

Economic valuation in selective solid waste collection

Valoração econômica da coleta seletiva de resíduos sólidos

Anny Kariny Feitosa^a
Júlia Elisabete Barden^b
Odorico Konrad^c
Manuel Arlindo Amador Matos^d

^aDocente no Instituto Federal do Ceará – IFCE,
Iguatu, CE, Brasil.
End. Eletrônico: akfeitosa@hotmail.com

^bProfessora Adjunta da Universidade do Vale do Taquari – Univates,
Lajeado, RS, Brasil.
End. Eletrônico: jbarden@univates.br

^cProfessor Titular da Universidade do Vale do Taquari – Univates,
Lajeado, RS, Brasil.
End. Eletrônico: okonrad@univates.br

^dDocente no Departamento de Ambiente da Universidade de Aveiro,
Aveiro, Portugal.
End. Eletrônico: amatos@ua.pt

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ABSTRACT

This article aims to estimate the economic valuation of selective solid waste collection in the city of Juazeiro do Norte, Ceará, Northeast of Brazil, through the Contingent Valuation Method, presenting the average Willingness to Pay (WTP) of the respondents. Besides, it identifies the variables that influence WTP. The study involved bibliographical research and fieldwork, with 360 interviews, qualitative data analysis and statistical analysis of variables, through binary regression, using a probit model (probability unit), using STATA 11. It was found that 91.94% of the respondents recognize that selective collection contributes to the reduction of pollution, but only 37.50% would be willing to pay for the referred collection. Concerning the respondents with positive WTP, the average monthly WTP found was R\$ 15.70. The higher or lower willingness to pay for the referred services was related to the variables gender, income and education. Based on the marginal effect, the variables with greater influence on WTP for selective collection in this study were gender (17.44%) and education (16.86%).

Keywords: Solid Waste Management; Selective collection; Contingent Valuation Method; Willingness to Pay; Urban environmental service.

RESUMO

Este artigo tem por objetivo estimar a valoração econômica da coleta seletiva na cidade de Juazeiro do Norte, Ceará, Nordeste do Brasil, por meio da aplicação do Método de Valoração Contingente, apresentando a Disponibilidade a Pagar (DAP) média dos entrevistados, além de determinar as variáveis que influenciam a DAP. Para o desenvolvimento do estudo, procedeu-se com pesquisa bibliográfica, pesquisa de campo, com a realização de 360 entrevistas, análise qualitativa dos dados e tratamento estatístico de variáveis, por meio de uma regressão binária, utilizando um modelo probit (probability unit), no software STATA 11. Dentre os resultados, destacam-se: 91,94% dos entrevistados reconhecem que a coleta seletiva contribui para a diminuição da poluição, porém somente 37,50% estariam dispostos a pagar pela referida coleta; considerando-se os entrevistados com DAP positiva, a DAP média mensal encontrada foi de R\$ 15,70; a probabilidade dos municípios apresentarem DAP pelo serviço da coleta seletiva aumentou quando relacionada com as variáveis gênero, renda e escolaridade. Baseando-se no efeito marginal, as variáveis com maior influência sobre a DAP da coleta seletiva, no presente estudo, foram gênero (17,44%) e escolaridade (16,86%).

Palavras-chave: Gestão de Resíduos Sólidos; Coleta Seletiva; Método de Valoração Contingente.

1 INTRODUCTION

Selective collection is an alternative for the reuse of materials, contributing to minimize the environmental impact caused by the final disposal of waste (MAIA et al., 2012), in view of the increasing generation and accumulation of solid waste in urban centers. Moreover, it promotes environmental and economic gains, although its cost is higher than that of the conventional collection system (RODRIGUES; SANTANA, 2012). Selective collection is therefore considered an urban environmental service that maximizes recycling and favors the correct disposal of solid waste, minimizing “negative environmental externalities” (IPEA, 2010, p. 8).

Among the studies on economic valuation of selective solid waste management it is worth stressing the methods of environmental economic valuation, especially the Contingent Valuation Method, often used to assess goods and services related to environmental resources and including the estimate consumers’ WTP values in a hypothetical market (MOTTA, 1988; RABÊLO NETO et al., 2014).

Environmental economic valuation studies have been conducted in several countries. Regarding municipal solid waste management services in Greece, Damigos et al. (2016) estimated the willingness to pay for improvements in this service, resulting in an average annual willingness to pay of USD 88.4 per household. Marella and Raga (2014) used the Contingent Valuation Method to quantify, in monetary units, the benefits perceived by a community in Italy regarding the transformation of an old dumping ground into a public park. The authors found that 91.3% of the respondents had Willingness to Pay (WTP) for the recovery of the area, in average 196 euros, while the average WTP for the establishment of the public park was 200 euros. Gaglias et al. (2016) also used the Contingent Valuation Method to estimate the WTP of a community for socio-environmental programs related to the implementation of a solid waste landfill in Ikaria, Greece. The authors found an average WTP of 6.5 euros, bimonthly.

