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THE TRANSITION FROM LINEAR ECONOMY TO CIRCULAR ECONOMY: A BEHAVIORAL CHANGE

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ABSTRACT

The circular economy is one of the major global concerns, and the transition from the linear economy to the circular economy requires not only the creation of new business models, but also a change in consumer behavior. Our research theme aims to analyze the perception of selective waste collection at the level of Galati County. As a research method we used questionnaire-based analysis with 544 respondents. The analysis was based on three working hypotheses, and in the future, we will extend the analysis to other components of the circular economy.

KEY WORDS: Recycling rate, consumer behavior, circular economy, selective waste collection.

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1. INTRODUCTION

The EU Circular Economy Action Plan underlines the impact of the circular economy on competitiveness, and its implications against resource scarcity and volatile prices, and the European Commission also considers that the circular economy will lead to the creation of new business opportunities and innovative

and efficient production and consumption models (European Commission, 2015). In addition to the favorable impact on the economy, the same European Commission Material (2015) highlights the impact of the circular economy on the environment, helping to avoid irreversible damage to the climate and the environment. Selective waste collection is only a small component of the circular economy. The objective of the circular economy is to minimize waste, increase resource productivity, optimize production by implementing innovative business models, all with the lowest impact on the environment (Ellen MacArthur Foundation, 2019).

At European level there are multiple legislative concerns, as well as strategies setting medium- and long-term objectives in the circular economy. All these states will not succeed without accepting and adapting manufacturers to new business models (Cherry et al., 2018; van Weelden et al., 2016).

Potential benefits of implementing the economic model based on the principles of the circular economy across EU-28 countries by 2035 (Henry, 2016):

- a 7% increase in GDP at EU level – 28, which will lead to economic growth;
- creating new jobs by 2035, especially in the waste management sectors;
- enhancing competitiveness and encouraging innovation;
- annual reduction of total greenhouse gas emissions by 450 million tones or 2-4%/ Year.

There is a general consensus that the efficient management of raw materials, waste, and energy is closely linked to sustainable economic and social development. In recent times, there has been an increase in the volume of waste globally but also a diversification of its flow. This is a consequence of the intensification of the urbanization process, the reduction of the product lifecycle, but also the stimulation of consumption. In the context of the sharp decline in natural resources, the rapid deterioration of the environment as a result of anthropogenic action, the problem of waste management has become increasingly current.

Raising public awareness of the implementation of a green approach is a feature of the transition to a green economy. The concept of green economy is closely linked to the concept of circular economy, both of which are components of sustainable development. The two concepts have common elements: waste

management and resource efficiency.

In Romania, the recycling rate of waste in 2017 was 13.9%, much lower than the EU-28 waste recycling rate for the same period (46.4%). In these circumstances, Romania risks not being able to meet the European targets for increasing the recycling rate of waste. In our opinion, the development of the circular economy in Romania can be supported by informing and educating the population about the selective collection of waste.

The objective of our research is to determine the perception of Galati citizens on the selective collection of waste. We believe that the transition from a linear economy to a circular economy is influenced by compositional changes among both producers and consumers.

2. LITERATURE REVIEW

Circular economy is a major concern at the global level, and can be defined as a sustainable economic model aimed at the efficient use of resources through not only waste minimization, but also waste cycled back into production processes. Morseletto (2020) considers that circular economy strategy has to include ten action directions: recover, re-use, recycling, repurpose, refurbish, remanufacture, repair, reduce, rethink, and refuse.

Implementing a system that allow to all users and businesses to engage in the circular economy, involves technological and economic challenges. Without a fundamental change in consumer behavior regarding reuse and recycling, the transition to circular economy is not possible (Planing, 2015). According to sustainability dimension (social well-being, economic resilience and environment integrity), new circular economy business models have to design their activities taking into account those dimensions (Kravchenko et al., 2019).

Even at the European level exist a lot of policies and strategies regarding management waste, in some countries, municipal waste still mainly ends at landfills. Significant investments were made in waste management centers based on mechanical-biological treatment, but the recycling rate is still low (Luttenberger, 2020).

Business models of the linear economy have led to a certain consumer behavior,

which may be an impediment to the transition to the circular economy. In a consumption-based economy it is difficult to generate demand for used or repaired products (Bittar, 2018).

