Tropical Agricultural Research Vol. 14: 268-279 (2002)

Financial Viability Analysis of Solid Waste Management Options in Kandy and Kalutara Urban Councils

J.M.D.D.J. De Alwis and H.M. Gunatilake[1]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *Haphazard open dumping of waste causes air, surface and ground water pollution, unpleasant odour, reduction of aesthetic values and sanitary and health problems. Success of the use of eco friendly methods for waste disposal depends on the sustainability of financing mechanisms. This paper addresses the financial viability of 10 available solid waste management (SWM) options incorporating social benefits of effective SWM. The annual operational costs were calculated for 10 options and financial analysis was carried out against the annual benefits assuming the average willingness to pay derived from contingent valuation study collected from households. Results show that social gain was less than the costs of managing solid waste in any of the options under consideration and the lack of financial incentives for private sector to invest. With the existing command and control approach and effective utilization of institutional capacities, an extension to the existing operation system introducing a user fee for every household recommended in short term. In the long term, a fee based on the amount of waste is recommended to create incentives for households to reduce the amount generated and finally achieving optimum levels of waste. Among the technological options, composting and recycling is recommended as the least cost option for effective management of solid waste.*

INTRODUCTION

Solid waste management (SWM) is a growing problem in Sri Lanka, and it is aggravated in the absence of proper management systems. Recent analysis of data pertaining to solid waste reveals that the real problem associated with solid waste at present lies to a great extent with the present haphazard disposal practices (National Strategy for Solid Waste Management, 1999). Due to limited availability of resources, local authorities (LAs) have been compelled to adopt common haphazard disposal methods such as direct dumping which brings about greater problems. These problems can be visible or invisible and some times irreversible. Environmental and health impacts such as surface and ground water pollution, air pollution and sanitary and health impacts are the most prominent.

The present policy in Sri Lanka on SWM depends entirely on a command and control approach and the LAs make use of limited available public funds generated through municipality taxes and financial resources allocated from central government for the provision of public services. Therefore, the present approach adopted by the LAs does not provide any incentives for individuals to take part in waste management activities. This has

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1 Department of Agricultural Economics, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

aggravated the problem whereas the people do not pay the full social costs of waste at every level of the production process and in the consumption of goods. It leads to generation of inefficient levels of waste, which are greater than socially optimal levels. As a result garbage is haphazardly disposed on roadsides and public lands causing serious environmental and health problems.

Developing an effective and efficient SWM method is a current need in most municipalities. This problem is slightly more complicated than the other environmental problems; because not only one must achieve the socially optimal amount of waste, but also one must determine the socially efficient method disposing of the waste. To adopt effective management practices, LAs either have to divert financial resources from other public services or seek external funding, which are both unsustainable. Therefore, LAs have to take a rational decision to manage solid wastes in a most effective manner while generating sufficient revenue to the municipalities.

This paper addressed the viability of 10 available SWM options against the social benefits derived through a contingent valuation study conducted in the Kandy municipality and Kalutara urban council. The purpose of the study was to guide the two selected LAs to take rational decisions on selecting efficient and effective SWM options. The specific objectives were to estimate willingness to pay (WTP) for SWM and to conduct a financial viability assessment for available SWM options. When compared to the previous cost effectiveness analysis by Weerahewa *et al.*, 2000, which guide LAs in selecting the least cost option, this study analysed the costs of each option against the financial benefits derived, in the form of a user fee achieved through the contingent valuation study.

THEORY, METHODOLOGY AND ANALYSIS

Contingent valuation method (CVM) for environmental valuation

There are two basic types of valuation methods, namely, stated preference method (direct method) and revealed preference (indirect) method. Direct method seeks to infer individual's preferences for environmental quality by directly asking the people to state their preferences for the environment. Indirect methods seek to obtain estimates of individual's WTP for environmental quality by observing the behaviour of people in related markets. In this method, demand for environmental good can be revealed by examining individual's behaviour in the market (Turner and Adger, 1996). In absence of information on revealed preferences, contingent valuation method evolved as the survey technique to quantify the benefits of non marketed environmental goods which uses the Hicksian consumer theory as a model for eliciting preferences (Larson, 1991).

In basic economic theory, there are two basic types of demand functions: Marshellian demand function and Hicksian demand function. The Marshellian demand function shows how the quantity of a particular commodity demanded vary with its own price, when the consumer's income and all other prices are held constant. The Hicksian demand function is the relationship between the quantity demanded of a particular good and the price of that good, holding all other prices and utility constant. It is also referred as "compensated demand function" and it is constructed in a way that compensation is made to eliminate the income effect of a price change (Perman *et al.*, 1999).

