Determinants of WEEE Recycling Behaviour in Romania:
A fuzzy Approach

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ABSTRACT: High levels of WEEE and limited capacities for disposal and recycling, together with the necessity to transpose the European legislation into national law have shaped the profile of WEEE system in Romania. In order to improve the functionality of this system it is important to understand the citizens' behaviour towards WEEE recycling. Recent research conducted in different countries suggest that various determinants, such as socio-economic and demographic factors, environmental knowledge, habits, convenience, motivations, can be used to analyse WEEE recycling behaviour. The results are contradictory and demonstrate that the peculiarities of each country have different influences on how people engage in WEEE collection and recycling. In the present paper, using hypotheses testing we have developed a WEEE recycling behaviour model for Romanians. It was assumed that socio-demographic factors and personal norms would predict WEEE recycling attitude and attitude, contextual forces, knowledge and recycling habits would influence WEEE recycling behaviour. The data, gathered using a survey, were processed using a fuzzy approach. The results showed that in the Romanian context the strongest determinants of WEEE recycling behaviour are people attitudes and habits. Moderate effects have recycling knowledge, pro-environmental norms and institutional support, while gender, income, perception of availability of collection points and regulations haven't any influence.

Key words: Recycling, WEEE, Pollution, Environment

INTRODUCTION

The first concerns regarding WEEE emerged in Romania after the year 2000 and were intensified after the accession to European Union on 1 January 2007. The emergence of EU regulations governing the management of WEEE (Directive 2002/96/EC (EC, 2003a) and Directive 2002/95/EC (EC, 2003b)) triggered a series of actions to implement the directives into national law. Since 2005, later than in other European countries, have been initiated specialized studies in the field (Fessé, 2007).

An important problem facing the WEEE decision makers is to meet the target regarding the annual collection rate. The new directive 2012/19/EU introduces higher WEEE collection targets. Beginning with 2019 EU member states have to recycle 85% of the WEEE generated on their territory or 65 % of the average weight of equipment placed on the market in the three preceding years (EC, 2012). According to a report developed by the Romanian Environmental Protection Agency (REPA, n.d.), in 2010 Romania had an annual WEEE collection rate of 1.4 kilograms per capita, a very small value, compared to the target imposed by regulations (4 kg / inhabitant).

The total EEE quantity existing in the Romanian households is around 25/30 kg/capita and the average use of the most equipments is higher than in other European countries (Gfk, 2011). Over 50% of the population uses electronic equipments and appliances until they break (Gfk, 2011). Exceptions are the mobile phones and the computers, which are replaced as new models with more performances are launched on the market. Under these conditions, the Romanian households possess huge amounts of historic WEEE. A survey realized by Daedalus Millward Brown in 2011 for ECOTIC and RECOLAMP (two associations that

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have taken the responsibilities of the manufacturers of electrical and electronic equipments) has shown that 33.40% of the households in the urban areas possess non functional WEEE (a decreasing rate compared to 65.80% as it was in 2008). Although nobody surveyed rural communities, the socio-economic conditions of the inhabitants living in these areas lead to the assumption that the amounts of non-functional WEEE are much higher. Important factors in the genesis of these negative issues are the low level of education concerning WEEE and the lack of information regarding the collection methods and collection points (Ciocoiu *et al.,* 2010a, Ciocoiu *et al.,* 2010b, Tartiu, 2011b). The economic crisis had also an impact, people holding old equipments in use for a longer period. To improve WEEE recycling, different programs have been initiated, including the extension of the network of WEEE collection facilities, more frequent drop-off special events and retail collection programs.

Studies on the attitudes and behaviour of individuals or households towards WEEE recycling have been realized in the last 10-15 years. Among the pioneers in the field were Cooper and Mayers (2000) in United Kingdom. They investigated the WEEE consumer attitude regarding the acquisition, use and disposal of household appliances using face-to-face interviews and focus groups. Some conclusion of their large study are that men and people of higher socio-economic status are more concerned about products becoming obsolete, while women and people of lower socio-economic status are more concerned about costs. In terms of waste disposal services, householders were influenced by convenience of collection and the possibility to obtain some financial incentive when return a product.

Another study for United Kingdom (conducted in Cardiff) was made by Darby and Obara (2005). Using a large-scale postal questionnaire and semi-structured interviews they analysed household waste behaviour and attitudes towards the disposal of small EEE. The findings highlighted the lack of awareness regarding small items of WEEE and the special attitudinal issues generated by their size and complexity.

Saphores et al. (2006) analysed in California the household willingness to recycle e-waste at drop-off centres. The findings have shown that convenience and familiarity with recycling other waste, gender, age, and environmental beliefs are important determinants of the willingness to recycle WEEE, while income and political affiliation haven't any influence.

Nixon and Saphores (2007) designed a study applied to 357 Californian households, with the goal to analyse people's willingness to pay for the expansion of the WEEE recycling infrastructure. The most significant factors in explaining people's willingness to pay an advanced recycling fee for electronics were: age, income, beliefs about government and business roles in protecting the environment, proximity to an existing recycling centre, level of education, and environmental attitudes.

Gurauskienė (2008) analysed the main factors of the willingness to use electric and electronic equipments in a sustainable way and to participate in the WEEE recycling. According to the author, the basic variables in the analysis of WEEE household recycling are: attitude, motivation, knowledge and behaviour. The success of the reduction of WEEE amounts and consumer engagement in collecting old equipments depends on finding ways to "close the loop", to ensure that discarded equipments are reused or recycled to make new equipments. The conclusion was that education and information are the main tools to change the attitude towards e-waste and involvement in acquiring habits to segregate e-waste from regular waste.

Nixon et al. (2009) investigated the preferences for different types of e-waste recycling programs in California highlighting the impact of environmental attitudes and beliefs on willingness to pay for recycling. The authors designed four alternatives of models based on interactions between 10 key variables. These variables include the costs and convenience of recycling, individual characteristics (such as age, ethnicity, gender), factors reflecting environmental quality attitude and the beliefs about the role of businesses and individuals in protecting the environment. They founded that environmental attitudes and beliefs are statistically significant for willingness to pay for e-waste recycling. Education becomes statistically significant when environmental attitudes and beliefs are not included in the model.

