Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Improvements in Urban Solid Waste Management: An Economic Valuation Analysis Using Choice Experiments in the City of Sullana, Piura

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ARTICLE INFO

Received: 24 Dec 2024

Revised: 12 Feb 2025

Accepted: 26 Feb 2025

ABSTRACT

The increase in the generation of solid waste in the city of Sullana represents a latent problem due to inadequate waste management, a situation that tends to worsen due to population growth, accelerated urbanisation, increased production and changes in consumption patterns, generating negative impacts on the environment and public health. The objective of the study was to assess citizen perception of current solid waste management, identify preferences for attributes proposed as policy alternatives for improvement, and estimate the willingness to pay (WTP) for such improvements through different intervention options. For this purpose, descriptive statistics and the method of economic valuation by choice experiments were employed, using discrete choice models, specifically the conditional logit and mixed logit models, estimated by maximum likelihood. A structured survey was applied to a random sample, resulting in 383 users in the urban area. The results show that the population of Sullana is aware of the solid waste problem, has a positive attitude and is willing to pay for improvement policies. Among the options evaluated, the attributes of waste minimisation and segregation at source, as well as incentives for neighbours to participate in selective collection programmes, are the ones that generate the greatest social benefits. It is concluded that users perceive an increase in their well-being when moving from a current poor situation to improved waste management.

Keywords: Social welfare, willingness to pay, choice experiments, solid waste, compensated variation.

INTRODUCTION

Municipal solid waste (MSW) management remains a major challenge in urban areas in many cities around the world, especially in rapidly growing cities, often developing countries (Foo, 1997). Rapid population growth and rising per capita incomes have resulted in the generation of large quantities of solid waste, posing a serious threat to health and the environment (Snigdha & Prasenjit, 2003).

Keeping pace with the demands of rapid economic development and population growth should be a priority and challenge for cities in developing countries, by the authorities in charge, because of their fundamental role in protecting the environment and public health by achieving effective and efficient MSW management (Marchand, 1998). Comprehensive MSW management means managing MSW properly throughout the entire process, from its generation to its safe disposal, using technologies appropriate to the reality of each place and without compromising the environment (R. Gonzales et al., 2016).

From an economic perspective, optimal solid waste management systems would be those that ensure that a society derives the maximum net benefit from the disposal of its waste (Garrod & Willis, 1998). But, because MSW collection

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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and disposal services often have low or no prices, it is difficult to infer their economic benefits from ordinary market prices (Anaman & Rasshidah, 2000).

There are ways to manage MSW management through public policies, with regulations governing generation, as well as economic incentives, taxes or subsidies, with the aim of reducing MSW generation (Miranda & Aldy, 1998), these should be socially efficient and should consider all the benefits and costs of these measures, not neglecting the environmental impact (Kinnaman, 2017).

The environment is the recipient of MSW, and when it is not managed properly, it causes negative externalities to the environment, generating external costs, such as bad odours, gases, leachates, diseases, and alterations to the ecosystem and landscape. These negatively affect the population and can be quantified through an economic value, whose value is useful as an indicator for decision-making in the analysis of alternative MSW management policies (León, 2016).

The MSW problem is present in most cities and small towns due to inadequate management and tends to worsen in certain regions due to multiple factors, such as rapid population growth and its concentration in urban areas, industrial development, changing consumption habits, the widespread use of containers, packaging and disposable materials, which significantly increase the quantity (Jaramillo, 2002).

In 2023, 8,706,237.3 t/year were produced annually, equivalent to 23,853 t/day. Lima is the department that produces the highest amount of urban solid waste at the national level, with 10,380.96 t/day. Furthermore, there are 2,899 ha. of degraded areas affected by solid waste (landfills) at the national level. In 2023, there were 91 sanitary landfills and 6 transitory cells for the adequate final disposal of solid waste, which allows for 61.04 % of the national waste generation (Ministry of Environment [MINAM], 2024).

Although there has been an improvement in the proper disposal of municipal solid waste in Peru, significant challenges remain. The existence of a high number of landfills and the need to expand the infrastructure for final disposal and recovery are critical aspects that require attention in order to move towards an integrated and sustainable management of solid waste in the country (Gestión, 2023).

