the municipal solid waste stream. Street sweeping was also not assigned to the private waste company as this service is still provided by the municipal services either by municipal staff or else, in certain areas of the city, by sub-contracted small and medium enterprises. Performance monitoring remains a task of the public sector, mainly the City Administration. This task of monitoring was however not clearly defined in the agreement which is unfortunately common as also described by Simões et al. (2012). Typically, municipal staff visually inspect the city neighborhoods randomly and check for cleanliness (with undefined benchmarks) or react to complaints by residents.

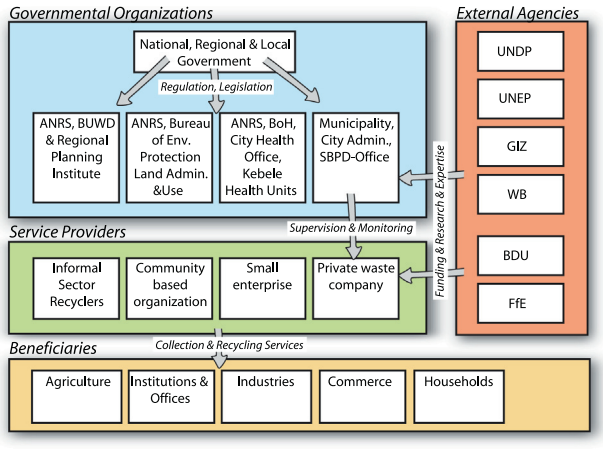

Fig. 1. Organizational set-up of the SWM system in Bahir Dar 2011.

A bit more than half (53%) of the total municipal solid waste (MSW) generated in the total 9 kebeles (administrative neighborhood units) of Bahir Dar is household waste from residential areas. Another 27% is waste from the commercial sector, 17% from institutions and 3% from street sweeping (UNEP, 2010a). Food waste and yard waste constitute 43% and 12% respectively of the total waste generation, the share of ash and soil is 24%. Paper with 9%, plastic and stones with each 3% are further fractions. The remaining 6% consists of textiles, glass, metals, rubber, leather, e-waste and other undefined materials (UNEP, 2010b). Average per capita waste generation in Bahir Dar is estimated at 0.25 kg/cap day for household waste only and 0.45 kg/d when also taking into account commercial, institutional waste and street litter (UNEP, 2010a). These waste amounts and characteristics are typical for developing country urban areas (Cointreau, 1983; UNEP and Calrecovery, 2005). Currently the contract with the private waste company covers the MSW collection in 8 kebeles. One kebele is not serviced by the private company but by an independent small private sector enterprise. Since the involvement of the private waste company, the collection coverage increased from roughly 50% in 2005 to 67% in 2010 (UNEP, 2010a). Thus from a total of 109.5 t/d generated, 73 tons/d are collected (Fig. 2), which shows a substantially improved cleanliness of the city (UNEP, 2010b). Such results compare well with findings from other developing country cities where private sector involvement has resulted in significant service improvements. In Tanzania for instance solid waste collection coverage improved from 10% in 1994 to 40% in 2001 (Kaseva and Mbuligwe, 2005). The areas in Bahir Dar still suffering from deficient collection service are those which are difficult to access by the waste collectors and thus need large amounts of time to service. As the number of equipment (trucks) available to the company is limited, increasing coverage to unserviced areas is a challenge. This average amount of collected waste from 2010 did not change significantly over the period from which the financial data for this study was derived (July 2009 to June 2011). When looking into more detail on individual collection coverage of different solid waste generators there are significant differences in service performance. According to the private waste company, approximately 70% (~39 t/d) of the total waste generated in the households and 80% (~23 t/d) from the commercial sector are collected. Also, street sweeping collects roughly 70% (~2 t/d) of litter laying on the 35 km of sealed roads of Bahir Dar. In contrast, only about 50% (~9 t/d) of waste generated by institutions is collected as many institutions handle (burn or dispose) their waste themselves.

Surveys revealed that the private waste company has staff numbers of 270 solid waste collectors, 28 coordinators and one head of field operations which all contribute to fulfill the contractual obligations. The waste collectors, organized in groups of around 15 people, which comprises one group coordinator, are assigned different areas within the city. They provide curb-side collection – where solid waste bags are placed by the residents at the households' entrance – and transport the waste in larger plastic bags carried on their shoulders or in manual push carts to one of the semi-official collection points. Approximately 100 such collection points are distributed throughout the city. At the collection point, the collectors wait idle for the collection trucks to arrive and then manually load the bags into the trucks. The private waste company has a fleet of 7 low-skip, open, non-standardized, collection trucks, each with a capacity of 4 m^3. An average of 5–6 trucks are operational at any time and regularly in use. They transport the waste from the collection points to an open dumpsite about 7 km outside of the city. The road leading to the dumpsite is predominately a rough gravel road, which strains these older second-hand trucks and causes frequent breakdowns and need for repairs.

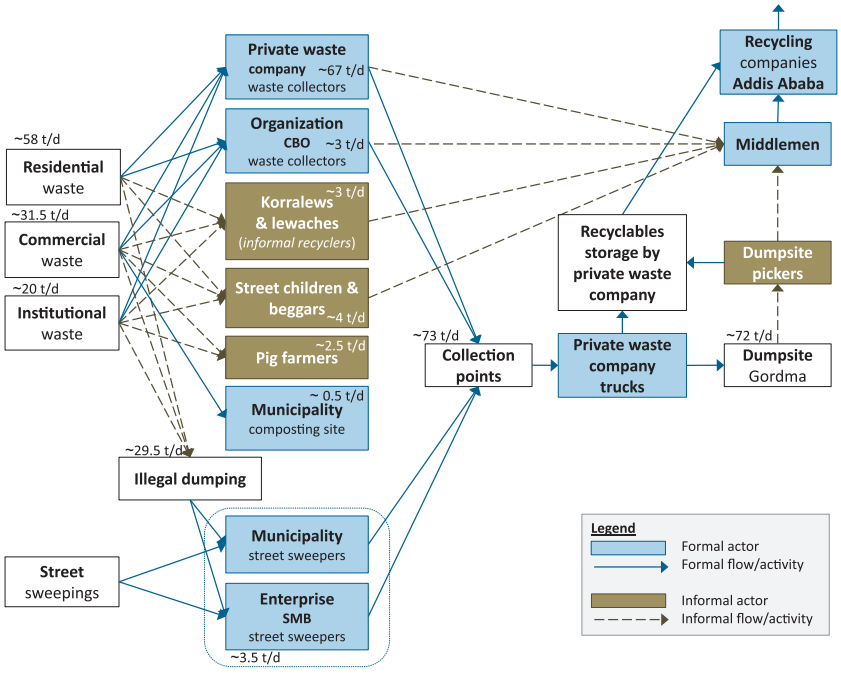

Fig. 2. Process flow diagram of the municipal solid waste system in Bahir Dar (Lohri et al., 2013).

