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EMERGING SOLID WASTE MARKET IN LILONGWE URBAN, MALAWI: APPLICATION OF DICHOTOMOUS CHOICE CONTINGENT VALUATION METHOD

Maganga Assa
Department of Agricultural and Applied Economics, Bunda College, University of Malawi, Lilongwe, Malawi

ABSTRACT

From over the recent past, Lilongwe city in Malawi has been one of the areas where more waste is generated. This solid waste generation has exceeded current infrastructural capacity of City Council and the resulting effect has been the steady degeneration in the quality of solid waste management. Consequently, solid waste management problem has threatened public health and environmental quality. Such environment changes might erode an enabling environment for potential investors, which could be a catalyst for economic development, in the near future. Consequently, health and economic development initiatives at other levels can be arrested and may remain unsustainable. Therefore, this paper provides an empirical analysis of the willingness to pay for the collection of household waste for improved solid waste management in Lilongwe urban. A multi-stage sampling technique was employed to select one hundred and fifty seven households from the study area. Using a comprehensive cross sectional data set on sampled households in a Lilongwe urban, the study used dichotomous choice Contingent Valuation Method to estimate factors that affect willingness to pay for household waste disposal. Total willingness-to-pay value was estimated to be MK14 million per month. This could be the solution to the problem of inadequate budget for improved and sustainability in solid waste management. Level of education, concern for environmental quality, income level and satisfaction for waste collection were shown to be important predictors of willingness-to-pay.

Keywords: Contingent valuation method, Lilongwe urban, solid waste management, waste disposal, willingness to pay

INTRODUCTION

There is a growing global environmental concern on the management of wastes in urban areas of cities from developing countries (Foo, 1997). With increasing population, there is a spontaneous increase in the generation of wastes. In the last two decades, urban population in Malawi has doubled and in some areas tripled (NSO, 2008). This can be attributed to urbanization and industrialization. Increased population has posed pressure on resources and, in turn, has increased quantities of the generated urban solid waste beyond the rate at which environment can decompose them.

Urban solid waste is regarded as waste emanating from human settlements, small industries and urban activities. Sources of urban solid waste include sewage sludge plants, public areas like streets bins, street sweepings, livestock manure and households (World Bank, 1999). Waste market has a place in urban and peri-urban agriculture. Organic waste market includes sale of urban waste and sale of manure from livestock. For example, solid waste might help to provide feed for livestock and livestock waste would provide manure for crops (Nunan, 2000). Such emerging markets would provide addition income to the municipal authorities and livestock farmers.

From over the recent past, Lilongwe city has been one of the areas where more waste is generated. The solid waste has the potential to be turned into manure that can be sold to both the urban and rural communities. Millions of financial resources are spent on waste management. The waste is collected by the Lilongwe City Assembly (LCA) under the cleansing section and they are dumped at Area 38 dumpsite. Turning of the municipal solid waste into saleable manure can, therefore, help recover the costs of waste management and reduce adverse environmental impacts coming from unused waste (Mkwambisi, 2006; Adeyemi et al. 2007).

However, the changing economic trends and rapid urbanization complicate solid waste management (SWM) in developing countries. Consequently, solid waste is not only increasing in quantity but also changing in composition from less organic to more paper, packing waste, plastics, glass, metal wastes among other waste, a fact leading to the low collection rates (Bartone *et. al*., 1993). Thus, making the waste unfit for manure. In order to cope up with these challenges and because of the critical role in protecting the environment and public health, accomplishing effective municipal solid waste management be a priority for emerging cities.

This solid waste generation in Lilongwe city has exceeded current infrastructural capacity of City Council and the resulting effect has been the steady degeneration in the quality of solid waste management. This infrastructural deficiency has diverse implications on the health outcomes of the urban residents. Gwatkin *et al*. (1999) notes that poor sanitary condition account for 7% of global deaths with women and children being at more risk. Consequently, solid waste management problem has threatened public health and environmental quality. Further, there is a threat that such environment would erode an enabling environment for investors, which are a catalyst for economic development in an emerging city. As a result health and economic i.e tourism, development initiatives at other levels would be undermined and unsustainable. Therefore, this study aims to assess demand for improved solid waste management by urban residents of Lilongwe city which is crucial for planning and policy orientation. More specifically, it aims to find the willingness to pay by households to attain a specified

standard of solid waste management and find the determinants of willingness to pay for a specified standard of solid waste management.

