Influence of the Total Consumption of Households on Municipal Waste Quantity in Romania

Irina-Elena Petrescu 1,*, Mariarosaria Lombardi 2, Georgiana-Raluca Lădaru 1, Răzvan Aurelian Munteanu 3, Mihai Istudor 3 and Georgiana Adriana Tărășilă 3

1 Department of Agrifood and Environmental Economics, The Bucharest University of Economic Studies, 010374 Bucharest, Romania; raluca.ladaru@eam.ase.ro
2 Department of Economics, University of Foggia, 71122 Foggia, Italy; mariarosaria.lombardi@unifg.it
3 Doctoral School, The Bucharest University of Economic Studies, 010374 Bucharest, Romania; munteanuarelian19@stud.ase.ro (R.A.M.); istudormihai14@stud.ase.ro (M.I.); tarasilageorgiana16@stud.ase.ro (G.A.T.)

* Correspondence: irina.petrescu@eam.ase.ro

Abstract: Sustainable development is a worldwide concern. This paper presents an analysis of the influence of the final consumption expenditure on the total consumption of households in Romania. The regression function of the association between "the amount of municipal waste" and "the total consumption of households" has a direct linear relationship. The regression variable "total household consumption" (X) has a regression coefficient of \(-0.03031\), which indicates that the amount of municipal waste decreases by one unit as household consumption increases by 30.31 units. Therefore, this regression coefficient indicates that the volume of municipal waste decreases by 30.31 tons to an increase in the final consumption expenditure of households of EUR 1 million. The influence of the final consumption expenditure of households by consumption purpose on the quantity of municipal waste is in the following order: health; housing, water, electricity, gas and other fuels; clothing and footwear; miscellaneous goods and services; recreation and culture; food and non-alcoholic goods; restaurants and hotels; furnishing and household equipment and routine household maintenance; alcoholic and tobacco goods; communications; and education. The value of the Significance F must be less than 0.05. In the case of the model, it is found that this value exceeds the threshold of 0.05 in the case of consumption generated by health services, recreation and culture, restaurants and hotels, alcohol and tobacco goods, and communications. Regarding the high value of Significance F in relation to consumption, we find the sectors that generate the least amount of waste (services). In the case of all of the independent variables, we can note that the relationship is a negative one, which proves that an increase in the quantity of any expenditure of the households generates a decrease of the municipal waste quantity.

Keywords: municipal waste; consumption of households; waste management

1. Introduction

Currently, environmental, social and ethical events are occurring with increasing frequency around the world, resulting in environmental costs and consequences that are difficult to correct in the short-to-medium term [1].

Waste is an important problem worldwide, as it is generated by all human activities. Economic growth and technological development have increased the consumption of goods and services, and the amount of waste. Some studies have shown that sustainable consumption is closely related to the concept of sustainable development and have proposed three dimensions of the latter for discussion: social, economic, and ecological [2]. In this case, one of the major concerns of states is how to achieve economic growth while decreasing the quantity of waste. The entrepreneur remains the main facilitator of regional growth, through the role of the agent of change [3].
According to the definition of the OECD/Eurostat joint questionnaire, municipal waste covers household waste and waste similar in nature and composition to household waste (European Commission, 2016) [4]. According to OECD, municipal solid waste accounts for only around 10% of total waste, but its management and disposal often account for more than a third of public sector financial efforts to reduce and control pollution [5]. According to a report realised by The World Bank (What a Waste 2.0), waste generation is expected to grow by 70% by 2050, while our global population is expected to grow at less than half of that rate [6]. The importance of research is given by the need to achieve the objectives of the Europe 2030 Strategy in terms of reducing the amount of waste, except for major mineral waste.

Several authors have studied the possibilities of achieving the goals by member states (SDG). Regarding Romania, Firoiu et al. (2019) analysed 107 indicators and estimated that only 40 are forecast to reach the EU average value in 2030 [7]. The evolution of the waste quantity by capita is an important indicator for SDG No. 12 “Ensure sustainable consumption and production patterns”. Firoiu et al. (2019) mentioned that Romania has set the following goals for 2030: a gradual transition to a new development model based on the rational and responsible use of resources, halving food waste per capita at the retail and consumer levels and reducing food waste in production and supply. The food waste recycling rate of municipal waste should reach 55% by 2025, and 60% by 2030; the packaging waste recycling rate should reach 65% by 2025, and 70% by 2030; this should apply to hazardous household waste collection by 2022, hazardous household waste by 2023, and bio-waste and textiles by 2025; we should establish a binding wholesale producer responsibility scheme for all packaging by 2024, and implement sustainable green procurement practices in line with national and European policy priorities [7].