Maintenance and repairs of these trucks poses a major problem, as these are Chinese brands and spare parts are hard to find in Ethiopia. This leads to a difficult procurement, long delays in supply of spare parts and thus results in long downtimes of the trucks.

Recycling is mainly conducted by the informal sector. Although there is no law to justify their activity, they are silently tolerated by the municipal authorities recognizing their positive contribution to waste reduction. At the dumpsite, 10–15 informal waste pickers recover reusable and recyclable materials like metals, glasses, plastic and textiles and sell it to middlemen or to the private waste company (mainly plastic recyclables) (Worku, 2012). Furthermore, informal itinerant buyers (koralews), about 70 in number, collect recyclables such as metals, plastics, glasses, corrugated iron sheets, tins and car batteries from door to door. They buy these materials from households and then resell them to one of the 55 middlemen in Bahir Dar (Worku, 2012). Another group of approximately 50 informal recyclers (lewaches) also collects certain waste fractions from door to door with special focuses on textiles and shoes in exchange for new plastic containers, sauce pans, spoons, and other household items depending on the quality of waste material obtained. Finally two pig farmers were identified, located in the north-east of the city, that directly collect 2.5 t/d of kitchen waste to feed a total of about 650 pigs. This waste originates from hotels, restaurants and the university campus and are collected using mule-pulled carts. However, according to UNEP (2010b), recycling of solid waste in Bahir Dar is less than 1% and thus described as insignificant. The few data collected on the role and relevance of the informal sector shows that this estimation of UNEP (2010b) is most probably too low. The private waste company makes large efforts to integrate the informal recyclers into the formal SWM system. To access more recyclables and therefore also the value from this resource, the company tries to act as "middleman" which means they buy recyclables from the informal sector, store these and then sell the larger amounts to industries or buyers in Addis Ababa. This results in some financial benefits although the activity is yet quite limited in its scope.

An estimated 73 t/d of MSW is collected and disposed at the disposal site, whereas the remaining uncollected amount (29.5 t/d) is most frequently burned, buried or simply dumped on the shores of the lake or into rivers (UNEP, 2010a). Although the Ethiopia Solid Waste Proclamation includes explicit prohibition of indiscriminate disposal of litter on streets, parks, bus stops, train stations and water bodies, this law is not actively enforced and violation not punished (SWM Proclamation Ethiopia, 2007). The open disposal site is operated without considering any sound engineering landfill practice (no entry gate for control and monitoring, no designated cells or tipping face, no compaction, no regular cover layer).

The process flow diagram in Fig. 2 illustrates the SWM system at one glance, including the main stakeholders with day-to-day activities, major waste streams and the different process steps.

In 2010 an 'Integrated Organic Waste Recycling Centre' was planned and designed by the private waste company and an Addis Ababa-based company working in the field of renewable energy. Construction started in 2011 (in 1 km distance to the dumpsite) with the aim to valorize a fraction of the collected organic waste. The term 'Integrated' stands for an approach with three different organic waste recycling technologies: 1. Charcoal briquetting, 2. Anaerobic Digestion, and 3. Composting. A description of this 'Integrated Organic Waste Recycling Centre" and a feasibility assessment for it can be found in Lohri et al. (2013).

3.2. Costs of the current SWM services in Bahir Dar

The private waste company's main costs are split into two different kinds of cost categories: capital expenditures (Capex) and operational expenditures (Opex).

Capital expenditures (Capex)

In the first two years of operation the private waste company obtained three major loans for capital investments (Table 1).

The only major investments in assets were the seven waste collection trucks. Procurement was through the City Administration and paid directly through the governmental loan (USD 86,471).

Table 1
Sources of funding and capital investments of private waste company and for SWM of Bahir Dar.

Type of capital loan	Principal amount	Effective interest	Annual repayment	Comments
Gov't. loan	USD 125,882 (ETB 2.14 million)	0	Repayment plan undefined	Loan at no interest; USD 86,471 (ETB 1.47 million) of this loan (69%) were invested for purchasing imported waste collection trucks
Loan of UNDP	USD 77,059 (ETB 1.31 million)	0	USD 29,301 (ETB 328,117) annually over 4 years	Interest rate of 10% (USD 4228 = ETB 71,883) was deducted at the beginning,
Seed capital	USD 21,176 (ETB 0.36 million)	0	No repayment plan	Private waste company's own capital
Total	**USD 224,118 (ETB 3.81 million)**	0		

The truck deprecation costs are accounted for under operational costs. The current offices and garages are rented and therefore not part of the capital expenditures. Other up-front costs, i.e. the costs incurred at the beginning of the business or project, such as expenditures for educating and raising awareness with the public or outreach activities are costs covered by the City Administration and the NGO Forum for Environment.

Operational expenditures (Opex)

These costs, also called running costs or recurrent costs, include expenditures to ensure that the collection service can be provided which includes maintenance of the assets as well as their depreciation. The private waste company has detailed accounting of all their running costs. Fig. 3 shows these expenditures in three categories: salaries, motorized vehicles, and all other expenses such as office equipment, handcarts, etc. over a period of two years by month.

The graph shows that salaries expenditures decreased by around 26% in the first half year and since then they have been relatively stable. The share of personnel costs with regard to total cost dropped from 66% to 56%, which can be explained by a decrease in the number of employees. Expenses related to motor vehicles however show a rapidly increasing trend, by around 82% over 24 months and an increase in the share of total costs from 25% to 34%. In particular expenditures for fuel/oil/lubricants as well as repair/maintenance have contributed to this overall increase, although the average utilization time of the trucks remained stable over these two years. In the final month of analysis the share of expenditures for transport and vehicle maintenance exceeded the salary expenditures. Fig. 4 shows details of expenditures for motorized vehicles by cost types. The increase in fuel, oil and lubricant costs can partly be explained by higher fuel tariffs. The sharp increase of repair and maintenance costs are due to the old vehicles that suffered frequent breakdowns, resulting in high maintenance expenses. Tyre expenses show sporadic peaks but no significant trend. Other costs, as shown in Fig. 3, have been quite stable and constitute 9–10% of the total costs. Thus, while employee salaries still make up for the bulk of expenditures, the costs for keeping the transport fleet operational is increasing steadily and rapidly.

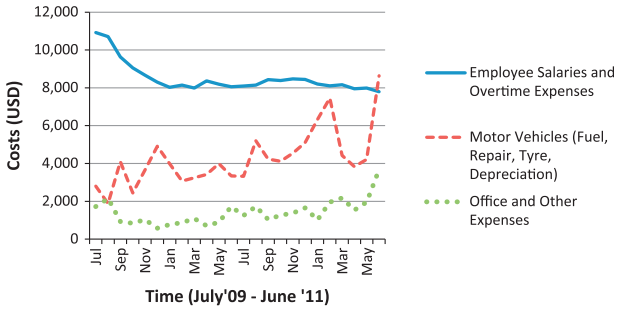

Fig. 3. Monthly operational expenditures of private waste company by cost categories.