It is important to note that per capita waste generation can vary significantly by region and local context. However, the average daily per capita generation of MSW from households was 0.53 kg/inhab/day at the national level (MINAM, 2017). In the city of Sullana it is 0.602 kg/inhab/day higher than the national average, and the total generation of household and non-household waste is 124.15 t/day, of which only 76.15% is collected by the municipality, with critical areas existing due to the large accumulation of MSW (Municipalidad Provincial de Sullana [MPS], 2013).

In Sullana, MSW accumulates in streets, markets and institutions without being collected for several days. This situation is aggravated by the bad habits and customs of some citizens, who deposit waste on public streets due to the lack of adequate infrastructure for its storage. As a consequence, public health is seriously threatened by the effects of environmental pollution.

The research proposes improvements in MSW management based on the preferences expressed by users, using the method of Economic Valuation through Choice Experiments (EE). This method or approach is based on microeconomic consumer theory and assumes that individuals choose among different alternatives the one that maximises their utility, benefit or satisfaction (Lancaster, 1966).

In choice experiments, service improvements are represented by a set of relevant attributes or options (e.g. minimisation and segregation at source, separate collection, user incentive, adequate treatment, etc.), each with different possible levels. Users are presented with hypothetical scenarios with alternative combinations of these attributes, including an associated cost, and are asked to choose the preferred option in each case.

Repeating these choices allows to infer, through econometric modelling, the relative importance of each attribute and to estimate users' willingness to pay (WTP) for the proposed improvements to establish benefits (Jianjun et al., 2005). This information is useful for guiding public policies and investment decisions based on social priorities and the perceived well-being of the population.

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According to McFadden (1974), random utility theory serves as a link between the EE method and microeconomics theories such as consumer decisions. Often applied in the valuation of changes in environmental attributes (Haab & McConnell, 2003), it is currently used in various academic fields (Lim et al., 2014).

The importance of the study lies in the fact that the research variables are current issues, it is a current problem and they are related to the correct management of waste, improvement of the city's appearance and people's health. A strong use of economic and econometric theory, methodology and its organisation is evident.

Given the above context, the objectives are: i) to evaluate the perception of the population of Sullana with respect to current MSW management and to identify preferences for the attributes proposed as policy options with respect to MSW management, ii) to determine the willingness to pay (WTP) for the improvement in MSW management, through the different intervention options, attributes, and iii) to determine the willingness to pay (WTP) for the improvement in MSW management, through the different intervention options, attributes.

LITERATURE REVIEW

The works consulted use the ES methods, each of which seeks to identify user preferences according to the attributes proposed to improve MSW management and optimise the well-being of the user population. It is important to point out that, due to the specific characteristics of each area of study, different attributes are proposed, but all of them lead to sustainable solid waste management.

Related research is by Bikash & Ichihashi (2022) who propose improvements in MSW management in Kathmandu, Nepal. Then Huynh et al. (2023) determines WTP to improve MSW management for households in Vietnam. Also, Chu et al. (2022) proposes attributes according to public preferences in Harbin, China. Also, Sharma & Jain (2020) discusses the improvement of MSW management system for India. Also, Ko et al. (2020) assesses the economic value of a sustainable MSW management and recycling policy in South Korea. Rai et al. (2019) estimate an MSW collection fee in Ilam Municipality, Nepal. In addition, Chen (2019) determines the WTP for MSW disposal in Taiwan. Rai, Nepal, et al. (2019) analyses residents' preferences according to the stated attributes in Bharatpur, Nepal.

Similarly, Farreras & Lauro (2016) estimate the value to the inhabitants of Mendoza of the effect of landfilling MSW on water quality, air and vector proliferation. Delgado (2016) estimated the social benefits that alternative MSW management policies could generate in Guaymallén, Argentina. Also, León (2016) estimated the social benefits of reducing the environmental effects caused by landfills in the city of Las Palmas, Spain. Lim et al. (2014) assesses the external benefits of MSW-to-energy conversion in Seoul. Similarly, Pek & Jamal (2011) determine citizens' preferences and identify a suitable strategy to improve MSW management in Malaysia.

