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Environmental Economic Valuation by the Improvement in the Management of Household Solid Waste in the City of Huancané, Puno – Peru

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ABSTRACT

The objective of the research was to estimate the willingness to pay for an improvement in the management of household solid waste in the city of Huancané, Puno – Peru. For which the most significant social, economic and environmental determinants were established to obtain the willingness to pay through a survey with referendum questions and double limits applied to 288 households; Likewise, the contingent valuation method (CVM) and the referendum econometric models (probit, logit and cloglog) and double limit were considered. It was established that 35.76% of households are not willing to pay, compared to 64.24% who indicated that they are willing to pay an average of S / 3.91 soles per month for an improvement in the management of household solid waste; The factors that directly influenced this decision were the level of education, income, perception of pollution generated by the waste and indirectly the hypothetical price and the level of satisfaction with the household solid waste management service. The benefits generated by the willingness to pay amounted to S / 4,480.86 soles.

Keywords
Willingnessto pay, contingent valuation method, referendum model, double limit model, household waste.

Introduction

Solid waste is defined as those substances, products or by-products in a solid or semi-solid state available to their generator, or is obliged to dispose of, in accordance with national regulations or the risks they cause to health and the environment to be managed through a system that includes, as appropriate, the following operations or processes: waste minimisation, segregation at source, reuse, storage, collection, marketing, transport, treatment, transfer, final disposal (Agunwamba et al., 1998; Alcántara Román et al., 2018). Waste is waste or leftover from human activities. It is classified into gases, liquids and solids; and because of their origin, in organic and inorganic (Agunwamba et al., 1998; Karak et al., 2012; Mahfuzur et al., 2017; Moy et al., 2008). In recent years, the nations of the industrialized world have quadrupled their domestic waste production, increasing this figure by two or three percent per year. In this sense, it is known that the environmental effects by inadequate management of solid waste, this due to the lack of collection

systems and adequate final disposal of solid waste, where from it there are a number of negative impacts to the environment (Henry et al., 2005; Jiménez Guethón et al., 2020).

Solid waste has become a constant problem of daily life, in any urban area there are problems with these wastes that are increasing further in recent years due to rapid exponential growth, industrial development, consumption and abundance of single-use products (Ojeda et al., 2008; Quispe et al., 2020; Sauad et al., 2005; Vesco, 2006). This greatly harms the public health of the population, as it generates infectious pockets of various diseases, in addition to soil pollution and social conflicts in the municipality of the area and civil society that arises when the accumulation of solid waste is given open air by the odors that in turn attract vectors of diseases (Quilla, 2017).

In Latin America, most countries have focused only on final collection and disposition, without taking into account other activities or processes that can complement them for the reduction of them, causing the land to (Sáez & Urdaneta, 2014), that could profitably be used as a factor of production, is totally devalued and unusable in addition to becoming a potential risk for citizens living near landfills and waste accumulation, which pollute soil resource and water resources by polluting rainwater and surface water in the filtration process (Henry et al., 2005; Karak et al., 2013; Mamani et al., 2021; Zulia et al., 2006).

In 2018, 2,010 million tons of municipal waste were generated worldwide, 0.74 kilos inhabitant/day. If this dynamic continues, by 2050 we will generate 3.4 billion tons of solid waste. As a result, the environment pays a high price, this body says. This is the main fact of a report recently published by the World Bank. As a result, the environment pays a high price, says this body (Biggar, 2005; Ejaz et al., 2010; Jebe, 2020; Kumar et al., 2004).

A World Bank report states that solid waste globally will grow by 70% by 2050, if urgent action is taken, waste will grow globally at current levels, and generations of waste globally are expected to grow over the next 30 years, driven by rapid urbanization and population growth, will increase from 2010 million tonnes recorded in 2016 to 3.4 billion tonnes. Since 2000, the World Bank has committed more than $4.7 billion to more than 340 solid waste management programs in countries around the world (Johari et al., 2012; Ogbonna et al., 2007; Yom Din & Cohen, 2012).

In Peru, there are deficiencies with respect to the management of solid waste and therefore that pollution of air, water, soil has become out of control. The average solid waste generation (RS) is 0.711kg/person/per day then you have a total of 23,000 tons generated per day nationally. Of that total, 66% of controlled landfills are available, but 34% are not adequately disposed of, i.e. 8,000 tonnes per day that are a serious problem for society (Christopher et al., 2008; Fuentes et al., 2008; Gómez, 2015; Huacani & Mamani, 2017; Rojas, 2012).

