The changing face of waste management – considerations when conducting a waste characterisation study

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ABSTRACT
Changing the face of waste management in South Africa, includes waste diversion from landfill to alternative management options. There are a number of interventions to consider which may vary from very low tech, labour intensive solutions to extremely high tech, capital intensive technology options. Making an informed decision about the preferred technology choice will require a certain level of knowledge of the composition of the waste stream at hand. The level of detail that is required from the waste characterisation study will be determined by site specific conditions, and the level of change you want to achieve. In some instances, a mere screening exercise will do the trick, but if the envisaged change include high tech, capital intensive solutions, you may want to have a high level of confidence in the characteristics and volumes of waste that will be diverted to the particular solution in question. This paper will unpack the considerations to take into account when conducting or evaluating a waste characterisation study in support of changed waste management in South Africa.

1. INTRODUCTION

Waste composition information has widespread applications. It can be used for solid waste planning, designing of waste management facilities and establishing a reference waste composition for use as a baseline to monitor progress towards diversion and recycling targets, to inform collection systems and choice of alternative waste treatment technology (AWTT) options (ASTM, 2008; Dahlen and Lagerkvist, 2008). Shortage of landfill airspace in some municipalities, stricter standards for landfill design combined with national government priorities to divert waste from landfills, have resulted in a number of municipalities, some neighbouring municipalities, engaging in feasibility studies, to divert waste away from landfill. Recent studies and studies that are underway investigating waste diversion from landfill include City of Johannesburg, City of Tshwane, Ekurhuleni, Rustenburg, uMgungundlovu, uMhlatuze, Mbombela, Emfuleni, and Mangaung to name a few. The ultimate decision on waste diversion strategies will have to be informed by the volumes and composition of the municipal waste in these municipalities and therefore waste characterisation studies will have to be done, if not yet completed.

A number of interventions previously introduced in South African municipalities failed due to inadequate information on waste volumes and composition, which resulted in inappropriate equipment and technology choices. Examples of such failures include a materials recovery facility constructed at a landfill in Mangaung (Personal communication, Mangaung, 2015) that was never commissioned and the imported equipment at another material recovery facility that was not suited to the material received for processing. Luckily, the imported equipment could be modified but at a great cost (Personal Communication, WastePlan, 2015). There are also similar examples globally, where a proven technology was introduced in a different location

Waste composition and volume by waste stream and geographic area are therefore at the core of decisions around interventions to divert municipal solid waste from landfill. Yet there is no national or international standard methodology for waste characterisation studies (Dahlen and Lagerkvist, 2008).

In the absence of a South African national standard methodology for waste characterisation studies, there is no benchmark against which to evaluate proposals for or findings from municipal waste characterisation studies. Waste characterisation studies performed in neighbouring municipalities are not necessarily comparable thereby limiting the potential for neighbouring municipalities to compare and possibly work together towards meeting economies of scale. Gauteng is a case in point where all three metropolitan municipalities are investigating AWTT options whereas a joint effort might have resulted in a more sustainable and financially viable solution benefiting all three metropolitan municipalities.

In the case of Ekurhuleni, the waste characterisation study undertaken in 2014/15 had to be repeated (the tender for this study has been re-advertised in December 2015) due to questionable sampling methods, un-representative sampling, inadequate compositional analysis and generally unreliable waste composition results (Personal Communication, GIFA, 2015). This situation could have resulted in substantial wasteful expenditure, if the incorrect data from this study was used to inform infrastructure investments. If waste characterisation and quantification of waste flows were performed and interpreted consistently, comparisons of different treatment technologies, collection systems and cause/effect discussions would be facilitated (Dahlen et al., 2007).

2. COMPARING SOUTH AFRICAN CHARACTERISATION STUDIES

Available waste characterisation studies done in South African municipalities to date are limited. As at 2012, total of 23 waste characterisation studies were undertaken in 17 out of the 284 South African municipalities (6%) (DEA, 2012). The following shortcomings relating to these studies were identified (DEA, 2012):

- Sampling and sorting methods used are not standard
- Waste categories vary between studies and are not comparable
- Low numbers of samples renders the study unrepresentative
- Sampling methods does not cater for seasonal variation (the majority was done in winter)
- Variability in sorting accuracy

Waste generation rates are influenced by income group and the composition of the waste also differs between income groups. Some of the mentioned waste characterisation studies lump income groups together and report a single figure (DEADP, 2007a, DEADP, 2007b, DEADP, 2007c). This inconsistency in reporting style between municipalities makes it virtually impossible to compare data and to reach informed decisions (DEA, 2012).

The most comprehensive waste characterisation study done in South Africa to date was done under the leadership of the CSIR for the City of Johannesburg in 2014/15 (COJ, 2015). This study covered three seasons, three socio-economic groups and reported waste composition in 15 main categories and 54 subcategories. The sample covered 40%, 54% and 20% of collection routes during the spring, summer and winter sampling periods respectively. The project therefore covered at least 128 out of 136 round collection routes and sorted 23 tonnes of household solid waste over the study period (CoJ, 2015). This characterisation study followed the same sampling methodology as was used in 2001 in the City of Johannesburg (Jarrod Ball and Associates, 2001), but introduced more detailed waste categories during sorting. The results of the 2001 and 2014/15 studies are comparable thanks to the level of detail captured in the write-up of the methodology in 2001.