Similarly, Ku et al. (2009) assesses the MSW disposal system in Korea. Similarly, Basset et al. (2009) economically evaluate the improvements of MSW collection service in Talca, Chile. Also, Karousakis & Birol (2008) identify attributes to improve MSW management in urban London. Thus, Sakata (2007) conducts a study for Kagoshima, Japan, users choose the components of the MSW management system. Furthermore, Jin et al. (2006) analyses the preferences of residents in the Macao region of China for changes in MSW management policies.

At the national level, Colquehuanca et al. (2020) economically assesses MSW management for Tambopata - Madre de Dios, with the aim of implementing policies for good MSW management. Diaz (2012) conducts a study for La Rinconada in Puno, estimating the benefits of an improvement in the MSW collection process. Quilla (2017) economically evaluates a set of strategies for the improvement of MSW management in Huancane, Puno. Figueroa (2018) assesses the current MSW management in Independencia, Huaraz. Finally, Castillo & Paredes (2020) estimate the total economic value of the environmental impacts generated by inadequate MSW management in Santiago de Chuco, Trujillo.

OBJECTIVES

The purpose of the research was to understand how citizens of the city of Sullana perceived municipal solid waste management in a context marked by growing waste accumulation and deficiencies in collection and treatment. The aim was not only to highlight this environmental and public health problem, but also to propose alternatives based on the population's own preferences and willingness to contribute to sustainable solutions.

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https://www.jisem-journal.com/

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In this regard, the study was developed based on three specific objectives. First, the residents' perceptions of the current solid waste management were assessed, considering aspects such as service efficiency, existing infrastructure, and visible environmental consequences. Second, citizens' preferences were identified in relation to certain attributes for improvement, such as minimising and segregating waste in the home, establishing incentives to encourage neighbourhood participation, and the possibility of involving private companies to optimise selective collection. Finally, the willingness to pay (WTP) of users for implementing these improvements was determined using a methodology based on choice experiments that allowed the value that people assigned to each alternative to be quantified in economic terms.

Overall, this research showed that citizens were not only aware of the problem but also had a positive attitude and were committed to change, recognising the importance of moving towards more efficient, participatory and environmentally responsible waste management.

METHODS

Regarding the scope or place of study, the research was carried out in the urban area of the district of Sullana, which is located in the region of Piura on the northern coast of Peru, at latitude 04°53'18‘ south and longitude 80°41'07’ west, at an altitude of 60 metres above sea level, on the left bank of the Chira River.

The present research is quantitative, since it analyses structured numerical data; applied, since it seeks to solve a practical problem of urban solid waste management; and non-experimental, cross-sectional design, at a correlational-explanatory level, since data were collected at a single point in time to identify causal relationships between variables. Likewise, the hypothetico-deductive method was adopted, which, according to (Mendoza, 2022), allows the formulation of hypotheses based on previous theory, predicting observable phenomena and contrasting them empirically through data.

The study population consisted of the inhabitants of the urban area of the city of Sullana, who, as direct users of the MSW management service, provided information on their perceptions, preferences and willingness to pay for improvements in the service. According to the 2017 Population and Housing Census, the district of Sullana had 311,454 inhabitants, of which 208,782 reside in the urban area. The sample was selected through simple random sampling (Hernández et al., 2014), obtaining a total of 383 respondents, in accordance with the sample size estimated to maintain adequate levels of confidence and error. Data collection was carried out by means of a survey technique, using a structured questionnaire as an instrument that collected information on socioeconomic variables, perception of the service and preferences for different management alternatives during the year 2023.

The economic valuation was carried out using an experimental design, based on discrete choice experiments (Choice Experiments), using structured surveys applied to household users in the urban area of Sullana. To model preferences, discrete choice models were estimated, specifically the conditional logit and mixed logit models, using the maximum likelihood method.

The experimental design applied in the ES constitutes a scientific approach that allows observing how the choice of individuals, considered as the response variable, varies in the face of controlled changes in the levels of various attributes that characterise the evaluated service (Tudela & Leos, 2017).