Since 2015, at EU level, a plan of measures has been adopted to stimulate the circular economy and generate sustainable economic growth. The action plan includes a set of legislative proposals with regulations in the field of waste management (European Commission, 2015). The circular economy is a prerequisite for sustainable economic growth, which involves the development of innovative new business models aimed primarily at making the use of resources more efficient.

The principles of the circular economy apply to all sectors of activity through different types of synergies, which can generate cumulative effects on the economy and the environment (Parajuly, 2017). Manufacturers must adopt new product design models that respect the principles of the circular economy, favorable to the end-of-life (EoL) scenario (Atlason et al., 2017).

Circular economy becomes an important issue for the United Nations, that adopted the 2030 Agenda for Sustainable Development, mentioning the Sustainable Development Goals, and management of waste is closely linked to several goals (Good health and Well-being, Clean water and Sanitation, Responsible Consumption and Production) (Baldé et al., 2017). Ghisellini et al. (2016), considers that the transition to circular economy has just started, and for the moment is necessary to improve the present production and consumption models in order to increase the used resource efficiency.

3. RESEARCH METHODOLOGY

In order to assess the perception of Galati citizens about selective waste collection, we design a pilot questionnaire, most of questions having a five-value response scale. The questionnaire was divided in two section, 5 questions have a nominal scale for determining the profile of the respondent, and 8 questions have a semantically differentiated scale of 5 steps and address the underlying issue of the research.

Finally, 544 filled questionnaires were analyzed in a SPSS database. According to the segmentation criteria the distribution of the population from our study

reveal that the majority of respondents are females (82.35%), while the males represent 17.65%; the majority have bachelor degree education (57.34%), 10.76% have master degree, while 29.33% have upper secondary education and only 2.57% have doctoral studies; in what concerns their age, 50% of respondents are included in the interval (18-25 years), 22.42% in the interval (36-45 years), 19.88% are over 45 years old and just 7.7% are in the interval (26-35 years).

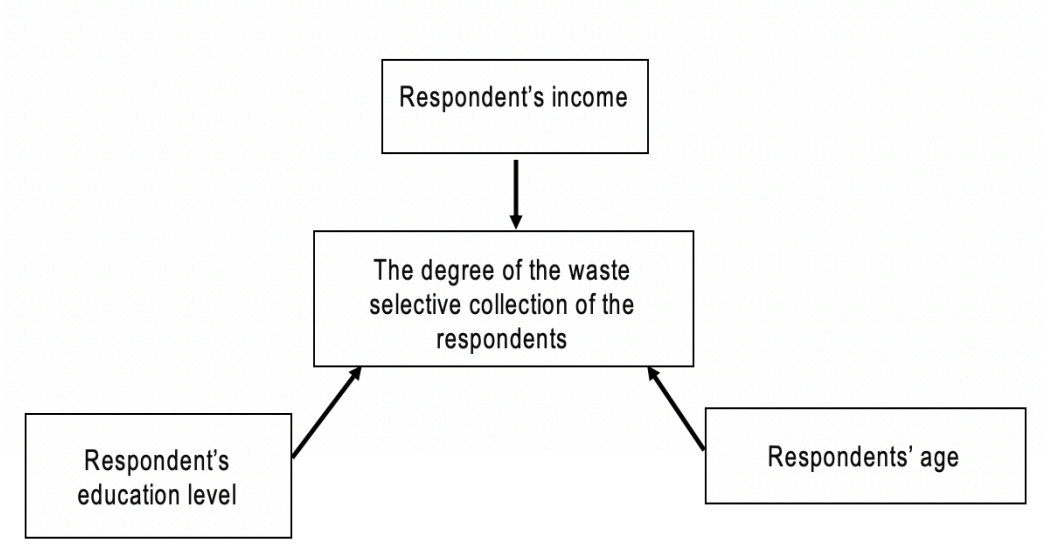


Figure 1: Conceptual model of the research

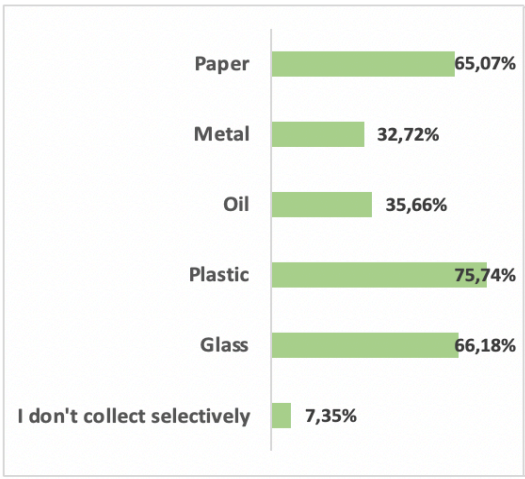
Three working hypotheses have been established, which will be analyzed according to the degree of association between the variables taken into account.