In recent years there has been an increase in the generation of solid waste involving the whole society as a whole, for example, the consumption and production of disposable products by citizens, municipal mismanagement, trade and educational institutions, all of them are part of the solution, since they all share responsibility (Huayhua, 2015; Ojeda et al., 2008; Sauad et al., 2005; Vesco, 2006). Per capita generation of solid household waste by department. For the department of Puno corresponds to 0.45 kg/day (Huamaní et al., 2020).

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The Contraloria detected that most municipalities have been leaving trash in unauthorized places, affecting people's health and polluting the environment. Only 118 Municipalities dispose of waste in a landfill. This results in the creation of infectious floodlights that expose the health of people living and transiting around, proliferating pests and polluting the environment. The supervisory body also identified that 75% of municipalities do not have a route plan for garbage collection and others are not articulated with their solid waste management plans, this leads to inefficiency and inefficiency in the cleaning service and use of public resources and finally, it was identified that 31% municipalities do not deliver safety equipment to waste collectors. Thus, the health of these endangered, exposed to infections and accidents at work (Chambilla, 2015; Gutierrez, 2020; Huacani, 2019; Rojas, 2012).

In the city of Huancané sweeping coverage as well as transport of solid waste are inadequate, insufficient, and there are also problems of defective location of the "botadero" that can adversely impact the environment and quality of life of the population. The management and final disposal of solid waste is not carried out properly due to technical knowledge, disinterest or lack of resources that they encounter to improve solid waste management (Mamani Apaza, 2014).

In the face of all of the above, the necessary funding would be key to improving the current management of solid household waste, which means knowing the amount that the population would pay to carry it out, so it seeks to answer the following research questions; What is the willingness to pay for an improvement in the management of solid household waste in the city of Huancané?, What are the socioeconomic factors that influence the willingness to pay for an improvement in the management of solid household waste in the city of Huancané?, What are the economic benefits generated with the implementation of the willingness to pay for an improvement in the management of solid household waste in the city of Huancané?.

The objective of the research was to estimate the willingness to pay for an improvement in the management of solid household waste in the city of Huancané, in addition to determining the socio-economic factors that influence the willingness to pay for an improvement in the management of solid household waste in the city of Huancané and estimating the economic benefits generated by the implementation of the willingness to pay for an improvement in the management of solid waste domiciles in the city of Huancané. It should be clear that poor management of solid waste will have a negative impact on the quality of life of the inhabitants living around the rubbish, affect the soil and water resource of that area, generating various diseases and perhaps negatively influence the production process of their activities, in the end causing a poor quality of life of people (Ejaz et al., 2010; Karak et al., 2013; Kurniawan et al., 2006; Mamani et al., 2021; Ofori-Boateng et al., 2013; Quispe-Mamani et al., 2021).

Method

The contingent valuation method (MVC) for estimating the willingness to pay (DAP) of families for an improvement in the management of urban solid waste in the city of Huancané, the same one that consists in figuring out changes in the well-being of individuals in the face of hypothetical (contingent) changes in an environmental good or service; seeks to simulate through surveys and hypothetical scenarios a market for a good or set of goods for which there is no market (Azqueta, 2013; Malte & Cazares, 2017).

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The model of contingent valuation is essentially probabilistic. This is because instead of figuring out how much was paid for a particular good, as you would if you were thinking of estimating a conventional demand function, you wonder if you are willing to buy the good or not, and at what price. Consequently, in this case a probability model should be used for parameter estimation. The contingent valuation method uses as a data collection tool the questionnaire that will be applied virtually and will be structured in three parts: socio-economic of the interviewee, environment and availability to be paid (Azqueta, 2013).

Methodology

In this research the methodological design applied is descriptive and correlation (Hernández et al., 2014), since data will be analyzed using an econometric model; where the Logit-Probit regression estimation method will be used.

It is descriptive in that it analyses the willingness to pay by the population of Huancané, also because the research aims to specify the properties of a given population, in relation to a particular phenomenon that is subject to descriptive studies, therefore, will independently measure the concepts and variables of relevance for the fulfilment of the objectives of the research (Hernández et al., 2014).

It is of a correlal type because it determines the relationships between the variables, independent with the dependent variable that is the willingness to pay by the inhabitant of the city of Huancané(Hernández et al., 2014).

Data Analysis

The materials used for the development of this research work are surveys aimed at people based in the city of Huancané and using the statistical program of STATA 16 and SPSS statistics 25.

The data collected for this work comes from primary information through surveys and forms, which are the most applied in an investigation. The survey has been applied to a large number of people, in which a pre-designed form was used, through questions that allow to research the social and economic characteristics that allow to know the willingness to pay for the improvement in the management of solid household waste in the city of Huancané. In addition, the characteristics, opinions, customs, habits, tastes, knowledge, occupational situation, etc., of a group of people.

