Selecting Appropriate Organic Waste Treatment Options in the Philippines

The first test of the SOWATT decision support tool showed that black soldier fly and slow pyrolysis are the most promising organic waste treatment technologies for San Fernando City. Local stakeholders considered environmental and social criteria more important than economic criteria. Imanol Zabaleta[1], Lisa Scholten[2], Christian Zurbrügg[1]

Introduction

Organic solid waste (biowaste) is the main fraction of the total generated municipal waste in low income countries [1]. Consequently, there is growing interest in municipalities to find appropriate management solutions for organic waste. Although there have been many attempts to construct and operate biowaste treatment technologies, these have largely failed because structured assessments and analyses that take local determinants into consideration were normally not done.

Waste related decisions are complex as they deal with many influencing factors and alternatives. In order to assist organic waste management decision making, Sandec developed the SOWATT manual (Selecting Organic Waste Treatment Technologies), which describes a structured decision making process based on the "Multi Attribute Value Theory". The approach was tested in San Fernando City, province of La Union, in the Philippines.

SOWATT, a decision support tool

Because there are different organic waste management technologies that exist, making decisions about which would work best is difficult. SOWATT provides a systematic structural approach that considers both technology and local characteristics to compare available treatment options. Five technologies are included in the SOWATT manual: windrow composting, in-vessel composting, anaerobic digestion, slow pyrolysis, and black soldier fly processing (BSF).

The technologies are assessed against an array of criteria, called objectives, which are arranged in an objective hierarchy. The first two columns of Table 1 show the objective hierarchy used for SOWATT; the objectives are grouped as higher-level objectives (HLO) and lower-level objectives (LLO). The third column presents the attributes, which are the variables identified to measure, either qualitatively or quantitatively, the extent of fulfilment of each objective. SOWATT makes use of the objective hierarchy as a default for all case studies. We, however, suggest validating the objective hierarchy with local stakeholders and, if required, adapting it accordingly.

HLO	LLO	Attributes	Composting windrow	In vessel composting	Anaerobic digestion	BSF	Slow pyrolysis
High technical reliability	—	Downtime days per year	10	30	10	10	30
High Social acceptance	**High job creation**	Workers/ton of waste treated per day	2.5–5.0	1.5	1.25–2.5	2.5–5.0	3.75–7.5
	High working safety	Level of potential hazards (1–10)	4	3	7	4	9
	Low smell impact	Hours per week of smell 20 m from the plant (hrs/week)	168	0	0	168	56
	High trust in technology	% of past experiences which are still working	0 %	50 %	33 %	No data	25 %
High environmental protection	**Low environmental pollution**	Emission of CO_2 equiv. (CO_2 eq./ton of waste treated)	325–390	23–33	170–690	200–300	1 600–2 700
		Risk level for Leachate (1–5)	5	1	4	2	0
	High resource recovery	Nitrogen recovered in product (% of input N)	25–91	62.5–91.0	90–100	43	0–10
		Phosphorus recovered in product (% of input P)	62–99	85–99	95–100	67	100
		Energy output (kWh/ton of waste treated)	0	0	600–900	0	2 000–3 000
High hygiene and community health protection	**Low residue generation**	Percentage of residue over original wet waste (%)	0	0	If no market for digestate: 1 000 L/t	If no market for residues: 350–400 kg	0
	High treatment capacity	% of generated waste treatable by the technology	38 %	38 %	20 %	20 %	55 %
High economic sustainability	—	Income expenditure ratio (IER)	0	0	0.003	3.77	2.44

Table 1: Performance table for San Fernando City.

The manual explains how to conduct a stakeholder analysis to identify the most relevant stakeholders. In addition, the Swing and the Reverse Swing methods are introduced. The first is used to assign weights to the objectives, whereas the second is used as a consistency check [2], [3]. The manual also describes how to estimate the performance of each technology for each objective. The estimations of performances are based on a literature review and should be adjusted accordingly whenever local data is available. Other performances are based on past experience, i.e., field data. Finally, the manual explains the additive model method that combines the weights given to the objectives by local stakeholders with the performances to obtain a single aggregated score for each technology [2].