The size of the error involved in using Marshellian Consumer Surplus (MCS) will depend on the size of the income effect associated with a price change for the commodity of concern. Therefore, Hicksian demand functions correct for the income effects whereas Marshellian demand functions do not (Perman *et al.*, 1999; Sugden, 1999). There are two 'Hicksian' monitory measures of utility change associated with a price change which differ from one another because these changes are valued at different sets of prices and use different reference points at two different utility curves. Compensating variance is the change in income that would compensate for the price change. It is therefore the maximum amount that the individual would pay to have the price fall occur The equivalent variance is the change in income that would be 'equivalent' to the proposed price change. It is therefore, the minimum compensation that the individual would accept in lieu of the price fall.

Using an environmental quality induced change as an estimate of compensating variance or equivalent variance, contingent valuation involves asking people about their WTP or accept. This valuation technique has an advantage over many of its alternatives, since it is believed to be able to estimate a "total" economic value, rather than just components of total value (Larson, 1991; Loomis, 1999).

It is widely accepted that contingent valuation method (CVM) has been accepted in valuating environmental damages including non-use values. The following guidelines have been proposed for effective utilization of CVM (Hanely *et al.*, 1997; Frykblom, 1997):

i) a dichotomous choice (DC) format should be used;
ii) a minimum response rate from the target sample of 70% should be achieved, in the case of mailed surveys;
iii) in person interviews should be employed with some role for telephone interviews in the piloting stage;
iv) WTP and Willingness to Accept (WTA) measures should be sought;
v) after excluding protest bids, a test should be made of whether WTP is sensitive to the level of environmental damage;
vi) CVM results should be calibrated against experimental findings; otherwise 50% discount should be applied to CVM results;
vii) respondents should be reminded of their budget constraint.

One important aspect of a CVM survey is the question mode that is being used when the respondent is asked the valuation question. Examples of such modes are DC method, open-ended (OE), bidding game and payment card. Dichotomous choice method is a bid offered to the respondent that he/she can either reject or accept. An OE question asks the respondent for his/her maximum WTP. The most common alternative to the use of DC method is historically been OE questions. The comparative reliability of OE and DC CVM is of practical importance to analysts who must choose between the two techniques (Frykblom, 1997; Wash Filed Report, 1988; Gunatilake, 2001). The advantages of DC CVM include:

i) fewer cognitive demands are placed on the respondent, resulting in lower non-responses;

ii) question format is matching that of a market setting, in which the price is stated and the individual engages in price taking behaviour of buying or not buying at that price;
iii) DC format is an incentive compatible device for respondents to reveal their true preferences about provision of the good.

Further the advantage of DC CVM in terms of reduced burden on the respondent can be enjoyed without any apparent loss in reliability of WTP estimates (Loomis, 1990). Despite the significant advantages of DC method, resulting estimates are sensitive to the assumptions made about the specific utility function, distribution of error term, and associated functional form of the estimated logit/probit equations. However, several empirical comparisons of two questions DC and OE have been made, with mixed results. (Frykblom, 1997; Loomis, 1999; Bateman, 1999). Therefore, it is more appropriate to use both OE and DC questionnaire formats to get reliable results.

The choice between WTP and WAC is a matter of property rights held by people for the public good. Though the public goods do not here clearly define property rights, the general agreement in literature is to use WTA for environmental losses. Theoretically, the divergence between WTA and ATP is negligible, but experimental evidence shows disparity between WTP and WTA (Sugden, 1999). Nevertheless, it seems that the WTP is the appropriate valid measure to estimate Hicksian compensation surplus (CS) for environmental goods (Gunatilake, 2001).

With the close-ended (CE) DC format responses are the answers of "yes" or "no", and the WTP value has to be obtained from these responses by introducing a statistical model that links these "yes"/"no" responses to randomly assigned bid values. Since these responses are binary variables, one need a statistical model appropriate for a discrete dependent variable. Random utility maximization (RUM) model is used to formulate appropriate statistical formula for binary response CV data. It is the RUM concept that provides the link between a statistical model of observed data and an economic model of utility maximization. In this model, it is assumed that, while the individual knows his/her preferences with certainty and does not consider them stochastic, they contain some components that are unobservable to the econometric investigator and are treated by the investigator as random.