Population and Sample

The urban population of the city of Huancané according to the National Statistical Institute in 2017 registers a population of 1088 people and in the 2007 census records a population of 927 people, considering an annual growth rate of 1.74% with which the corresponding projections were made for the year 2020 whose results are:

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Table 1. Urban Population Projection (Heads of Families)

Year	Population
2017	1088
2018	1107
2019	1126
2020	1146

Source: Own elaboration in INEI database

As detailed in the table above, the population considered for the study is 1146 inhabitants who are heads of family in the city of Huancané. The sample is random probabilistic type stratified. The sample estimate had a maximum error of (5%) and a 95% confidence level. Applying the following formula got the sample size:

$$n = \frac{N * Z^2 * P * q}{E^2 * N + Z^2 * P * q}$$

Where, n is the sample size, Z is the value of the nominal curve (Confidence level: 95%), P is the probability of success: (0.5), q is the probability of failure: (0.5), N is the population: (1146) and E is the sampling error 5%: (0.05). Replacing this formula, it was determined that the number of surveys to be applied was 288.

Variable analysis

The variables were structured in three parts: socioeconomic: age, educational level, gender, monthly household income, municipal management, head of household and family size; of the part of the environment will be, perception of pollution generated by waste and level of satisfaction by management service solid household waste. Finally, the quota valuation variables: availability payable in soles (hypothetical price).

Table 2. Model variables

Variables	Notation	Concept	Characteristic	Unit of measurement
Dependent variable				
Probability of availability to pay	PROBDAP	Referendum format 1 = the answer is YES to the DAP 0 = If the answer is NO	Qualitative	Nominal (Electionclosed)
Plausibility function of availability to pay	FVDAP	Double Limit Format 4 possible combinations of answers are achieved: yes-yes, yes-no, no-yes and no-no. With the answers, 4 binary variables are constructed, which take the value of 1 when the respondent's answer is in that position and 0 otherwise.	Qualitative	Nominal (Electionclosed)
Dummy variable for SI-SI	DYY	If the answer in the first round was YES: 1 = If the answer in the second round is YES 0 = otherwise.	Qualitative	Nominal (Electionclosed)
Dummy variable for YES-NO	DYN	If the answer in the first round was YES: 1 = If the answer in the second round is NO 0 = otherwise	Qualitative	Nominal (Electionclosed)
Dummy variable for NO-YES	DNY	If the answer in the first round was No: 1 = If the answer in the second round is YES	Qualitative	Nominal (Election closed)

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		0 = otherwise		
Dummy variable for NO-NO	DNN	If the answer in the first round was NO: 1 = if the answer in the second round is NO0 = otherwise	Qualitative	Nominal (Election closed)
Independent variable				
Initial hypothetical price	PHI	S/2, S/2.5, S/3, S/3.5, S/4, S/4.5, S/5, S/5.5	Qualitative	Continuous / Soles
Minimum initial hypothetical price	PHMIN	S/1.5, S/2., S/2.5, S/3, S/3.5, S/4, S/4.5, S/5	Qualitative	Continuous / Soles
Maximum initial hypothetical price	PHMAX	S/2.5, S/3, S/3.5, S/4, S/4.5, S/5, S/5.5, S/6	Qualitative	Continuous / Soles
Age	E	1 = From 18 to 29 years old 2 = From 30 to 39 years old 3 = From 40 to 49 years old 4 = From 50 to 59 years old 5 = From 60 to more years	Cuantitativa	Discreet / Years
Education level	NE	1 = No level 2 = Elementary incomplete 3 = Complete primary 4 = Secondary incomplete 5 = Complete secondary 6 = Incomplete non-university superior 7 = Complete non-university superior 8 = University Superior Incomplete 9 = University Superior Complete 10 = Master / PhD	Qualitative	Discreet / Years
Gender	GEN	Gender of the respondent 1 = Female 0 = Male	Qualitative	Nominal (Electionclosed)
Monthly family income,	IFM	1 = Minus 250 soles 2 = From 250 to 499 soles 3 = From 500 to 749 soles 4 = From 750 to 999 soles 5 = From 1000 to 1249 soles 6 = From 1250 to 1499 soles 7 = From 1500 to 1749 soles 8 = From 1750 to 1999 soles 9 = Greater than or equal to 2000 soles	Cuantitativa	Continuous of closed election / Soles
Perception of the municipal management regarding the management of solid waste	PGM	1 = Poor 2 = Bad 3 = Regular 4 = Good 5 = Excellent	Qualitative	Nominal
Family size	TF	Number of family members 1 = 1 Person 2 = 2 People 3 = 3 People 4 = 4 People 5 = 5 People	Nominal	Discreet / People