Concerning selective solid waste collection, Ferreira and Marques (2015) used the contingent valuation method to estimate the willingness to pay for solid waste collection in Portugal. The contingent valuation method was also used for the same purpose by Zeng et al. (2016) in a study with residents of a community in China. In Brazil, Gullo and Gregori (2011) also used the aforementioned method to estimate the WTP for selective solid waste collection in Caxias do Sul, Rio Grande do Sul, while Rodrigues and Santana (2012) conducted a similar study in Palmas, Tocantins, in the Northern region of Brazil.

Therefore, the present article aimed to estimate the economic valuation of selective solid waste collection in the city of Juazeiro do Norte, Ceará, Northeast Brazil, through the Contingent Valuation Method, estimating the average WTP of the respondents, as well as determining the variables that affect consumers’ WTP.

The municipality of Juazeiro do Norte is located in the meso-region Sul Cearense and Microrregião Cariri, forming the Metropolitan Region of Cariri – RMC. The total area is 248,83 km² and population density is 1.004,45 inhabitants/km². According to the 2010 Population Census, Juazeiro do Norte has a population of 249.939, urbanization rate of 96.07%, that is, 240,128 people live in the urban zone of the city. In 2017, the population was estimated in 270,383 inhabitants (IBGE, 2017).

In 2014, 98.96% of the households had water supply in the urban area and 38.61% had a sewerage system. Regarding electric power and waste collection, the rates were respectively 99.51% and 94.22%. In 2010, the Human Development Index of Juazeiro do Norte was 0.694 (IPECE, 2016). Concerning compliance with the stipulation of the Municipal Solid Waste (MSW), the municipality throw away their wastes in a dump, the so-called “Lixão da Palmeirinha”, and don't have selective collection and recycling of waste materials.

2 MATERIALS AND METHODS

This study involved bibliographic research, field research, qualitative analysis and statistical analysis of variables. Fieldwork began with a visit to the Department of Management where the real estate registry of the city of Juazeiro do Norte is maintained, in order to identify the number of households in each neighborhood of the city. According to the referred department, the city had 109,044 households in 2016. In order to determine the number of households for the survey, considering a 95% confidence level, the following formula was used to determine the sample size (number of households for the survey) (GIL, 2008).

$$n = (\delta^2 \cdot p \cdot q \cdot N) / (e^2 (N-1) + \delta^2 \cdot p \cdot q) \quad (1)$$

where:

n = Sample size (number of households for the survey);

δ^2 = Level of confidence selected expressed in number of standard deviations;

p = Percentage of occurrence of the phenomenon (probability of occurrence);

q = Additional percentage (probability of non-occurrence);

N = Total number of households in the city of Juazeiro do Norte;

e^2 = Maximum number of allowed errors

The sample size obtained with calculation was 334 households, stratified according to the 39 neighborhoods, as shown in Table 1. The Salesianos district has the largest number of households, followed by São José and Tiradentes districts. In turn, Industrial District and Vila Padre Cícero had the smallest number of households. Rounding was used to ensure a sample more representative of each neighborhood, resulting in 360 households to be visited. The selection of the households to be surveyed was made by simple random sampling (GIL, 2008), through random draws, after identification of the main street of each neighborhood.

Table 1 – Number of households in the sample.

Neighborhood	Number of households	Households/ Neighborhood (%)	Number of Households (sampling calculation)	Number of households in the research
Distrito Industrial	67	0.06	0.21	2
Vila Padre Cicero	96	0.09	0.29	2
Pedrinhas	104	0.10	0.32	2
Cidade Universitária	164	0.15	0.50	2
Carité	241	0.22	0.74	2
Três Marias	271	0.25	0.83	2

Neighborhood	Number of households	Households/ Neighborhood (%)	Number of Households (sampling calculation)	Number of households in the research
Mons. Francisco Murilo	617	0.57	1.89	3
Socorro	930	0.85	2.85	3
Salgadinho	978	0,90	3	3
Leandro Bezerra	1.089	1	3.34	4
Romeiro Aureliano	1.169	1.07	3.58	4
Horto	1.374	126	4.21	5
Fátima	1.384	1.27	4.24	5
Juvêncio Santana	1.411	1.29	4.32	5
Campo Alegre	1.609	1.48	4.93	5
Novo Juazeiro	2.001	1.84	6.13	7
Romeirão	2.152	1.97	6,59	7
Brejo Seco	2.336	2.14	7.16	8
Planalto	2.489	2.28	7.62	8
José Geraldo da Cruz	2.544	2.33	7.79	8
Pio XII	2.653	2.43	8.13	9
Antônio Vieira	2.882	2.64	8.83	9
Santa Tereza	3.007	2.76	9.21	10
Timbaúba	3.072	2,82	9.41	10
Betolândia	3.098	2,84	9.49	10
João Cabral	3.309	3,03	10,14	11
Franciscanos	3.488	3.20	10,68	11
Triângulo	3.652	3.35	11.19	12
São Miguel	3.856	3.54	11.81	12
Lagoa Seca	4.165	3.82	12.76	13
Frei Damião	4.411	4.05	13.51	14
Pirajá	4.535	4,16	13,89	14
Limoeiro	4.651	4.27	14.25	14
Aeroporto	5.398	4.95	16.53	17
Jardim Gonzaga	5.598	5.13	17.15	18
Centro	5.961	5.47	18.26	19
Tiradentes	6.222	5.71	19.06	20
São José	6.940	6.36	21.26	22
Salesianos	9.120	8.36	27.93	28
Total	109.044	100.00	334	360

Source: applied research. (Data on the households: Secretaria de Gestão do Município, 2016).