Nnorom et al. (2009) analysed the willingness of Nigerians to participate in WEEE recycling, taking mobile phone recycling as a case study. The results of a principal component analysis highlighted that Nigerians are willing to pay for green cell phones, the main drivers for this behaviour being age, general awareness and concern about environment and the general attitude towards the environment.

Wang et al. (2011) analysed the determinants of behaviour and willingness to participate in WEEE recycling for Beijing residents. The results of their regression model, tested on 957 respondents, indicated that people living in Beijing are not very willing to participate in e-waste recycling. The main identified drivers of WEEE behaviour were: recycling habits,

economic benefits, residential conditions and convenience of recycling facilities. The other investigated factors, like environmental awareness, education, income and knowledge of environmental laws haven't been found to be statistically significant.

A national survey of U.S. households made by Saphores et al. (2012) has shown that the strongest predictors of willingness to recycle WEEE are the personal/moral norms, environmental beliefs and social expectations. Other variables like gender, marital status, recycling convenience, knowledge of the potential toxicity of WEEE and prior e-waste recycling experience have a smaller impact, while familiarity to recycle conventional household waste, knowledge of e-waste laws, household income, family size, and living in a rural area don't matter in explaining household behaviour.

Recently, Song et al. (2012) investigated the behaviour, attitude and willingness to pay for WEEE recycling for people in Macaw. Using a logistic regression model the authors found that education level, age and household income were significant factors affecting WEEE behaviour.

MATERIALS & METHODS

To enhance the efficacy of measures for stimulation of WEEE recycling behaviour, it is essential to investigate the personal characteristics of those who are inclined to recycle (Rode, 2012). Thus, the purpose of the research was to identify the determinants of WEEE recycling behaviour in the Romanian context. In order to achieve the objective of the research, we have synthesized a list of 13 variables that were considered important for the analysis (Table 1). To assess the intensity of each variable we have identified an associated question (Table 1).

Based on the selected factors was designed a WEEE recycling behaviour model (Fig. 1) composed by two main parts: attitudinal determinants and behavioural determinants. Because many studies have proven that structural variables, such as socio-demographics and specific personal beliefs, norms and values influence attitude and indirectly the behavior (Fishbein and Ajzen, 1975; Schwartz, 1970; Bortoleto *et al.,* 2012), in the attitudinal determinants we have included the age, income, education, gender, household size and the pro-environmental norms. In conformity

Table 1. Determinants of WEEE recycling behaviour

Factor	Question
Socio – economic and demographic factors	
Age	Possible values: < 30; 30-45; 45-60; >60
Education	Possible values: Middle school or less; High school; College or more
Income	Possible values: < 500 RON; 500-1500 RON; 1500-2500 RON; 2500-3500 RON; >3500 RON
Gender	Possible values: Male/Female
Household size	Possible values: 1; 2; 3-4; >=5.
Contextual forces	
Institutional support	Do you consider that there is institutional support for the WEEE recycling?
Perception of availability of WEEE collection points	How much do you appreciate that the network of WEEE collection points is developed?
Perception of WEEE regulations	Do you appreciate that WEEE regulations are clear and appropriate?
Personal norms	
Pro-environmental norms	How much do you consider the effects on the environment when purchasing EEE?
Knowledge	
WEEE recycling knowledge	How better do you know how to properly recycle WEEE?
Habits	
Recycling habits	How often your family recycles waste (of any kind)?
Attitude towards WEEE recycling	To what extent do you agree with the idea of recycling WEEE?
WEEE recycling behaviour	How often you recycle WEEE?

with Stern's model (Stern 2000), the behavioural determinants have comprised attitude, contextual forces, knowledge and recycling habits. The proposed model considered the existence of an attitude-behaviour gap.

To test the model 12 hypotheses were defined:
H1:There is a relation between age and WEEE attitude
H2:There is a relation between education and WEEE attitude
H3:There is a relation between income and WEEE attitude.
H4:There is a relation between gender and WEEE attitude.
H5:There is a relation between household size and WEEE attitude.
H6:There is a relation between pro-environmental norms and WEEE attitude.
H7:There is a relation between WEEE attitude and WEEE recycling behaviour.
H8:There is a relation between recycling habits and WEEE recycling behaviour.
H9:There is a relation between WEEE knowledge and WEEE recycling behaviour
H10:There is a relation between institutional support and WEEE recycling behaviour

H11:There is a relation between perception of availability of collection points and WEEE recycling behaviour.
H12:There is a relation between the perception of WEEE regulation and WEEE recycling behaviour.

The aim was to test the hypotheses and determine the strength of the relationships between variables. To meet this goal we conducted a fuzzy statistical analysis. A questionnaire composed of 34 questions was designed to gather the data. The questionnaire was structured in three main parts. The first part extracted the socio-demographic features: gender, age, education, income, household size, profession, place and type of residence. The second part comprised questions concerning various WEEE recycling behaviour determinants. Each item in the second part of the questionnaire was measured using a 100 points scale. These items, together with the socio-demographic variables were used in hypotheses testing. In the third part of the questionnaire were integrated additional questions with the goal to extract the main incentives and barriers concerning the transformation of WEEE attitude in WEEE behaviour.