The Waste Framework Directive sets a waste hierarchy, represented as a pyramid. At the bottom of the pyramid is the prevention action, followed by preparing for re-use, recycling, recovery, and at the top of the pyramid is the disposal action. The Waste Framework Directive and the Europe 2030 Strategy set objectives for member states, including reducing the quantity of municipal waste and increasing the recycling rate of municipal waste. Thus, any scientific approach that can contribute to the analysis of the possibilities for achieving these objectives proves important. The results of the paper could be useful for the public authorities (central and local) in their actions for the prevention of waste generation, the analysis of the evolution of the quantity of municipal waste, and the determination of the best solutions for influencing the behavior of citizens regarding waste generation.

The novelty of the paper is given by the determination of the influence of the final consumption expenditure of households by consumption purpose (health, housing, clothing, restaurant, education etc.) on the quantity of municipal waste. The analysis of these influences brings benefits to the local public authorities in the elaboration of the management plans. The results could also help central public authorities to develop the National Strategy for the Circular Economy.

The following sections in the paper review the literature in the field of waste, especially from recent years, and present the study hypothesis and findings regarding the influence of the final consumption expenditure of households by consumption purpose (health, housing, clothing, restaurant, education etc.) on the quantity of municipal waste. At the end of the paper are presented the conclusions of the study, as well as the limitations and future research perspective.

2. Literature Review

Environmental problems threaten the health and economic prospects of many countries. One of the important factors causing global warming and environmental degradation is the generation of waste [8].

Waste is a relational concept: it is a collection of items that no longer have any value or utility for an individual in a given social context. Due to the ambiguity of these representations, different actors can see different “wastes” at the same time. For example,
informal recyclers and libertarians (ideologically motivated people who feed on the waste of a consumer society) often recycle items from the waste stream for reuse or resale, such as household items and groceries (in some cases). These potentially usable/saleable items are initially thrown into the trash stream, indicating a different perception of the value of a particular item [9].

Waste is generated from a variety of sources, such as domestic, industrial, and commercial sources, and the rate of waste generation is steadily increasing: a common phenomenon observed in urban centers around the world. It is common to dump rubbish in and out of cities. Trash can clog sewers (causing flooding during monsoons), curbs and even the middle of streets, markets, commercial centers, residential buildings and open spaces, wherever it is found [10].

Countries around the world are working to improve their approach to solid household waste [11].

Many countries were to temporally postpone their plastic use reduction policies and plastic waste management strategies [12].

In terms of sustainability, waste management is an activity that shapes environmental protection. Sustainability has become an internationally adopted development model, with organizations and individuals acting in accordance with principles and changes [13].

Waste management discusses the “Waste Hierarchy”, which is a concept according to which different waste management measures are grouped according to both their long-term impact on the environment and the type of waste category with the lowest impact on environment. As such, the waste management hierarchy involves: waste prevention, reducing (minimizing) the amount of waste produced, the reuse of materials, the recycling (recovery) of waste, conditions of economic efficiency, the energy recovery of waste, the controlled storage of waste, and the recovery of gases resulting from waste storage [14].

Currently, in the field of municipal waste management, there are various models that help to highlight deficiencies in the field. However, most of the models identified in the literature are decision support models, and for model improvement there is research in which the models are divided into three categories based on cost–benefit analysis, based on waste life cycle assessment, and based on decision-making criteria [15].

The most popular approaches to municipal waste management are reprocessing, composting, combustion, and landfilling/open dumping [16]. Waste management processes and standards rely heavily on the operations strategy [17].

According to Han et al. (2018) [18] poor domestic waste management in developing countries, including a lack of sanitation and inadequate waste disposal facilities, leads to severe environmental pollution, landscape damage, and even negative impacts on the health of local people; therefore, these considerations give a topical importance to the chosen research theme.

As an important part of modern cities, municipal waste management not only aims to improve the living environment of urban residents but also plays an important role in preventing resource waste and protecting the overall ecological environment [19].

Various sectors have been affected by COVID-19 and its consequences. The waste management system is one of the sectors affected by such unpredictable pandemics. The experience of COVID-19 proved that adaptability to such pandemics and the post-pandemic era has become a necessity in waste management systems, and this requires an accurate understanding of the challenges that have been arising [20].

Additionally, given the evidence that COVID-19 spreads through food, food containers or food packaging, the use of reusable bags is discouraged in order to minimize the risk of store workers contracting the virus on the surface of the bags [21].

