Willingness to Accept for Municipal Waste Recycling:

A Case Study from Lima, Peru

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Abstract

Waste management seems to be a wide challenge for cities in developing countries. Resource constraints and inefficient institutions inevitably call for labour from the informal sector in this activity. We employ the contingent valuation method and a logit model to estimate recyclers' Willingness To Accept (WTA) to participate in recycling household's waste in Lima (la Victoria District). We examine various aspects, including socioeconomics factors, awareness and recycling activity.
The required WTA estimate is 1,355.86 Soles (USD 413.13), higher than both the minimum living wage fixed at 750 Soles and the monthly per capita productivity of recyclers, calculated at 986.05 Soles (USD 300.45), using a market prices method in the latter. The economic value of solid waste finance more than 70 percent of the recyclers' monthly willingness to accept, considering recyclers productivity. Although this is a promising outcome, there is a need for further research on the effects of education, attitudes, and awareness of solid waste management from both the public and private sectors.

Keywords: Waste management, contingent valuation, informal sector, Lima.

Introduction

Overview

Municipal waste management in developing countries is characterized by the weak participation of the public sector, although it implies a large part of the municipal budget, between 3-15 percent according to estimates (Masood and Barlow 2013, Wilson et al., 2012). The presence of resource constraints and inefficient institutions imply the role of the informal sector in this management (Gutberlet, 2008). In the case of Peru, around 100,000 people work as recyclers, more than 50 percent of them in Lima Metropolitan (Diaz and Otoma, 2012). Informal sector in waste management is characterized by its diversity of practices (waste collection, disposal and resale of recyclable products,...) and profiles: recyclers, sellers, micro enterprises, NGOs, communities, etc. It is also defined by its low productivity level and the presence of high risks for health by emissions of harmful substances impacting workers and their families living near landfills. However, the role of the informal sector is essential for the municipal waste management, through the interrelations between the public sector and private enterprises in the formal sector. Similarly, governments and cities in developing countries have an increasing responsibility to develop an integrated and inclusive approach to waste management (Gutberlet, 2008; Sembiring and Nitivattananon, 2010).

We employed the contingent valuation method to estimate the recyclers' perception of Lima (la Victoria District) to recycle. We examine various aspects of recyclers' perception of municipal

waste collection, in particular. First, we investigate the factors that can improve participation in municipal waste collection, including socioeconomics factors, awareness and recycling activity. Then, we analyse average incentive levels, approximated by the willingness to accept (WTA) required attracting recyclers' participation in municipal waste collection and whether incentives are appropriate, given the current recyclers' productivity and municipal waste market price.
The contributions of this study are twofold. First, few studies include the informal sector in contingent valuation approach (Afroz et al., 2009). This study is probably the first to concern evidence about recyclers' perception in Lima about municipal waste. Second, most of studies concern evidence for willingness to pay (Damigos et al., 2016; Afroz & Masud, 2011; Akhtar et al., 2017; Challcharoenwattana & Pharino, 2016; Ezebilo, 2013; Hazra et al., 2013; Rahji & Oloruntoba, 2009) and few concern willingness to accept (Basili et al., 2006; Cho et al. (2015).

Waste Management in Lima and la Victoria District

La Victoria (Lima City) is one of the smallest district of Lima (8.74 km²), but the waste production per capita is almost double, compared on average to the other districts (0.976 kilograms<1.94 kilograms). The commerce and industry generate waste represented by the so-called Gamarra Mart, which includes thousands of shops (fruit markets and popular kitchens and restaurants). The streets are contaminated by solid waste, affecting hospitals and other places that clearly seek an improvement in the quality of life. As presented in Figure 1, the main component of the Municipal waste is the organic waste, approximately 45% of the total waste.

