Tropical Agricultural Research Vol. 14: 258-267 (2002)

Feasibility of Benefit Transfer in Solid Waste Management

K. Vasantharuba and H.M. Gunatilake[1]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *As a developing country, Sri Lanka faces severe budgetary restrictions in conducting research in each and every site for solid waste management. The benefit transfer method offers the opportunity to use benefits estimated for one site to be used for other sites. However, the reliability of benefit transfer is being questioned frequently. Therefore testing the reliability and applicability of benefit transfer techniques is important in managing the environment in developing countries.*

The main objective of this study is to test the reliability of the benefit transfer approach for solid waste management in Sri Lanka. Two sites, namely Kandy and Kalutara, have been used to test the reliability of the benefit transfer methods. Close-ended and open-ended contingent valuation questions were asked to elicit the willingness to pay for solid waste management. Results demonstrated that the willingness to pay function for solid waste management is transferable among the two sites. Benefit estimated using the close-ended and open-ended questions yield similar results. Despite the available evidence of poor reliability, this study shows that benefits of solid waste management can be transferred between the test sites, in Sri Lanka.

INTRODUCTION

Benefit transfer is the practice of adapting available estimates of the economic value for a change in environmental quality (or quantity) to evaluate a proposed, policy induced change in the same or a "similar" resource in another site (Smith *et al.*, 2000). In these situations, the analyst is typically taking the results from one or more existing studies and transferring them to a different context that is relevant for a policy being evaluated. The new policy context can require changes in both the features of the resource and the characteristics of the people who care about it.

In the context of social costing, original studies that examine willingness to pay (WTP) to avoid further environmental degradation would be of greater use in benefit transfers than studies that examine WTP for environmental improvements (Krupnick, 1993). In general, primary data collection on a site by site basis is expensive and time consuming. The research agencies also face considerable uncertainty regarding the continued financial support. For certain policy purposes analysts need inexpensive benefit estimates obtained in a timely manner. As the benefit transfer method offers the opportunity to meet these needs, one can expect increasing use of benefit transfer in the future.

---

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

Most tests of the reliability of benefit transfer conclude that benefit transfer is unreliable. However, few acknowledge that this conclusion holds for the approaches used to implement the method, rather than the method itself (Poulos, 2000). Overall, the simple transfer approach does not fare well in these tests. The model transfer approach, too has failed many reliability tests.

Disposal of solid waste has become a major environmental problem in Sri Lanka. With the accelerated generation of waste caused by increased population, urbanization, and industrialization, nature's assimilative capacity has been severely curtailed. Due to increasing awareness of environmental effects would result in people not disposing solid waste in their back yard and environmentalists are concerned with the long-term effect of landfill gas and leachates.

Efficient and effective solid waste management requires investment, operational cost and technologies. The rampant practice of disposing waste (open dumping) is common in most of the developing countries including Sri Lanka. When solid waste is disposed in open dumps without any environmental safeguards, the leachates from these dumps can pollute surface and ground water. Open dumping sites are generally found in the outskirts of the urban areas. These sites have been turning into sources of contamination due to the incubation and proliferation of flies, mosquitoes and rodents; these in turn are disease transmitters.

The high cost of solid waste management makes it difficult to implement a proper solid waste management system without people paying for it. Currently the urban councils implement the solid waste management programs. The municipal tax is collected as lump sum payment, and from the tax collection a portion is allocated for solid waste management. This current system of tax payment by the people is inappropriate to sustain a proper solid waste management programme. Therefore, to implement an effective solid waste management programme, it is necessary for residents to pay a solid waste management fee. Although there are a few economic studies on solid waste management in Sri Lanka, no study has focused on benefit transfer for solid waste management. Thus objective of this study was to test the reliability of the benefit transfer approach for solid waste management in Sri Lanka.