We assume indirect utility function as v (q, y, ε), environment commodity - q, income - y, stochastic component - ε and environmental quality improvement from $q^0 - q^1$ ($q1 > qo$). In RUM model C (qo, q1, y, ε) is a random variable. Let $G_c(.)$ be the assumed Cumulative Density Function (cdf) of C and g_c is the corresponding density function that the investigator estimate from CV data. Therefore, the formula below satisfies both the economic model of the respondent behaviour and the statistical model.

$$Prb.(yes) = 1 - G_c(A)$$

There are two ways to formulate a statistical model (Hanemann and Kanninen, 1999).

1. Probit model

$$Prb.(yes) = 1 - G_c(A) = 1 - G(A-\mu)/\sigma$$

The standard normal cdf in probit model

$$Prb.\,(yes) = \phi\,(\mu - A)/\sigma$$

$$G(x) = \phi\,(x)$$

Linear model:

$$Prb.\,(yes) = \phi\,(\alpha - \beta A)$$

where; $\alpha = \mu/\phi, \quad \beta = 1/\phi$

μ = Population Mean, σ = Standard Deviation, A = WTP

2. Logit model

$$Prb.\,(yes) = 1/1 + \exp[(A-\mu)/\phi]$$

$$\theta = 3^{-2}/\Pi^{8}, \quad G(x) = (1-e^{-x})^{-1}$$

Once the statistical model has been designed, useful measures of monetary value should be obtained. The literature has generally focussed on two summary statistics. One is the mean and the other is the median. Deciding which measure is appropriate involves consideration of both statistics and economics. Considering both aspects, literature recommend the use of median WTP in cost-benefit analysis which has a much smaller sampling error than the point estimate, the mean. In the probit model median WTP (C*) is given as $C^* = -\alpha/\beta$ (α - intercept, β - co-efficient of bid value). In logit model Median WTP is $C^* = e(-\alpha/\beta)$ (Hanemann, 1984; Creel, 1998; Hanemann and Kanninen, 1999). Tobit model is an extension to the probit model. This model is used in situations where we have information as the variables/regressors and regressond of a part of the sample and for the remaining sample regressors only are known (Gujarati, 1995). Since in both data sets we could observe high non-response rates for WTP, tobit model was used for OE data analysis.

This study consisted of two distinct steps, namely estimation of WTP for providing a clean city (step 1) and financial analysis for alternative disposal options (step 2).

Estimation of WTP

A questionnaire survey was used as the survey instrument. In the introductory section of the questionnaire, respondents were given an explanation about the purpose of the study, existing situation of SWM in the respective LAs and undesirable consequences of existing waste management practices. They were also made familiar with the environmental benefits of the proposed SWM options.

The first step was to set up a hypothetical market for clean environment. Respondents were told in the questionnaire survey that the LAs could engage in cleaning the city and solid wastes will be properly disposed off. People were explained that the operation could only be achieved if extra funds will be generated to LAs. This sets up a reason for payment for services. Tax payment was used as appropriate payment vehicle since respondents are familiar with municipal taxes.

In the first part of the questionnaire, respondents were interviewed on the current situation of SWM. Second part contained information on the suggested improved SWM method. WTP bids were obtained through both OE and CE DC questions of a pilot study. For the CE version Rs. 15, 25, 40, 50, 75 and 100 were used as bid values and the respondents were asked whether they are willing to pay or not for the bid amount.

In both locations randomly selected households (HH) were interviewed. A sample consisting of 300 HH were used for each municipality. Out of each sample, 150 households were given OE questionnaires and remaining 150 were given CE questionnaires. In the Kandy municipality, 88 units were used to OE questionnaire analysis and 76 units of data for the CE questionnaires. In Kalutara municipality, 75 units of data were used for the OE questionnaire analysis and 74 units for CE questionnaire analysis. In the questionnaires, each respondent was asked whether they are willing to participate in the proposed waste management activities. Once the survey instrument was set up, the survey was administered. Face to face interviewing was carried out in the study, considering advantages over other two methods such as, telephone interviewing or mail.

A probit model was estimated with dependent discrete variable "yes" and "no" responses for randomly assigned bid values and independent variables. A tobit model was used to analyze the OE WTP data to check the reliability of the results obtained in WTP estimates. Independent variables were quantity of waste (bags/week), frequency of waste collection (time/week), distance to leave waste for collection (m), environmental attitude (dummy - 1 = agree and strongly agree and 0 = otherwise), head of households', education level (number of years) and family income (Rs/month). DC model, bid value was included in addition to other variable mentioned above. Details of the variables and the corresponding hypotheses are given in elsewhere (Vasantharuba and Gunatilake, 2002).