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		6 = From 6 to more people		
Perception of pollution generated by waste	PCGR	1 = Low 2 = Normal 3 = Severe 4 = Very serious 5 = Dangerous	Qualitative	Nominal
Satisfaction level for household solid waste management service	NSPSMD	1 = Very dissatisfied 2 = dissatisfied 3 = Indifferent 4 = Satisfied 5 = Very satisfied	Qualitative	Nominal

Results

Descriptive analysis of variables

Table 3 shows the description of the variables in summary form, which are used for statistical analysis and econometric estimation, also includes the name of each variable, the mean, fashion, standard deviation, the minimum and maximum value.

Table 3. Descriptive analysis of variables

Variable	Observ.	Mean	Median	Dev. Standard	Minimum	Maximum
DAP	288	0.6424	1	0.48014	0.00	1.00
IFM	288	5.0278	5.	3.22435	1.00	9.00
AGE	288	2.5833	2.0000	1.08522	1.00	5.00
EDUCATION LEVEL	288	6.7500	7.0000	2.02080	1.00	10.00
FAMILY_SIZE	288	3.2014	3.0000	1.60825	0.00	7.00
GENDER	288	0.5347	1.0000	0.49966	0.00	1.00
GM	288	1.5903	1.0000	0.95116	1.00	5.00
PCGR	288	2.8715	3.0000	0.94121	1.00	5.00
NSPSMD	288	2.2847	2.0000	0.91950	1.00	5.00

Source: Own elaboration based on surveys.

In the age variable, of the total number of respondents, 25.3% are between 18 and 29 years old, 37.5 from 30 to 39 years old, 25.7 from 40 to 49 years old, 6.7 from 50 to 59 years old, 4.9 from 60 to 49 years; in the same way it can be shown that in the highest proportion of respondents 88.5% has been to children under 50 years of age. With regard to the gender of the respondent, it can be shown that of the people surveyed, 46.5% were male and 53.5% were female, i.e. most of the respondents were women.

In the case of the educational level, respondents were shown to be in greater proportion (34.4%) have a full secondary education level and in a lower proportion (1.4%) are levelless and incomplete primary; In addition, 3.1% of respondents have completed their master's and/or doctorate and 69.1% of respondents are not professionals or technicians. The size of the family, of respondents you can know that most households (24.7%) have 3 people as members of their household, and 24.3% of households are made up of 4 people, 17.7% of 2 people, 2.4% of 7 to more people; in the same way it can also be shown that more than half of households 57.6% are integrated from 3 to fewer people.The family income analysis of families in the city of Huancané showed that 19.8% of families have an income of less than 250 soles, 28.4% from 250 to 499,

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26% from 500 to 749 soles, 9.7% from 750 to 999 soles and 3.5% equal to or greater than 2000 soles; most respondents (83.9%) have a household income of less than 1000 soles.

On the other hand, it is important to analyze the variable municipal management, where most respondents (63.5%) considered the municipal management carried out by the Provincial Municipality of Huancané to be deficient, also 22.9% considered as bad, 15.9% considered regular, 6.3% considered as good and only 1.4% considered it excellent; noting that most respondents are not in line with management due to multiple issues that need to be taken into consideration and subsequently re-addressed by those in charge of the subject.

When considering the perception of pollution generated by waste in the city of Huancané, most respondents (52.8%) considered perception to be severe, in the same way 10.8% considered it to be low, 15.6% considered it normal, 17.4% considered it to be very serious and 3.5% considered it dangerous. Therefore, the level of satisfaction by management service of solid household waste is important, of which 50.3% indicated that they are dissatisfied, 21.9% claimed to feel indifferent, 17.0% felt very dissatisfied, 8.7% satisfied and 2.1% very satisfied; on the other hand it can be known that most of the respondents indicated that the management of waste as inadequate so they are not satisfied with the service provided by the municipality.

Analysisof availability payable

In the analysis of the willingness to pay (DAP) for the improvement in the management of solid household waste in the city of Huancané conducted by a referendum-type contingent valuation survey, out of a total of 288 surveys, 35.76% of respondents are unwilling to pay, compared to 64.24% who declared they were willing to pay. The following table illustrates the descriptive results of the DAP, where it can be seen that for an rateS/. 2.00 soles, 93.02% of a total of 43 respondents responded in the affirmative, compared to 42.86% who responded in the affirmative at anrate S/. 5.50 soles. In general, a priori is met, i.e. for lower rates there are more positive responses, compared to higher rates where there are more negative responses.