MATERIALS AND METHODS

Theory of benefits transfer

Benefit transfer refers to the use of benefits estimated in one site (study site) for policy purposes in another site (policy site). Three types of benefit transfer are possible; benefits transfer across different time periods over the same study site, the benefit transfer across different regions within the same time periods and benefit transfer to a future time period and to a different region. Most benefit transfer approaches impose restrictive assumptions about the similarity of benefits at the two sites. Following are the assumptions made in benefit transfer:

- Non-market commodity valued at the study site must be identical to that at the policy site.

- The populations affected by the quality changes of the non-market commodity under consideration at the study site and the policy site preferably have identical characteristics.
- The property rights at both sites are similar so that they lead to the same theoretically appropriate welfare measure, namely willingness to pay (WTP) or willingness to accept (WAC).

In practice, the value to be transferred can be either benefit or cost. Most benefit transfer methods use either the benefit value or the benefit function approaches. In the case of a benefit value approach, a single point estimate (usually WTP) or a range of a value, is typically used to summarize the results of one or more studies that have been developed for another purpose. In the case of a benefit function transfer approach (Loomis, 1992; Desvousges *et al.*, 1992), the WTP function from the study site (including functional form, model specification, and parameter estimates) is combined with site-specific data describing the population and other characteristics of the policy site to derive the values for the policy site. As suggested by many researchers (Loomis, 1992; Krupnick, 1993; Downing and Ozuna, 1996; Kirchhoff *et al.*, 1997; Brouwer and Spaninks, 1999), the benefit function transfer approach is preferred over the direct transfer of benefits.

To assess the reliability of the benefit transfer process, the following was tested:

$$E(Vss) = \mu ps$$

where;

μps is the true value of benefits at the policy site and
E(Vss) is the expected value of the benefit at the study site.

This study involves concurrent estimation of non-market values at the study site and the policy site, using primary data collected at both sites. Initially, individual WTP functions in the two sites were tested separately and the mean WTP for solid waste management was calculated. At this stage, the extent the WTP values were determined by the socio-economic characteristics of the household were examined and the magnitude and directional effect of variables that significantly affect the estimated values were identified. Then the data was pooled and the transferability of the benefit function was tested by using the dummy variable approach. Finally the benefit transfer values were compared for the policy site (based on the study site valuation models) with the values estimated for the policy site from primary data. Comparison of the benefits at the study and policy sites were carried out using the confidence interval approach.

Data

A contingent valuation study carried out by the Department of Agricultural Economics, University of Peradeniya, was used as the base for present analysis. Simple random sampling method was used and 300 families were randomly selected in each urban council area. First, the respondents were asked whether they were willing to pay a solid waste management fee if they were provided an environmentally sound and efficient solid

waste management service. Those who answered 'yes' to this question were divided into two groups and the first group was given an open-ended question and the other was given a close-ended question. Only the households, which answered yes to the participation question, were used for the analysis. "How much they were willing to pay" was asked from people as an open-ended question. In the case of the close-ended version, respondents were given a bid and they were asked whether they would pay the amount or not. Similar to the other case, the WTP question was asked only from the people who indicate willingness to participate.

The payment vehicle (basically included to avoid the hypothetical nature of the question and to get a bidding response from the respondents) used in the contingent valuation survey was tax. The institution that collect the tax and provides the service was presented based on the household preferences. In order to do that the household was first asked whether they like the municipal council or a private company to offer the service and collect the solid waste management fee. Those who prefer a private sector service were told that a private company was going to provide the service. For the others the WTP question was framed indicating that the municipal council was going to provide the service.

For the open-ended version some respondents reported zero WTP. For WTP data with large numbers of zero bids as in the data set, the Tobit model is a theoretically correct model to explain the variation in stated WTP amounts (Halstead *et al.*, 1991). The following site characteristics, user characteristics and socio economic characteristics were incorporated into the WTP function. Details of the variables and the corresponding hypotheses are presented in Table 1.

$$WTP = \beta 0 + \beta 1\, Qty + \beta 2\, Frq + \beta 3\, Dis + \beta 4\, EnvAtt + \beta 5\, Edu + \beta 6\, Inc + Ui$$

where;

I = 1, 2, 3 ------- n, the individuals surveyed
Yi = the answers to open-ended/close-ended WTP questions
$\beta 0$ = intercept term
$\beta 1$-$\beta 6$ = vector of slope coefficient

Table 1. Independent variables and the corresponding hypothesis.