It should be stressed that the 360 interviews identified, among other factors, the amount of money the respondents would be willing to pay for the environmental service of selective solid waste collection, using the Contingent Valuation Method (CVM).

According Hanley et al. (1997, p. 384), the CVM has become the most widely used of all environmental valuation techniques and “any CVM exercise can be split into five stages: (1) setting up the hypothetical market, (2) obtaining bids, (3) estimating mean WTP and/or WTAC, (4) estimating bid curves, and (5) aggregating the data”.

To Faria and Nogueira (2000 , p. 2), the CVM “seeks to value public and / or environmental goods for which there are no market prices. In the absence of market signals, the method proposes, by means of surveys, to disclose the results of the market analysis and the consumer preferences for an environmental good or service and thereby capture their willingness to pay for the good in question”. The questionnaires may contain: “open-ended questions, bidding game, referendum model, referendum with follow-up, contingent with ranking, contingent activity, among others.”

It should be noted that the potential biases resulting from the use of CVM come from four sources (MITCHELL; CARSON 1989, p. 235): scenarios that encourage respondents not to respond to true WTP; scenarios that have incentives to induce the individual to respond to the questionnaire; bad specification of the scenario, either by incorrect or incomplete description of important aspects; and the inadequate sample, as well as the erroneous aggregation of benefits.

In this sense, the CVM is criticized mainly because of its hypothetical character, that is, it is considered that the price estimates given by these methods are only hypothetical and do not represent real disposition to pay (KAHNEMAN; KNETSCH, 1992; ROSENTHAL; NELSON, 1992; HAUSMAN, 1993; DIAMOND et al., 1993; CUMMINGS et al., 1995). For this reason, the CVM is rejected as an evaluation method because, in the opinion of these authors, the results of studies are inconsistent and do not measure the individual’s underlying preferences (HAUSMAN, 1993).

In addition to being an adaptive model, it is important to consider the existence of environmental services (BARBISAN et al., 2009). Thus, despite being criticized by some authors, especially due to the hypothetical nature, it is the one that best suits as a methodological strategy to be used in the present study, given the proposed objective.

Thus, the interviewees, in the case of analysis, were supposed to reveal their preferences for the environmental service of selective collection in the city of Juazeiro do Norte. The values are obtained “through information collected from the answers to questions on how much these individuals would be willing to pay to ensure the improvement of well-being” (MOTTA, 1998, p. 44). Open-ended questions were used to produce a continuous variable of bids, in order to avoid the bias of the starting point (RODRIGUES; SANTANA, 2012). Finally, the average WTP value for the study sample was identified, which was based on the average values different from zero listed by the respondents.

The interviews were administered from November 2016 to February 2017, at different times, in the morning and afternoon shifts. The collected data refer mainly to socioeconomic variables of the individuals, such as income, age, education, knowledge about selective collection, among others. The qualitative data analysis was done through content analysis (BARDIN, 2011).

In order to measure the variables that influence the respondents WTP for a selective solid waste collection, binary regression was estimated using the probit model (probability unit) through STATA 11 software (BALASUBRAMANYA et al., 2017; GUJARATI; PORTER, 2011), which consists in presenting two possible values for the variable under analysis, with 0 for non-occurrence of the phenomenon and 1 for occurrence (PINO, 2007). In the present study, WTP was considered as a binary or limited dependent variable and “Gender”, “Age”, “Marital status”, “Income” and “Schooling” were considered independent variables.

Similar studies used variables such as age, gender, family income and years of schooling (GULLO; GREGORI, 2011; LUCENA; TÁVORA JR, 2006; RODRIGUES; SANTANA, 2012; ZENG, et al. 2016). The explanation for the use of these variables is that in selective collection, “social participation depends on the socioeconomic and cultural profile of the population, with emphasis on aspects such as educational level and access to education” (BRINGHENTI; GÜNTER, 2011, p. 422).

As a sample, it is used the data of the respondents who answered positively to the question about WTP for selective solid waste collection and of those who said they were unwilling to pay for selective solid waste collection for economic reasons. Thus, we obtained (PINO, 2007, p. 47).

$$\Pr[Y = 1 | X = x] = F(\beta' x) \text{ and} \quad (2)$$

$$\Pr[Y = 0 | X = x] = F(\beta' x)$$

The Marginal Effect was also calculated for the identification of changes in the dependent variable (WTP) associated to changes in the explanatory variables (Gender, Age, Marital Status, Income and Education). In the probit model, the marginal effect is given by (PINO, 2007, p. 52; GUJARATI; PORTER, 2011).

$$\frac{\partial E[Y | X = x]}{\partial X_i} = \phi(\beta' X) \beta_i \quad (3)$$

If $\phi > 0$, the change of the dependent variable is related to the signal of the β parameter vector (PINO, 2007; GUJARATI; PORTER, 2011).