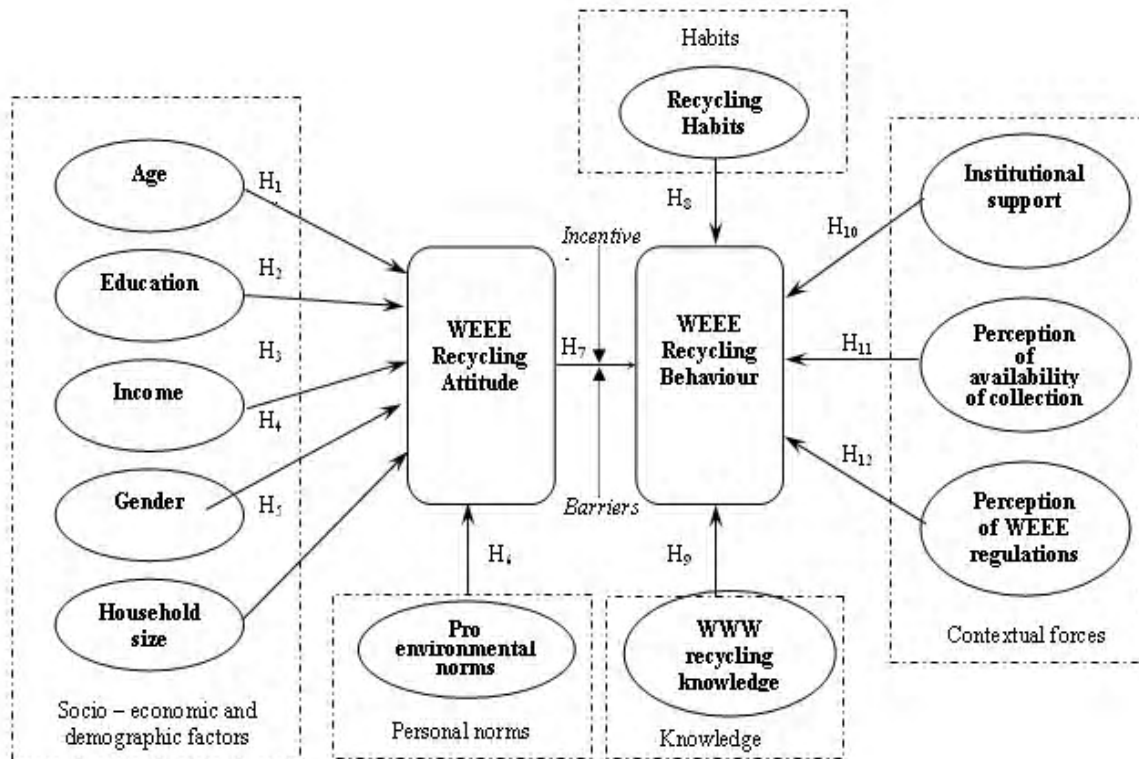Based on the questionnaire, a survey was conducted in Romania in November - December 2012.

Fig. 1. WEEE recycling behaviour model

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The sample consisted of people older than 20 years, from all geographical regions of the country. The questionnaires were distributed by e-mail and in paper form. The response rate was around 20%. Only 253 questionnaires were completed correctly and selected for analysis. Table 2 presents the demographic profile of the respondents.

In their study "Fuzzy versus statistical linear regression", Kim et al. (1996) have demonstrated that fuzzy analysis may be used when the data set is insufficient to support statistical analysis. So, because the dimension of the sample wasn't very big and the responses to many questions were subjective, to test the hypotheses H1-H12, we have used a fuzzy approach.

Since the introduction by Zadeh (1965), the use of fuzzy theory has been proved to be a useful method for solving problems where the information available is subjective. The membership function is the most important concept in this theory. It measures the degree assessment of the membership of elements in a set.

In the following we present the main concepts we have used in the present paper.

Definition 1 (Zadeh, 1975): If X *is* a universe of discourse, $X = \{x_1, x_2, x_3, \ldots, x_n\}$, a fuzzy set $\tilde{A}$ of X is a set of pairs

$$\{(x_1, \mu_{\tilde{A}}(x_1)), (x_2, \mu_{\tilde{A}}(x_2)), \ldots, (x_n, \mu_{\tilde{A}}(x_n)\}.$$

$\mu_{\tilde{A}}(x): X \rightarrow [0,1]$ is the membership function of

and represents the membership degree of x_i in . In many papers, for discrete fuzzy sets it is used the notation:

$$\tilde{A} = \frac{\mu_{\tilde{A}}(x_1)}{x_1} \oplus \frac{\mu_{\tilde{A}}(x_2)}{x_2} \oplus \ldots \oplus \frac{\mu_{\tilde{A}}(x_n)}{x_n} \quad (1)$$

Definition 2 (Bargiela et all, 2007; Cheng and Lin, 2002): A fuzzy number is a special fuzzy set of real numbers with the following properties:

▪Normal ($\exists x \in \Re : \mu_{\tilde{A}}(x) = 1$).

▪Convex (all its α-cuts are closed ordinary intervals, $Acut = \{x \in X \mid A(x) \geq \in [0,1]\}$).

▪Bounded (the support of the fuzzy set is a bounded interval).

There are many types of fuzzy numbers: triangular, trapezoidal, gaussian. In the present paper, triangular and trapezoidal fuzzy numbers were used because of their frequent use in practice (Liou and Chen, 2006).

Definition 3 (Lazim, 2010): A triangular fuzzy number $\tilde{A} = (L, M, U)$ is a special type of fuzzy number defined by three ordered parameters (L≤M≤U), with the membership function defined as:

$$\mu(x) = \begin{cases} \dfrac{x - L}{M - L} & , L \leq x \leq M \\[2mm] \dfrac{U - x}{U - M} & , M \leq x \leq U \\[2mm] 0 & , \text{in the rest of cases} \end{cases} \quad (2)$$

Definition 4 (Taheri and all, 2010): A trapezoidal number is a special type of fuzzy number $\tilde{A} = (L, M, N, R)$ defined by four ordered parameters (L≤M≤N≤R), with the membership function defined as:

Table 2. Demographic Profile of Respondents

Measure	Possible values	Frequency	Percentage
Gender	Female	147	58.10%
	Male	106	41.90%
Age	< 30	88	34.78%
	30-45	64	25.30%
	45-60	48	18.97%
	>60	53	20.95%
Education	Middle school or less	76	30.04%
	High school	96	37.94%
	College or more	81	32.02%
Income	< 500 RON	30	11.86%
	500-1500 RON	61	24.11%
	1500-2500 RON	45	17.79%
	2500-3500RON	83	32.81%
	>3500 RON	34	13.44%
Household size	1	24	9.49%
	2	56	22.13%
	3-4	156	61.66%
	>=5	17	6.72%

$$\mu_{}(x) = \begin{cases} 0 & , x < L \\ \dfrac{x - L}{M - L} & , L \le x < M \\ 1 & , M \le x < N \\ \dfrac{R - x}{R - N} & , N \le x < R \\ 0 & , x > R \end{cases} \qquad (3)$$