According to the results of the research developed by Yoada et al. (2014) [22], who studied the domestic waste disposal practice and perceptions of private sector waste management, it turned out that “93.1% of households disposed of food debris as waste and 77.8% disposed of plastic materials as waste. The study also showed that 61.0% of the households disposed of their waste at community bins or had waste picked up at their
homes by private contractors. The remaining 39.0% disposed of their waste in gutters, streets, holes and nearby bushes. Of those who paid for the services of private contractors, 62.9% were not satisfied with the services because of their cost and irregular collection.

Considering that waste management could represent an important aspect for public authorities in any country, Ahangar et al. (2021) designed a disposal for municipal solid waste using fuzzy programming, with an impact on the cost through the decrease of the use of manpower as well as the amount of pollution [23].

Different authors have analysed the medical waste supply chain and the opportunity of investing in environmental aspects. Some of them consider that the generators of medical waste would allocate more funds for the suppliers that incorporate environmental aspects in their products [24]. In terms of consumption, this has changed recently, as Kearney (2010) [25] stated in his paper. Changes in agricultural practices in recent years have improved the world’s ability to feed its population by increasing productivity, increasing food variety and reducing seasonal dependence. Food availability has also increased due to higher income levels and lower food prices. This has led to significant changes in food consumption in recent years.

The COVID-19 pandemic has changed the way people live by requiring people to work from home. This has increased the home delivery of food and groceries, leading to an increase in demand for single-use plastic bags and food packaging materials. The use of online shopping and delivery services has surged during the pandemic [26].

The demand for natural resources has increased enormously in recent decades in the world, as a result of population growth, welfare and consumption. The highest levels of wellbeing and consumption were recorded in developed countries. The identification factors for the higher demand for resources are the increase of the income level, which allowed the purchase of more products and the wider use of services, the increase in the number of smaller households, and the changes in lifestyles, which supported the more individualized purchasing model [27].

Given the significant increase in the population, which puts pressure on resources, obviously leading to an increase in consumption, there will be some pressure on waste management.

People consume an increasing variety of goods and services produced by industrial sectors that generate direct and indirect waste. Humans are the main driver of production, consumption, and the resulting waste [28]. Although waste generation can be directly attributed to increased consumption, the authors concluded that “75% of Australian household waste generation is related to indirect waste generation.”

In developed countries, a large amount of food is wasted at the end of the food supply chain, and according to the existing literature, this is mainly due to consumer behavior, habits and attitudes [29].

The awareness of environmental issues associated with consumption habits has led to the more careful use of resources. The Eurobarometer Attitudes of European Citizens towards the environment shows a positive evolution of the behavior of European citizens. A larger share of Europeans reported taking measures to improve resource efficiency. From those presented in relation to the behavior towards the environment, the data of the Barometer show that in European Union countries, including Romania, there is currently a positive evolution [27].

3. Study Hypothesis

Given the growing concern of the European Union and, implicitly, of Romania regarding waste management, there is a need to determine the correlation between the amount of municipal waste and the final consumption expenditure of households in Romania. Considering the previous research regarding the influence of household consumption on municipal waste, the hypotheses tested in the paper are the followings:

- The amount of municipal waste and household consumption are interconnected, and as a society develops, it becomes more aware of the environmental impact of waste from consumption, and the amount of waste should decrease.
- The relationship between the final consumption expenditure of households for education and the municipal waste quantity presents an inversely proportional relationship.

In order to determine if the hypotheses of the paper are validated, were analyzed the dynamics of the total quantity of municipal waste from Romania in the period 2000–2020, as well as the evolution the final consumption of households in the period 2000–2019. Following this analysis, in order to measure the influence of the final consumption expenditure of households (total and by consumption purpose) on the quantity of municipal waste, was used the linear regression function. In the same time, the modern lifestyle can generate a greater waste quantity if governments do not implement a waste management strategy in order to increase the awareness of citizens regarding the importance of environmental protection. Lately, e-commerce has increased significantly, especially due to the restriction imposed by states for the pandemic of COVID-19, and this type of commerce requires more packaging.

4. Findings

According to OECD (2013), household final consumption expenditure is typically the largest component of the final uses of GDP, representing in general around 60% of GDP; it is therefore an essential variable for the economic analysis of demand [30]. According to the same source, household final consumption expenditure covers all purchases made by resident households (home or abroad) to meet their everyday needs: food, clothing, housing services (rents), energy, transport, durable goods (notably cars), health, leisure, and miscellaneous services [30].