3 RESULTS AND DISCUSSION

3.1. SOCIOECONOMIC PROFILE OF RESPONDENTS

After data collection, the socioeconomic profile of the 360 respondents was identified based on the information collected, which concerned gender, marital status, age, education, household monthly income and number of residents at home (Table 2).

Table 2 – Socioeconomic aspects of the participants.

Item	Answer	No of respondents	Percentage (%)
Gender	Male	171	47.50
	Female	189	52.50
Age range (Age in years)	18-25	77	21.39
	26-35	66	18.33
	36-50	84	23.34
	51 to 65	80	22.22
	> 65	50	13.89
	Not reported	3	0.83
Marital Status	Single	131	36.39
	Married	180	50.00
	Divorced	23	6.39
	Widowed	26	7.22

Item	Answer	No of respondents	Percentage (%)
Education	Illiterate	46	12.78
	Primary education	129	35.83
	Secondary education	121	33.61
	Technical education	8	2.22
	Graduation	40	11.11
	Postgraduation	14	3.89
	Not reported	2	0.56
Household monthly income	Up to 1 minimum wage*	225	62.50
	1 to 3 minimum wages	96	26.66
	3 to 5 minimum wages	27	7.50
	5 to 10 minimum wages	5	1.39
	> 10 minimum wages	2	0.56
	Not reported	5	1.39
Number of residents in the household	1	33	9.17
	2	63	17.50
	3	90	25.00
	4	92	25.56
	5	35	9.72
	6	22	6.11
	7	13	3.61
	8	6	1.67
	9	2	0.56
	10	1	0.27
	11	3	0,83

Source: applied research. *Minimum wage as of 2016: R\$ 880, 00.

According to Table 2, approximately 63.06% of the respondents are aged between 18 and 50 years. Regarding marital status, 50% reported being married or living in a stable union. Regarding education, 48.61% said they had incomplete secondary education. With regard to monthly family income, 62.50% earned up to one minimum wage per month, equivalent to eight hundred and eighty reais (R\$ 880.00).

3.2. QUALITATIVE DATA ANALYSIS

After their identification, respondents were asked about selective solid waste collection, as follows: asked whether a selective solid waste collection service was available in the city of Juazeiro do Norte. In this regard, 93.06% reported that the municipality did not provide such environmental service; 4.72% mentioned the existence of selective collection services, and 2.22% were unable to answer.

The respondents who stated that the municipality counts on a selective solid waste collection service meant the service provided by waste pickers, who, despite their significant role in the recovery of such materials, are part of the informal recycling sector, which cannot meet all the needs of the city regarding waste collection. According to the Compromisso Empresarial para Reciclagem (Cempre), in 2016, only 18% of the Brazilian cities had selective solid waste collection services, as follows: 81% in the Southern and Southeastern regions of the country; 10% in the Northeastern region; 8% in the Central-West region, and 1% in the Northern region (CEMPRE, 2016). Regarding the performance of recyclable waste pickers in Brazil, Rebehy et al. (2017) identified the following obstacles:

Instability and the absence of working relationships; income fluctuation due to fluctuations in prices and volumes collected; the low administrative capacity of the collectors' organizations; low bargaining power vis-a-vis recyclable materials traders; strenuous working hours due to the excess weight carried through large distances; a lack of government assistance; and, finally, health problems due to the dreadful working conditions (REBEHY et al. 2017, p. 463).

Subsequently, participants were asked whether they believed selective collection services would contribute to reduce environmental pollution. The results were as follows: 91.94% said yes; 4.17% said they did not believe selective collection services would contribute to reduce environmental pollution, and 3.89% were unable to answer.

Therefore, most respondents were aware of the contribution of selective collection to environmental preservation. Regarding selective collection, Rebehy et al. (2017, p. 468) affirmed: "environmental and public health collaboration is evident, eliminating potential breeding grounds for infectious disease and the accumulation of residues on public roads."

Asked about what should be done to ensure the implementation of selective solid waste collection services in Juazeiro do Norte, 46.78% of the respondents said that the government should provide this service to the population; 15.10% were unable to answer; 14.60% said the population should collaborate with the government to implement selective collection in the city; 7.42% believe the city lacks adequate infrastructure for the implementation of this service; 6.93% mentioned the absence of environmental education programs aimed at raising population's awareness about solid waste generation and disposal; 2.47% believe the municipal government should encourage the population's participation in programs of selective solid waste collection; 2.23% mentioned the lack of financial resources allocated to the sector; 1.49% said environmental agencies should oversee waste disposal in the city; 0.99% believe that it would be necessary to set up a recycling company; 0.74% stated that the need for further cleaning activities offered by the municipal government; 0.50% stressed the lack of public policies to encourage waste generation reduction; 0.25% stressed the need to encourage the commercialization of recyclable materials; 0.25% believe that selective collection cannot be implemented in the city without appropriate sanitation, and 0.25% reported that the city is ready for the implementation of selective solid waste collection.