The logic of the method of choice experiments is that respondents are faced with a set of alternatives, which are based on utility comparisons between each available alternative of the choice set L, so they choose or select the alternative that provides them with the greatest utility or satisfaction. The utility function of each alternative is represented as:

$$U_i = V(Z_{ij}, S_i, m_i) + \varepsilon_{ij} \quad [1]$$

Where U_i is the overall utility, V is the indirect utility, is specified as a function of the levels taken by the attributes Z_{ij}, the socio-economic characteristics of the respondents S_i and the income level m_i. The term ε_{ij} is a stochastic component, representing unobserved attributes that affect choices. If individual i chooses alternative w from any of

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e-ISSN: 2468-4376
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j options given the choice basket L, the utility of this alternative is greater than that obtained by choosing another alternative from the same set.

Regarding the variables used in the research, information was collected on: i) Socio-economic characteristics, ii) User perception of MSW management, the way it is currently managed, and the ways in which it can be improved, proposing attributes, iii) Aspects to economically value and estimate the WTP for the improvement of waste management according to proposals. The proposed attributes are: a) Minimisation, segregation and recycling of MSW at source, b) Selective collection and service provider, c) Incentives for citizen participation.

These attributes have different levels: poor is the current situation (status quo), i.e. without any change; good is the situation of improvement, innovation or intervention, i.e. when the attributes are implemented by means of a project or programme. Haab & McConnell (2003) recommend introducing a monetary attribute, in order to restrict the choice of alternatives, thereby requiring a monetary consideration from the user. The levels of the economic attribute (cost) are determined through the pilot survey, identifying the maximum and minimum price for the proposed service (Table 1).

Table 1. Summary of attributes and levels to be used for the EE method

Attributes (alternatives)	Description	Levels
Minimisation, segregation and recycling of MSW at source (Minimisation)	- Reduction of the daily generation of waste and indiscriminate use of articles made of polyethylene, technopor and plastic. - Source segregation programme as part of the services provided by the municipality. - Implement intra-household storage devices (delivery of bins). - Recycling practices and communication and awareness-raising activities to motivate, educate and involve the population.	- **Deficient (Current situation - Status quo)** - **Good** (Improved - innovated)
Private service provider for selective collection (Collection)	- It is proposed to the private company, they have qualified personnel, technology, experience, monitoring, authorised waste storage centre, responsibility and know the penalties for non-compliance. - Selective collection, which involves operation, follow-up and monitoring. - Cleaning of public spaces (roads, pavements, squares, parks).	- **Deficient** (Current situation - Status quo) - **Good** (Improved – innovated)
Incentives for neighbours participating in the segregation programme. (Incentives)	- Application of incentives for residents who participate in the segregation and recycling programme, such as: discount on the payment of the public cleaning tax, comprehensive cleaning campaign, health campaigns, delivery of cleaning modules, delivery of products made from recycled material.	- **Deficient** (Current situation - Status quo) - **Good** (Improved - innovated)
Price or Cost	Proposed additional price for each of the proposed attributes.	- S/. 1.00 - S/. 3.00 - S/. 5.00 - S/. 7.00

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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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Source: Based on the diagnosis and Calatayud (2014).

Statistical analysis for survey design

Fractional factor analysis was used to design the combination of selection alternatives in order to minimise the relationship between attributes (Bennett, 1999). For a good execution of the factor analysis, the orthogonal design was used, which consists of constructing a set of hypothetical alternatives ensuring that the attributes presented to the respondents vary independently of each other (Colquehuanca et al., 2020).

The set of alternatives was constructed by combining two levels for each of the three attributes linked to the four prices (2x2x2x4), resulting in 32 choice cards showing different options for the new MSW management plan, thereby capturing the stated preferences of the population. However, conducting the survey with 32 cards or alternatives is impractical. Therefore, we opted for a minimum of nine combinations. The minimum requested is at the discretion of the researcher, which has to do with the number of choice cards presented to each respondent (Tudela & Leos, 2017).

These optimal scenarios are orthogonal (i.e., there is no correlation between levels and attributes) and balanced (each level appears in the attribute the same number of times). SPSS software and Microsoft Excel 2021 were used to design the cards and perform the factor analysis with orthogonal sketching for data processing.

Econometric design for estimating willingness to pay - WTP

To estimate WTP for MSW management improvements according to the proposed attributes, discrete choice, conditional logit and mixed logit models were used, using the survey-derived data. In both models, an elementary specification is made to show the importance of choice attributes in explaining respondents' preferences for different MSW management programme or project options.