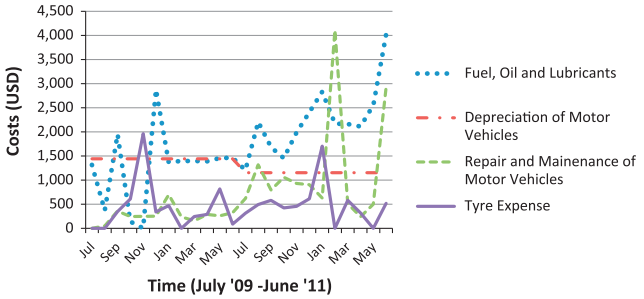

Fig. 4. Monthly costs for motorized vehicles.

Costs can be analyzed with different methods. Most frequently cited in academic literature and used for decision analysis are the methods of cost-benefit analysis (Morrissey and Browne, 2004). These however are of limited use when the viability of business proposition should be analyzed. This study uses the method of process cost accounting also called activity-based cost accounting which has been used successfully in other service sectors (Emmett and Forget, 2005) to control and contain costs. The costs are disaggregated by different functional processes (Fig. 5) which together define the system. In this case:

- (Primary-) collection costs (salaries of waste collectors, clothing, phone bills, maintenance of push carts, depreciation of carts).
- Transportation costs (salaries of truck drivers, fuel, oil and lubricants, car wash and greasing, phone, stationary, repair and maintenance of motor vehicles, tires, depreciation of motor vehicles).
- Cash collection costs (salaries of fee collectors).
- General administration and support services (salaries of admin. staff, office electricity, water, office supplies, depreciation of offices equipment, computer, accessories, etc.).

Also here the increasing costs for waste transportation (mainly expenses related to motor vehicles) can be identified. Although they do tend to fluctuate quite significantly depending on the specific breakdowns and repairs needed, they have reached an alarming height in June 2011 (as detailed in Fig. 4). The yearly total for repair of trucks amounts to USD 8843. Per truck (7 in total) this amounts to USD 1263 per year.

For 2009/10 the total annual costs were around USD 160,000 (ETB 2.72 million), whereas in 2010/11 the same costs increased to around USD 180,000 (ETB 3.06 million).

3.3. Revenues

Analyses reveal that the private waste company has only one major stream of regular revenues. This income derives from tariff payments for the solid waste collection service. Only about 1% of the total revenue stream is from the direct collection and sales of recyclables such as plastics (this does not include the revenue

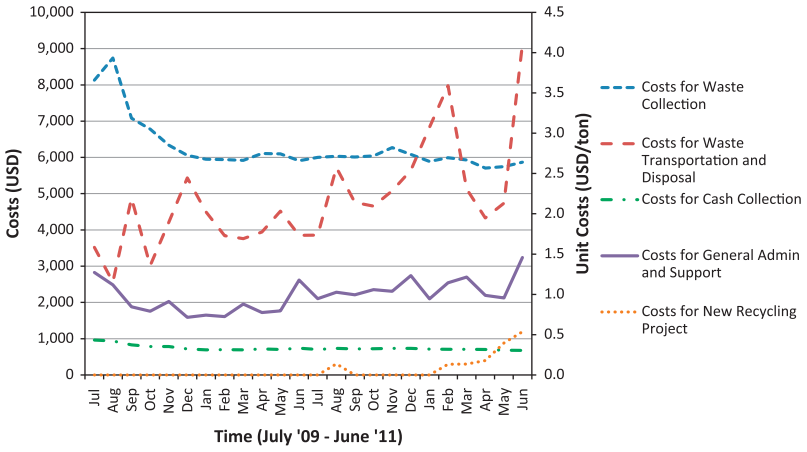

Fig. 5. Total monthly costs rearranged by SWM activities between July 2009 and June 2011.

stream of the informal recycling sector). From collection tariffs, revenues can be distinguished by type of waste generator. There are three different customer types: residential, commercial and institutional customers.

Each household is required to pay a monthly flat fee of USD 0.59 (ETB 10) to the fee collectors of the private waste company who go from door-to-door to collect it in cash. For commercial enterprises and institutions there are no fixed tariffs. The private waste company negotiates individual fees with each commercial and institutional customer based on the waste quantity and frequency of collection. The payment rate is reported as being low: Only about 50% of the households pay the collection fee, whereas roughly 90% of the commercial enterprises and institutions pay the fee regularly.

Of all revenues from waste collection service payments, 86% come from residential and commercial areas and around 13% from institutions. Of the 86% roughly 3% come from the market center which can be considered as one special kind of the commercial customer (Fig. 6; no revenues data was available from July to September 2009 and from May to June 2011).

During the first year, the increase in revenues resulted from obtaining new institutional customers. In the second year, the revenue stream increased as more households were serviced. Revenues increased from USD 8235/month to USD 8824/month. Revenues from institutional sources remained on the same level at around USD 1941 per month.

3.4. Comparing costs and revenues

The private waste company's overall 2-year expenses, revenues and net income are depicted in Fig. 7. It includes the main operational costs as well as the depreciation of assets and interest on capital.

Fig. 8 gives an overview of total costs, revenues and net income of the two examined fiscal years. It shows that for 2009/10 the total annual costs were around USD 160,000 (ETB 2.72 million), whereas in 2010/11 the same costs increased to around USD 180,000 (ETB 3.06 million).

When compared to the waste service of 26,645 tons of waste collected per year (73 t/d) the cost per ton for 2010/11 amounts to USD 6.8 (ETB 115). A family with 11 members per household (refers to the open concept of a household as a group of people living under one roof or within one compound) and an average generation of 0.25 kg/cap day (for household waste) produces 82.5 kg per household and month. The associated cost of collecting this amount of waste is therefore USD 0.56 (ETB 9.5) per household and month. This is in the range of the currently charged USD 0.59 (ETB 10) per household and month. However, as the tariff collection efficiency is only 50% the collected revenues are not able to cover the running costs.

The annual revenues also increased during the two years of analysis from USD 111,176 up to USD 137,059 per year, which in turn reduced the total net loss from USD 48,824 down to USD 43,529.

In addition, it has to be mentioned that the private waste company is in delay with repayments of loan from both the municipality and from UNDP. The net loss of the first two years (around USD 92,353) were balanced by the capital from UNDP thus diverting this earmarked investment capital to cover for operational expenditures. This buys a bit of time, however increases the future burden as loans need to be repayed and running costs remain above the revenue level (Table 1).

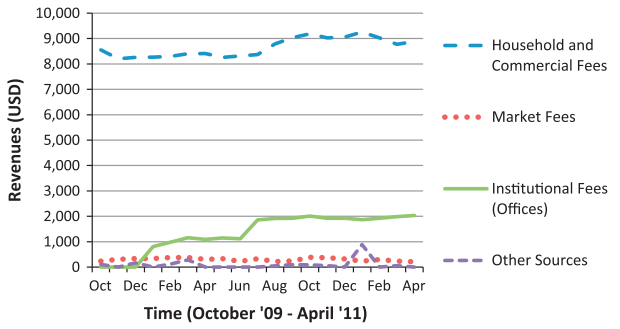

Fig. 6. Development of private waste company's revenues disaggregated by sources.