One important aspect mentioned by the respondents concerns the population's perception of the need for collaboration, i.e., the importance of social participation to ensure the appropriate implementation of selective solid waste collection in the city. According to Lima (2006, p.35) "the implementation of a selective collection program must consider [...] population's adherence to a new habit that must be acquired. The population must be aware that their contribution represents an effective environmental improvement and citizenship affirmation. "Therefore, community participation is necessary to ensure satisfactory waste sorting and subsequent selective collection.

Regarding the need for adequate infrastructure, respondents (7.42%) said that the following investments were needed: a site for disposing waste, i.e. containers and pickup assembly for collection or recyclable materials (trucks for the collection of recyclable materials); an area for waste separation and labor. However, only 0.50% mentioned the lack of public policies aimed to encourage the waste generation reduction, which suggests that respondents have little understanding of the need to change the population's patterns of consumption and waste disposal habits.

Zanirato and Rotondaro (2016, p. 87) warned that "reducing consumption is a condition for an effectively sustainable world". Nonetheless, respondents also stated that "the process of adapting consumption to sustainability involves multiple actors - government officials, entrepreneurs, workers, ecologists, advertisers, that is, subjects committed to construct, in a continuous process, a culture of recovery" (ZANIRATO; ROTONDARO, 2016). Therefore, more investments should be made in sustainability education, so that the population becomes aware of the consequences of their consumption, including responsibility for waste disposal.

Respondents (2.23%) were also aware of the lack of financial resources allocated for selective waste collection, because the municipal government does not charge a fee for solid waste collection. However, when asked whether they would pay for the environmental service of selective solid waste collection

(Fig. 1), 61.11% of the respondents said they were not willing to pay for these services; 37.50% would be willing to pay, and 1.39% were unable to answer.

Figure 1 – Payment for selective municipal solid waste collection

Source: applied research.

Similar studies carried out in Brazil about willingness to pay for selective solid waste collection found availability to pay in 18% and 36% of the respondents (GULLO; GREGORI, 2011; LUCENA; TÁVORA JR, 2006).

Among the respondents who reported refusal to pay for selective solid waste collection services, the reasons provided were: for 34.46%, the service should be provided by the municipal government, through allocation of funds for this purpose; 31.06% claimed they could not afford paying for a selective collection service; 25.96% said they were overcharged with taxes; 4.26% said they were not interested in participating in the selective collection program; and 4.26% said they would not pay the fee because they did not believe in the effectiveness of the program (credibility). Corroborating these findings, Lucena and Távora Jr (2006), in a study on WTP for the environmental improvement resulting from the reduction of waste disposal in a landfill in Pernambuco, found that the main reasons for refusal to pay are.

Lack of economic resources and the belief that the government is responsible for social actions. In addition, many respondents claimed that they would not pay for the service because they did not believe the money collected would be destined to selective collection (LUCENA; TÁVORA JR, 2006, p.14).

Concerning the respondents with WTP greater than zero (37.5% of them), the total WTP was obtained through the sum of positive WTP's: R\$ 2,119.50 (two thousand, one hundred and nineteen reais and fifty cents) for the monthly payment of the selective solid waste collection service. The values reported by the respondents ranged from R\$ 0.50 (fifty cents) to R\$ 50 (fifty reais) per month. Table 3 shows the distribution of the monthly willingness to pay values of the respondents.

Table 3 – Distribution of WTP values.

WTP (R\$)	No of respondents	%
Zero	220	61.11
0.50	1	0.28
1.00	7	1.94
2.00	4	1.11
3.00	1	0.28
5.00	19	5.28
8.00	2	0.56
10.00	49	13.61
15.00	10	2.78
20.00	17	4.72
25.00	2	0.56
30.00	9	2.50
40.00	1	0.28
50.00	13	3.60
Unable to answer	5	1.39
Total	360	100

Source: Applied research.

As shown in Table 3, most respondents (61.11%) are not willing to pay for selective collection, while 23.06% are willing to pay amounts equal to or less than R\$ 10.00 (ten) reais per month; 14.44% are willing to pay values between R\$ 15 (fifteen reais) and fifty reais (R \$ 50.00); and 1.39% did not inform whether or not they would pay for selective solid waste collection. The average WTP found was R\$ 15.70 (fifteen reais and seventy cents) per month, equivalent to USD 4.77 (four dollars and seventy-seven cents), at an exchange rate of 0.3039. It should be noted that the average WTP in this study sample was based on the average values different from zero mentioned by the respondents. “This result shows a certain willingness of the respondents to collaborate with the implementation of a service that is less aggressive to the environment” (RODRIGUES; SANTANA, 2012, p. 311).

In a similar study conducted in Caxias do Sul, Rio Grande do Sul, Gullo and Gregori (2011) found an average WTP of R \$ 9.05 (nine reais and five cents) per month. In turn, Rodrigues and Santana (2012), in a study carried out in Palmas, Tocantins, found an average WTP of R\$ 23.88 (twenty-three reais and eighty-eight cents) for selective solid waste collection in residential buildings.