Financial viability assessment

In the financial analysis, 10 options available for SWM were considered. Based on secondary data from Weerahewa *et al.* (2001); Database of Municipal Waste in Sri Lanka (1999) and Annual Budget of Kalutara Urban Council (2001); annual operational costs of the ten available SWM practices were calculated and compared against the annual financial benefits derived, assuming that the user fee derived from the contingent valuation study was imposed on households. Financial analysis was conducted for three scenarios namely, 1) financial viability at 50% household participation rate, 2) financial viability at full household participation rate and, 3) user fee at the break even point.

Options considered for financial analysis were (1) direct dumping with soil application, (2) direct dumping with EM application, (3) land filling with EM application, (4) wet portion compost (compost selling), dry portion incineration, (5) wet portion compost (compost selling) dry portion direct dumping with EM application, (6) wet portion compost (compost selling) dry portion recycling (recyclable matter is sold in the market), (7) wet portion bio gas (selling bio gas and bio fertilizer) dry portion incineration, (8) wet portion bio gas (selling bio gas and bio fertilizer) dry portion direct dumping with EM application. (9) wet portion bio gas (selling bio gas and bio fertilizer) dry portion recycling (selling recyclable matter in the market), (10) privatize SWM where collection and separation is done by LAs, with wet portion is used for bio gas generation and dry portion is recycled.

The recent private sector initiative for solid waste management is included as option 10. A private entrepreneur is willing to accept US $ 5 for managing a ton of waste. At present they have focused mainly on the western province and later it will be extended to other provinces. Financial costs were calculated based on assumptions given in Appendix 1.

RESULTS

According to the contingent valuation questionnaire survey, approximately 50% households stated their willingness to participate (164 respondents out of 300) in the proposed waste management activity. Similar result was observed in the Kalutara urban council (149 households out of 300 households). The log likelihood function and the lower standard error achieved in OE model indicates a reasonably good fit with the data. McFadden's R^2 and Chow R^2 of the probit regressions for both local authorities showed reasonable fit of the model with the data in both locations and comparatively low goodness of fit as reported by Vasantharuba and Gunatilake (2002). In both LAs, econometric results appeared to have very little divergence in CE and OE data analysis and it further strengthened the reliability of CV information revealed in the analysis. Therefore, considerably high accuracy is achieved in both CV studies.

According to the econometric results both CV functions achieved in OE and CE analysis can be explained in relationship with respondent's attitude towards environmental conservation, distance to leave waste and family income. The CE version, the offer amount had a negative and significant coefficient for both LAs. As revealed in the CV data analysis, the median WTP achieved in CE data analysis is Rs. 28/households/month in Kandy municipality and Rs. 29/households/month is achieved in OE data analysis for Kalutara urban council. Therefore, a fee of Rs. 28/households/month and Rs. 29/households/month are recommended for Kandy municipality and Kalutara urban council, respectively. In the statistical results, WTP significantly depends on the level of household income in both LAs. Therefore, a higher fee can be imposed on high income earners. Introducing a fixed fee at a rate recommended above and the approximately 50% household participation rate will generate annual financial benefits of Rs. 4,047,960.00 and Rs. 1,685,172.00 for Kandy municipality and Kalutara urban council, respectively.

According to the revealed information negative net revenue is achieved for each option considered at 50% household participation rate. It indicates that the fee and the household participation rate achieved in the CV study do not generate sufficient revenue to manage solid waste effectively. The annual fee collection is sufficient to manage only a portion of waste generates and this is a clear indication that both local authorities are generating an excessive amount of waste which is beyond their optimum. The participation rate and the user fee both have to be increased to manage whole amount of solid waste generated in Kandy municipality effectively. For Kalutara municipality the least cost option is feasible with the full participation of households while imposing the user fee (Rs. 28.90/household) achieved in CV study.