In order to test the hypotheses, we used the statistical methods that are chi-square, Pearson's R and Spearman coefficients of correlation. These working hypotheses are based on 4 variables: education, age, venue and degree of selective waste collection.

H1: The respondents' education level significantly influences the degree of selective waste collection.
H2: The respondents' income level significantly influences the degree of selective waste collection.
H3: The respondents' age significantly influence the degree of selective waste collection.

4. RESULTS AND DISCUSSION

As a result of analyzing the responses to multiple choices questions related to waste types collected by respondents and their incentives for collecting selectively the waste, the data gathered are shown in Figure 2 and 3.



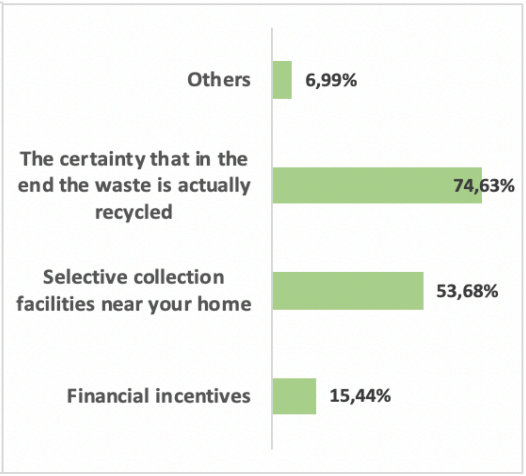


Figure 2: Type of selective collected waste **Figure 3:** Motivations for selective collection

As we observe in Figure 2 and Figure 3, the respondents selectively collect to a large degree plastic, glass and paper. This choice can be explained by the existence of collecting facilities for such waste type at the local level. Regarding the respondents' incentives for selective waste collection (Figure 3), there is a great percent (74.63%) of 'certainty that in the end the waste is recycled' responses, followed by 'the existence of the selective collection facilities near home' (53.68%). Only 15.44% of respondents are motivated by financial incentives. In the following, we test the association between the variables of the designed
hypothesis.

H1: The respondents' education level significantly influences the degree of selective waste collection.

For the first hypothesis a contingency table with double entry was generated, allowing the classification of observed and expected frequencies (Table 1).

Table 1. Contingency tables associated to H1

Selective waste collection * Education level Crosstabulation

			Education level						
			Bachelor's degree (ISCED 6)	Doctoral studies (ISCED 8)	Master's degree (ISCED 7)	Post-secondary education (ISCED 4)	Short-term higher education (ISCED 5)	Upper secondary education (ISCED 3)	Total
Selective waste collection	Greatly (4)	Count	64a	4a	16a	8a	6a	28a	126
		Expected Count	68.1	3.2	13.4	6.0	4.2	31.0	126.0
		% within Selective waste collection	50.8%	3.2%	12.7%	6.3%	4.8%	22.2%	100.0%
		Adjusted Residual	-.8	.5	.8	.9	1.0	-.7	
	Highly (5)	Count	218a	10a	42a	18a	10a	94a	392
		Expected Count	211.9	10.1	41.8	18.7	13.0	96.6	392.0
		% within Selective waste collection	55.6%	2.6%	10.7%	4.6%	2.6%	24.0%	100.0%
		Adjusted Residual	1.2	-.1	.1	-.3	-1.6	-.6	
	Remotely(2)	Count	2a	0a, b	0a, b	0a, b	2b	2a, b	6
		Expected Count	3.2	.2	.6	.3	.2	1.5	6.0
		% within Selective waste collection	33.3%	0.0%	0.0%	0.0%	33.3%	33.3%	100.0%
		Adjusted Residual	-1.0	-.4	-.9	-.6	4.1	.5	
	Undecided(3)	Count	10a	0a	0a	0a	0a	10a	20
		Expected Count	10.8	.5	2.1	1.0	.7	4.9	20.0
		% within Selective waste collection	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	100.0%
		Adjusted Residual	-.4	-.7	-1.6	-1.0	-.8	2.7	
Total		Count	294	14	58	26	18	134	544
		Expected Count	294.0	14.0	58.0	26.0	18.0	134.0	544.0
		% within Selective waste collection	54.0%	2.6%	10.7%	4.8%	3.3%	24.6%	100.0%

Each subscript letter denotes a subset of Education level categories whose column proportions do not differ significantly from each other at the .05 level.