METHOD

Study area and data

The study was conducted within the city of Lilongwe (Lilongwe urban). The area was chosen because of the overwhelming availability of solid waste generated by households. A field survey was done to provide a better understanding of the nature and problems of municipal solid waste in March 2011. The study area was stratified into high density, medium density and low density in order to capture a representative sample. In the second stage, a semi-structured questionnaire was used to collect data from 157 households. A household was the unit of analysis (Czaja and Blair, 1996; Sarantakos, 1998). Data was collected on socio-economic characteristics, willingness to pay for solid waste generated, perceptions, waste collection, disposal and knowledge of the respondents on solid waste management. Key informant interviews were also conducted with officials from Lilongwe city assembly including information on current solid waste management.

Empirical Model

Utility is unobservable, thus, difficult to quantify. Unlike ordinary utility, indirect utility is observable. Following Afroz et al. (2009), dichotomous choice Contingent Valuation Method (CVM) is based on random utility theory. It assumes utility to be transitive for the competing alternatives and that the option that yields highest utility is preferred most (Adamowicz et al., 1994). The utility function of each option is given as

(1) $u_i = \psi_i + \mu_i$

Where u_i is the overall utility, ψ_i is the indirect utility function. Indirect utility function is specified as a comprising the characteristics of an environmental good or service, or a policy that can be measured and socio-economic characteristics of household head (Afroz et al., 2009) and μ_i is a stochastic element of the model.

The probability of individual n choosing option i rather than option j is given by

(2) $P_n(i) = P_r(U_{in} \geq U_{jn}; \forall_j \in C, i \neq j)$

$= P_r(\psi_{in} + \mu_{in} \geq \psi_{jn} + \mu_{jn}; \forall_j \in C, i \neq j)$

The individual was asked whether they would be willing to pay for a giving initial bid, B_1. If the individual accepts the bid, he or she was asked if he or she could pay for high bid, $B_{u,}$ for solid waste management. If the answer is no, then he or she was asked if he or she could be willing to pay for a bid, $B_{L,}$ for solid waste management. Following Mcfadden (1974), we assume that the error terms are distributed as type I extreme values. Hence, the probability of choosing option i is given by

(3) $$P_n(i) = \frac{\exp^{\mu\psi_{in}}}{\sum_{j \subset C_n} \exp^{\mu\psi_{jn}}}$$

From equation 3, we have four response probabilities that can be obtained:

(4) $$P(\text{Yes} - \text{Yes}) = P(\text{YY}) = 1 - \frac{1}{1 + e^{(\alpha + \beta Bu + \sum \delta Zn)}} = \pi^{yy}$$

(5) $P(\text{Yes} - \text{No}) = P(\text{YN}) = \frac{1}{1+e^{(\alpha+\beta Bu+\sum \delta Zn)}} + \frac{1}{1+e^{(\alpha+\beta B1+\sum \delta Zn)}} = \pi^{ny}$

(6) $P(\text{Yes} - \text{No}) = P(\text{YN}) = \frac{1}{1+e^{(\alpha+\beta B1+\sum \delta Zn)}} + \frac{1}{1+e^{(\alpha+\beta BL+\sum \delta Zn)}} = \pi^{yn}$

(7) $P(\text{No} - \text{No}) = P(\text{NN}) = 1 - \frac{1}{1+e^{(\alpha+\beta BL+\sum \delta Zn)}} = \pi^{nn}$

The log-likelihood function for the double-bounded model, parameterized by

$\theta = \alpha + \beta B + \sum \delta Z_n$ is

(8) $$\ln L^D(\theta) = \sum_{i=1}^{n} \{d_i^{yy} \ln \pi^{yy}(B_{i,} B_i^u; \theta) + d_i^{nn} \ln \pi^{nn}(B_i, B_i^d; \theta) + d_i^{yn} \ln \pi^{yn}(B_i, B_i^u; \theta) + d_i^{ny} \ln \pi^{ny}(B_i, B_i^d; \theta)\}$$

Where, B_i is initial bid, B_i^u is upper bid if the answer to the initial bid was yes, B_i^d is the lower bid after the initial if the answer to the initial bid was no.

Where, α_{in} is a scale parameter, which is usually assumed to be equal to 1 (Hanley *et al*., 1998b). Louviere et al., (2000), assumes the utility function to be linear and additively separable the indirect utility function of alternative i. From equation 3, indirect utility function (willingness to pay), ψ, is then represented as:

(9) $\psi_{in} = \alpha_{in} + \beta_i X_i + \theta Z_n + \delta(Y_n - C_i)$

Where α_{in} is a constant which captures the intrinsic preference of respondent n for option *i*; β, θ, δ are coefficients; X represents the characteristics of the alternative *i*; *C* is the bid offered; Y is the total income and Z is the other socio-economic characteristics of respondent n. All the estimates in this study were arrived at using STATA 10.0 analytical package.