Assuming that the error terms have a type I, independent and identically distributed extreme value distribution - iid (McFadden, 1974). The probability of choosing the alternative from the set of options L, by individual i, is given by:

$$\Pr\left(iw|L\right)=\frac{e^{\left[\beta_1 Precio+\beta_2 Minim+\beta_3 Recol+\beta_4 Incent\right]}}{e^{\left(\beta_1 Precio\right)}+e^{\left(\beta_2 Minim\right)}+e^{\left(\beta_3 Recol\right)}+e^{\left(\beta_4 Incent\right)}} \quad [2]$$

Equation [2] is the description of the conditional logit model, the estimation of the parameters is performed using the maximum likelihood methodology. The mixed logit model has the following specification:

$$\Pr\left(iw|L\right)=\int\frac{e^{\left[\beta_1 Precio+\beta_2 Minim+\beta_3 Recol+\beta_4 Incent\right]}}{e^{\left(\beta_1 Precio\right)}+e^{\left(\beta_2 Minim\right)}+e^{\left(\beta_3 Recol\right)}+e^{\left(\beta_4 Incent\right)}}f\left(\beta/\theta\right)d\beta \quad [3]$$

The term $f(\beta/\theta)$ is the normal distribution function of β and θ is the parameter of the normal distribution.

The variables used to estimate Willingness to Pay (WTP) in both models, along with their main characteristics and expected signs, are presented in Table 2. These variables are derived from the attributes identified in Table 1, which represent the characteristics of the alternatives that respondents were asked to choose in the experiment. In specific terms, these attributes correspond to waste minimisation, the collection system, the incentives offered and the price or cost associated with each alternative.

Table 2. Variables used to estimate WTP

Variable	Description	Expected Sign
Minimisation	MSW minimisation and source segregation project or programme.	+
Collection	Private service provider, for selective collection.	+

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e-ISSN: 2468-4376
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Incentives	Incentives to users or citizens for participating in segregation and recycling programmes.	+
Price or Cost	Additional payment for improvement in different attributes (willingness to pay).	–
Election	A set of policy alternatives or options set out in plans or programmes.	

Note. Based on Jianjun et al. (2005) and Sakata (2007).

For the choice of the best model, economic and econometric criteria are followed: a) that the coefficients of the variables have the expected signs, i.e. that they reflect a logical relationship with the dependent variable of choice, b) that the coefficients of the independent variables are significant at an acceptable level of reliability of 0.05, c) that the statistics: Percentage of prediction, Log likelihood, Chi-square (Likelihood ratio), Wald test are consistent and have a good fit according to the data. The analysis of the information and estimations was carried out with the support of Stata software.

RESULTS

Perception of users regarding solid waste management

Regarding the socio-economic characteristics of those interviewed, the age of the individuals fluctuates between 20 and 67 years, the majority of those interviewed have completed university (37.19%), then incomplete university (19.01%) and to a lesser extent incomplete primary school (1.65%). The average monthly income amounts to S/. 1641.09 soles. A large number of respondents (10.44%) have an income of S/. 2500.00 soles per month. The majority of the respondents are women (59%) compared to men (41%).

According to the results, it is evident that there is a gap between traditional waste management methods and waste management with sustainable attributes. Of the 383 respondents, the majority, 230 (60%), were unaware of the existence of any investment projects for the improvement and expansion of MSW management. 264 (69%) respondents indicated that MSW collection by the municipality is inefficient, furthermore, 203 (53%) indicated that the municipality does not have sustainable methods of disposal, 176 (46%) individuals stated that the municipality does not provide for MSW collection, 280 (73%) stated that the municipality does not have adequate technology, 283 (74%) revealed that MSW pollutes the environment, and 192 (50%) indicated that there is the presence of bad odours due to its accumulation and that there should be an adequate management and final disposal of MSW to guarantee human health and the environment.