As presented in Figure 1, in 2020, the final consumption expenditure of households in the European Union was EUR 6,767,546.5 million in current prices, registering a decrease of 7.83% compared with 2019, when the consumption was EUR 7,342,501.2 million in current prices, the highest value from 2000. From 2000 until 2020, the consumption expenditure of households in the European Union increased constantly by EUR 873.190 million/year, with two exceptions: one in 2009, due to the financial crisis from 2008, when the consumption decreased by 3%, and the second in 2020, caused by the sanitary crisis generated by the COVID-19 pandemic, with a decrease of 7.83%. The data series has a standard deviation of ±0.872 million euro, which determines a variation of ±15%, with the standard error being 0.19.

![Figure 1. Evolution of the final consumption expenditure of households, in the European Union, in the period 2000–2020.](image)

In 2020, all European Union countries decreased the final consumption expenditure of their households. Figure 2 presents the decrease of the final consumption expenditure of households in 2020 compared with 2019 for all European countries. The main key factors
for household consumption are represented by income, inflation, wealth, and preferences, etc. The decreases are different from one country to another; the highest decrease compared to 2019 was registered in Malta, with a 21.13% decrease, while the minimum decrease was registered in Slovakia, with only 0.30%. According to Broom (World Economic Forum, 2021) and Eurostat, household consumption fell the most in countries with the severest lockdowns, while lockdowns, social distancing and restrictions on non-essential business activity reduced household consumption across the EU by 7.83%—an impact not seen since the 2008 financial crisis [31].

Figure 2. Decrease of the final consumption expenditure of households in 2020 compared with 2019.

The year 2020 was marked by the onset of the crisis caused by the COVID-19 pandemic. Starting in March 2020, household consumption has been declining massively. Figure 3 presents the decreases of household consumption by category in Romania in 2020 compared with 2019 and the most affected categories are restaurants and hotels, miscellaneous goods and services, recreation and culture, and transportation. The first case declared to be COVID-19 was registered in Europe on 24 January 2020, in France. According to Al-Salem et al. (2021), the Maastricht Treaty (1993) guaranteed free movement for the citizens of Iceland, Norway, Switzerland, the UK and all European signatory countries, and this freedom of movement led to an acceleration in the transmission of the disease throughout Europe [32]. As of 17 March 2020, all EU member states had reported cases of COVID-19, and Italy was the first country to declare a lockdown due to the alarming increase in cases. Thus, on 18 March 2020, most states in the European Union were in lockdown [33].

In Romania, on 16 March 2020, a state of emergency was declared, and on 25 March authorities announced the following lockdown measures: individuals were allowed to leave their homes to buy groceries, seek urgent medical attention, and for work, with a signed note from their employer; all shopping malls were closed, except for businesses selling food, veterinary services, and pharmaceutical products; additionally, elderly people who were aged 65 and above were only permitted to leave their homes between 11:00 to 13:00 for essential reasons, such as purchasing necessities etc. [34].

Imposing restrictions on social distance, the movement of people, the closure of restaurants and hotels, and the cancellation of social events have led to a reduction in household consumption, especially for the HoReCa, recreation and culture, and transportation categories. The reduction of consumption for this sector contributed to the registration of massive losses for the hospitality industry not only in Romania but also worldwide. In Romania, despite the potential value of our country for tourism development, the industry
is not a significant source of contribution to the Gross Domestic Products, only 2.8%, but tourism has a larger sense when focusing on its multiplicative effect [35]. According to Garcia-Madurga et al. (2021), the HoReCa channel is the set of commercial catering food establishments whose main activity is the production and sale of the direct out-of-home consumption of food [36].

![Figure 3. Decreases of household consumption by category in Romania in 2020 compared with 2019.](chart.png)

The categories of the final consumption expenditure of households that increased are the following: health, food and non-alcoholic, education, communication, and alcoholic and tobacco. The total consumption in Romania decreased by 4.1% in 2020 compared to 2019.

Figure 4 presents the evolution of municipal waste in Romania, in the period 2000–2019. Between 2000 and 2019, the average amount of municipal waste was 6631 thousand tons/year, and the variation was 1443.98 thousand tons/year. The maximum value of the amount of municipal waste was registered in 2008, at 8439 thousand tons/year, and the minimum value was registered in 2015, at 4904 thousand tons/year. Starting in 2015, there was an increase in the quantity of waste, with an average of 205.19 thousand tons/year. The data series has a standard deviation of ±1.45 thousand tons/year, which determined a variation of ±22%, with the standard error being 0.32.