The perception of each respondent concerning the linguistic terms depends on its experience and knowledge, so the definition of a linguistic term could change from a person to the other. To reflect the fact that respondents may have different perceptions about linguistic terms, each respondent has defined, in a separate sheet, the value range for the linguistic terms in his/her assessments, using a 1-100 scale and values from 5 to 5. The sets of responses for each linguistic term were represented using histograms (Fig. 2).
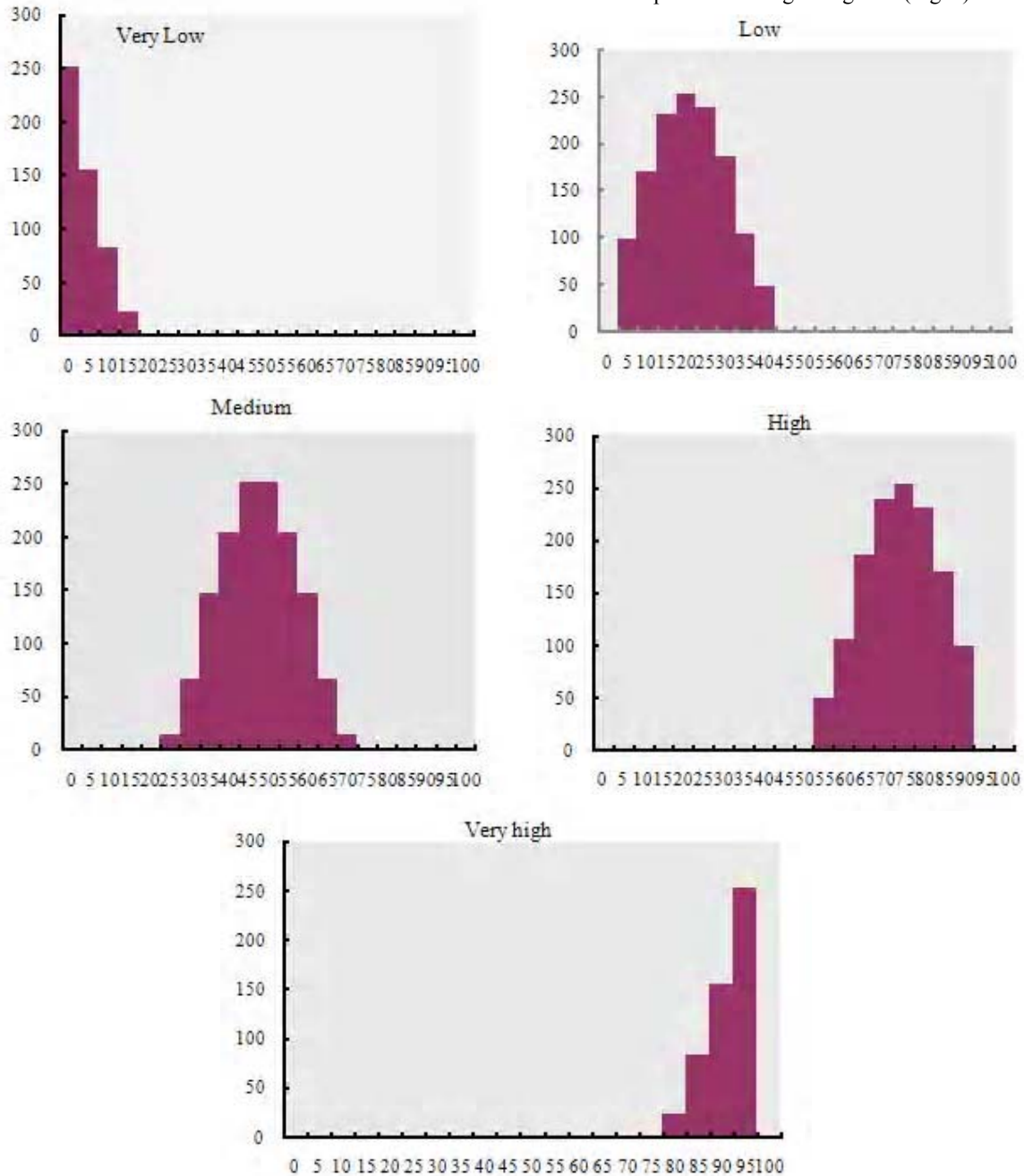

Fig. 2. The histograms of each linguistic variables

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Based on the histograms, the *Very Low* and *Very High* linguistic terms was characterized by trapezoidal fuzzy numbers, and *Low, Medium* and *High* by triangular fuzzy number.

For triangular fuzzy numbers we have used the following rule: if $(L_i, U_i)_A$, is the response of the ith respondent for the $\widetilde{A}$ linguistic term (i=1..n, n=number of respondents),

then $L_{\widetilde{A}} = \min_{i=1..n} L_i$, $U_{\widetilde{A}} = \max_{i=1..n} U_i$ and $M_{\widetilde{A}}$ = the integer mean of the interval with the most number of responses.

For trapezoidal fuzzy numbers we have used the following rule: if $(L_i, U_i)_A$, is the response of the ith respondent for the linguistic term (i=1..n, n=number of

respondents), then , , and equalled the minimum and maximum of the interval with the most number of responses.
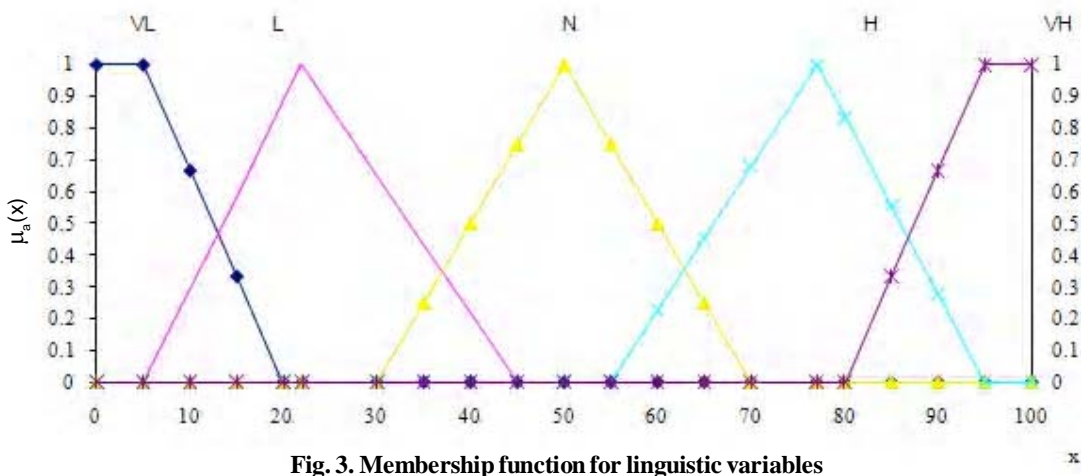
The final calculations for the values of fuzzy membership function of each linguistic term are shown in Table 3. Fig. 3 shows the graphical representation of the membership function for linguistic terms.