Independent variables	Definition	Expected signs
Qty	Quantity of waste (bags/week)	Positive
Frq	Frequency of waste collection (times/week)	Positive
Dis	Distance to leave waste for collection (metre)	Negative
Env Att	Environmental attitude dummy variable (1 = agree and strongly agree, 0 = otherwise)	Positive
Edu	Heads of households' education level (no of years)	Positive
Inc	Family income Rs/month	Positive

The same payment vehicle method was used for both WTP versions. For the close-ended version Rs. 15, 25, 40, 50, 75 and 100 were used as bid values and the respondents were asked whether they were willing to pay or not the bid amount. The close-ended version was single bounded, *i.e.*, only one response of yes or no was obtained for a randomly selected bid. Therefore, yes/no responses are the dependent variables in this case and the Probit model is the appropriate method to obtain mean WTP and to analyse the factors influencing the WTP. Therefore, answers to the dichotomous choice questions were analysed by using the Probit regression model. Model specification is similar to the Tobit regression except that the dependent variable is the answer to dichotomous choice method and bid amount is included as an explanatory variable, in addition to the above described variables. The mean WTP value was calculated by using the following equation.

$$Mean\ WTP = \beta_0 / -\beta_1$$

Where $\beta 0$ and $\beta 1$ refer to the intercept and the coefficient of the bid value, respectively, of the regression model (Gunatilake, 2002). The average WTP for solid waste management calculated for different sites using different WTP questions were compared to test the reliability.

There are different methods to test the validity of the benefit function transfer. In this study the approach followed by Downing and Ozuna (1996), which uses the dummy variables to test the constancy of coefficients is used. The data were pooled from the two districts, and regressed the following WTP function to check the transferability of the benefit function.

$$Yi = \beta 0 + \beta 1 Si + \beta 2 Di + \beta 3 Di * Si + Ui$$

where;

I = 1, 2, 3 ------- n, the individuals surveyed
Yi = answers to open-ended/closed- ended WTP questions
$\beta 0$ = intercept term; $\beta 1$ = vector of slope coefficient
Si = vector of determinants of WTP; Di = dummy variable (site 1=1 and site 2=0)
$\beta 2$ = intercept shifter; $\beta 3$ = vector of slope shifter; Ui = Error term.

RESULTS AND DISCUSSION

All the variables except for education have the expected signs in both sites. The variables "distance to leave the waste" and "family income" are statistically significant in both sites (Table 2). In site 2 the attitude variable is not significant. The log likelihood function and the lower standard error showed that the model has a reasonably good fit with the data.

The "distance to leave the waste" for collection has a negative impact with the WTP amount. It indicates that, if the distance is far, people would not be willing to pay for solid waste management or to participate in a solid waste management programme. Results also clearly showed that households with higher income are willing to pay more for

environmental improvements than households with lower incomes in both sites. The service of the municipal council included in the model by using the variable "frequency of waste collection", is statistically insignificant in the two sites. Respondent's education level does not play a significant role in both samples. Environmental attitude was regressed by using a dummy; those who strongly agree and agree for the statement "every citizen in a country is responsible to manage the environment properly" were assigned one and zero otherwise. This variable also showed the positive response in site 1 indicating that if the people's attitude towards the environment is good, they are willing to pay more for solid waste management to avoid further degradation of the environment. In the context of environmental benefits, culture and attitudinal variables may play a role in improving the explanatory power of WTP amounts. Overall, the results showed that the WTP values derived from the survey are accurate. Mean WTP values are Rs. 25.77 and 28.93 per household per month in Kandy and Kalutara, respectively.