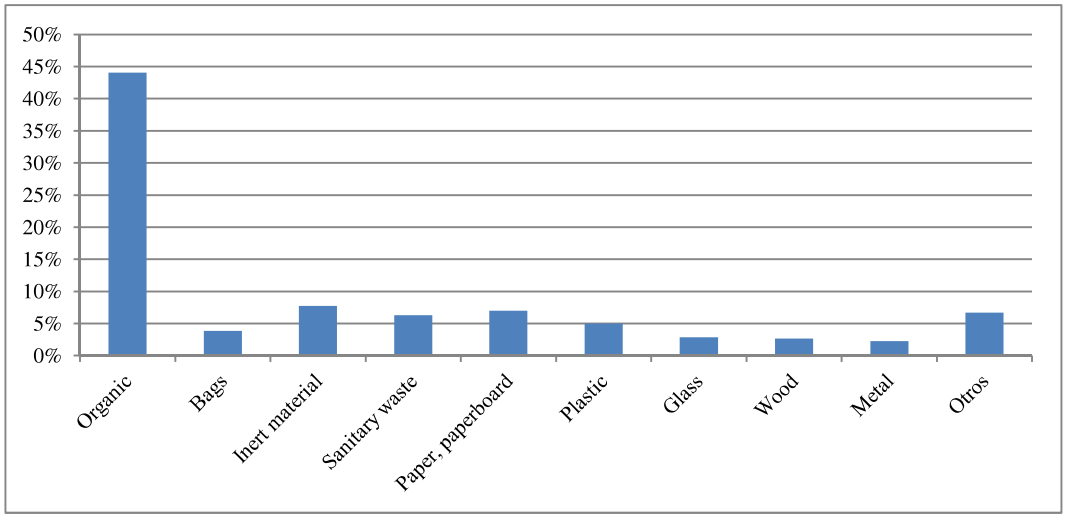

Fig 1: Main components of the municipal waste in the Coast Region of Peru, 2013. Source: 6th National Report on Solid Waste of Municipal and No Municipal Management, 2013.

Since 2011, the Ministry of the Environment has been implementing a national program called the Program for Sorting at the Source and Selective Collection of Solid Waste. According to the Ministry (2014), the criterion of a recycling economically efficient implies the collection of waste at the source by 100 percent community support of a locality.

Methodology

Measuring

The contingent valuation method attempts to measure changes in the welfare of people in money, due to an increase or decrease in the quality and / or quantity of a good, this measure in monetary units is usually expressed in terms of the maximum amount that a person would pay for a good, also known as the Willingness to Pay, or the minimum amount that a person would accept to be compensated for not having a good or service, also known as the Willingness to Accept.
To model willingness levels for tolerating loss, the utility function is defined as follows,

$$u_j = v_j(p, y; q_j) + \varepsilon_j$$

Where j=0 is the initial situation and j=1 represents the changed situation, in this case the improvement in the quality of the environment, and *y* represents the family income, p is the vector of prices that individuals face to get their goods and q represents the quantities that individuals ultimately consume, ε the error term.
Hanemann (1984) describes the mathematical behavior equivalent to the willingness to pay, in this investigation we represent in a similar way the mathematical behavior for the willingness to accept.

$$\Pr(si) = \Pr\left[v_1(p, y; q_1) + \varepsilon_1 < v_0(p, y + A_t; q_0) + \varepsilon_0\right]$$
$$\Pr(si) = \Pr\left[v_1(p, y; q_1) - v_0(p, y + A_t; q_0) < \varepsilon_0 - \varepsilon_1\right]$$
$$\Pr(si) = \Pr\left[\Delta v < \varepsilon_0 - \varepsilon_1\right]$$
$$\Pr(si) = \Pr\left[\Delta v < \eta\right]$$
$$\Pr(si) = F_\eta(\Delta v)$$