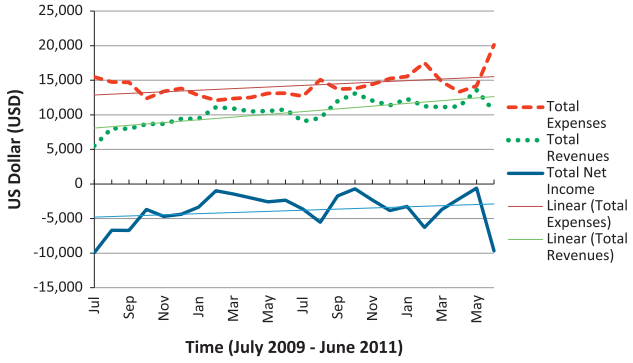

Fig. 7. Development of costs, revenues and net income over two years.

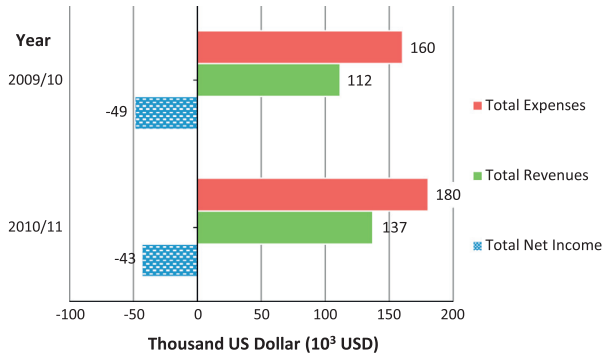

Fig. 8. Overview of total expenses, revenues and net income.

3.5. The way forward

While costs in the SWM system of Bahir Dar have been increasing mainly due to expenditures related to waste transportation, there is currently only one major cost recovery system in place: The user's fee collection from households, commercial enterprises and institutions. However, the revenues from these collected fee charges are not sufficient to cover all costs. In other words, financial sustainability is currently not ensured. To avoid financial failure of the company strategies must be envisaged to improve and achieve financial cost recovery. Either the revenue streams need to be increased and diversified, or costs have to be reduced and cost efficiency increased. The options described below discuss some potential possibilities focusing on the cash-flow.

Reducing costs by increasing cost efficiency of activities is clearly also an option. Literature suggests improved waste logistics positively influence efficiency and lower costs (Ichinose et al., 2013). In this paper this aspect is only discussed in a marginal way as only limited data was available which could provide evidence where cost-efficiency could be increased. A time motion study would for example help analyze such aspects in more detail. Observational information however suggests that the current practice of primary collection is not time-efficient. Each collector walks only one collection round (with or without primary collection vehicle), then spends most time at the collection point waiting for the truck to arrive. In cases where the truck arrives at the collection point before the collectors it has to wait idle thus wasting operational efficiency. In addition to time-motion optimization significant gains in efficiency could also be expected with staff training and sensitization towards improved work flow. Another cost-saving measure envisaged is to reduce fuel consumption, downtime and repairs of each truck – thus saving costs. This can be achieved with driver training programs which have the goal to ensure appropriate operation of vehicles with minimization of wear and tear (Brauer, 2011). Investment into newer vehicles to thus reduce the maintenance cost, downtime and repair cost of vehicles is also an option to reduce operational costs, however this increases the need for investment capital.

Revenue streams can be increased by improving waste fee collection, higher tariffs or by mobilizing new revenue streams through sales of recyclables or recovery of resources and/or energy and thus increase of the value chain of waste. Below, four options are presented and their feasibility qualitatively described on how revenues might be increased, financing mechanisms diversified and costs reduced.

Option 1: Improved fee collection efficiency by linking the fees of solid waste collection and water supply

The private waste company is pursuing the idea to increase the collection rate of the monthly waste collection fee. The new approach is based on experiences from Addis Ababa and follows the principle and assumption that the amount of water consumed by each household correlates with its amounts of waste generated. Larger or more affluent households consume more water and also generate more solid waste. The tariff of the waste collection fee would therefore be linked to the water bill and the amount of water used. This approach is similar to the approach, well documented in literature, called polluter-pays principle (Kim, 2004) often applied in waste management but in this case linked to water consumption. This approach also includes elements of the one-stop-shop approach which facilitates tariff collection but also provides easier payment practice for residents where service fees can all be paid in one instance (Turner 2012). The private waste company plans to implement this new payment system in Bahir Dar. Theoretically, an implementation of this approach for households in Bahir Dar is feasible as all have a water meter installed in their compound and each household needs to go to the Regional Bureau of Water Supply once per month to pay their monthly water bill else the water supply will be cut. Linking collection fees to the water bill has quite a few advantages: (1) The tariff structure can be divided into progressive categories depending on the amount of fresh water consumed per month and corresponds to a simplified approach of the pay-as-you-throw (PAYT) system (Bilitewski, 2008); (2) Having both waste collection water fee on the same bill leverages the incentive to pay, as non-payment will affect water supply which is a high priority issue of all households; (3) One bill for water as well as waste collection reduces costs of the fee collection system as synergies between the two organizations can be maximized and users of service must come to pay rather than the staff of the private waste company needing to go to each household to collect money; and (4) Integrating the two fees on one bill would also give disincentive to institutions or commercial enterprise to self-manage their waste. Currently the most common self-management of waste, to avoid paying fees, is to burn, bury on-site or dispose indiscriminately. On the downside, integrating two fees in one bill will increase administrative complexity of the financial disbursement system between the two organizations. The question of willingness to pay (Abdrabo, 2008) and how to deal with urban poor that cannot afford either the water or solid waste fees need to be looked at in detail to ensure that the service remains equitable and affordable for all. This option would require some infrastructure investment which includes hard- and software for joint invoicing and tariff calculations and some process coordination, control and monitoring to ensure transfer on funds between organizations. The decision to implement this option is not determined by its technical feasibility but rather by political will and social acceptance to combine the water and waste tariff. Its implementation would then further require a solid strategy on how to depict and raise awareness with the population on the social costs and benefits in order to mobilize the preparedness of the citizens to pay. With a very optimistic assumption of an payment compliance increase from 50% to 100% by household service users, the revenues would double and an additional USD 105,882 (ETB 1.8 million) per year could be collected. This would clearly cover the current deficient net income. A more conservative assumption would be to exclude the fraction of urban poor from the paying customers. Gebremedhin and Whelan (2008) list a 26% head count of urban population in Bahir Dar living below the poverty line. A calculation, assuming only 70% of payment compliance with 30% of urban poor which cannot afford the waste tariff, still shows promising results. The revenues would increase by an additional USD 63,530 which could still balance the net loss of USD 43,529.