Table 2. Chi-square test for H1 hypothesis

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.260	15	.008
Likelihood Ratio	24.616	15	.055
Linear-by-Linear Association	1.253	1	.263
N of Valid Cases	544		

It is noted that the significance tests of the first two measures of the association of variables (Pearson Chi-Square, Likelihood Ratio) have values less than 0.05, and the value of Pearson Chi-Square (31.260) is greater than the Chi-Square value reflected by Chi-Square Distribution Table for Degrees of Freedom (24.996).

Thus, the null hypothesis is rejected and we note that there is an association between the degree of selective waste collection and the level of education of the respondents of our study.

Table 3. Chi-squared association measures for the H1 hypothesis

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.240	.008
	Cramer's V	.138	.008
	Contingency Coefficient	.233	.008
N of Valid Cases		544	

The result of the chi-square test of the first H1 hypothesis is also validated by the association coefficient φ (phi), the coefficient V Cramer and the coefficient of contingency (cc), derived from χ2 and their significance tests. Based on these, we establish that the association is significant with a p-value of 0.008.

H2: The respondents' income level significantly influences the degree of selective waste collection.

For the research of hypothesis H2 (The respondents' income level significantly influences the degree of selective waste collection) the relationship between the variables 'family income' and 'selective waste collection' was analyzed (Table 4).

Table 4. Contingency tables associated to H2

Selective waste collection * H2 Crosstabulation

			H2			
			< 3000 RON	>5000 RON	3000 - 5000 RON	Total
Selective waste collection	Greatly (4)	Count	44a	28a	54a	126
		Expected Count	43.1	31.5	51.4	126.0
		% within Selective waste collection	34.9%	22.2%	42.9%	100.0%
		Adjusted Residual	.2	-.8	.5	
	Highly (5)	Count	130a	102a	160a	392
		Expected Count	134.0	98.0	160.0	392.0
		% within Selective waste collection	33.2%	26.0%	40.8%	100.0%
		Adjusted Residual	-.8	.9	.0	
	Remotely(2)	Count	$2_{a, b}$	4_{b}	0_{a}	6
		Expected Count	2.1	1.5	2.4	6.0
		% within Selective waste collection	33.3%	66.7%	0.0%	100.0%
		Adjusted Residual	.0	2.4	-2.0	
	Undecided(3)	Count	10_{a}	2_{a}	8_{a}	20
		Expected Count	6.8	5.0	8.2	20.0
		% within Selective waste collection	50.0%	10.0%	40.0%	100.0%
		Adjusted Residual	1.5	-1.6	-.1	
Total		Count	186	136	222	544
		Expected Count	186.0	136.0	222.0	544.0
		% within Selective waste collection	34.2%	25.0%	40.8%	100.0%

Each subscript letter denotes a subset of H2 categories whose column proportions do not differ significantly from each other at the .05 level.

Table 5. Contingency tables associated to H2

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.704	6	.098
Likelihood Ratio	12.195	6	.058
Linear-by-Linear Association	.766	1	.381
N of Valid Cases	544		

According to these results, it was found that there is no association between the two variables because the value of the asymptotic significance related to Pv (0.098) and the ratio of verisimility (Likelihood ratio chi-square 0.058) is higher than the permissible significance level of 0.05, and the Pearson Chi-Square

contingency coefficient value (10.704) is less than the Chi-Square value reflected by Chi Square Distribution Table for Degrees of Freedom (12.592).

Table 6. Chi-square-based association measures for H2 hypothesis

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.140	.098
	Cramer's V	.099	.098
	Contingency Coefficient	.139	.098
N of Valid Cases		544	

The result of the Chi-square test of the first H2 hypothesis is also validated by the association coefficient φ (phi), coefficient V Cramer and contingency coefficient (cc), derived from χ2 and their significance tests.

Based on these, with a p-value of 0.098, it was found that it is not a significant association between variables income level and selective waste collection.

H3: The respondents' age significantly influence the degree of selective waste collection.