Where F_η remains the cumulative distribution function of η which also remains η =$\varepsilon_0 - \varepsilon_1$, and Pr represents the probability of such a situation occurring. It is understood that the payment is an amount to receive (Hanemann, 1984), so A_t is positive in the equation, in addition the initial situation and the amount received are more useful than the final situation. If the indirect utility function is linear we have for the initial situation:

$$v_0 = \alpha_0 + \beta(y + A_t) + \varepsilon_0$$

Finally we observe:

$$v_1 = \alpha_1 + \beta y + \varepsilon_1$$

The difference between these two utilities represents the change in well-being:

$$\Delta v = v_1 - v_0 = \alpha_1 - \alpha_0 - \beta A_t + \varepsilon_1 - \varepsilon_0$$
$$\alpha_1 - \alpha_0 + \varepsilon_1 - \varepsilon_0 = \beta A_t$$
$$\alpha - \eta = \beta A_t$$
$$A_t = \frac{\alpha - \eta}{\beta}$$

Where A_t represents the disposition to Accept.

Logit model

The participation in recycling is influenced by socioeconomic factors, awareness of recycling activity and initial bid amount. These potential determinants are examined by estimating the following binomial logit model,

$$P_i = \frac{1}{1 + e^{-Z_i}}$$

where $Z = \beta_0 + \beta_i X_i$

P_i represents the probability of an event occurring given certain variables called X_i, the utility of the model consists in that Z_i as takes infinite values, the probability that the event occurs will be a dichotomous variable with a value of one if the respondent states that they do want to accept the amount of S /.1200 soles per month to recycle and a value equal to zero if the respondent states that he does not want to accept the amount. β_0 represents the intercept of the model. X_i represents a set of explanatory variables of the model, corresponding to the survey questions to recyclers. The subscript i refers to the number of variables included in the model (5 exogenous variables). β_i represents the set of betas parameters related to each of the explanatory variables, the subscript i in this case is related to the explanatory variable that we mentioned in the previous paragraph. The coefficients are 6, one for each model variable and one intercept. u_i represents the error of the econometric model. Finally, the average productivity of a recycler has been defined using the market price method.

Questionnaire design

The questionnaire included five sections. The first and fifth section presented questions about the recyclers' socio-economic characteristics, such as gender or education. The second section included questions related to awareness. The third section reported information about willingness to accept and the fourth to the recycling activity.

Data description

Sample selection

The population analyzed is the total of recyclers working in the La Victoria district, Lima. Due to the lack of formal data on the amount of recyclers in the district of La Victoria, a short random interview with some recyclers in the La Victoria district was carried out. From this interview it can be seen that there are approximately 400 recyclers in this district. This data was corroborated with personnel working in the municipality of La Victoria who were not clear about how many recyclers are currently working in La Victoria. To make the calculation of the sample of analysis, we use the characteristic formula for the calculation of a sample for a finite population of individuals, according to the following equation:

$$n = \frac{N\ (Z^2)\ p\ q}{d^2(N-1) + Z^2\ p\ q}$$

Where n represents the sample size, Z the Degree of reliability (1,645), p the probability of occurrence of the event (0.5), q the probability of non-occurrence of the event (0.5), d the level of significance (0.10) and N the size of the total population (400).

Therefore, our total sample represent 58 persons. In addition, a pilot survey was carried out on 20 recyclers, which were added to the research sample for the purpose of improving the sample size and thus moving away from the problems that can present a small sample, because while the

samples are larger the estimators have diverse desirable statistical properties. Finally, 78 surveys were carried out.

Socio-economic characteristics

The population surveyed consisted of among 400 recyclers from La Victoria district aged from 20 to 82 years old. A questionnaire was administered to 78 individuals. The survey was conducted via face-to-face interviews in 2016.

Table 1 summarizes the socio-economic characteristics of the respondents. The target population included recyclers. Due to particularity of the recycling activity, mostly occupied by men; the sample was composed by 98.7% male and 1.3% female. The respondents' ages ranged from 20 to superior to 71, with the majority (38.5%) between 51 to 60 years old. The education level corresponds from basic school completed (29.5%) to high school uncompleted (34.6%).