Option 2: Increasing the value chain by sales of organic waste recycling products

As mentioned in the section on capital investment and loans, the private waste company is pursuing the completion of an 'Integrated Organic Waste Recycling Centre' in order to valorize organic

solid waste that previously landed on the dumpsite. With different waste treatment processes envisaged the company estimates that more value could be generated to increase revenues. These are:

- Production of biogas from organic waste. As biogas is difficult to transport to customers interested in this fuel, the company pursues a strategy to directly use this gas in their own bakery. The bakery oven is therefore fueled with biogas from anaerobic digestion of organic waste and the product sold to customers is bread.
- Composting of fresh organic waste together with digestate from the biogas reactor described above. The company plans to use the resulting compost for their own agricultural fields rather than selling compost to customers. The value product sold to customers is cotton and sesame seeds cultivated on their fields which are fertilized and amended by compost.
- Production of charcoal briquettes from organic municipal and agricultural waste by dry pyrolysis. These briquettes shall then be sold as cooking fuel to the public.

The private waste company hopes to obtain additional income from the sale of products from the new recycling project. Value products offered to customers are bread baked in a biogas oven, charcoal briquettes and compost. With these additional revenues the company intends to recover some costs in the waste collection and transport services, which are currently not generating enough income to balance the expenditures. The basic concept is to create an enhanced value chain with a diversified portfolio of waste derived products (compost, biogas, charcoal-briquettes) where sales prices outweigh the production cost and these profits can be used to cross-subsidize the waste collection costs. This approach would allow the private waste company to distribute the risk, but on the other hand also requires a sound business plan for all the value chain segments. This study shows that the company put only limited effort into analyzing the local market demand, affordability and willingness to pay for these products and in comparing the expected revenues with the cost of production. For the compost product, the market demand was primarily assessed as very high given the large numbers of flower plantations in the region. The Ethiopian floriculture industry has become the second largest flower exporter in Africa (after Kenya) and fourth largest flower exporter in the world (Deccan Herald, 2013) with the export value expected to reach USD 550 million by 2016. Many of these farms are located in the Amhara region. They all require soil amendment and nutrients which can partly be supplied by compost from waste. On the other hand the waste derived product biogas shows to be a promising alternative to other fuels (Rapport et al. 2012; Lohri et al., 2013) only if it can be used at the location of biogas production. Gas bottling and transport is not economically feasible given the high technical requirement of gas scrubbing and compressing. Furthermore gas is not a widespread fuel used in Ethiopia. This situation practically eliminates the marketing of biogas to individual customers from a centralized biogas plant. An alternative is to make use of the biogas at the facility for heating purposes such as is proposed by the company which intends to use the gas in a bread baking oven. Finally the production and sales of char briquettes is considered feasible as 65% and 63% of urban households use charcoal or wood respectively. In average the share of expenditures for charcoal and wood together per household and month amounts to 36.5 ETB which is a 43% share of the total amount spent for fuel by households (Mekonnen and Köhlin, 2008). This implies a large demand by households for solid biomass fuels like charcoal from waste.

For implementing and sustaining production of waste derived value products however, a sufficient level of staff skills and knowledge is required. The study results show that the human capacity within the private waste company is not yet well developed, to manage these new technical processes. Approached by this concern, the private company responded with the strategy to start small with projects at pilot scale, and with this learn from experiences and mistakes, to then modify, expand, and scale-up. This commendable strategy, as practiced in other innovation project in developing countries (Zurbrügg et al., 2012) however has the back-side that the cost efficiency and margin of profit in this period will probably be very low if not also negative and therefore will probably increase losses rather than revenues. As technical performance of these treatment and production facilities are difficult to assess, production cost is also yet unknown. Furthermore also sales of the various products are difficult to estimate. The viability of the business plan for these additional capital investments is thus very insecure. For this option high infrastructure investment, skills, development of markets and good customer relations are needed.

Option 3: Diversifying revenue streams and financing mechanisms

While current revenues from fee collection (at a fee collection rate of 50%) are just sufficient to cover costs of primary waste collection, fee collection, overall administration and support, the other expenditures for transportation (secondary collection), disposal and recycling have to be covered by additional revenues streams which could be provided by governmental tax money. The municipality would thus either have to install a payment system to the private waste company or else contribute in kind by providing infrastructure or equipment (transfer stations, waste collection trucks, waste disposal equipment). A direct financial contribution would have to be in the order of the current deficit of USD 43,529 per year. This is still significantly less than the municipal expenditures for SWM before the PPP system which amounted to USD 118,000–176,000 per year (Camenzind, 2012). By giving the private waste company the waste collection task the municipal authorities were able to reduce their annual SWM budget dramatically to about USD 35,294 (ETB 0.6 million). As a comparison, the municipality of Mekelle (a city about 1.3 times the size of Bahir Dar) has a SWM total annual budget of USD 388,235 (ETB 6.6 million) in 2011. Cost recovery from the waste collection fees (according to the "polluter-pays-principle") was not achieved in Mekelle. The only way to cover the deficit was through higher payments from wealthier companies, institutions and factories, and through government support through its overall development budget ("cross subsidies"). Another relevant municipal support to SWM improvement would be to ensure a decent (asphalted) access road to the disposal site. This would help the private waste company be more efficient in transportation and reduce their cost of wear and tear on trucks. However, the impact of such a measure is limited as even with an estimated cost reduction of equipment maintenance by 50% this would only alleviate the company's deficit by 10%.

A system where diversified financial mechanisms are in place to cover different working steps of the SWM process can help to ensure financial sustainability. Basically there can potentially be three financing mechanisms at work:

1. The "polluter-pays principle" (revenues from waste generators): The polluter, in this case the waste generator, covers all or a fraction of the costs of waste management.
2. The "cross-subsidy principle" (higher fees for special waste generators or more affluent generators; support by the national central budget or local municipal budget): This complements the polluter-pays-principle by using a variety of progressive tariff structures depending on income level and/or type of waste generator. Support by governmental authorities can be argued for, especially to cover cost for services in SWM that should be ensured to safeguard public interest (e.g. environmentally safe sanitary landfilling or

ensuring that also the poor have access to collection services) as these comprise public good or merit good aspects of solid waste management (Zurbrügg, 2013). Financial contributions of this kind can originate from specific tax bases (producer tax, property tax, income tax) as provided for other services such as security (police) or management of public spaces (parks). Such an approach would imply some redistribution of municipal budget and is therefore a high sensitive political decision.

3. The "business principle" (revenues from waste processing): Costs are covered from sales of products and services; in the case of SWM, that would be waste products from waste-to-energy, recycling and material recovery (as discussed in Option 2).

Currently the SWM system of Bahir Dar relies almost exclusively on the first principle, while trying to establish the third one, neglecting the second one to a larger degree (only few investments and other financial support from the public sector). A more balanced and diversified cost sharing approach, which makes full use of all above suggested principles, is an option which needs more detailed research but can be considered an approach which can improve the financial sustainability of the system. This option, which is basically a hybrid between options 1 and 2, however requires the initiative and strong support of the political level.