Given the oscillating evolution of the total quantity of municipal waste, there is a need to study its influencing factors, especially because the concerns related to ensuring the sustainable development of society and the transition to a circular economy are growing, both in the European Union and worldwide. According to Hasan (2004), a critical component in any waste management program is public awareness and participation, in addition to appropriate legislation, strong technical support, and adequate funding, as waste represents the result of human activities and everyone needs to have a proper understanding of waste management issues, without which the success of even the best-conceived waste management plan becomes questionable [37].
Figure 4. Evolution of the municipal waste in Romania, in the period 2000–2019, in terms of thousands of tons.

Figure 5 presents the evolution of the final consumption expenditure of households, in Romania, in the period 2000–2020. The data series has a standard deviation of ±33.78 million euros, which determines a variation of ±43%, with the standard error being 0.75.

Figure 5. Evolution of the final consumption expenditure of households in Romania, in the period 2000–2020, in terms of millions of Euro (EUR).

5. Results

Regarding the correlation between the amount of waste and household consumption, the regression function of the association between “the amount of municipal waste” and “the total consumption of households” has a direct linear relationship. The regression variable “total household consumption” (X) has a regression coefficient of −0.03031, which indicates that the amount of municipal waste decreases by one unit as household consumption increases by 30.31 units.

The free term, i.e., the ascertainable variable of the regression function (Y), presents a positive value of 8966 thousand units (representing the value of Y regardless of the variation of X, or even in the absence of X). The coefficient of determination $R^2$ expresses the fact that 44.75% of the variation of the quantity of municipal waste is determined by the variation of the total consumption of the households.

From the analysis of the obtained parameters presented in Table 1a and Figure 6, the following hypotheses are attested:
1. The correlation coefficient is quite high, at 0.66, which denotes a close relationship in terms of intensity. The high value of the correlation ratio shows that there is a strong dependence between the two series (Romer, 1997) [38].

2. By testing the correlation ratio, the regression model is statistically validated; the value of Significance F ≤ 5% (0.05). As such, the model adjusts well the data in the sample.

3. By testing the parameters of the regression model (Y and X) for a significance threshold of \( \alpha = 5\% \), the existence of an association between the two variables is attested by statistically significant coefficients (\( p \) value ≤ 5%; the parameter is significant).

4. The confidence intervals of the parameters are statistically significant, as the limits have the same sign. For the estimated evaluation of X, the confidence interval is \((-0.04)\)–\((-0.01)\), and for the free term Y, the confidence interval is 7580.9–10,351.4. In both cases, the confidence interval does not include the value 0.

Table 1. Linear regression results.

| Regression Statistics | Value   |
|-----------------------|---------|
| Multiple R            | 0.66893939 |
| R Square              | 0.44279903 |
| Adjusted R Square     | 0.416784347 |
| Standard Error        | 1102.752513 |
| Observations          | 20      |

| ANOVA                  |
|------------------------|
| df | SS    | MS    | F        | Significance F |
|-----|-------|-------|----------|----------------|
| Regression             | 1     | 17,727,768.9 | 17,727,768.9 | 14.57800078 | 0.001259506 |
| Residual               | 18    | 21,889,135.9 | 1,216,063.105 |          |                |
| Total                  | 19    | 39,616,904.8 |              |              |                |

| Coefficients          | Standard Error | t Stat   | p-Value       | Lower 95%    | Upper 95%    | Lower 95.0% | Upper 95.0% |
|-----------------------|----------------|----------|---------------|--------------|--------------|-------------|-------------|
| Intercept             | 8966.21007     | 659.3526598 | 13.59850444 | 6.57501 \times 10^{-11} | 7580.961535 | 10,351.4586 | 7580.961535 | 10,351.4586 |
| CONSUMPTION           | –0.030316478   | 0.007940169 | –3.818114821 | 0.001259506 | –0.046998155 | –0.046998155 | –0.046998155 | –0.046998155 |

Source: Data processing, Eurostat.

Therefore, the regression equation between the dependent variable (municipal waste) and the independent variable (the final consumption expenditure of households) is as follows:

\[
\text{Municipal waste} = -0.03 \times \text{Consumption} + 8966.21
\]

The value of the Significance F must be less than 0.05. In the case of the model, as presented in Table 2, it was found that this value exceeds the threshold of 0.05 in the case of consumption generated by health services, recreation and culture, restaurants and hotels, alcohol and tobacco goods, and communications. For the high value of Significance F in relation to consumption, we found that the sectors that generate the lowest amount of waste (services). In the case of all of the independent variables, we can see that the relationship is a negative one, which proves that an increase in the quantity of any expenditure of the households generates a decrease of the municipal waste quantity.
Figure 6. The regression function of the association between “the amount of municipal waste” and “the total consumption of households”.