For the third hypothesis a contingency table with double entry was generated, allowing the classification of observed and expected frequencies (Table 7).

Table 7. Contingency tables associated to H3

Selective waste collection * H3 Crosstabulation

			H3				
			>45 years	18-25 years	26-35 years	36-45 years	Total
Selective waste collection	Greatly (4)	Count	28a, b	54b	16a	28a, b	126
		Expected Count	25.0	63.0	9.7	28.3	126.0
		% within Selective waste collection	22.2%	42.9%	12.7%	22.2%	100.0%
		Adjusted Residual	.8	-1.8	2.4	-.1	
	Highly (5)	Count	78a	198a	24a	92a	392
		Expected Count	77.8	196.0	30.3	87.9	392.0
		% within Selective waste collection	19.9%	50.5%	6.1%	23.5%	100.0%
		Adjusted Residual	.0	.4	-2.2	.9	

	Remotely(2)	Count	2a	2a	0a	2a	6
		Expected Count	1.2	3.0	.5	1.3	6.0
		% within Selective waste collection	33.3%	33.3%	0.0%	33.3%	100.0%
		Adjusted Residual	.8	-.8	-.7	.6	
	Undecided(3)	Count	0a	18b	2a, b	0a	20
		Expected Count	4.0	10.0	1.5	4.5	20.0
		% within Selective waste collection	0.0%	90.0%	10.0%	0.0%	100.0%
		Adjusted Residual	-2.3	3.6	.4	-2.5	
Total		Count	108	272	42	122	544
		Expected Count	108.0	272.0	42.0	122.0	544.0
		% within Selective waste collection	19.9%	50.0%	7.7%	22.4%	100.0%

Each subscript letter denotes a subset of H3 categories whose column proportions do not differ significantly from each other at the .05 level.

Table 8. Chi-square test for H3 hypothesis

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.850	9	.005
Likelihood Ratio	30.912	9	.000
Linear-by-Linear Association	.654	1	.419
N of Valid Cases	544		

The value of the asymptotic significance of Pv (0.005) is less than 0.05 and the value of Person Chi-Square 23.850 is greater than the Chi-Square value reflected by Chi-Square Distribution Table for Degrees of Freedom (16.919), which indicates an association between the degree of selective waste collection and the level of education of our study respondents.

Table 9. Chi-square-based association measures for H3 hypothesis

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.209	.005
	Cramer's V	.121	.005
	Contingency Coefficient	.205	.005
N of Valid Cases		544	

The result of the chi-square test of the first H3 hypothesis is also validated by the association coefficient φ (phi), coefficient V Cramer and contingency coefficient (cc), derived from χ2 and their significance tests. We find an association between the variables analyzed, thus the hypothesis formulated by us H3: The respondents' age significantly influence the degree of selective waste collection, is validated.

In the study, measures of association for the level of education of respondents and their age were calculated to highlight the value of comparability of statistical coefficients. We note that the association between the level of education and the degree of selective waste collection (H1) is as strong as that between the age and the degree of selective waste collection(H2). Cramer's V value for H1 hypothesis is 0.138, and for H2 is 0.121.

5. CONCLUSION

As a final conclusion of our study, we can state that the education level has positive influence on the degree of selective waste collection, but the income level hasn't. Our study revealed that there is no association between income level and the degree of selective waste collection. Also, the age seems to be a determinant for the degree of selective waste collection.

As the 'certainty that in the end the waste is recycled' and 'the existence of the selective collection facilities near home' are two important incentives for selective waste collection, it is very important for the local communities to invest in such facilities for all the districts of the city, to provide facilities for all waste types, to invest in recycling industry, to motivate citizens to act responsibly.

Behavioral changes for both producers and consumers are essential in the transition from the linear economy to the circular economy. Our analysis shows that education has a strong impact on increasing the degree of selective collection, and thus on increasing the recycling rate.

The issue of waste management must be taken very seriously, given the irreversible impact it can have on the environment. Awareness of the need for selective waste collection, resource efficiency, implementation of innovative business models are essential factors for creating conditions conducive to the development of the circular economy.

The main limitations of our study were represented by the fact that we carried out the survey on citizens of one city. As a future research direction, we intend to develop the research model and to extend the analysis at the national level.

DISCLOSURE OF CONFLICT

The author(s) declare that they have no conflicts of interest.

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