Option 4: Cost reduction and improved cost-effectiveness

The analysis of cost development has shown that one of the critical cost factors in the SWM of Bahir Dar is transportation, and more precisely the usage of motorized vehicles for collection and conveyance of waste from the residential areas to the landfill. This is confirmed by other studies from other cities of the developing world (Guerrero et al., 2013). Different factors influence the costs of transportation and should thus be taken into consideration when planning measures for an improved cost-revenue balance:

- Type, size and efficient use of vehicles (dump trucks, carts): The type of vehicle is important especially in terms of fuel consumption, availability of spare parts and maintenance cost. The private waste company currently uses a cheap truck model which lacks spare parts on the national market, and thus requires expensive import of spares when needed. The carrying capacity of the trucks is also quite low (4 m^3). In this regard the private waste company plans to double the possible maximum carrying volume by redesigning the truck loading platform. Simple improvements can be implemented to reduce fuel consumption such as better routing, avoiding unnecessary idling, eliminating quick accelerations, and making sure tire pressure is correct. Such simple measure combining with engine optimization can reduce fuel consumption by 20% (Nguyen and Wilson, 2010). With an estimated average fuel cost of 3500 USD per month (Fig. 3) the savings would therefore amount to USD 8400 annually which is 19% of the current deficit. Studies from other countries have shown that such measures can have a high impact on cost reduction or in other words of expanding service delivery. El-Hamouz (2008) has described the impact of the private sector's logistical management in reducing the cost of municipal solid waste collection service in the Tubas area of the West Bank and in consequence reduction of the waste collection tariff for households.
- Type and condition of roads (within the city as well as access road to landfill): The access road to the landfill and also the roads in certain areas of the city were at the time in a rather rough or bad condition. This is one of the main reasons for car breakdowns and fuel consumption, contributing to increased repair and operating costs. Providing asphalted and well maintained roads could substantially decrease the costs for transportation.
- Truck Drivers: To find reliable, careful and skilled drivers at a low wage is oftentimes difficult. Their lack of skills often cause preventable high costs. At certain points in time the private waste company was even forced to use their own office stuff as truck drivers, since they struggled to find skilled drivers (some drivers even got imprisoned due to accidents and careless driving).

If we assume that substantial investments into road construction and other infrastructure were made (by the public sector) at the end of year one, tyre, repair and maintenance cost could be halved (50%), and fuel oil and lubricant expenses reduced by 30% during the second year. In this scenario (assuming every other cost and revenue factor would remain the same) a total cost reduction of 10% could be achieved and thus the total net loss of USD 43,340 in the second year could be downsized by 42% to USD 25,050. This, however, is just one example to illustrate the potential cost savings which may be achievable through a closer collaboration with and higher financial support by the public sector.

Another main cost factor, besides transportation (motorized vehicle costs), is related to personnel and organisational field issues. Operational costs could be saved if shift work was introduced or working hours and processes were optimized. Reduction of the employees' salaries are not considered feasible as the current wages correspond to local standards. Optimization of waste collection routes to increase efficiency was not examined further in this study due to lack of specific geospatial data. The theoretical option to increase productivity of the working staff (waste collectors) is discarded as this is a very difficult task to achieve involving cultural, social and behavioral factors.

This is by no means a comprehensive cost reduction plan; nevertheless, as the cost analysis has shown in the case of Bahir Dar, if such plans are to be elaborated they should primarily focus on the major cost factors work-efficiency and motor vehicles (fuel, tyres, repair, maintenance, depreciation).

Such an option would on one hand require additional infrastructure investment (vehicles), and on the other hand the support on political level as decisions about improvement of road infrastructures are within the power of the public sector. Improving work-efficiency is however a more complex task as this involves an overall training and learning and appropriate incentives to change workforce behavior.

4. Conclusions

This study examined the costs and revenues of a private waste company in Bahir Dar, Ethiopia engaged in waste collection and transport. Within the given time period of two years (July 2009 – June 2011), the study revealed that the SWM system in Bahir Dar is not financially sustainable. This situation is quite typical for cities of the developing world where waste services are seldom analyzed using cost-revenue accounting because the service is seen as "public financed" independent of the cost (Guerrero et al., 2013). The situation in Bahir Dar was not evident from the outset as the company was successful in obtaining new grants which were able to cover for some of the running costs although they were not earmarked for this purpose. The analysis indicates that important adjustments need to be envisaged in order to ensure a solid financial base of the company and long-term functioning of the system. The analysis over two fiscal years show that the costs have increased continuously while revenue streams are not able to match

the gap. The current revenue stream relies entirely on the waste collection tariffs paid by households, commercial enterprise and institutions. Different strategies and options can be envisaged to improve cost recovery of this waste collection and transport system. Although no clear and definite answer can be given as to which option is the most feasible and effective, this paper discusses the advantages and disadvantages of each option using limited data. An alternative to the currently practiced tariff setting is to rely on a variety of financial cost recovery mechanisms, considering that some of the cost be covered by affluent waste generators and other directly by the municipal budget (obtained through property and income taxes) rather than through fixed tariffs. This option, would also take into account that a certain urban poor fraction of the population, which cannot afford the tariff, is nevertheless serviced by waste collection and thus reflects a social equity objective. Plans for an adapted revenue collection system and variable tariffs are also being discussed. This potential setup refers to the polluter-pays-principle where those that generate more waste pay more, although the proposed model would couple the tariff to the water consumption bill rather than directly measuring waste generation. All options on how to increase revenue streams through tariffs or taxes are highly political and thus need strong political will and acceptance of the political constituency. Finally, another option which is being pursued by the private company is to ensure ways to increase revenues through the sales of waste-derived recycling products (business principle).

Complementary to increasing the revenue base the study discusses options to reduce the current running cost by increasing cost-efficiency. As the spending on transportation is the largest share of the annual cost, solutions can be envisaged to improve transport efficiency and cut down on maintenance costs. Various solutions are proposed, which however need a more detailed analysis with better estimates of cost reduction levels as well as a detailed Net Present Value (NPV) calculation to assess if further investments can be justified. Examples given for cost reduction measures are the improvement of road infrastructure which would have a positive impact in terms of reducing on-route time and fuel consumption as well as maintenance cost. Investment in newer trucks and other vehicles could also lower maintenance cost and fuel consumption, however this aspect requires significant equipment investments which would be difficult to achieve at this moment in time. Finally, running cost could be reduced by investing in human resource and capacity development of skills, and cost saving work flow of staff in their daily practice. The level of cost saving are however difficult to quantify and would have to be subject of further studies.

Through its well-developed networking and fund-raising skills, the private waste company in Bahir Dar has repeatedly obtained access to loans from financial institutions. However, these are earmarked for investments and not to cover the financial losses. The proposals on how these loans will be invested to strengthen the revenue stream are critical and problematic, particularly without sufficiently obvious business models and plans. There is a risk that the past years of losses are being covered by the additionally obtained loans. This shortcut however does not alleviate the situation but rather postpones it and also diminishes the possibility to use the capital for investments and thus to open pathways to reduce the financial burden for the private waste company. Interventions are required very soon to bring this system towards a stronger financial foundation else the private partnership may fail in the medium to long term thus endangering the now well improved and reliable service.