Table 2. The influence of the final consumption expenditure of households by consumption purpose on the quantity of municipal waste.

| Independent Variable                        | Multiple R | R Square | Intercept | Regression Function Coefficients | Sig. |
|---------------------------------------------|------------|----------|-----------|----------------------------------|------|
| Health                                      | 0.87       | 0.77     | 8706.29   | -0.54                            | 3.24 |
| Housing, water, electricity, gas and other fuels | 0.60       | 0.36     | 8983.85   | -0.14                            | 0.005|
| Clothing and footwear                       | 0.58       | 0.34     | 7901.19   | -0.37                            | 0.006|
| Miscellaneous goods and services            | 0.73       | 0.53     | 8485.13   | -0.64                            | 0.000|
| Recreation and culture                      | 0.78       | 0.61     | 8724.91   | -0.45                            | 4.17 |
| Food and non-alcoholic goods                | 0.66       | 0.44     | 9505.33   | -0.13                            | 0.001|
| Restaurants and hotels                      | 0.14       | 0.02     | 7079.98   | -0.14                            | 0.54 |
| Furnishing and household equipment and routine household maintenance | 0.60       | 0.36     | 8200.36   | -0.37                            | 0.004|
| Alcoholic and tobacco goods                 | 0.78       | 0.61     | 9070.44   | -0.59                            | 3.81 |
| Communications                              | 0.89       | 0.80     | 9019.20   | -0.95                            | 8.99 |
| Education                                   | 0.65       | 0.42     | 8470.23   | -1.31                            | 0.001|

Source: Data processing, Eurostat.

In the case of the final consumption expenditure of households for housing, gas, cloths and footwear, miscellaneous goods and services, food and non-alcoholic goods, furnishing and household equipment, and education, the Significance F value is less than 0.05, which proves that the models are statistically valid. The value of the R Square coefficient is relatively small (below 0.5) except for the independent variable miscellaneous goods and services (R square = 0.53), which means that the amount of municipal waste is influenced by other factors. The coefficient of determination R Square, for correlations whose Significance F is less than 0.05, states that:

1. 36% of the variation of the amount of municipal waste is determined by the variation of the final consumption expenditure of households for housing, water, electricity, gas and other fuels;
2. 34% of the variation of the amount of municipal waste is determined by the variation of the final consumption expenditure of households for clothing and footwear;
3. 53% of the variation of the municipal waste quantity is determined by the variation of the final consumption expenditure of households for miscellaneous goods and services;
4. 44% of the variation of the quantity of municipal waste is determined by the variation of the final consumption expenditure of households for food and non-alcoholic goods;

5. 36% of the variation of the quantity of municipal waste is determined by the variation of the final consumption expenditure of households for furnishing and household equipment, and routine household maintenance;

6. 42% of the variation of the municipal waste quantity is determined by the variation of the final consumption expenditure of households for education.

Worldwide, more than three billion people depend on solid fuels, including biomass (wood, dung and agricultural residues) and coal, to meet their most basic energy needs: cooking, boiling water, and heating [39]. Figure 7 presents the correlogram indicating the correlation between the amount of municipal waste and final consumption expenditure of households by consumption purpose. The R Square determination coefficient states that 36% of the variation in the amount of municipal waste is determined by the variation in the final consumption expenditure of households for housing, water, electricity, gas and other fuels.

The relationship between the amount of municipal waste and final consumption expenditure of households for housing, water, electricity, gas and other fuels shows that changing the consumption expenditure of households for housing, water, electricity, gas and other fuels by 1000 monetary units generates a decrease of municipal waste of 0.14 tons. The increase in the consumption expenditure of households for housing, water, electricity, gas and other fuels can be explained either by an increase in prices, which our country is currently facing, or by an increase in energy or gas consumption. In either case, in order to meet basic needs, households tend to reduce the consumption of other services or products that can generate large amounts of waste. This shows that there is a negative relationship between the two variables analyzed. The coefficient of Significance F is 0.005, which expresses a significant probability and determines a valid model.

According to the European Parliament (2020), clothes, footwear and household textiles are responsible for water pollution, greenhouse gas emissions and landfill; likewise, fast fashion—the constant provision of new styles at very low prices—has led to a big increase in the quantity of clothes produced and thrown away [40]. In order to decrease the impact upon the environment of the textile industry, the European Commission adopted, in March 2020, the New Circular Economy Action Plan, showing actions for changing the way we produce and consume in order to achieve a climate-neutral, competitive economy of empowered consumers [19]. The measures presented in the New Circular Economy Plan complete the EU Industrial Strategy, and include the following: making sustainable products the norm in the EU, empowering consumers, focusing on the sectors that use the most resources and where the potential for circularity is high, and ensuring less waste [41].