Table 4. Answers to the referendum question

Rate range	Affirmative answer	%	Negative answer	%	Number of survey	Total surveys %
2	40	93.02	3	6.98	43	14.93
2.5	43	93.48	3	6.52	46	15.97
3	28	75.68	9	24.32	37	12.85
3.5	17	45.95	20	54.05	37	12.85
4	21	55.26	17	44.74	38	13.19
4.5	8	28.57	20	71.43	28	9.72
5	16	51.61	15	48.39	31	10.76
5.5	12	42.86	16	57.14	28	9.72
Total	185	64.24	103	35.76	288	100.00

Source: Own elaboration based on surveys.

In addition, by analyzing the answers to the questions by applying the double limit, 61.11% of respondents responded positively to DAP (Yes- Yes and No-Yes positions), while 38.89% responded negatively to DAP (Yes-No and No-No positions) (Table 5). These results differ

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significantly from that obtained in the referendum format, where according to the results shown in the table above there is a higher percentage of positive responses to the DAP question.

Table 5. Answers to questions - double limit

Rate range	Answers					
	Yes	No	Yes-Yes	Yes-No	No-Yes	No-No
1.5					3	
2	40	3			2	1
2.5	43	3	32	8	7	2
3	28	9	31	12	8	12
3.5	17	20	20	8	9	8
4	21	17	9	8	10	10
4.5	8	20	14	7	7	8
5	16	15	6	2	5	11
5.5	12	16	9	7		
6			4	8		
Total	185	103	125	60	51	52
% (Yes-Yes; No-Yes)	61.11					
% (Yes-No; No-No)	38.89					
% Total	100.00					

Econometric analysis to establish the variables that determine DAP
When selecting the best model in the Referendum Format and Double Limit Format, in order to determine which variables affect payment decisions, three models were tested as specified in the methodology, where you have different specifications. The authenticity of the best model is based on the expected sign, the statistical significance of the coefficient, the individually estimated as global, the Akachi reporting standard is Schwarz and predicted percentages.

The following table presents the regression results for the 3 referendum and one double-limit models with different specifications. The models include all variables, when estimating the expected signs of the coefficients of the variables are correct in addition to being significant, however the coefficients of the variables: gender, municipal management, family size with respect to the willingness to pay for the management of solid waste, are not significant even at 15% significance level for this reason these variables are discarded. It is observed that the probit model, is the most coherent model, the signs are expected, and all the coefficients of the variables individually as global are statistically significant to 5% and 1% respectively in addition to the expected symbols being maintained correctly.

The coefficient of environmental perception variables is not significant even at 15%. Aldrich & Forrest (1984) claim that the use of R2 as a summary statistic should be avoided in models containing qualitative dependent variables as in this study. According to Gujarati (2013) the use of R2 goodness of adjustment in models with binary regression should be avoided, i.e. the goodness of the adjustment is of secondary importance so priority will be given to the expected signs of regression coefficients and their practical and/or statistical importance for each variable.On the other hand, for the result of the estimation of the double limit model, the signs of the coefficients of the double limit model results show that they have the expected signs:

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- The coefficient of the price variable (PH) is negative, which indicates that in the face of a higher price for the improvement in the management of home solid waste, the probability of obtaining a lower response decreases.
- The coefficient of the household income variable (IFM) is positive, indicating that in the face of higher income, the probability of obtaining a positive response from the respondent is higher.
- The coefficient of the household size (TF) variable is positive, indicating that in the face of one more person inside the household, the probability of obtaining a positive response from the respondent is higher.
- The education coefficient (EDUC) registers a positive sign, indicating that in the face of a higher level of education of the respondent, the greater the willingness to pay.
- The coefficient of the variable perception of waste pollution (PCGR) is positive, indicating that in the face of a high level of perception of contamination, the probability of obtaining a positive response from the respondent is higher.
- The coefficient of the variable level of satisfaction by home solid waste management service (NSPSMD), which registers a negative sign, indicating that in the case of a larger household size of the respondent, the greater the willingness to pay.