3. INTERNATIONAL EXPERIENCES

Decisions based on incorrect data could result in significant programmes, businesses and technology investments being incorrectly put in place. Such investments have a high potential for failure if it was based on incorrect data on waste stream volumes and/or composition.

Examples of technology failures because of incorrect data include:

> The local waste-to-energy plant in Chandigarh, India – this technology failed because it was deprived of non-biodegradables needed for refuse-derived pelletisation (Acharya, K, 2011).
>
> EarthPower - Australia's first anaerobic digester for solid food organics, built at a cost of $36 million with the aim of creating an anaerobic digester to treat municipal solid waste (MSW), was a commercial failure and shut down in December 2004. These facilities are common in Europe, particularly the UK, but the feedstock in Australia proved to be too contaminated (Serpo, 2014). After eight years of repairs and upgrades, the plant was re-opened in 2012 and is now operational.

4. INTERNATIONAL BEST PRACTICE

There are several methods for solid waste component analysis described in literature in different levels of detail (Dahlen and Lagerkvist, 2008; ASTM, 2008) but there is no international or even European standard for waste characterisation studies (European Commission 2004; Dahlen and Lagerkvist, 2008). A review by Dahlen and Lagerskvist (2008) lists twenty different methods and they conclude that the most crucial choices in household waste composition studies are:

- To divide the investigation into relevant number and types of strata;
- To decide the required sample size and number of samples;
- To choose the sampling location, i.e., sampling at household level or sampling from loads of waste collection vehicles;
- To choose the types and number of waste component categories to be investigated.

Most methods suggest a limited number of primary waste categories into which the waste must be sorted. A larger number of secondary and even tertiary categories can enrich the data for more applications. The level of detail required is depending on the purpose of the study (Dahlen and Lagerskvist, 2008). For example, to assess the potential for energy from waste, one category of glass would suffice, but to determine the glass recycling potential of the waste, the categories of clear glass, green glass, brown glass, glass and flat glass will be of interest (Dahlen and Lagerskvist, 2008).

In general, it is accepted that local seasonal variation in waste generation should be considered and each sample should cover at least one full week’s worth of waste generation since waste generation over weekends differ from week days (Dahlen and Lagerskvist, 2008). However, there is no definite conclusion about the appropriate sample size and number of sub-samples. Dahlen and Lagerskvist,(2008) suggest, as a general rule of thumb, based on practical experiences, that the minimum number of samples for a waste characterisation is ten, if the sample size is 100kg or larger. Always using the same primary components for sorting and classification will facilitate comparisons both over time and between regions/countries (Dahlen and Lagershvist, 2008).

5. SAMPLING

It is a challenge to perform a correct solid waste sampling procedure (Dahlen and Lagershvist, 2008). Features for waste composition studies reviewed by Dahlen and Lagershvist (2008) are summarised in Table 1.

Table 1: Features for waste composition studies

Base of size of sample	Stratification i.e. base for sample location	Sub-sampling method	Sorting process
Bulk samples			
Mass	Selection of vehicle arriving at specific site Geographic urban/rural climatic, demographic, socio-economic Collection variables	Coning and quartering Randomised grab procedure Grid over flattened load	Manual Combined manual and stepwise screening
No of households	Geographic Single/multi-family Collection variables	Coning and quartering Grid over flattened load	Manual Combined manual and stepwise screening
Percentage of population	Single/multi-family Collection variables	Grid over flattened load	Manual
Individual household samples			
Number of households	Socio-economic Single/multi-family Community type Collection variables	No sub-sampling	Manual Combined manual with conveyor belt, drum sieve, magnets, vibrator, cyclone
Volume of waste bins	Residential structure Collection variables Other	No sub-sampling	Combined manual and screening

Sampling and sub-sampling should be done to eliminate sampling errors as far as possible, while capturing the full variation of the waste in any specific stratum. Logistical challenges is a given, and the interpretation of the data and analysis should take these into account.

6. CONCLUSIONS

There is no standard waste characterisation methodology that can be applied to all waste characterisation studies. The choice of methodology should be appropriate to the objectives of the study. Accurate and detailed recording of the sampling methodology will allow for comparative studies to be done in future.

The most crucial choices to be made are:

- The number and types of strata based on the objectives of the study
- Sampling location, i.e. at households or sampling loads from ordinary collection vehicles
- Sample size and number of samples
- Type and number of waste components to be investigated

Other important considerations include seasonal variation including special events and holidays that could impact the validity of the sample and each sample should cover at least one full week. As a general rule, a minimum number of 10 samples for a characterisation campaign is required, if the sample size is 100kg or more (Dahlen and Lagerskvist, 2008).

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