Table 2. WTP function for both sites with open-ended version.

Variable	Kandy (site 1)		Kalutara (site 2)	
	Estimated Co-efficient	t-ratio	Estimated Co-efficient	t-ratio
Constant	-21.761	-0.6172	-10.088	0.3986
Quantity of waste (Qty)	0.35466	1.5970	1.1777	1.5618
Frequency of waste collection (Frq)	0.21958	0.8170E-01	1.0282	0.7954
Distance to leave waste (Dis)	-0.6345E-01	1.6620*	-0.8583	2.7259**
Environmental attitude (EnAtt)	3.9444	2.2548**	3.1952	0.1783
HH education (Edu)	-2.5529	0.9267	-0.1396	0.1059
HH Income (Inc)	0.3459E-03	2.6044**	0.743E-02	2.3633**
Mean WTP	25.77		28.93	
Log likelihood function	-304.589		-320.987	

* and ** refers to significance level at P<0.1 and P<0.05, respectively.

Results of the Probit regressions are reported in Table 3. Maddala R^2 showed reasonable fit of the model with the data in site 1. Site 2 showed a comparatively low goodness of fit. As expected, standard socio-economic variables such as the respondent's income play a significant role in explaining differences in stated WTP. The estimated income coefficient is significant in each sample, while the respondent's education level did not play a significant role in the WTP choice.

In the close-ended version, as expected, the offered amount had a significant negative coefficient, reflecting a decreased probability of the expected 'yes' response as the bid amount increases. This was found in all the estimated contingent valuation functions. As expected, a respondent's attitude ranked preferences and actual behaviour towards paying for nature conservation significantly help explain differences in WTP in both sites.

Variable distance to leave the waste is statistically significant and negatively affects on WTP response. The mean WTP values (Rs. 27.95–28.98) in the two sites showed a smaller difference closer in this case when compared to the open-ended values.

Table 3. WTP function for both sites with close-ended version.

Variable	Kandy (site 1)		Kalutara (site 2)	
	Estimated Co-efficient	t-ratio	Estimated Co-efficient	t-ratio
Constant	0.9780	0.99844	0.4395	0.69712
Bid amount	-0.3550E-01	-4.6862**	-0.1516E-01	-2.6904**
Quantity of waste (Qty)	0.1555E-01	0.85014	-0.1048E-01	-0.37979
Frequency of waste collection (Frq)	0.5917E-01	0.54308	0.1289	1.6116
Distance to leave waste (Dis)	-0.1276E-01	-1.6586*	-0.1179E-01	-1.6573*
Environmental attitude (EnAtt)	0.84026	1.7071*	0.48324	1.74207*
HH education (Edu)	-0.3366E-01	0.55666	-0.1040E-04	-0.1644E-01
HH Income (Inc)	0.9298E-04	2.5543**	0.5555E-04	2.3915**
Mean WTP	27.95		28.98	
Log likelihood function	-31.635		-37.066	
Maddala R-square	0.4290		0.1937	

* and ** refers to significance level at P<0.1 and P<0.05, respectively.

Reliability of benefit transfer

Table 4 shows the benefit function transfer results with the open-ended version. Open-ended analysis showed that the function is transferable between the two sites as the intercept and slope shifters are statistically insignificant, indicating that the benefit function has the same coefficients.

The close-ended pooled results are presented in Table 5. The function is transferable in the two sites because the intercept and slope shifters are statistically insignificant, indicating that the benefit function has the similar coefficients. Downing and Ozuna (1996) and Brouwer and Spaninks (1999) found that transferring functions is more robust than transferring averages. Kirchhoff *et al.* (1997) and Loomis (1992) made similar conclusions. However, equality of regression coefficients of the individual model does not guarantee equality of the benefits at the two sites. The transfer of functions is generally considered the most appropriate procedure for environmental benefit transfer, as it enables someone to control the site, and environmental good characteristics, population characteristics or procedural research differences related to specific market properties such as how environmental values are or would be elicited (*e.g.*, through income taxation or private funds, monthly or annual payments).