Each respondent has its own perceptions and opinions in the evaluation of each statement. The use of the membership function to represent the respondent degree of its feelings will give better results. So the next step was the fuzzification of each respondent response.

Let's note with R_{ij} the rating made by respondent i to the statement j. R_{ij}, a crisp value, has partial

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	45-60	48	18.97%
	>60	53	20.95%
Education	Middle school or less	76	30.04%
	High school	96	37.94%
	College or more	81	32.02%
Income	< 500 RON	30	11.86%
	500-1500 RON	61	24.11%
	1500-2500 RON	45	17.79%
	2500-3500RON	83	32.81%
	>3500 RON	34	13.44%
Household size	1	24	9.49%
	2	56	22.13%
	3-4	156	61.66%
	>=5	17	6.72%

Fig. 3. Membership function for linguistic variables

memberships in various linguistic terms. The membership in a linguistic term could be calculated using the rules defined in (2) and (3). For example $\mu_{VL}(35)=0$, $\mu_L(35)=0.43$, $_M(35)=0.25$, $\mu_H(35)=0.0$, $\mu_{VH}(35)=0.0$ (Fig.2). If L={VL, L, M, H, VH} is the set of linguistic terms, the fuzzy number of R_{ij} is

$$(4)$$

$$\mu(R_{ij}) = \frac{\mu_{VL}(R_{ij})}{VL} \oplus \frac{\mu_L(R_{ij})}{L} \oplus \frac{\mu_M(R_{ij})}{M} \oplus \frac{\mu_H(R_{ij})}{H} \oplus \frac{\mu_{VH}(R_{ij})}{VH}$$

For hypotheses testing we have used the methodology proposed by Nguyen and Wu (2006) in "*Fundamentals of Statistics with Fuzzy Data*". In the following we present the definitions of the main lemmas used in the analysis.

Lemma 1 (Yao, and Huang, 2004): If L={L1,...,Lk} is a set of k-linguistic variables on a discussion domain U, and $\left\{ \mu(\tilde{x}_i) = \frac{\mu_{L_1}(\tilde{x}_i)}{L_1} \oplus ... \oplus \frac{\mu_{L_k}(\tilde{x}_i)}{L_k}, i = 1..n \right\}$ a sequence of random fuzzy sample on U, the fuzzy sample mean is defined by:

$$(5)$$

$$\mu(\overline{x}) = \frac{\frac{1}{n}\sum_{i=1}^{n}\mu_{L_1}(\tilde{x}_i)}{L_1} \oplus ... \oplus \frac{\frac{1}{n}\sum_{i=1}^{n}\mu_{L_k}(\tilde{x}_i)}{L_k}$$

In order to test if there is a relationship between two variables we have used the fuzzy χ^2-test of homogeneity (Nguyen and Wu, 2006). The first step in applying the fuzzy χ^2 test of homogeneity is to build the fuzzy contingence table. At this moment appears a difference from the traditional statistical method, because a point could simultaneously have partial memberships in multiple groups.

Lemma 2 (Taheri *et al.*, 2010; Georgescu, 2002): If $\left\{ (\tilde{x}_1, \tilde{y}_1), (\tilde{x}_2, \tilde{y}_2), ..., (\tilde{x}_n, \tilde{y}_n) \right\}$ are fuzzy random samples of observations, a two -way contingency table with fuzzy categories $G = \left\{ \tilde{G}_1, ... , \tilde{G}_t \right\}$ and $H = \left\{ \tilde{H}_1, ... , \tilde{H}_k \right\}$ (t-number of groups in the independent variable, k-number of groups in the dependent variable, n-total number of observations), is defined by $f_{ij} = \sum_{k=1}^{n} T(\mu_{G_i}(\tilde{x}_k), \mu_{H_j}(\tilde{y}_k))$, where T is a T-norm (min is one of the most popular ones and we have used it)

For hypotheses H1-H5, G_1, G_2, ..., G_t are defined by crisp values, so the contingency table looks like in Fig. 4. We have 5 linguistic terms, so k=5

For hypotheses H6-H12, the contingency table is a 5*5 matrix, like in Fig. 5.

	VL	L	N	H	VH	Total
G_1						
...			f_{ij}			$R_i = \sum_{j=1}^{5} f_{ij}$
G_t						
Total			$C_j = \sum_{i=1}^{t} f_{ij}$			$n = \sum_{i=1}^{t}\sum_{j=1}^{5} f_{ij}$

Fig. 4. Fuzzy contingency table for hypotheses H1-H5

	VL	L	N	H	VH	Total
VL						
L						$R_i = \sum_{j=1}^{5} f_{ij}$
N			f_{ij}			
H						
VH						
Total			$C_j = \sum_{i=1}^{5} f_{ij}$			$n = \sum_{i=1}^{5}\sum_{j=1}^{5} f_{ij}$

Fig. 5. Fuzzy contingency table for hypotheses H6-H12

For each hypothesis we defined the null hypothesis H_0: The analysed variables are statistically independent (no significant relationship), and H_a: The variables are related.

Based on contingency tables we calculated χ^2 using **lemma 4** (Nguyen and Wu, 2006)

$$\chi^2 = \sum_{i \in G} \sum_{j \in H} \frac{(f_{ij} - E_{ij})^2}{E_{ij}}, \quad E_{ij} = \frac{R_i * C_j}{n} \quad (6)$$

If $\chi^2 \geq \chi^2_{\alpha(t-1)*(k-1)}$ under the significance level α, then H_0 is rejected.