Table 6. Econometric estimates of referendum models and dual-limit model

Variables	Referendum model			Double limit model
	Coefficients and level of significance			
	Probit model	Cloglog model	Logit model	Logisticsdistribution
PHI	-0.643999 (-5.51) ***	-0.75859 (-5.58)***	-1.087176 (-5.09)***	-1.250767 (15.20)***
AGE	-0.2647469 (-2.26)**	-0.3241221 (-2.54)**	-0.4599498 (-2.11)**	-0.2005416 (-2.18)**
EDUC	0.1372034 (2.14)**	0.112817 -1.58	0.2452623 (2.16)**	0.1109386 (2.38)**
GEN	-0.1593499 (-0.68)	-0.2257 (-0.9)	-0.2425377 (-0.57)	0.0221143 .(0.12)
IFM	0.3280181 (7.77)***	0.344399 (7.16)***	0.5741905 (7.12)***	0.1219757 (4.06)***
GM	-0.1727556 (-1.33)	-0.1436599 (-0.96)	-0.3087466 (-1.32)	0.0454796 .(0.45)
TF	0.1111357 -0.16	0.09907 -1.12	0.2127652 -1.48	0.1090107 (1.71)*
PCGR	0.4599696 (3.46)***	0.4826594 (3.21)***	0.8142243 (3.38)***	0.4296604 (4.09)***
NSPSMD	-0.5929371 (-4.08)***	-0.7022272 (-3.87)***	-1.05318 (-3.89)***	-0.2224106 (-2.09)**
_cons	1.213943 -1.37	1.590675 -1.57	1.889474 -1.2	2.316053 (3.83)***
Logarithm of likelihood	-78.983176	-79.974	-79.87395	-347.43452
r2_p	0.5794063		0.5746628	
McFadden R2	0.579	0.574	0.575	
LR chi2 (9)	217.61306	215.6314	213.80435	
Count R2	0.875	0.875	0.875	
aic	177.966	179.948	179.748	
Correctly classified	87.50%		87.50%	

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The numbers in parentheses represent the z – statistical, ***indicates significance at a level of 1%, ** at 5% and * to 10%.

According to the criteria presented the lowest AIC has the probit model compared to the other two models, within the measures as goodness of fit is the R2 McFadden higher it has the probit model with a value of 0.579. The combined significance of the model is high, in terms of the likelihood ratio (LR) statistic, the critical value of a Chi-square at 1% significance with 9 degrees of freedom is 21.67, so the null hypothesis that the coefficients of all explanatory variables are zero is rejected. In the probit model, the LR-217.61306 is larger than the Chi-square table.

$$H_0 = \widehat{\beta_1} = \widehat{\beta_1} = \cdots = \widehat{\beta_1} = 0 \text{ Null hypothesis}$$

$$H_0 \neq \widehat{\beta_1} \neq \widehat{\beta_1} \neq \cdots \neq \widehat{\beta_1} \neq 0 \text{ Alternate hypothesis}$$

The null hypothesis is rejected; it is concluded that there is joint dependence and all variables as a whole are statistically significant (at 1% significance level) in the model. That is, it can be said that independent variables as a whole are important for explaining the behavior of the binary dependent variable (PROBDAP). In general, the model provides 87.50% of observations correctly for both the logit and probit models, which is a result that determines the advantage of these models over the cloglog model.

In this sense, by analyzing the marginal effects of the chosen model that is the probit model, the expected symbols are maintained correctly. The coefficient of the variables gender, municipal management and family size, is not significant, not even 15% for this reason has not been taken into consideration for the marginal effects whose interpretation is as follows: If the suggested hypothetical price increases in sol, the probability of the willingness to pay for the improvement in solid waste management will decrease by 9.66%. If the age of the respondent is going to increase by one unit then the probability that the willingness to pay for the improvement in solid waste management will decrease will be 3.96%; If the respondent's education is going to increase by one level then the likelihood of increased willingness to pay for improvement in solid waste management will be 2.05%. In addition, if the monthly household income increases in a solthen the likelihood of willingness to pay for the improvement in solid waste management increases by 4.90%, also if the perception of pollution generated by solid waste increases by one category, i.e. to a higher level then the likelihood of willingness to pay for the improvement in solid waste management will increase by 6.88%; finally if the level of satisfaction of the respondent is going to increase by one category then the probability of decreased willingness to pay will be 8.87% (Table 7).

Table 7. Marginal effects of the winning model

Variables	Coefficients	Marginal effects
Hypothetical Price	-0.643999 (-5.51) ***	-0.09663463
Age	-0.2647469 (-2.26)**	-0.0396078
Education	0.1372034 (2.14)**	0.0205265
Monthly family income	0.3280181 (7.77)***	0.0490735
Perception of pollution generated by waste	0.4599696 (3.46)***	0.0688143
Satisfaction level for household solid waste management service	-0.59293707 (-4.08|)***	-0.088707

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Logarithm of likelihood	-78.983176

The numbers in parentheses represent the z – statistical, ***indicates significance at a level of 1%, ** at 5% and * to 10% Source: Own elaboration based on the results obtained from stata software15

Average Payable Availability Analysis (DAP)

After the analysis and validation of the econometric results, the availability to be paid for the referendum model and double limit was estimated. For comparison purposes it is the double limit model that does not take much advantage over the probit model because as we explained above the "double bound" is based on a logistic distribution.