San Fernando City, a case study

San Fernando is the capital city of La Union Province and has approximately 115 000 inhabitants and a growth rate of 2.27 %. The city has an area of 10 699 ha and is divided into 59 barangays (districts). It already has an existing solid waste management plan (2014–2023) and there is a well-functioning recycling sector and a sanitary landfill that was built in 1998. Waste assessment and characterisation studies were done, and showed that the total generated waste in San Fernando amounts to 45 475 kg/day, out of which 39 % consists of biodegradable organic waste. Household waste amounts to 69 % of the total generated waste [4].

The stakeholder analysis in San Fernando City identified five different key stakeholder groups: the municipal "Environment and Natural Resources Office" (CENRO); the municipal "General Service Office" (GSO), which is in charge of the waste collection and the landfill; a local NGO called Solid Waste Management Association of the Philippines (SWAPP); the informal recycling sector; and the inhabitants, represented by the Pollution Control Officers (PCO) designated for environmental issues within the district councils. For our study, 12 PCOs were interviewed, one from each of the 12 model districts (those with the best environmental performance). Furthermore, two representatives from each of the other four stakeholder groups were interviewed.

During the interviews, weights were obtained for every HLO and LLO. Averaged weights given to the HLO show that *high social acceptance* was considered most important, followed by *high environmental protection, high hygiene protection, high economic sustainability* and finally *high technical reliability* (Figure 1). The informal sector was the only stakeholder group that regarded *high economic sustainability* as the most important objective; the others did not believe this to be highly relevant. Not surprisingly, the governmental agency CENRO and the PCOs, both responsible for environmental issues, scored *high environmental protection* as the most important HLO.

As for the weights given to LLOs, *high working safety* was considered the most important among the LLOs of *high social acceptance*. The stakeholders working with waste on a daily basis especially regarded *high working safety* as a high priority. *High job creation* ranked last, which suggests that economic prosperity is not a major preference for the interviewed stakeholders. Finally, regarding the LLO of *high environmental protection, low pollution* weighted stronger than *high resource recovery*, showing the overall awareness and importance given to avoiding pollution, while resource recovery is given less priority.

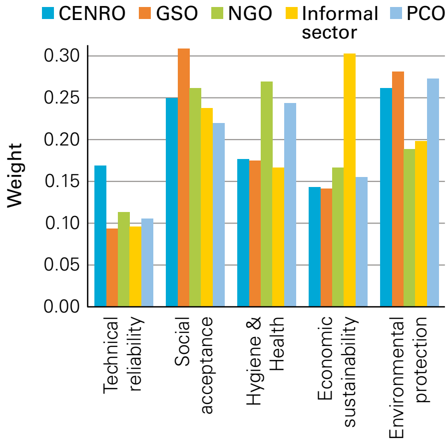

Figure 1: Weights given by the 5 stakeholder clusters to the HLO.

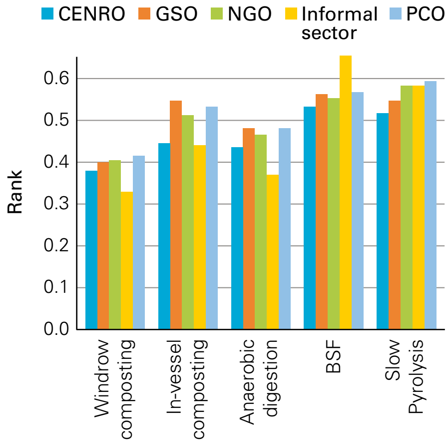

Figure 2: Final scores of each technology by each stakeholder cluster.

Focus group discussions and interviews were used to estimate the performances of the five technologies for each objective. These results are summarized in Table 1.

Final Assessment for San Fernando

Figure 2 shows the final scores that were obtained after applying the additive model. BSF and slow pyrolysis scored the highest in San Fernando City. BSF is the first choice of three stakeholder clusters (CENRO, GSO and the informal recycling sector), while pyrolysis is preferred by the NGO and PCOs. Both technologies should be financially profitable, whereas revenues from compost or biogas from anaerobic digestion are not foreseen to be sufficient to cover operational costs.

Conclusion

The main weakness of SOWATT lies in the limited available evidence concerning the performances of the technologies. Some technologies are still in the early development phase, and for them, there is little implementation evidence. Over time we hope to obtain more reliable information on how they perform, and to further test SOWATT to identify where improvements and simplifications can be made, especially in its structured approach for doing assessments and analyses.

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