The χ^2 test shows only if there is a statistical relationship between two variables, but doesn't evaluate the relative strength of it. To measure the correlation between two variables we have used the τ Goodman Kruskal measure of association (Reynolds, 1984) (7). If τ equals zero there is no association between variables, if equals 1 there is a perfect association.

$$ \quad (7) $$

$$\tau = \frac{E_1 - E_2}{E_1}, \quad E_1 = \sum_{i=1}^{t} \frac{n - R_i}{n} * R_i, \quad E_2 = \sum_{j=1}^{5} \sum_{i=1}^{t} \frac{C_j - f_{ij}}{C_j} * f_{ij}$$

Where results indicated a relationship between two variables, in order to analyse which groups of the independent variable caused the resulted behaviour, we have calculated the adjusted standardized residuals (ASR_{ij}) (Argesti, 2002).

$$ASR_{ij} = \frac{(f_{ij} - E_{ij})}{\sqrt{E_{ij} * (1 - \frac{R_i}{n}) * (1 - \frac{C_j}{n})}} \quad (8)$$

A larger absolute value of the adjusted standardized residual shows a more significant association between the analysed variables.

RESULTS & DISCUSSION

Table 4 summarizes the results of χ^2 tests for hypotheses H1-H12: 8 hypotheses are supported and 4 not. Fig. 6 presents the validated WEEE behaviour relationship model.

As shown in Table 6 and in Fig. 6 the WEEE recycling attitude is correlated with age, education, income and personal and moral norms. Other variables, such as gender and number of members in the household, are not statistically significant. From the socio-economic and demographic variables, age is the most significant determinant of WEEE attitude ($\tau = 0.417$), followed by income and education level.

While most of the studies on WEEE recycling behavior agree that age is a significant factor, there are differences regarding the type of correlation (positive or negative). Our study revealed that as age increase, there is a noticeable decrease of the positive attitude towards WEEE recycling. The results are oposite with those obtained by Saphores et al. (2012) showing the older people are more willing to engage in WEEE recycling. In Romania, there are different cultural patterns. The mobile phones, MP3 players and laptops are the most replaced EEE products, while ubiquitous products like fridges or washing machines are replaced only when breaks (Daedalus Millward Brown, 2010). The fashion to have the newest models of iPads, mobile phones, iPhones or laptops reached young Romanian people. A survey conducted by Daedalus Millward Brown (2010) has shown that 33.20% of respondents replaces the mobile phone at maximum six months, usually until a new model is launched. Only 11.60% keeps it for more than three years, and another 12.60% for more than five years. Opposite, there are many people older then 65 years that use the same fridge for more than 30 years and never used in their life an ITC product. So, the powerfull difference between generations regarding the use of technology could explain that younger are more inclined towards WEEE recycling than elders.

The results of the present study show that education has a modest impact on WEEE recycling

Table 4. Hypotheses results

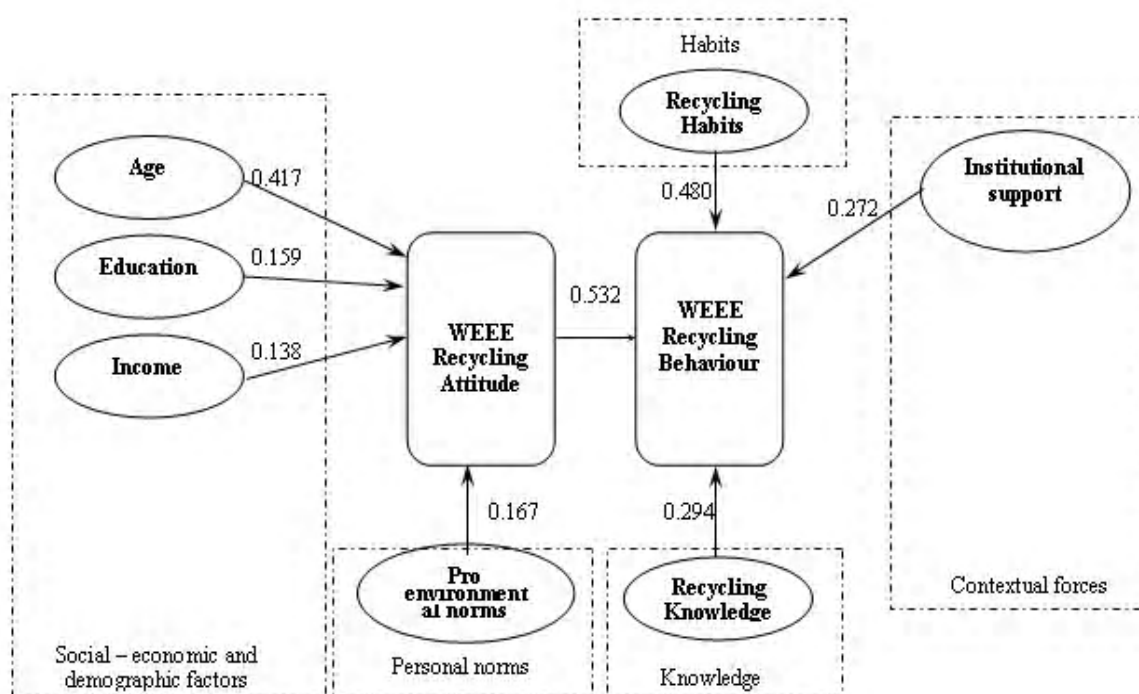| Hypothesis	χ^2	$\chi^2_{0.05(t-1)*(k-1)}$	Supported	τ
H1	25.312	21.026	Yes	0.417
H2	10.099	9.488	Yes	0.159
H3	28.081	26.296	Yes	0.138
H4	7.538	15.507	No	-
H5	9.840	21.026	No	-
H6	63.121	26.296	Yes	0.167
H7	297.79	26.296	Yes	0.532
H8	117.71	26.296	Yes	0.480
H9	48.532	26.296	Yes	0.294
H10	15.692	26.296	Yes	0.272
H11	7.565	26.296	No	-
H12	5.876	26.296	No	-

Fig. 6. Validated WEEE behaviour model

attitude (τ= 0.159). As education increases, increases and the positive attitude towards WEEE recycling. High educated people are more environmentally conscious and more likely to participate in WEEE recycling programs. But it is important to make the difference between education and WEEE knowledge. Being highly educated not necessarily imply a high level of knowledge about how WEEE is recycled.