Table 1: Descriptive statistics for recyclers' socio-economic characteristics

Characteristics	Number of respondents
Gender	
Female	1(1.3%)
Male	77(98.7%)
Age	
20-30	9(11.5%)
31-40	5(6.4%)
41-50	12(15.4%)
51-60	30(38.5%)
61-70	17(21.8%
> 71	5(6.4%)
Education	
High school completed	18(23.1%)
High school uncompleted	27(34.6%)
Basic school completed	23(29.5%)
Basic school uncompleted	10(12.8%)

Awareness of and attitudes toward recycling

The respondents were generally concerned about the problem of municipal waste (Table 2), according to the mean statement (6). However, the respondents seem not concerned about health impact of recycling activity (3). The awareness about environment seems moderate (5). Then, the respondents reported the awareness on their activity, comparing to other collectives. The impact activity is higher (14), considering other groups (authority (6.2), community (6.8)). Finally, the respondents are very concerned to improve their labor situation and occupy a formal job.

Table 2: Awareness of the socio-environmental effects of waste management in La Victoria district (Lima, Peru)

Variable	**Mean (S.E)**
Problematic of urban waste (0=no problem-10= high problem)	6 (2)
Awareness on waste impact on health (0= no impact-10= high impact)	3(3)
Awareness about environment (0= no impact-10= high impact)	5(3)
Awareness of the recycler's activity on environment (0= no impact-20= High impact)	14(2.5)
Awareness of the authority's activity on environment (0= no impact-20= High impact)	6.2(4.2)
Awareness of the community's activity on environment (0= no impact-20= High impact	6.8(4.3)
Willingness to occupy a formal job (0=no; 1=yes)	0.8(0.4)

Results

Factors influencing participation in recycling activity

Table 3 summarizes the definitions and descriptive statistics for the explanatory variables.

Table 3 Definitions and descriptive statistics for explanatory variables

Variable	Definition		Mean (S.D)
WTA	Willingness to accept		1567.3 (1323.4)
DAY WORK	Number of day worked in a week		6.2 (1)
DISTANCE	Number of kilometers covered in a week		16 (9.1)
PROD	Productivity per Capita		1469.9 (1282.1)
HEALTH	Awareness of the health effect of Waste Municipal Collection (1-10: 1 not at all concerned; 10 very concerned		0.3 (0.3)

The results to estimate the minimum wage for a recycler of the La Victoria district would be willing to accept to carry out future activities of recycling, is on average S /. 1,355.86 soles per month (Table 4). The econometric model was corrected for heteroskedasticity problems with the standard errors and Huber-White (QML) method of covariance.
On the other hand, the test of significance for the variables is checked with the z-statistic that is analogous to Student's t of linear models and has a null hypothesis of non-significance for each of the variables, therefore for all variables model can be verified to reject the null hypothesis raised in this test, which means that all coefficients of the model are significant, except the intercept coefficient, fulfilling the expected results in a model with logistic cumulative distribution.
Similarly we can evaluate the joint significance of the variables of the models with the statistical LR (likelihood ratio) which is also equivalent to the statistical F for linear models and has as null hypothesis the joint significance of the estimated coefficients, so we can observing that there is no probability to accept this hypothesis, and for this reason the coefficients as a whole are significant to explain the behavior of the probability of the event.

The R^2McFadden in parallel with the account R^2 are the most suitable indicators to analyze the goodness adjustment of the model. We can observe the first value obtained is equal to 0.79 which is totally acceptable for these cases , despite not being a relevant data of the model. For the case of account R^2 we obtained a value of 94.87 and we must take into account that for this value is expected a behavior above 60%. This value implies that the model is predicting correctly 94.87% of the cases. Therefore we can conclude that the goodness adjustment of the Logit model is adequate.