Financial viability assessment for SWM options in Kandy municipality and Kalutara urban council are given in Tables 1 and 2. Column 4 indicates the net annual revenue at 50% household participation rate. Column 5 indicates the net annual revenue at full household participation and column 6 indicates the user fee that would achieve each waste management option operating at its breakeven point. To adopt the least cost option, the fee has to be increased to Rs. 42.48/household along with the full household participation in the Kandy municipality. It is Rs. 28.90/household in the Kalutara urban council. The current average household municipality tax is Rs. 37.73/household/month in Kandy municipality and it is Rs. 49.55 in Kalutara urban council. Therefore, the least cost option is feasible with the monthly average municipality tax imposed on households at present in the Kalutara urban council. It is clear in the results that the least cost option is feasible for Kandy municipality only with the current average monthly tax rate imposed on households added to the average household WTP revealed in the CV study.

Table 1. Financial viability assessment for Kandy municipality.

Option	Total annual operational cost (Rs)	Total annual revenue (Rs)	Net revenue at 50% HH participation (Rs)	Net revenue at 100% HH participation (Rs)	Monthly HH fee at break even point (100%)* (Rs)
1. Direct dumping with soil application	53,948,824	4,047,960	-49,900,864	-45,852,904	184.58
2. Direct dumping with EM application	54,825788	4,047,960	-50,777,828	-46,729,868	189.61
3. Land filling with EM application	60,652,348	4,047,960	-56,604,388	-52,556,428	209.76
4. Wet portion composting: dry portion incineration	74,273,466	17,655,960	-56,617,506	-52,569,546	209.81
5. Wet portion composting: dry portion direct dumping with EM application	40,409,565	17,655,960	-22,753,606	-18,705,646	92.69
6. Wet portion composting: dry portion recycling	37,847,046	29,610,960	-8,236,086	-4,188,126	42.48
7. Wet portion bio-gas selling: dry portion incineration	80,887,948	18,117,720	-62,770,226	-58,722,266	231.09
8. Wet portion bio-gas selling: dry portion direct dumping with EM application	45,267,148	18,117,720	-27,149,428	-23,101,468	107.89
9. Wet portion bio-gas selling: dry portion recycling	42,444,628	30,072,720	-12,371,908	-8,323,948	56.78
10. Privatize waste management	43,122,908	4,047,960	-39,074,948	-35,026,988	149.14

* Monthly household fee at break even point at 100 household participation rate; HH – households.

Table 2. Financial viability assessment for solid waste management options in Kalutara urban council.

Option	Total annual operational cost (Rs)	Total annual revenue (Rs)	Net revenue at 50% HH participation (Rs)	et revenue at 100% HH participation (Rs)	Monthly HH fee at break even point (100%)* (Rs)
1. Direct dumping with soil application	12,328,854	1,685,172	-10,643,682	-8,958,510	106.04
2. Direct dumping with EM application	12,517,657	1,685,172	-10,832,485	-9,147,313	107.67
3. Land filling with EM application	13,927,254	1,685,172	-12,242,082	-10,556,910	119.79
4. Wet portion composting: dry portion incineration	-10,624,922	5,746512	-4,878,410	-3,196,238	56.48
5. Wet portion composting: dry portion direct dumping with EM application	8,523,162	5,746,512	-2,776,650	-1,091,478	38.38
6. Wet portion composting: dry portion recycling	8,159,978	6,477,132	-1,682,846	2,326	28.90
7. Wet portion bio-gas and bio fertilizer: dry portion incineration	19,766,988	3,025,452	-14,639,776	-15,056,364	158.50
8. Wet portion bio-gas selling: dry portion direct dumping with EM application	17,665,228	3,025,452	-14,639,776	-12,954,604	140.42
9. Wet portion bio-gas selling: dry portion recycling	17,322,044	2,920,332	-14,401,712	-12,716,540	138.37
10. Privatize waste management method: Bio gas and fertilizer generation	10,255,254	1,685,712	-8,569,542	-6,884,370	88.21

* Monthly Household fee at break even point at 100 Household participation rate

Table 3 and 4 summarizes results of sensitivity analysis carried out for compost price changes. Column 8 presents the household fee that should be imposed after adjustments too changes in recycling and composting market.

Table 3. Sensitivity analysis for Kandy municipality.