In determining the availability payable average (DAP) using the referendum model, taking into account the econometric results of the probit model shown in the table above, the DAP was estimated for each respondent, the same as set out in the following table, where the average DAP of the referendum model gives a positive and statistically significant value of S/ 3.91 representing the willingness to pay.

Table 8. DAP results of the referendum model

Variable	Mean	Standard deviation	[95% conf.	Interval]
$DAM_{referendum}$	3.910944	1.324239	2.323732	5.053638

Source: Own elaboration based on the results obtained from Stata15 software.

When estimating the average pay-to-pay (DAP) availability for the dual-limit model, it can now be seen that DAP with a 95% confidence interval is variant; which is more consistent than that found in the referendum model since it is not a negative willingness to pay as in the referendum in the event that this is the minimum (Table 9).

Table 9. DAP results half model double limit

Variable	Mean	Standard deviation	[95% conf.	Interval]
DAM_{dl}	3.491683	0.0901782	3.962378	4.31587

Source: Own elaboration based on the results obtained from Stata15 software.

Therefore, for the referendum model, the estimated DAP was S/. 3.91 soles with a standard deviation of 1.324239 and a confidence interval ranged from -1,324 to S/. 9.05 soles, wherefore for the double limit diatomical model the calculated DAP was S/3.49, presenting a standard deviation of 0.0901782 and its respective confidence interval of S/. 3.96 soles to S/. 4.32 soles, with a 95% confidence level for both models. Following the criteria chosen, the model with greater accuracy in the estimation of DAP is the double limit diatomical, so subsequent calculations in the research will take into account its results.

Estimating economic gain

For the estimation of the economic benefit generated by DAP from the improvement in the management of solid household waste in the city of Huancané has been obtained taking into account the criterion of aggregation of benefits proposed by Dobbs (1993) cited inHuamaní et al. (2020) and Boñon et al. (2014) who poses the linear aggregation of the willing availability of the beneficiaries of a policy as a way to find the added benefits. The formula is presented below:

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$$BEA = \sum_{i=1}^{n} DAP$$

Where, BEA are the annual economic benefits, THE DAP is the availability to be paid and n is the N-nth observation. Replacing values in the formula for the referendum model has:

$$BE_{ref} = \sum_{i=1}^{1146} 3.91$$

$$BE_{ref} = 1146*3.91$$
$$BE_{ref} = 4480.86$$

In this sense, the economic benefit generated by the willingness to pay for the improvement of collection for the improvement in the management of solid household waste in the city of Huancané is S/.4480.86 soles per month.

Therefore, the willingness to pay average obtained is S/. 3.91 soles which is a value greater than 2 soles is therefore accepted the null hypothesis and the alternative hypothesis is rejected, also according to Pearson's chi square where the P value Pr is 0.000 and is less than 5%, so it can be determined that there is an association between the hypothetical price and the willingness to pay. In addition, socioeconomic factors of education level and income level influence the willingness to pay because they are significant at 5%. Finally, according to the estimate of economic benefit can be evidenced in the results that the economic benefit generated by the improvement in the management of solid household waste amounts to an amount of S/. 4480.86 soles per month which exceeds what is planted in the hypothesis.

Discussions

The results found in this research relate to other research as follows: According to Table 10, it is observed that research is available in the Puno region that has estimated DAP specifically in places such as the city of Juliaca, Puno, the Rinconada, by Rojas (2012); Diaz (2012) and Chambilla (2015), estimated a higher DAP than those obtained by this research. Then, in general, it can be understood that the result of THE DAP will depend a lot on the size of the sample and the geographical environment because in places established in the Costa del Perú region the provisions to be paid for an improvement is much greater.

Within local studies, there is a previous study in the city of Huancané conducted by Quilla (2017), where it was determined that the payment amount would be S/. 3.74 soles per month very similar to the S/ 3.91 soles that was taken as a result of a survey of 382 people the same that is highly influenced as the results of this work by socioeconomic factors (education, income, household size, age) however unlike study the variable gender and municipal management was not significant because the sample for this research project is lower.