Table 4. Open-ended regression results for pooled data.

Variable	Estimated Co-efficient	Standard error	t-ratio
Constant	10.277	0.7859	0.3307
Quantity of waste (Qty)	1.2793	0.2346E-01	1.6859*
Frequency of waste collection (Frq)	1.0016	0.4010E-01	0.6347
Distance to waste collection (Dis)	-0.8948	0.9650E-02	2.3566**
Environmental attitude (EnAtt)	2.3345	0.5561	0.1066
HH Education (Edu)	-0.1431	0.4086E-01	0.8902E-01
Family income (Inc)	0.1012E-03	0.6488E-05	0.3967
Dummy for site one =1 and site two =0	13.503	1.0755	0.3190
Qty * Dummy	1.3659	0.2522E-01	1.3761
Frq.* Dummy	-0.8424	0.6986E-01	-0.3064
Dis.* Dummy	-0.9532	0.9729E-02	-0.4899
EnvAtt * Dummy	21.882	0.8099	0.6866
Edu.*Dummy	3.3408	0.5467E-01	1.5528E-01
Inc.*Dummy	0.2144E-03	0.1389E-04	0.3923
Mean WTP value	27.12		
Log likelihood function	-629.155		

* and ** refers to significance level at P<0.1 and P<0.05, respectively.

Table 5. Close-ended regression results for pooled data.

Variable	Estimated Co-efficient	Standard error	t-ratio
Constant	0.4391	0.6305	0.6964
Bid amount	-0.1516E-01	0.5637E-02	-2.6904**
Quantity of waste (Qty)	-0.1048E-01	0.2760E-01	-0.3798
Frequency of waste collection (Frq)	0.12895	0.8001E-01	1.6515*
Distance to waste collection (Dis)	-0.1179E-01	0.1855E-01	-0.6357
Environmental attitude (EnAtt)	0.48302	0.8915	0.5417
HH Education (Edu)	0.3962E-04	0.1004E-02	0.3943
Family income (Inc)	0.5554E-04	0.2323E-04	2.3908**
Dummy for site one =1 and site two =0	0.3389	1.0025	0.3381
Bid*Dummy	-0.2034E-01	0.9444E-02	-1.1539
Qty * Dummy	-0.5068E-02	0.3311E-01	-0.1530
Frq.* Dummy	-0.6977E-01	0.1351	-0.5161
Dis.* Dummy	0.1307E-01	0.1865E-01	0.7007
EnvAtt * Dummy	0.3572	1.2210	0.2925
Edu.*Dummy	0.3362E-01	0.6047E-01	0.5559
Inc.*Dummy	0.3743E-04	0.4318E-04	0.8668
Mean WTP value	28.95		
Log likelihood function	-682.698		
Maddala R-square	0.3444		

* and ** refers to significance level at P<0.1 and P<0.05, respectively.

The benefit function transfer approach in previous studies indicated that many of the benefit functions are transferable. However, the question that really needs to be answered is, do these transferred benefit functions also yield statistically similar welfare measures? Applying WTP values from one site to another is difficult as such values are highly sensitive to site specific variables. But in the case of solid waste management as shown in Table 6, it is possible to transfer the benefit function as shown by the results.

Table 6. Estimated willingness to pay (WTP) values for solid waste management.