Importance of implementing the attributes for proper MSW management

Of the 383 respondents, the majority consider the implementation of the attributes, through projects or programmes, to be important to very important. According to the order of preference, 268 (70%) users prefer the implementation of an MSW minimisation, segregation and recycling programme at source. Next, 260 (68%) respondents prefer the implementation of incentives for neighbours who participate in the segregation programme. Finally, 241 (63%) prefer the implementation of a separate collection programme involving operation, follow-up and monitoring.

Estimation of the conditional logit and mixed logit models

In Table 3, the estimates of the conditional logit and mixed logit models are shown. These results will serve as input to estimate the WTP. The coefficients of all variables (i.e. attributes) of both models have the expected signs and are consistent with a priori expectations. Moreover, the coefficients of the attributes of the choice sets are significant at the 1% level.

In this type of probabilistic models, only the sign of the coefficient is interpreted, but not the magnitude. The signs of the coefficients associated with the attributes (Minimisation, Collection, Incentives) indicate that the higher the level of the coefficients, the higher the users' welfare, and the higher the level of the Price coefficient, the lower the welfare.

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e-ISSN: 2468-4376
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A positive sign suggests that, as the value of the attribute increases, the probability of choosing that alternative increases, a negative sign is the opposite. On the other hand, an increase in the prices of the attribute causes the probability of choosing that alternative to decrease. That is, the higher the price, the lower the disposable income available to compare higher levels of attributes offered in the other alternatives, hence the lower the indirect utility.

In the mixed logit model, the interpretation of the coefficients on the standard deviation of a regressor indicates that there is heterogeneity among individuals with respect to the effect of the independent variable on the alternative chosen.

Table 3. Estimation of the conditional logit and mixed logit models

Variable	Coefficients	
	Conditional Logit	Mixed Logit
Price / Cost	-0.269 (0.024)***	-0.271 (0.025)***
Minimisation	0.713 (0.046)***	0.716 (0.049)***
Collection	0.455 (0.051)***	0.455 (0.052)***
Incentives	0.709 (0.050)***	0.712 (0.052)***
Standard Deviation		
Minimisation	-	0.035 (0.148)*
Collection	-	-0.081 (0.240)*
Incentives	-	0.001 (-0.051)
Percentage of prediction	64.68%	64.68%
Log-likelihood	-1511.15	-1511.11
Chi-square [Likelihood ratio].	343.84***	0.088*
Wald test	290.68***	287.52***
Number of Observations	4596	4596

Note. Values in parentheses are standard errors.

Z-statistics: *** significance al 1%, ** al 5% y * al 10%.

In both cases the models are adequate, but the best fit is the conditional logit model, since it is globally significant at 1%, as shown by the chi-square statistic or Likelihood Ratio. The higher the value of the log likelihood, the better the fit of the model to the observed data (Sasao, 2004).

Also, the Wald statistic allows us to compare the fit of different models. The higher the value of the statistic, the better the model fit (Christie et al., 2006). As shown in Table 3, the conditional logit model has a higher value of the Wald statistic. So, the model is useful to represent the relationship. Therefore, the conditional logit model is considered the superior model, or the model of choice, which will be used to estimate the marginal WTPs.

The coefficients are estimated using the maximum likelihood method. The values of the coefficients of the likelihood model represent the marginal utility of the attribute levels (Lucich & Gonzales, 2015). From the results of the conditional logit model, the marginal WTP of each attribute in the choice sets of the ES model is determined by dividing the coefficient of a given attribute by the price or cost coefficient (Boxall et al., 1996; Morrison et al., 1999).

Estimating the willingness to pay - WTP for MSW management improvements

Table 4 shows the marginal WTP results for each attribute. The WTP values for the attributes Minimisation (minimisation, segregation and recycling of waste at source) and Incentives (incentives for participating in segregation) are quite similar. An implicit ranking of attributes in terms of importance for the sample can also be derived. The marginal WTP of Collection (selective waste collection) is the lowest ranked attribute. The percentages show how important these three attributes are to users.

The average WTP for the new MSW management programme derived from the ES method using the conditional logit model (best model) is S/. 6.95 soles (1.85 US$) per person per month, assuming a linear and additively separable

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e-ISSN: 2468-4376
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indirect utility function. For each attribute the average WTP is S/. 2.64 soles (0.68 US$) for the Minimisation attribute, S/. 2.63 soles (0.68 US$) for the Incentives attribute, and S/. 1.68 (0.43 US$) for the Collection attribute.