According to the model, the R Square determination coefficient states that 34% of the variation in the amount of municipal waste is determined by the variation in the final consumption expenditure of households for clothing and footwear. The relationship between the amount of municipal waste and the final consumption expenditure of households for clothing and footwear shows that changing the consumption expenditure of households for clothing and footwear by 1000 monetary units generates a decrease of municipal waste of 0.37 tons. The increase in the final consumption expenditure for clothing and footwear does not necessarily represent an increase in the quantity purchased of clothes and footwear, this being determined more by an increase in prices for these product categories. This means that there is a negative relationship between the two variables analyzed. The coefficient of Significance F is 0.001, which expresses a significant probability and determines a valid model.
According to the model, the R Square determination coefficient states that 53% of the variation in the amount of municipal waste is determined by the variation in the final consumption expenditure of households for miscellaneous goods and services. Regarding the relationship between the amount of municipal waste and the final consumption expenditure of households for miscellaneous goods and services, a change in the consumption expenditure of households for clothing and footwear by 1000 monetary units generates a decrease in municipal waste of 0.64 tons. The increase in the final consumption expenditure of households for miscellaneous goods and services does not necessarily represent an increase in the quantity purchased, with this being more determined by an increase in prices for these product categories. This determines that there is a negative relationship.
between the two variables analyzed. The Significance Coefficient F is 0.000, which is a significant probability and means a valid model.

According to Food and Agriculture Organization, food loss and waste has indeed become an issue of great public concern, and The 2030 Agenda for Sustainable Development reflects the increased global awareness of the problem [42]. Food and non-alcoholic consumption has concentrated in the last years to a healthier and more ecological model. This model includes less processed food, in a smaller quantity, but at higher prices for consumers. This explains the increase of the consumption expenditure of households for food and non-alcoholic goods, which does not necessarily represent an increase of the quantity of the food.

The correlation between the two variables, the municipal waste quantity and the final consumption expenditure of households for food and non-alcoholic goods proves that consumers have spent more and generated a smaller quantity of waste. Additionally, the concerns for a healthier environment have focused consumers from our country on decreasing food waste.

Analyzing the coefficient of determination R Square, we can notice that 44% of the variation of the quantity of municipal waste is determined by the variation of the final consumption expenditure of households for food and non-alcoholic goods. The relationship between the amount of municipal waste and the final consumption expenditure of households for food and non-alcoholic goods shows that changing the consumption expenditure of households for food and non-alcoholic goods by 1000 monetary units generates a decrease of municipal waste of 0.13 tons. The coefficient of Significance F is 0.005, which is a significant probability and means a valid model.

An important part of the municipal waste is represented by furniture and household equipment, as mentioned by Article 3 of Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste. Additionally, the same directive mentions in Article 9 that member states should prevent the generation of municipal waste by encouraging the re-use and repair of products, including furniture and household equipment [43].

Analyzing the coefficient of determination R Square, we can notice that 36% of the variation of the amount of municipal waste is determined by the variation of consumption expenditure of households for furnishing and household equipment and routine household maintenance. The relationship between the amount of municipal waste and the final consumption expenditure of household consumption for furnishing and household equipment and routine household maintenance demonstrates that changing the consumption expenditure of households for furnishing and household equipment and routine household maintenance by 1000 monetary units results in a decrease in municipal waste of 0.37 tons. The coefficient of Significance F is 0.004, which is a significant probability and means a valid model.

Ozturk (2008) mentioned that education is indispensable and fundamental for economic development, and there is a positive feedback from improved education to greater income equality, which in turn is likely to favor higher rates of growth [44]. The effects of investing in education not only contribute to the expansion of human knowledge, abilities and competences but also to the improvement of values and even better decision-making [45]. This is the reason why sustainable economic development requires important investments in the education system.

The determination coefficient R Square shows the fact that 42% of the variation of the amount of municipal waste is determined by the variation of the final consumption expenditure of households for education. At an increase of consumption expenditure of households for education by 1000 units of consumption, this will determine a decrease of 1.31 tons, representing the largest decrease of all of the variables analyzed.
6. Conclusions

In September 2015, Romania adopted the objectives of Agenda 2030 for sustainable development. Agenda 2030 involves achieving 17 objectives for sustainable development. As mentioned by Firoiu et al. (2019), achieving the targets of the 2030 Agenda depends exclusively on an effective approach for the implementation of objectives by ensuring a continuous dialogue between all of the entities directly and indirectly involved [7].