The weakest correlation in the proposed model is between income level and WEEE recycling attitude (τ= 0.138). The analysis showed that people with higher levels of income are more positive with the ideea of WEEE recycling. WEEE replacement requires larger amounts of money. Higher-incomes people can more easily afford to buy new EEE products and to replace the old ones. From another point of view, using EEE for a large period of time represents a method of saving for people with lower income. The level of welfare in Romania is modest compared to other European countries. An ICPE study (2006) revealed that the average use of large appliances in Europe is of 8-10 years, while in Romania is 13-17 years. Receiving a discount on the purchase of a new equipment when they give in return an old one, seems to be the most important way to stimulate recycling for respondents with low incomes. 58.30% of the respondents with the income lower than 1500 RON (~350 Euros) responded that they have used the take-back as recycling method.

Variables like gender and household size haven't found to be statistically significant for WEEE recycling attitude. The results are opposite to the findings of Saphores et al. (2012), who found that family size has a positive impact on e-waste recycling and gender plays a minor role. Maybe, in the Romanian context, the formation of individual attitude towards WEEE is influenced more by household attitude and doesn't depend on gender or household size.

The socio-demographic factors explain only a part of attitude. The results have also confirmed the existence of a corelation between pro-environmental norms and WEEE recycling attitude (τ= 0.167). Individual's choice to consider the effects on the environment when purchasing EEE is the expression of the WEEE awareness and of the posibilities to take action in WEEE issues.

People's beliefs are important drivers of their behaviour. But many times, between beliefs and actions there are important differences, external factors may preventing a positive intention to be converted into behaviour. Thus, the correlation between attitude and behaviour it isn't perfect. In our investigation, the attitude toward WEEE recycling was measured using the extent of agreement with the idea of recycling and WEEE behaviour by the frequency of recycling. The result of the study is consistent with previous research in recycling (Wan et al., 2012; Chen and Tung, 2010): there is a relation between attitude and recycling behaviour. Even the hypothesis was accepted, the measure of association between variables was not very strong, t =0.532. An analysis of the external factors

explaining this difference has shown that the main inhibitors for the conversion of attitude in behaviour are: the lack of information about the places where non-functional products can be disposed (43.48%), commodity (5.93%), lack of time (15.81%), distance to recycling facilities (13.04%), intention to repair (21.74%), while the main incentives are: releasing space in the households (68.77%), obtaining discounts at the acquisition of a new product (17.79%), the desire to protect the environment from harmful effects (13.44%). The maximum adjusted standardized residual (8.94) corresponds to VH (attitude) - H (behaviour) cell in the contingency table, so people with a positive attitude towards WEEE recycling are more like to engage in WEEE recycling.

Results from previous research have shown that household waste recycling is a stable behaviour (Bagozzi and Dabholkar, 1994; Pieters, 1991; Dahab et al., 1995), having powerful drivers as personal habits and household routine (Stern, 2000). Consistent with these findings, our analysis showed that one of the strongest correlation, t =0.480, is between recycling habits and WEEE recycling. The surprise was that 64.43% of respondents rated better the frequency of WEEE recycling than the frequency of recycling other type of waste. One explication for this result could be the following. In Romania the rate of recycling waste is very low, around 2% in 2009 (FRD, 2011). Separate collection is implemented only in some pilot locations. The main method used for household recycling is selling recyclable waste to specialized companies. Using this system are recycled paper, cardboard, plastics, glass and metals. These products have generally low value and big volumes and many times the money received are less than the transportation costs, so the general trend is to throw all waste together. WEEE benefited from the take-back programs. Until 2008 there was a boom of the domestic EEE consumption and a lot of people preferred to obtain a price reduction giving in place an old product. Many studies highlighted the importance of knowledge in shaping WEEE recycling behaviour (Gurauskienë, 2008; Saphores *et al.,* 2012). A person who intends to participate in recycling, but does not know how to do, or has an incorrect knowledge of the rules, will not participate properly (Tucker, 2003). In our study the respondents were asked to rate their perception of knowledge about how WEEE is recycled. The processing of responses reflected that there is a relation between WEEE knowledge and WEEE recycling behaviour (t =0.294). However, in order to better understand the links between people WEEE knowledge and behavior the questionnaire comprised three additional questions:

•*How do you recycle WEEE?* (with 7 possible responses)
•*Please check the name of the association responsible for WEEE collection you have heard* (with 7 possible responses)
•*Please check the name of the WEEE collecting campaign you have heard* (with 7 possible responses)

The results showed that unfortunately there are still Romanians who don't participate in WEEE recycling because they are not sufficiently informed about recycling facilities and campaigns. Some of them even throw WEEE together with other types of waste, without knowing how dangerous are (15.02%). The distribution of responses for the method of WEEE disposal is presented in Fig. 7.

Even many people responded that have knowledge about WEEE recycling, when asked about the name of collection campaigns and associations responsible for WEEE collection the responses were disappointing. More than 70% of respondents specified maximum 1 association and 1 campaign. Moreover, the main declared barrier for not participating in recycling was the lack of information about the places where non-functional products can be disposed (43.48%). When the perceived knowledge exceeds the real knowledge, people might recycle incorrectly (Pieters, 1991). This result shows that decision makers should take proper actions in order to increase the education and information levels concerning WEEE recycling.

Without the implementation of large-scale WEEE recycling programs it is very difficult to obtain high rates of WEEE collection. Hicks et al. (2005) mention that the institutional support for WEEE recycling is very important, especially in developing countries. In Romania, the formal WEEE collecting system is based on three collection channels (Ciocoi *et al.,* 2010a):
▪„single day" collection actions – actions organized at fixed dates with the goal to collect WEEE from households;
▪the „take-back" system – the retailers offer a discount when buying a new equipment of the same type;
▪collection centers – where the consumers can dispose WEEE free of charge.