	Mean WTP amount	Confidence interval	Sample size
Open-ended			
Kandy - site 1	25.77	30.64 - 25.76	90
Kalutara - site 2	28.93	31.42 - 24.52	83
Pooled result (n1+n2)	27.12	31.77 - 23.56	173
Average	27.12		
Close-ended			
Kandy - site 1	27.95	28.55 - 27.34	77
Kalutara - site 2	28.98	30.02 - 27.93	74
Pooled result (n1+n2)	28.95	29.95 - 27.94	151
Average	28.63		

The benefit estimates in open-ended and close-ended analysis have different WTP amounts. However, the function is transferable between the two sites. Confidence interval for the estimated benefits are shown in the above Table. The average value is transferable between sites because all estimated benefit values from the close-ended contingent valuation method lie in the 95% confidence interval for the transferred function. This showed that the estimated WTP values could be transferable between the two sites.

The results of the study suggested that this approach has the potential to apply benefit transfer in solid waste management in Sri Lanka. However, it would be better, if this analysis is expanded for some other districts within the country before a policy for solid waste management programmes is adopted.

CONCLUSIONS

This study estimated the WTP for solid waste management in Kandy and Kalutara urban council areas. The mean WTP for Kandy and Kalutra are Rs. 25.77 and 28.93 per month per household, respectively, with the open-ended WTP question. The mean WTP values for the same sites with the close-ended questions are Rs. 27.95 and Rs. 28.98, respectively. The analysis on the determinants of WTP for solid waste management in both

sites with both question types showed that WTP values at each site are reliable. Therefore, these values can be used to estimate the possible revenue from an improved solid waste management in Kandy and Kalutara urban councils.

This benefit transfer technique would be a useful tool for developing countries as they are facing severe financial crises, which do not allow conducting primary data collection in each municipality. In many previous studies researchers have shown that benefit transfer is not reliable. These studies have recommended avoiding benefit transfer unless it is absolutely necessary, given the circumstance. Researchers have been encouraged to conduct more methodological work on benefit transfer in order to improve the methods of benefit transfer. This study, in contrary to the existing evidence, shows that the application of benefit transfer for solid waste management is feasible, as both WTP functions and direct value transfer provide reliable results. The results are consistent between the sites as well as between the WTP question formats used in the study. However, this is the first study done on benefit transfer in solid waste management in two sites in Sri Lanka and it is recommended that further studies on benefit transfer in solid waste management be conducted for more sites in the country.

REFERENCES

Brouwer, R. and Spaninks, F.A. (1999). The validity of environmental benefits transfer: Further empirical testing. Env. Res. Econ. 14: 95-117.

Desvousges, W.H., Naughton, M.C. and Parsons, G.R. (1992). Benefits transfer: Conceptual problems in estimating water quality benefits using existing studies. Water Resources Res. 28(3): 675-683.

Downing, M. and Ozuna, T.O. (1996). Testing the reliability of the benefit function transfer approach. J. Env. Mgt. 30(0021): 316-322.

Gunatilake, H.M. (2002). A Theoretical Manual for Environmental Valuation in Sri Lanka. A Report Prepared for Ministry of Forestry and Environment, Colombo, Sri Lanka.

Halstead, J.M., Lindsay, B.E. and Brown, C.M. (1991). Use of the tobit model in contingent valuation: Experimental evidence from the Pemigewaset wilderness area. J Env. Mgt. 33: 79-89.

Kirchhoff, S., Colby, B.G. and La France, J.T. (1997). Evaluating the performance of benefits transfer: An empirical inquiry. J. Env. Mgt. 33: 75-93.

Krupnick, A.J. (1993). Benefit transfers and valuation of environmental improvements, resources - Res. for the Future. Winter. 1993(110): 01-06.

Loomis, J.B. (1992). The evolution of a more rigorous approach to benefit transfer: Benefit function transfer. Water Resource Res. 28(3): 701-705.

Poulos, C. (2000). Improving the reliability of the benefit transfer method: A new approach and an application to malaria prevention. www.eepsea.org/publications/ policybr3/ACF3CA.html.

Smith, K.V., Houtven, G.V., Pattanayak, S. and Bingham, T.H. (2000). Improving the practice of benefit transfer: A preference calibration approach. www.epa.gov/waterscience/economics/benefits.pdf.