Regarding gender, men were found to be more willing to pay for selective collection than women, with 51.85% and 48.15% respectively. In addition, the average WTP of men was R\$ 17.66 (seventeen reais and sixty-six cents), while among the women the average WTP was R\$ 13.58 (thirteen reais and fifty-eight cents). Likewise, in the study by Gullo and Gregori (2011), the average male WTP was higher than the female WTP, as follows: R\$ 10.87 (ten reais and eighty seven cents) per month for men and R\$ 7, 60 (seven reais and sixty cents) for women.

3.3. ECONOMETRIC ANALYSIS

The results shown below (Table 4), refer to the probit model used to determine the likelihood that the WTP of respondents is affected by the variables: gender, age, marital status, income and education. This analysis included data from respondents who expressed a positive WTP and from those who

were not willing to pay for selective collection for economic reasons. However, four observations from participants who did not report income and marital status during the interviews were removed, resulting in 204 samples.

Table 4 – Regression result.

WTP			
Variables	P-value	Coefficient	MS
Gender	0.017**	0.4977 (2.38)	17.44%
Age	0.546***	0.0596 (0.60)	2.08%
Marital Status	0.171***	0.1918 (1.37)	6.72%
Income	0.048**	0.4146 (1.98)	14.53%
Education	0.000*	0.4811 (3.71)	16.86%
Observations	204		
Log Likelihood	-110		
χ^2	44.24		
Prob > chi2	0.0000		
Pseudo R ²	0.1670		
% correct	70.59%		
$y = Pr(wtp)(predict)$	0.6946		

Source: applied research, 2017. Notes: (.) indicates statistics t; */** represent the level of significance of 1% and 5%, respectively; *** indicates that the variables did not obtain statistical significance; χ^2 indicates the likelihood ratio test; correct percentage indicates in percentage value that the model correctly predicted the observations; $y = Pr(wtp)(predict)$ indicates the probability of WTP at the midpoint of the sample.

As shown in Table 4, it is assumed that the null hypothesis was rejected, or else, that no independent variable would influence the limited dependent variable since the value found in the likelihood ratio test (χ^2) was 44.24, indicating that the variables are jointly significant to explain the WTP for selective collection in this study. Moreover, the level of significance of the model was determined by P value = 0.0000, significant to justify the relationship between the variables, being less than 1%. Nevertheless, when analyzed separately, the variables “Age” and “Marital Status” showed no statistical significance for the sample used, and were based on the results of significance probability (P- value) equal to 0.546 and 0.171, respectively.

Regarding the variable “Gender”, it was found to have statistical significance ($p = 0.017$) to influence the respondents’ WTP, at a level of 5%, in the estimated model. The positive sign in the coefficient (0.4977) allows affirming that the referred variable contributes to increase the probability of the respondent being willing to pay for a selective collection service. Based on the marginal effect, it can be assumed that men increase the probability of WTP by 17.44%, compared to women, keeping the remaining variables constant. Corroborating this information, the results obtained by Ferreira and Marques (2015) for the variable “Gender” indicate that men are more likely to be willing to pay for selective solid waste collection than women.

The variable “income” showed a positive coefficient (0.4146) and is statistically significant (5%) had a P value of 0.048. Based on the marginal effect, it can be seen that additional income levels increase by 14.53% the probability of the individual being willing to pay for the selective collection service. Ferreira and Marques (2015) reported that individuals with higher income are more likely to have positive WTP. Similarly, Rodrigues and Santana (2012) also found a statistically significant result for the income variable, which contributes to increase WTP for selective collection, although its reported effect on WTP was close to zero (0.000037%).

Regarding the variable “Education”, a statistically significant relationship (1%) was found, as well as a positive coefficient (0.4811), indicating that this variable contributes to increase the WTP of the respondents. The marginal effect showed that a higher level of schooling increases by 16.86% the probability of WTP for selective solid waste collection, in the sample of this study. Likewise, a study conducted by Rodrigues and Santana (2012) demonstrated that the level of education of residents affects their willingness to pay for selective collection services. The authors reported that every one year increase in years of schooling increased WTP by 0.05%,

4 FINAL CONSIDERATIONS

Based on the results of the present study on economic valuation of selective solid waste collection, in the city of Juazeiro do Norte - Ceará, using the Contingent Valuation Method, 61.11% of the respondents said they were not willing to pay for the selective collection service, while 37.50% would be willing to pay for the referred service, and 1.39% were unable to answer. Although few respondents were willing to contribute financially to support selective solid waste collection, 91.94% of them recognized that these resources contribute to reduce environmental pollution, indicating that this segment of the population is aware of the environmental issues, especially with regard to solid waste.

Regarding the respondents with positive WTP, the average monthly WTP found was R\$ 15.70. Men were more willing to pay than women, accounting for 51.85% of the respondents with positive WTP. Moreover, men’s average WTP was higher than that of women, with values of R\$ 17.66 and R\$ 13.58, respectively.