Before the private waste company took over SWM collection, the municipality had similar costs of the SWM system, a finding that is in line with literature (e.g. Ohlsson, 2003; Bel and Costas, 2006; Bel and Mur, 2009; Jacobsen et al., 2013). However, outsourcing the main activities has led to substantial improvement regarding cleanliness of the city. Despite transferring the financial risk to the private company, the municipality remains responsible for guaranteeing a proper SWM system (Zurbrügg, 2013). In case the financial situation of the private waste company worsens and in the worst scenario the company must quit its services, the municipality would most likely not be able to respond and provide adequate services to all city residents. It is thus important and in the interest of all that the City Administration and the private waste company cooperate in implementing functioning cost recovery mechanism to reach financial sustainability. The necessary conditions that must be met for successful private sector involvement include competition, transparency and accountability (Scheinberg et al., 2010). This is only partly fulfilled in Bahir Dar, as for instance no proper tender with numerous bidders was conducted prior to outsourcing the services. This might have increased the chance to select a private company that is able to achieve financial sustainability (Gomez-Lobo and Szymanski, 2001).

While this study solely examined financial data of the private service provider and mainly focused on costs related to waste collection and transport, it is well acknowledged that costs of SWM go beyond this. Analyzing costs and benefits of all formal and informal stakeholders (full cost accounting) and including issues such as environmental protection costs would allow a more holistic picture of the SWM system. Lack of data is most often the main obstacle for such an all-inclusive analysis. Nevertheless, examining detailed data of the major service provider already allows essential insights for instance that, with the prevalent tariff collection efficiency, fees alone cannot cover the expenses related to waste collection and transport services.

A general conclusion of this study is that financial monitoring and continuous analyses of the financial data are absolutely essential to first understand the financial flows and secondly to react timely when financial sustainability is threatened. Although this statement seems obvious, literature analysis shows that this issue is seldom raised when discussing sustainability of waste services. Our findings provide valuable lessons to local authorities in other developing countries wishing to assess the performance of their SWM systems. Main lessons include that independent if services are public or private, a detailed regular cost revenue analysis is critical as a financial monitoring tool and to avoid unpleasant sudden surprises of a PPP failing due to financial deficit. The analysis in Bahir Dar also shows the risk of financial intransparency when various loans from different donors flow into the same business without any clear distinction which funds are used for what purpose. If financial analyses reveal a tendency that the revenues are not sufficient to cover the costs any longer, the two fundamental options are to either initiate measures to reduce the cost or to envisage arrangements to increase the revenues. When calculating future revenue streams, it is important that a precise business plan, based on reliable data and realistic assumptions, is elaborated. Often measures, such as tariff changes or improvement of road infrastructure to reduce maintenance cost of vehicles, are not within the competence of private enterprises but fall into the power domain of governmental authorities. In addition, the municipal authorities remain responsible and, as the contracting body, need to have sufficient understanding and capacity to carry out their 'client' function. A sound alliance between the municipality and the private enterprise is thus crucial to develop and implement appropriate solutions that lead to an enhanced financial sustainability of the SWM system.

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References

Abdrabo, M.A., 2008. Assessment of economic viability of solid waste service provision in small settlements in developing countries: case study Rosetta, Egypt. Waste Manage. 28, 2503–2511.

Bartone, C., Bernstein, J., Wright, F. 1990. Investments in Solid Waste Management. Infrastructure and Urban Development Department, The World Bank, Washington.

Bel, G., Costas, A., 2006. Do public sector reforms get rusty? Local privatization in Spain. J. Policy Reform 9, 1–24.

Bel, G., Mur, M., 2009. Intermunicipal cooperation, privatization and waste management costs: evidence from rural municipalities. Waste Manage. 29 (10), 2772–2778.

Bilitewski, B., 2008. From traditional to modern fee systems. Waste Manage. 28 (12), 2760–2766.

Brauer, C. 2011. Using technology to impact driver behavior – green driver program. In: Green Fleet, July/August 2011. <http://www.donlen.com/uploadedFiles/Home/The_Donlen_Difference/Green_Solutions/WaterOne-GreenDriver-GreenFleetMag.pdf> (accessed 12.02.13)

Brunner, P.H., Rechberger, H., 2004. Practical handbook of material flow analysis. Advanced Methods in Resource and Waste Management. Lewis Publishers.

Camenzind, E. 2012. Financial Sustainability of the Solid Waste Management System in Bahir Dar City, Northwestern Ethiopia – Assessment of the Organizational Structure, the Private-sector Involvement and the Financial Sustainability. Swiss Federal Research Institute for Aquatic, Science and Technology (Eawag). Unpublished.

Coffey, M., Coad, A. 2010. Collection of Municipal Solid Waste in Developing Countries, 2nd ed. UN-HABITAT, Nairobi.

Cointreau, S.J., 1983. Environmental Management of Urban Solid Wastes in Developing Countries. The World Bank.

Cointreau, S., Gopalan, P., Coad, A. 2000. Private Sector Participation in Municipal Solid Waste Management: Guidance Pack (5 Volumes). SKAT, St. Gallen, Switzerland.

Deccan Herald, 2013. Indian Growers Help Ethiopia become World's Fourth Largest Flower Exporter. Addis Ababa, May 16, 2013 (IANS). <http://www.deccanherald.com/content/332764/indian-growers-help-ethiopia-become.html> (accessed on 10.09.13).

Diaz, L., Savage, G., Eggerth, L. 1999. Overview of solid waste management for economically developing countries. In: Proceedings of Organic Recovery and Biological Treatment, ORBIT 99, Weimar, Germany, pp. 759–765.

El-Hamouz, A.M., 2008. Logistical management and private sector involvement in reducing the cost of municipal solid waste collection service in the Tubas area of the West Bank. Waste Manage. 28 (2), 260–271.

Emmett, D., Forget, R., 2005. The utilization of activity-based cost accounting in hospitals. J. Hosp. Market. Public Relat. 15 (2), 79–89.

Gebremedhin, T.A., Whelan, S., 2008. Prices and poverty in urban Ethiopia. J. Afr. Econ. 17 (1), 1–33.

Gomez-Lobo, A., Szymanski, S., 2001. A law of large numbers: bidding and compulsory tendering for refuse collection contracts. Rev. Ind. Organ. 18 (1), 105–113.

Guerrero, L.A., Maas, G., Hogland, W., 2013. Solid waste management challenges for cities in developing countries. Waste Manage. 33 (1), 220–232.

Hanrahan, D., Srivastava, S., Ramakrishna, A. 2006. Improving Management of Municipal Solid Waste in India: Overview and Challenges. Environment and social Development Unit, South Asia Region, World Bank, New Delhi, India.

Henry, R.K., Yongsheng, Z., Jun, D., 2006. Municipal solid waste management challenges in developing countries – Kenyan case study. Waste Manage. 26 (1), 92–100.