The results suggest that the population of Sullana would be willing to pay a certain amount of money to improve waste management in the city and thus improve the quality of life through a change in their well-being/utility. The results reflect the importance of the attributes and can be used by decision-makers for policy implementation.

Table 4. Marginal WTP for each attribute in the choice sets

Attributes	Formula	Marginal WTP (S/.)	Percentage (%)	CI[a]
Minimisation, segregation and recycling of MSW at source.	$-\frac{\beta_{Minim}}{\beta_{Precio}}$	2.64	37.99	2.38 – 2.90
Private service provider for selective collection.	$-\frac{\beta_{Recol}}{\beta_{Precio}}$	1.68	24.17	1.45 – 1.92
Incentives for neighbours participating in the segregation programme.	$-\frac{\beta_{Incent}}{\beta_{Precio}}$	2.63	37.84	2.37 – 2.89
Total		6.95	100.00	6.20 – 7.71

Note: [a]95% Confidence Intervals

The most preferred attribute is Minimisation, segregation and recycling at source, followed by Incentives to neighbours to participate in such programmes. The attribute Collection generates less change in well-being, which may be due to the fact that the user population does not agree with the participation of private companies due to the high costs that would be incurred for waste management, they prefer the municipality to continue with this work.

DISCUSSION

Regarding the results of citizen perception on aspects related to the effectiveness, capacity and potential of MSW management, there are limitations and gaps between traditional and sustainable methods (Colquehuanca et al., 2020). These results are social indicators that must be overcome through the implementation of public policies with investment projects or programmes (Gonzales, 2010).

The implementation of the attributes for the adequate management of MSW were designed according to the reality of Sullana and through a pilot survey, the results are in accordance with what is stated by (Hernandez, 2018), that the attributes or policy options should be with a sustainable vision, consistent with the demand for the service and social, economic and environmental benefits.

The results in Table 3 are in line with Katchova (2013), that an increase in the price of an alternative decreases the probability of choosing that alternative and increases the probability of choosing other alternatives. Furthermore, to the findings of Colquehuanca et al. (2020), where they express that the results of their research show that, in a series of options of different choice alternatives, the selected attributes are explanatory for a scenario of improvement of integrated solid waste management and disposal.

The marginal WTP in Table 4, amounts to S/. 84.00 soles per year (6.95*12), these results are consistent with the values found by Colquehuanca et al. (2020), who estimate a WTP of S/. 120.00 soles per year, as the positive attitude of the population of Madre de Dios to accept behavioural change programmes for sustainable waste management is evident. Also, with the findings of Castillo & Paredes (2020), that the population is willing to pay the amount of S/. 7.20 soles per month for the proper management of MSW.

Furthermore, the results are in line with the findings of Farreras & Lauro (2016), who estimate a marginal WTP of US$ 20.48 per year, which at the exchange rate of S/3.85 soles translates into S/. 78.85 soles per year. Similarly, they are similar to the results of Jin et al. (2006), who estimates a marginal WTP of US$ 2.10 per month. It is important to note that due to the specific characteristics of each study area, different attributes are proposed, but all are conducive to sustainable solid waste management.

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CONCLUSIONS

The first conclusion is that all users showed a positive attitude towards the improvement plans, related to the current waste situation or status, and are aware of the current management and its impact on human health and the environment. Most of the users considered the implementation of the proposed attributes (alternative policies) as important to very important, such as implementing waste minimisation, segregation and recycling programmes at source, selective collection programmes involving operation, monitoring and surveillance through private companies, and implementation of incentives for neighbours who participate in segregation and recycling programmes.

The second conclusion is that by applying the method of choice experiments with the conditional logit model, it is determined that users are willing to pay an average of S/. 6.95 soles (US$ 1.85) per person per month for the implementation of the new programme to improve solid waste management. According to the order of preferences, the average willingness to pay for each proposed attribute is S/. 2.64 soles (0.68 US$) for the attribute of waste minimisation and segregation at source, S/. 2.63 soles (0.68 US$) for the attribute of incentives to participate in segregation, and S/. 1.68 (0.43 US$) for the attribute of selective waste collection.

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