In other cities like Puno, Chambilla (2015), determines the willingness to pay (DAP) to 390 houses in the village of Puno where the amount is greater than our S/. 4.45 soles since most of the citizens of Huancané are plunged into monetary poverty unlike Puno. Both studies agree with the

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determinants. Finally, in the study of Quispe et al. (2020)Probit binomial was also applied to surveys of 382 households in the city of Juliaca where they also find a larger DAP than this S/. 5.36 soles per month resulting in larger aggregated DAP.

In the model presented, it is clear that there are variables that have not reached the expected confidence level such as the gender variable, the number of household members (TF) and the municipal management variable for the probit model. But the main socioeconomic factors that affect the payment provision are the hypothetical price (PH), the level of education (EDUC), monthly household income (IFM) and age (E) which coincides with this work. For this reason, relatively low DAP has been obtained. Although according to the background shown in the following table, there is similarity in terms of hypothetical price and household income with respect to the calculation of DAP.

Table 10. Comparison of contingent valuation studies for improvements in solid waste management

Year	Author	Format	Researchlocation	Samplesize	Results
2012	Rojas	Referendum	Juliaca	384	DAP=S/13.07
2017	Quilla	MVC Referendum	Huancane	386	DAP=S/3.74
2012	Díaz	Referendum	La Rinconada-Ananea	180	DAP= S/ 4.20
2015	Chambilla	Referéndum	Puno	374	DAP=S/ 4.45
2016	Huancani	MCO	Juliaca	384	DAP=S/1 A S/2
2020	Quispe, Guevara, Marca, Mamani	Referendum	Juliaca	382	DAP=S/ 5.36
2017	Meza	Referendum	Villa el Salvador	100	DAP=S/ 7.99 o S/ 10.85
2015	Toledo	Referendum	Huaraz	560	DAP=S/ 9.71
2005	Sauad	Referendum	Argentina	1600	DAP=$ 45.67

Source: Own elaboration from literary review

Studies at the national level have the studies of Meza (2017) and Toledo (2015) made in Villa el Salvador and Huaraz respectively, where higher amounts of DAP S/ are observed. 7.99 soles or S/. 10.85 soles per month per dwelling compared to local studies as a result, added DAPs are obtained greater S/. 275,902.69 soles (mean evaluation) and S/. 374, 661.35 soles (fashion assessment) in which if it coincided with these national studies it was with the variables hypothetical price, education and income.

Internationally, studies such as that carried out by Vesco (2006), Ávalos et al. (2018) and Sauad et al. (2005) in Argentina, among others, the same ones that are appreciated that the variables that explain these amounts of willingness to pay are the level of income, the level of education, the age (with a negative sign) as in this study which would explain that in recent years environmental responsibility has been increasing since there is greater access to information about the consequences of environmental pollution , so there would be greater environmental awareness in the population considered young compared to older adults than in the vast majority of cases do not have much ease in accessing the internet.

Finally, it should be noted that, on the limitations of this research were generated due to the deficiency in conducting the surveys in a virtual way to elderly people considered representatives of a household.

Conclusion

The willingness to pay for the improvement in the management of solid household waste in the city of Huancané is S/. 3.91 soles, as well as 35.76% of respondents are unwilling to pay, compared to 64.24% who declared they were willing to pay, where 93.02% of citizens are willing to pay an S/ fee. 2.00 soles and 42.86% are willing to pay an S/ fee. 5.50soles, it follows that for lower rates there are more positive responses, compared to higher rates where there are more negative responses the factors that also influence a negative response by home members are that 53% do not rely on the proper use of funds, 34.62% indicate that the government must bear the costs and 11.54% indicate that they do not have sufficient financial resources.

Socioeconomic factors influencing the willingness to pay for an improvement in solid waste management in the city of Huancané are hypothetical price, monthly household income, education, pollution perception and satisfaction level. That is, if the head of household education increases by one more level, the likelihood of paying for the improvement in solid waste management will increase by 13.72%, if monthly household income increases by a sole, the likelihood of paying for the improvement in solid waste management increases by 3.28%. Also, if the respondent has a level of satisfaction by management service home solid waste then the availability to be paid for the improvement in solid waste management decreases by 59.29%, finally if the perception of pollution generated by the waste increases by a higher level then the probability of paying for the improvement in solid waste management would increase by 45.99%.

In the analysis carried out the economic benefit generated by the willingness to pay for an improvement in the management of solid household waste in the city of Huancané is S/. 4480.86 soles/months, whose economic capital can be budgeted for the implementation of projects that contemplate the optimization of the collection and transport service of solid household waste from its point of origin, the improvement of the public cleaning service, as well as the final disposal of such waste in a landfill, equipped and installed with the relevant technical specifications for the city of Huancané.

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