The demand function for household waste disposal was derived by regressing amount of waste disposed by a household against mean willingness to pay per bag of waste. Othman (2002) used double-log model as:

(9) $Q = e^{\alpha}(\text{AWTP})^{\beta 1}$

Applying natural logarithm across equation 9, we get

(10) $\text{Ln}Q = \alpha + \beta_1 \text{Ln}(AWTP)$

Where, Ln*Q* is natural log of the number of bags of waste and Ln(*AWTP*) is natural log of the mean willingness to pay for bag of wastes. From equation 11, number of waste quantity an average household will be willing to dispose were forecasted.

The behaviour of the marginal willingness to pay for the addition cost of waste disposal was checked by satisfaction of the second order condition:

$$\frac{\partial^2 AWTP}{\partial Q^2} < 0 \quad (12)$$

RESULTS AND DISCUSSION

The descriptive statistics of the sample data are reported in Table 1. It is found that 85% of the sample was males and females comprised 15%. At least every one included in the sample had attended education to some level. Six percent (6%) attended primary school, 68% attended secondary school education and 26% went as far as tertiary education. An average household head had 38 years with a household size of 5 and income level of MK17000 per month.

Table 1: Socio-economic characteristics of the respondents

Variable	**Number of Respondents**		**Percentage**	
Education				
Never attended school	0		0	
Primary school	10		6	
Secondary school	102		68	
Tertiary school	38		26	
Sex				
Male	128		85	
Female	22		15	
Occupation				
Farming	23		15	
Formal business	53		35	
Informal business	14		9	
Formal employment	33		22	
Informal employment	29		19	
	Mean	**Std dev.**	**Minimum**	**Maximum**
Age (years)	38	7.3	24	65
Household size (persons)	4.5	1.2		
Income (MK/Month)	17000	2123	5000	85000

1USD=MK150

Larger proportion of households (35%) depends on informal business which includes the selling of charcoal, firewood, doughnuts and other small assets. This is not very stable because when the capital is used up people will have no source of income and therefore, it is not very reliable. In addition, there are those who are formally employed. Household heads (15%) that had large pieces of land rely on farming. The highest number of farmers is found in peri-urban because most of the

household heads were born there and they have land which was passed on to them from their parents. Only 22% are into formal business, these people mostly own grocery shops. Depending on the sources of income it was found that those people whose income is higher produce more wastes since they have the capability to buy different types of products (Nilanthi et al., 2007).

The independent variables included in the double bounded logit model for willingness to pay included age, education, income, gender, concern about waste management and satisfaction on waste management. The coefficient for age was significant at 1% and positive. The values (seven households) for which willing to pay were zero or not willing were dropped following Afroz *et al.* (2009). Model results reported a Mc-Faden R^2 of 0.17 implying acceptable goodness of fit. The value of LR was statistically significant at 1% showing that all the variables determine the willing to pay in the model.

Table 2: Factors affecting the Willingness To Pay of the households

Variable	Coefficient	T-value
Intercept	50.23(16.477)	3.04***
Age	0.231 (0.032)	7.12***
Income	0.021 (0.005)	4.32***
Gender	0.023 (0.205)	1.12
Concern about waste management	0.914 (0.491)	1.86*
Education	0.544 (0.103)	6.23***
Satisfaction on waste correction	2.643 (1.19)	2.22*
LR statistics	18.34***	
Mc-Faden R^2	0.17	

*** and * means significant at 1% and 10%, respectively

Source: Survey data, 2011

The coefficients for age and income were positive and significant at 1% implying a positive relationship between age, income and willingness to pay. The result corresponds with the findings of Afroz *et al*. (2009). This would be attributed to the fact that older people have more experience and make mature decisions patterning waste management. It can also be said that people with higher age have higher work experience and, hence, high salaries. With high incomes, household are more willing to pay because it is only a small proportion of their total wealth which becomes easier to sacrifice. The model suggests that for every additional MK100 a household earns per annum his/her WTP will increase by MK2.

The coefficient for education was positive and significant at 1%. With high education, individuals are more aware of the environmental issues emanating from poor waste management. Thus, with more awareness, individuals are more willing to pay for improved solid waste management. Other studies like Jin et al., (2006), Danso et al., (2006) and Caplan et al., (2002) found similar finding.

Concern about waste management was positive and significant and 10%. Thus, less concerned about waste management one is, not often will they be willing to pay for improved waste management. This result is validated by similar result of the study conducted by Jin et al. (2006). Satisfaction on waste correction was positive and significant at 10% showing that willingness to pay goes together with satisfaction of waster correction, in line with Afros, et al. (2009) and Kassim and Ali, (2006).

Using the sample data, the mean willingness to pay of MK92 (USD 0.54) per month was estimated. From this, willingness to pay was aggregated for the total population. The city had an urban population of 153,717 households (NSO, 2008). In aggregate terms the city has the willingness to pay of MK14 million (USD 0.08 million). In which case, households are willing to trade off 0.54% of their income. From the survey data, the average waste production by a household is 46kg per month.