Hoornweg, D., Lam., D., Chaudhry, M. 2005. Waste Management in China: Issues and Recommendations. East Asia Infrastructure Development, The World Bank, Washington, DC, USA.

Ichinose, D., Yamamoto, M., Yoshida, Y., 2013. Productive efficiency of public and private solid waste logistics and its implications for waste management policy. IATSS Res. 36 (2), 98–105.

Jacobsen, R., Buysse, J., Gellynck, X., 2013. Cost comparison between private and public collection of residual household waste: multiple case studies in the Flemish region of Belgium. Waste Manage. 33, 3–11.

Kaseva, M.E., Mbuligwe, S.E., 2005. Appraisal of solid waste collection following private sector involvement in Dar es Salaam city, Tanzania. Habitat Int. 29 (2), 353–366.

Kim, J.-H., 2004. Sustainable urban waste management system in metropolitan Seoul, South Korea. Adv. Architec. Ser. 18, 717–726.

Lohri, C.R., Rodic, L., Zurbrügg, C., 2013. Feasibility assessment tool for urban anaerobic digestion in developing countries. J. Environ. Manage. 126, 122–131.

Massoud, M., El-Fadel, M., 2002. Public–private partnerships for solid waste management services. J. Environ. Manage. 30 (5), 621–630.

Mekete, D., Atikilt, A., Hana, T. 2009. Solid Waste Management in Bahir Dar City. School of Civil and Water Resources Engineering, Bahir Dar University.

Mekonnen, A., Köhlin, G. 2008. Determinants of Household Fuel Choice in Major Cities in Ethiopia. Environment for Development Discussion Paper Series, August 2008. EfD DP 08-18.

Memon, M.A., 2010. Integrated solid waste management based on the 3R approach. J. Mater. Cycles Waste Manage. 12 (1), 30–40.

Morrissey, A.J., Browne, J., 2004. Waste management models and their application to sustainable waste management. Waste Manage. 3, 297–308.

Nguyen, T.T.T., Wilson, B.G., 2010. Fuel consumption estimation for kerbside municipal solid waste (MSW) collection activities. Waste Manage. Res. 28 (4), 289–297.

Ohlsson, H., 2003. Ownership and production costs. Choosing between public production and contracting-out in the case of Swedish refuse collection. Fiscal Stud. 24 (4), 451–476.

Oteng-Ababio, M., 2010. Private sector involvement in solid waste management in the Greater Accra metropolitan area in Ghana. Waste Manage. Res. 28 (4), 322–329.

Parthan, S.R., Milke, M.W., Wilson, D.C., Cocks, J.H., 2012. Cost estimation for solid waste management in industrializing regions – precedents, problems and prospects. Waste Manage. 32, 584–594.

Rapport, J.L., Zhang, R., Williams, R.B., Jenkins, B.M., 2012. Anaerobic digestion technologies for the treatment of municipal solid waste. Int. J. Environ. Waste Manage. 9 (1–2), 100–122.

Rodic, L., Scheinberg, A., Wilson, D.C. 2010. Comparing Solid Waste Management in the World's Cities. Key-note paper at ISWA World Congress 2010, Urban Development and Sustainability – A Major Challenge for Waste Management in the 21st Century, Hamburg, Germany, 15–18 November 2010.

Scheinberg, A., Wilson, D.C., Rodić, L. 2010. Solid Waste Management in the World's Cities. UN-Habitat's Third Global Report on the State of Water and Sanitation in the World's Cities. Earthscan, London.

Schmeer, K. 1999. Guidelines for Conducting a Stakeholder Analysis. Partnerships for Health Reform, Abt Associates Inc. <http://www.who.int/management/partnerships/overall/GuidelinesConductingStakeholderAnalysis.pdf> (accessed on 24.04.13).

Schübeler, P. 1996. Conceptual Framework for Municipal Solid Waste Management in Low Income Countries. Working Paper No.9, Urban Management and Infrastructure, UNDP/UNCHS/World Bank-UMP, Nairobi, Kenya.

Simões, P., Cruz, N.F., Marques, R.C., 2012. The performance of private partners in the waste sector. J. Clean. Prod. 29–30, 214–221.

SWM Proclamation Ethiopia, 2007: Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia. Proclamation No. 513/2007. Addis Ababa, 12 February 2007. <http://ppp.worldbank.org/public-private-partnership/library/ethiopia-solid-waste-management-proclamation-no-5132007> (assessed on 26.06.13)

Turner, M., 2012. Decentralization, politics and service delivery: the introduction of one-stop shops in Mongolia. Public Manage. Rev. 14 (2), 197–215.

UNEP, 2010a. Assessment of the Solid Waste Management System in Bahir Dar Town and the Gaps identified for the Development of an ISWM Plan. Forum for Environment, June 2010. <http://www.unep.or.jp/ietc/gpwm/data/t3/is_7_4_asses.pdf> (accessed on 25.03.2011).

UNEP, 2010b. Solid Waste Characterization and Quantification of Bahir Dar City for the Development of an ISWM Plan. Forum for Environment, June 2010. <http://www.unep.or.jp/ietc/gpwm/data/t3/is_7_3_wastecq_bihardar.pdf> (accessed on 25.03.11).

UNEP, CalRecovery, 2005. Solid Waste Management. United Nations Environment Programme, Division of Technology, Industry and Economics (DTIE) – International Environmental Technology Center (IETC).

Wilson, C.D., Rodic, L., Scheinberg, A., Velis, C.A., Alabaster, G., 2012. Comparative analysis of solid waste management in 20 cities. Waste Manage. Res. 30 (3), 237–254.

Wilson, C.D., Velis, C.A., Rodic, L., 2013. Integrated sustainable waste management in developing countries. Waste Resour. Manage. 166 (WR2).

Worku, D. 2012. Recycling Practices and Potentials in Bahir Dar and the Influence of Landfill Leachate on Groundwater Quality. Cornell University, Ethiopia and Swiss Federal Research Institute for Aquatic Science and Technology (Eawag).

Zhu, D., Asnani, P.U., Zurbrügg, C., Anapolsky, S., Mani, S., 2007. Improving Municipal Solid Waste Management in India: A Sourcebook for Policymakers and Practitioners. The World Bank, Washington, DC.

Zurbrügg, C. 2013. Assessment Methods for Waste Management Decision-support in Developing Countries. Ph.D. Thesis – Università degli Studi di Brescia, Facoltà di Ingegneria, Dipartimento di Ingegneria Civile, Architettura, Territorio, Ambiente e Matematica.

Zurbrügg C., Becker, B., Voegeli, Y. 2007. Cash Flow in Solid Waste Management. Sandec News, 8, 14–15. Eawag, Dübendorf.

Zurbrügg, C., Gfrerer, M., Ashadi, H., Brenner, W., Küper, D., 2012. Determinants of sustainability in solid waste management – the gianyar waste recovery project in Indonesia. Waste Manage. 32 (11), 2126–2133.