Scenario	Total annual operational cost (Rs.)	Tax revenue (Rs)	Revenue from compost selling (Rs)	Total revenue (Rs)	Net benefits at 50 % HH participation (Rs)	Net benefits at 100 % HH participation (Rs)	Monthly HH fee Rs. at 100% HH participation (Rs)
Compost price 3 Rs/kg	40,409,566	4,047,960	13,608,000	17,655,960	-22,753,606	-18,705,646	92.69
Compost price 1.50 Rs/kg	40,409,566	4,047,960	7,128,000	11,175,960	-29,233,606	-25,185,646	115.10
Compost price 1 Rs/kg	40,409,566	4,047,960	4,752,000	8,799,600	-31,609,606	-27,561,646	123.32
Compost is given Free of charge	40,409,566	4,047,960	-	4,047,960	-36,361,606	-32,313,646	139.75

Scenario 5: Wet portion composting, dry portion direct dumping with EM application.

Table 4. Sensitivity analysis for Kalutara urban council.

Scenario	Total annual operational cost (Rs)	Tax revenue (Rs)	Revenue from compost selling (Rs)	Total revenue (Rs)	Net benefits at 50 % HH participation (Rs)	Net benefits at 100 % participation of HH (Rs)	Monthly HH fee at 100% HH participation (Rs)
Compost price 3 Rs/kg	8,523,162	1,685,712	4,060,800	5,746,512	-2,776,650	-1,090,938	38.38
Compost price 1.50 Rs/Kg	8,523,162	1,685,712	2,030,400	3,716,112	-4,807,050	-3,121,338	55.84
Compost price 1 Rs/kg	8,523,162	1,685,712	1,353,600	3,039,312	-5,483,850	-3,798,138	61.70
Compost is given free of charge	8,523,162	1,685,712	-	1,685,712	-6,837,450	-5,151,738	73.31

Scenario 5: Wet portion composting, dry portion direct dumping with EM application.

However, the cost structure for each option was derived subjected to certain assumptions. Market for recycling and composting is not yet assured with a larger quantity coming into market. With regard to the absence of recycling market, the next best solution is the option 5 wet portion composting and dry portion direct dumping with EM application.

CONCLUSIONS AND POLICY IMPLICATIONS

This study analyzes 10 available options for SWM against the financial benefits derived in a form of a user fee achieved by a contingent valuation study conducted in the Kandy and Kalutara municipalities. According to the financial analysis each of the options are not financially viable at the current rate of household participation and average willingness to pay. Therefore, no sufficient financial incentives exist for a private entrepreneur to invest on effective SWM. The local authorities will have to continue SWM using the existing command and control approach and institutional capacities. Assuming the same institutional and command structure effectively implemented, LAs should recover the cost while generating sufficient revenue to local authority to manage waste more effectively. Therefore, the imposture of a user fee for households is recommended. This will create incentives for individuals to take part in SWM.

Household income significantly affects the household WTP for SWM in each LA. Therefore, higher fee for high-income households can be suggested. However, there will be a high transaction cost in operating a differential payment system, because such a system requires systematic monitoring. Due to high transaction cost and the problem of free riders, only a fixed fee on every household may be feasible initially. In short term, revised municipality tax rates while incorporating a household user fee for SWM is recommended. In order to create real incentives for individuals to take part in SWM activities, the fee should be imposed based on the amount of waste generated by the households or individuals. Therefore, in long term introducing a fee based on the amount of solid waste generated is recommended and finally it will lead to socially optimum level of waste generation.

According to the financial analysis, the least cost option is composting the wet part and selling the dry part in the recycling market. If environmental benefits are concerned, composting and recycling is also a preferred option for effective management of solid wastes. Therefore, among the existing options available for waste management, composting is recommended as the most appropriate method for effective management of solid waste. In case of the uncertainty in the market, selling compost and recyclable matter is subjected to price changes. Local authorities can adjust for market uncertainty by adopting the next best option 'composting and direct dumping with EM application' and increasing the user fee according to the price changes. Both options are flexible to transform from one option to other in adjusting to the market price changes.

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APPENDICES

Appendix 1. Assumptions for financial benefit cost calculations.

Item	Assumption
Composting	Compost utilization, 20% of waste input compost price, Rs. 3/kg
Bio Gas	Bio gas utilization, 18%,100 tons capacity, 4 months duration is required to produce bio gas, bio gas price 4 Rs./4 m^3
Recycling	Selling price, Rs. 0.25/kg, metal Rs. 4.5/kg, Glass Rs. 2/kg, paper Rs 1.75/kg
Bio fertilizer	Bio fertilizer utilization 15% of waste input
Annual depreciation of capital items	Compost unit 5%, building 2%, vehicle5%, accessories 1%
Office maintenance	5 % of total costs
Waste separation cost	Rs 0.07/kg
Contingencies	Excluded
Storage cost	Excluded