Statistical analysis showed that the variables gender (17.44%), education (16.86%) and income (14.53%) impact the residents’ WTP for the service, that is, it can be said that the willingness to pay for selective solid waste collection increased when related to the referred variables in the study sample. Therefore, the results of the present study suggest that males with more years of schooling and income are more likely to be willing to pay for the environmental service of selective collection in Juazeiro do Norte.

It should be stressed although this study has emphasized consumer preferences regarding the payment for a selective solid waste collection, from the economic point of view, the environment is useful and valuable for producers and consumers. Thus, it can be affirmed that pollution-generating activities are production, consumption and trade activities (ARAGÃO, 2014). Therefore, Brazil’s National Solid Waste Policy - PNRS (Law 12305/2010), emphasizes shared responsibility for the products’ life cycle (Article 3), with the purpose of reducing the generation of solid waste and refuse, as well as the impacts on the environment and human health (BRASIL, 2010).

Through the implementation of reverse logistics systems (Art. 33), plastic, metal and glass packages, among other products with potential for reuse, should return to the production systems, to be used as secondary raw material. Compliance with this article remains a challenge, as that depends on various actors that share the responsibility for the life cycle of the products, according to the PNRS, namely: producers, distributors, traders, consumers and suppliers of the service of urban public cleaning and waste management (BRASIL, 2010),

Therefore, although many residents mistakenly believe the municipality is solely responsible for the operational and financial management of solid waste generated, such responsibility is also shared with businessmen and the community, and assessment of the technical and economic feasibility of the implementation of selective solid waste collection is required.

REFERENCES

ARAGÃO, A. **O princípio do poluidor pagador**: pedra angular da política comunitária do ambiente. São Paulo: Inst. O Direito por um Planeta Verde, 2014.

BALASUBRAMANYA, S.; EVANS, B.; HARDY, R.; AHMED, R.; HABIB, A.; ASAD, N. S. M.; RAHMAN, M.; HASAN, M.; DEY, D.; FLETCHER, L.; CAMARGO-VALERO, M. A. Towards sustainable sanitation management: Establishing the costs and willingness to pay for emptying and transporting sludge in rural districts with high rates of access to latrines. **Plos One**, 12(3): e0171735, 2017.

BARBISAN, A. O.; MARTINS, M. S.; SAÚGO, A.; PANDOLFO, A.; ROJAS, J. W. J.; REINEHR, R.; PANDOLFO, L. M. Aplicação do método da avaliação contingente através da técnica de disposição a pagar em área ocupada irregularmente no município de Passo Fundo, RS. **Teoria e Prática na Engenharia Civil**, v. 9, n. 13, p. 27-36, 2009.

BARDIN, L. **Análise de conteúdo**. São Paulo: Edições 70, 2011.

BRASIL. **Law nº12305/10**. Política Nacional de Resíduos Sólidos. Diário Oficial [da República Federativa do Brasil], Brasília, DF, 147, 2010.

BRINGHENTI, J. R.; GÜNTHER, W. M. R. Participação social em programas de coleta seletiva de resíduos sólidos urbanos. **Eng Sanit Ambient.**, v. 16, n. 4, p. 421-430, 2011.

CEMPRE - Compromisso Empresarial para Reciclagem. **Ciclosoft 2016**: Radiografando a coleta seletiva. Cempre: São Paulo, 2017.

CUMMINGS, R. G.; HARRISON, G.W.; RUTSTRÖM, E. E. Homegrown Values and Hypothetical Surveys: Is the Dichotomous Choice Approach Incentive-Compatible?, **American Economic Review**, v. 85, p. 260–266, 1995.

DAMIGOS, D.; KALIAMPAKOS, D.; MENEGAKI, M. How much are people willing to pay for efficient waste management schemes? A benefit transfer application. **Waste Management & Research**, v. 34, n. 4, p. 345-355, 2016.

DIAMOND, P. A.; HAUSMAN, J. A.; LEONARD, G. K.; DENNING, M. A. Does Contingent Valuation Measure Preferences? Experimental Evidence, in J. A. Hausman, ed., **Contingent Valuation: A Critical Assessment**. Amsterdam: North-Holland, p. 41–90, 1993.

FARIA, R. C.; NOGUEIRA, J. M. Métodos de valoração contingente: aspectos teóricos e testes empíricos. **Anais do 52a Reunião Anual da SBPC**, de 9 a 14 de julho de 2000.

FEITOSA, A. K.; BARDEN, J. E.; KONRAD, O. Economic valuation of urban solid waste: a review. **Revista Espacios**, v. 38, n. 14, p. 1-13, 2017.

FERREIRA, S.; MARQUES, R. C. Contingent valuation method applied to waste management. **Resources Conservation and Recycling**, v. 99, p. 111-117, 2015.

GAGLIAS, S.; MIRASGEDIS, C.; TOURKOLIAS, E. Georgopoulou, Implementing the Contingent Valuation Method for supporting decision making in the waste management sector, **Waste Management**, v. 53, p. 237-244, 2016.

GIL, A. C. **Métodos e técnicas de pesquisa social**. 6 ed. Atlas Novo: São Paulo, 2008.