Beside the formal system, there is a powerful informal WEEE system (Ciocoiu and Tartiu, 2012). People go from house to house and collect WEEE and other type of waste (Tartiu, 2011a). The same people collect WEEE thrown at trash bins. A big problem of the informal sector is that WEEE is recycled using high polluting technologies causing threat to environment and human health. Another problem is that the most of informal collectors aren't registered under the country's WEEE management system and they don't report the collected
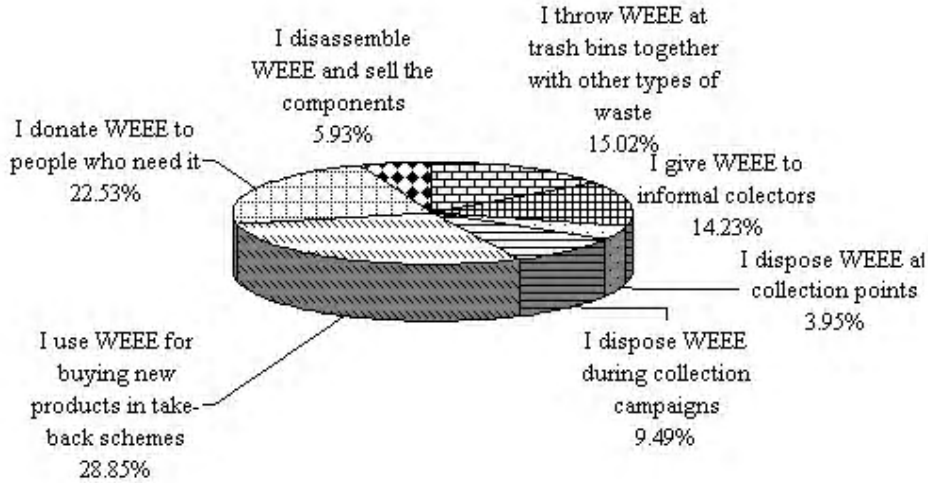
Fig .7. Distribution of responses for the method of WEEE disposal

waste, this fact being an important barrier in achieving the collection rate imposed by the European Directive.

The present study confirmed that there is a relation between how Romanians perceive the institutional support and WEEE recycling behaviour (τ =0.272). 42.29% of surveyed people responded that dispose WEEE using the formal system, while 29.25% dispose in the informal system. The amounts disposed in the informal system aren't so high like in China (Liu et al., 2006), where the 94% of households dispose WEEE using informal sector, but are still far from desired values. In order to reduce the negative impacts caused by informal recycling, the Romanian decision makers have to develop a powerful formal sector and to decrease the size and role of the informal sector.

The analysis showed that there isn't any relation between the perception of the availability of collection points and WEEE recycling behaviour. Asked if they know how much is developed the network of collection points in their region, many respondents (45.85%) rated the question with low scores (corresponding to Very Low and Low linguistic terms). At another question only 10 persons (3.95%) reported that WEEE disposal was made at collection points. The most preferred recycling methods were: the take back programs (28.85%) and donations to other people (22.53%) (Figure 7). Even if people have knowledge about the existence of recycling centres, they prefer another way of recycling, the main barrier for WEEE disposal in collection points being the was the lack of information about these (43.48%).

Another hypothesis that hasn't been confirmed is the relation between the perception of WEEE regulations and WEEE recycling behaviour. In the third part of the questionnaire, the respondents were asked

if they know that recycling and disposal of WEEE is governed by specific regulations. 204 persons (80.63%) responded Yes, 23 (9.09%) No and 26 (10.28%) responded that they have low knowledge about the subject. Despite this high rate of positive responses, when asked to rate the perception on WEEE regulations, the most of the responses were in the range Neutral - Very Low (57.70%). The explication is that people can recycle based on own initiative, without the constraints of any regulation.

CONCLUSION

The growth of e-waste caused by increased levels of consumption became a problem in Romania in the last few years because the WEEE management system is still in its infancy. The very fast rate of innovation in electronics convinced people to buy new types of products or to replace the old ones with other more efficient. Some Romanians are willing to collect and recycle the old equipments, but most of them don't know how the recycling could be done, where are the collection points and what are the negative impacts of WEEE over the environment. In this context, the purpose of the present study was to identify and analyse the main determinants of the Romanians' behaviour towards WEEE recycling. The necessity to increase the effectiveness of the WEEE management system and to meet the collection target imposed by the European Union requires such an analysis.

Like other studies in the field, in the present paper we have explored the links between socio-economic and demographic variables and WEEE recycling attitude. The results show the existence of correlations between WEEE recycling attitude and age, education and income, while gender and household size haven't been found to be relevant. Young people, better educated and with knowledge about environmental

protection are more likely to be implied in WEEE recycling than other categories of people.

The analysis showed that the strongest determinants of WEEE recycling behaviour are people attitudes and habits. People coming from families with a recycling culture tend to be more involved in WEEE recycling. The development of recycling habits is a long process and unfortunatelly, Romania occupies the last position in EU regarding selective waste collection (Tartiu, 2011a). Under these conditions, WEEE stakeholders should take various actions in order to stimulate the forming of recycling habits.

The study is underlining the importance of education and the value of knowledge regarding the process of WEEE collecting and recycling. If people are not informed about these issues then it is difficult to achieve the goal of a healthy electronic waste management system. Improving knowledge on WEEE recycling represents a relatively easy way of action. This can be done by an efficient promotion of recycling campaigns and a powerful involvement of the education system. Currently, the collective associations of producers together with the Romanian Ministry of Education promote a national program for selective WEEE collection in schools, but the action could be extended in universities.Stern (2000) considers that contextual forces are major drivers for environmentally behaviour. From contextual forces only the correlation with institutional support has been confirmed. This result supports Stern's idea that when contextual factors are not very important, then attitudes, personal capabilities and habits can have a stronger impact on influencing behaviour.

Another reason for developing this research refers to the fact that studies on the determinants of WEEE recycling behavior are very few and it does not appear to be any research that explores the attitude and behavior of consumers towards WEEE recycling in Romania. In this context, our empirical results show that is necessary to know more about WEEE recycling and to participate actively to the recycling process with all that involve it.

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