The coefficient associated with the variable WTA indicates the probability of accepting the labor supply decreases by 0.507% when the amount earned at least by a recycler increases from S/. 1 sol. Additionally, we observe when current productivity of the recycler increases from S/. 1 sol, the probability of the recycler accepting the labor proposal decreases by 0.424 percent. When the current recycler travels one kilometre more, the probability of accepting the labor supply decreases by 39.55 percent.
The positive sign on the coefficient for the variable DAY WORK indicate recyclers working more days are more likely to accept the job offer. Finally, the perception of the health problem is positively related with the labor proposal.

Table 4: Determinants of participation in recycling activity

Variable		Parameter estimate		z-Stat
WTA		-0.005084		-2.64607
DAY WORK		3.516134		3.320909
DISTANCE		-0.503327		-2.783587
PROD		-0.004248		-2.276223
HEALTH		-6.039835		-3.154475
C		-3.028436		-0.518837
McFadden R-squared	*0.79*			
LR statistic	*85.81*			
Prob(LR statistic)	*0*			

Productivity of Recyclers

According to the Sixth National Solid Waste Report for the Management of the Municipal and Non-Municipal Scope 2013 of MINAM (2014), the composition of urban solid wastes from the coast Region, including Lima Metropolitan is shown in figure 1. Table 4 reports only 4 types of recyclable materials.

SINIA (2016) in its environmental indicators, reports that in the district of La Victoria in 2013 a total of 126,997 tonnes of municipal solid wastes was recorded, that is, if we count the total of paper, cardboard, glass and plastic which could have been obtained in that year would have the calculation of table 8. We report the economic value of these materials at market prices with the prices of 2016, obtained from the survey applied to recyclers for these materials.
The evidence shows that for a minimum wage equivalent to S / .1,355.86 soles per month, it seems a total of S / .16,270.32 soles by year, it would have been possible to cover the annual salary of 487 recyclers (Table 5). To conclude, we observe that the estimated population registered in SIRTOD (2016) for the district of La Vitoria in 2016 concern 169,239 inhabitants, so we estimate that each recycler in this group of 488 must attend to 346.8 inhabitants of the district and thus be able to cover 100% of the area, collecting solid waste in source of origin, minimizing the use of energy, maximizing the use of recyclable materials, improving the working conditions of recyclers, generating formal employment, reducing pollution, and of this sustainable development, achieving eco-efficient self-financing of eco-efficient recycling.

Table 5: Economic value of the material recycled from 2013 (2016 price)

Category of waste	Proportion	Total Kg	Average Price 2016	Economic Value
Papel	3.79%	4´813,186	S/. 0.36	S/. 1'732,747
Paperboard	3.26%	4´140,102	S/. 0.25	S/. 1'035,026
Glass	2.88%	3´657,514	S/. 0.12	S/. 438,902
Plastic	5.56%	7´061,033	S/. 0.67	S/. 4'730,892
				S7. 7'937,566

Conclusion

With the use of a contingent valuation method and a logit model, we have estimated that a recycler from the La Victoria district would be willing to accept (WTA) a minimum monthly wage of S / .1,355.86 Soles on average. We built an indicator of recycler's monthly per capita productivity in the district of La Victoria by the amount S / .986.05 Soles at market prices.

The economic value of the average recycling activity in the district of La Victoria, estimated at S /. 7,937,566 Soles, can currently finance up to 72.72 percent of the recycler's monthly disposition to accept recycling glass, paper, plastic and cardboard in 2013 in the La Victoria district, at 2016 prices. The WTA fixed at a monthly salary of S/. 1,355.86 Soles can finance up to 488 eco-efficient recyclers. Given that the district of La Victoria currently has an estimated population of 169,239 inhabitants, each eco-efficient recycler could meet 347 inhabitants' needs for waste management. Under a future scenario of eco-efficient recycling, 100% of workforce could be financed by the value obtained from municipal solid waste in the district of La Victoria.

In addition to the willingness to pay method, the present work focused on the WTA can serve as a complementary reference for local governments, NGOs and recycling enterprises to maximizing the use of recyclable materials, improving the working conditions of recyclers, generating formal employment and achieving sustainable development goal self-financing recycling.

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