From basic theory of demand analysis, price increase is expected to throttle demand. Similarly, as the willingness to pay increases, quantity of wastes disposed is expected to dwindle. To test this theory, a log-log regression model for demand for waste disposal was run on mean willingness to pay. The results are presented in Table 3.

Table 3: WTP and Demand for Waste Disposal

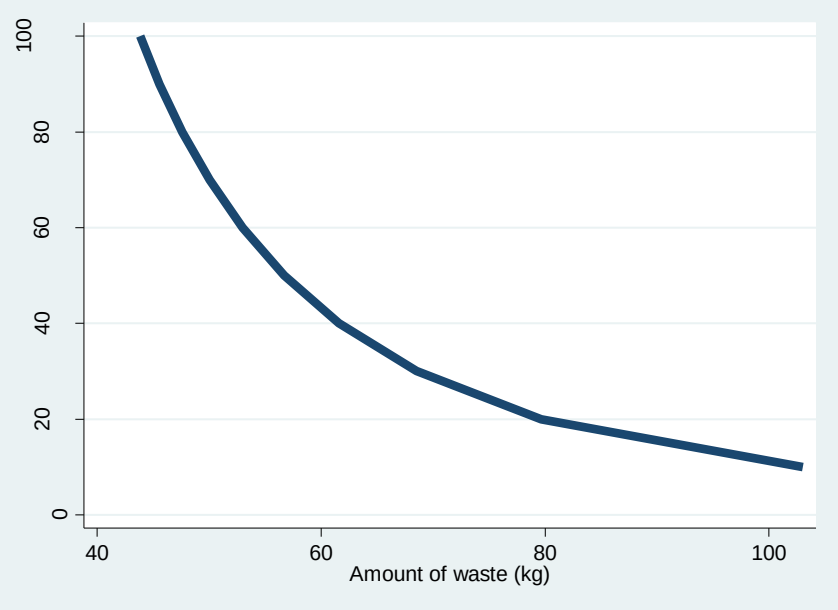
Variable	**Coefficient**	**Std. Err.**	**t**
Ln(WTP)	-0.371	0.047	-7.86***
Intercept	5. 489	0.828	6.63***
F-Value	174***		

*** means significant at 1%. Dependent variable is log of quantity of waste disposed

Source: Survey data, 2011

The result was consistent with economic theory showing a significant negative relationship between the willingness to pay and quantity of waste disposed. The regression model implies that an increase in the cost of waste collection by MK100 will reduce the quantity of waste disposal by 40%. Using the log-log model, the demand schedule for waste disposal is derived in Figure 1. The mean average willingness to pay is MK2 [MK92/(46kg/month)].

Figure 1: Demand Curve for Waste Disposal Given Different Charges



Source: Author's computation.

The estimated demand function for waste disposal is well behaved, twice differentiable, with second derivative less than zero ($\frac{\partial^2 Q}{\partial WTP} < 0$). The inversed demand function is found by expressing WTP as a function of quantity of waste disposal demanded. Thus, the second derivate is less than zero ($\frac{\partial^2 WTP}{\partial Q} = -0.03Q^{-1.629} < 0$). This implies that as far as the cost of waste disposal increases at the margin households will be reducing the quantity of wastes they generate.

The result shows that lump-sum fee for waste collection may distort efficient prices as households may not have incentives to reduce waste disposal. If waste disposal is charged on a per unit basis, households will be rewarded financially and have the incentive to reduce waste generation. Linderhof *et al*., (2001) and Dijkgraaf *et al*. (2003) reported similar result.

CONCLUSION

The solution to the problem of inadequate budget for improved solid waste management is suggested. This study has explored the possibility of cost sharing by households in solid waste management which could provide sustainable avenue for financing solid waste management in Lilongwe urban. The study employed contingent valuation method to determine efficient prices for the management of municipal solid waste. The study finds that there are factors that significantly affect willing to pay for household solid waste disposal including household income level, concern about waste management, education and satisfaction on waste correction.

In addition, the behavior of demand for waste disposal has shown that fixed charges for waste disposal are self defeating for a sound waste management policy. Fixed charges would call off the households' incentive to recycle wastes as more waste generation would reduce their average waste disposal costs. Thus, the finding implies per unit charge policy option to encourage waste reduction and recycling. The finding has also shown that the households in the city are willing only to share 0.54% of their income for improved waste management. This is drawn from a willing to pay of MK92 per month in the city.

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ABOUT THE AUTHORS

Maganga Assa is a social science research consultant and also a graduate student in the Department of Agricultural and Applied Economics at Bunda College, University of Malawi. He is pursuing his second degree programme in Agricultural Economics with a specialization in Environmental and Natural Resource Economics.