GUJARATI, D. N.; PORTER, D. C. **Econometria básica**. 5. ed. Porto Alegre: AMGH, 2011.

GULLO, M. C. R.; GREGORI, L. Valoração de recursos ambientais: uma análise do método de valoração contingente aplicado à coleta dos resíduos sólidos seletivos na cidade de Caxias do Sul. In: **IX Encontro Nacional da Sociedade Brasileira de Economia Ecológica**. EcoEco: Brasília, 2011.

HANLEY, N.; SHOGREN, J. F.; WRITE, B. **Environmental Economics: In Theory and Practice**. London: Macmillan, 1997.

HAUSMAN, J. **Contingent Valuation: A Critical Assessment**. Amsterdam: North-Holland, 1993.

IBGE. **Portal Cidades@. Juazeiro do Norte, 2017.** <<http://cidades.ibge.gov.br/xtras/perfil.php?lang=&codmun=2307304>> Last access in: 30 Mayo 2017.

IPEA – Instituto de Pesquisa Econômica Aplicada. Diretoria de Estudos e Políticas Regionais, Urbanas e Ambientais. **Relatório de Pesquisa: Pesquisa sobre Pagamento por Serviços Ambientais Urbanos para Gestão de Resíduos Sólidos.** IPEA: Brasília, 2010.

IPECE. **Perfil Básico do Município de Juazeiro do Norte.** 2016. Disponível em: <http://www.ipece.ce.gov.br/publicacoes/perfil_basico/pbm-2016/Juazeiro_do_Norte.pdf> Acesso em: 15 Abr. 2017.

KAHNEMAN, D.; KNETSCH, J. L. Valuing Public Goods: The Purchase of Moral Satisfaction. **Journal of Environmental Economics and Management**, v. 22, p. 57-70, 1992.

LIMA, R. M. S. R. **Implantação de um programa de coleta seletiva porta a porta com inclusão de catadores: estudo de caso em Londrina – PR.** Dissertação (Mestrado) – Mestrado em Engenharia de Edificações e Saneamento, Universidade Estadual de Londrina, 2006.

LUCENA, L. F. L.; TÁVORA JÚNIOR, J. L. A importância da redução do lixo para a qualidade ambiental em Recife – PE – Uma análise por valoração contingente. In: **XXXIV Encontro Nacional de Economia.** ANPEC: Salvador, 2006.

MAIA, H. L.; SILVA, P. A.; CAVALCANTE, L. S.; SOUZA, M.; SILVA, M. P. Coleta seletiva: benefícios da sua implantação no bairro de Santa Rosa, Campina Grande-PB. **POLÊMICA**, v. 12, n. 2, p. 352-368, 2013.

MARELLA, G.; RAGA, R. Use of the Contingent Valuation Method in the assessment of a landfill mining project. **Waste Management**, v. 34, n. 7, p. 1199-1205, 2014.

MITCHELL, R. C.; CARSON, R. T. **Using Surveys to Value Public Goods: The Contingent Valuation Method,** Resources for the Future, 1989.

MOTTA, R. S. **Manual para valoração econômica de recursos ambientais.** Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. Brasília, 1998.

PINO, F. A. Modelos de Decisão Binários: Uma Revisão. **Rev. de Economia Agrícola**, São Paulo, v. 54, n. 1, p. 43-57, 2007.

RABÊLO NETO, A.; SOUSA, J. L. R.; MESQUITA, R. F.; FONTENELE, R. E. S.; MELO, J. A. M. Valoração Econômica de Projetos de Requalificação Urbana: Uma Aplicação dos Métodos de Avaliação Contingente e Preços Hedônicos. **Rev. Desenvolvimento em Questão**, v. 12, n. 28, p. 104-143, 2014.

REBEHY, P. C. P. W.; COSTA, A. L.; CAMPELLO, C. A. G. B.; ESPINOZA, D. F.; JOÃO NETO, M. Innovative social business of selective waste collection in Brazil: Cleaner production and poverty reduction. **Journal of Cleaner Production**, v. 154, p. 462-473, 2017.

RODRIGUES, W.; SANTANA, W. C. Análise econômica de sistemas de gestão de resíduos sólidos urbanos: o caso da coleta de lixo seletiva em Palmas, TO. **Revista Brasileira de Gestão Urbana**, v. 4, n. 2, p. 299-312, 2012.

ROSENTHAL, D. H.; NELSON, R. Why Existence Value Should Not Be Used in Cost-Benefit Analysis, **Journal of Policy Analysis and Management**, v. 11, p. 116–122, 1992.

ZANIRATO, S. H.; ROTONDARO, T. Consumo, um dos dilemas da sustentabilidade. **Estud. av.**, São Paulo, v. 30, n. 88, p. 77-92, 2016.

ZENG, C.; NIU, D.; LI, H.; ZHOU, T.; ZHAO, Y. Public perceptions and economic values of source-separated collection of rural solid waste: A pilot study in China. **Resources, Conservation and Recycling**, v. 107, p. 166-173, 2016.