The quantity of municipal waste increased in Romania until 2009. Due to approaches to the environment, Romania developed programs through its local authorities for decreasing this quantity. Still, economic growth has increased the consumption of goods and services. The correlation between the quantity of municipal waste and household consumption shows a close relationship in terms of intensity. The high value of the correlation ratio shows that there is a strong dependence between the two series. The regression variable “total household consumption” (X) has a regression coefficient of −0.03031, which indicates that the amount of municipal waste decreases by one unit as household consumption increases by 30.31 units.

The policies of the business environment for waste management influence the quantity of municipal waste. Additionally, with proper plans for recyciling, the business environment can contribute to increasing the recycling rate. Presenting the evolution of the household consumption expenditure by category in Romania in 2020 compared with 2019 could bring useful information for business decisions with strong managerial and practical implications.

Analysing the evolution of consumption brings economical implications, as consumption represents an important factor for economic growth. Moreover, the correlation with the municipal waste quantity is useful, with social implications for political decision factors. In order to reduce the quantity of municipal waste while increasing the recycling rate, public authorities make efforts to develop consumer education programs for sustainable consumption.

One of the main concerns of Romanian local authorities should be to develop programs to prevent waste generation. Additionally, Romania should increase the rate of recycling of municipal waste by 55% until 2025, and by 60% until 2030. Selective waste collection generates raw material for reuse, recycling and energetic recovery, with a positive impact for the environment.

It is our desire that the analysis will present support for local public authorities in the elaboration of the management plans, and for the central public authorities in developing the National Strategy for the Circular Economy and achieveng the Sustainable Development Goals (SDG). All European countries must meet the Sustainable Development Goals (SDG). Municipal waste is an important issue for the achievement of SDG 11 regarding Sustainable Cities and Communities, and monitoring the evolution of the waste quantity is an essential condition for fulfilling this objective. The originality of the paper in the determination of the consumption expenditure’s influence on municipal waste could be extended to other countries or regions, especially because the level of income, as main key factor that influences the consumption of households, is different in different European countries and could bring important conclusions for the elaboration of waste management policies.

The limitations of the paper are caused by data availability. A future research perspective of the present study is to analyse the influence of the final consumption of households by purpose, but at the regional level (NUTS 2), especially after March 2020, a period in which the household consumption was influenced by the COVID-19, as soon as the data are available.

Author Contributions: The authors worked together for this research, but, per structure: conceptualization I.-E.P., M.L. and G.-R.L.; methodology, software validation and resources, I.-E.P., R.A.M. and M.L.; formal analysis, G.A.T., M.L., R.A.M. and M.I.; writing—original draft preparation, and writing—review and editing, I.-E.P., M.L., G.-R.L., R.A.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.
24. Maihami, R.; Ghalekhondabi, I. Pricing problem in a medical waste supply chain under environmental investment: A game theory approach. *J. Ind. Prod. Eng.* 2022, 1–17. [CrossRef]

25. Kearney, J. Food consumption trends and drivers. *Phil. Trans. R. Soc.* 2010, 365, 2793–2807. [CrossRef]

26. Parashar, N.; Hait, S. Plastics in the time of COVID-19 pandemic: Protector or polluter? *Sci. Total Environ.* 2021, 759, 144274. [CrossRef]

27. Humă, C. Modificarea comportamentului de consum al populației, din perspectivă ecologistă, în țările uniunii europene. *Qual. Life Calitatea Vietii* 2013, 24, 353–372.

28. He, H.; Reynolds, C.J.; Hadjikakou, M.; Holyoak, N.; Boland, J. Quantification of indirect waste generation and treatment arising from Australian household consumption: A waste input-output analysis. *J. Clean. Prod.* 2020, 258, 120935. [CrossRef]

29. Principato, L.; Mattia, G.; Di Leo, A.; Pratesi, C.A. The household wasteful behaviour framework: A systematic review of consumer food waste. *Ind. Mark. Manag.* 2020, 93, 641–649. [CrossRef]

30. OECD. Household consumption. In *National Accounts at a Glance*; OECD Publishing: Paris, France, 2013; Available online: https://www.oecd-ilibrary.org/docserver/na_glance-2013-12-en.pdf?expires=1641467357&id=id&accname=guest&checksum=7D6355B535069A27AD384783D84C64A2 (accessed on 14 January 2022). [CrossRef]

31. Broom, D. This Is How COVID-19 Hit Household Expenditure in Europe. 2021. Available online: https://www.weforum.org/agenda/2021/12/pandemic-impact-europe-consumer-spending/ (accessed on 14 January 2022).

32. Al-Salem, W.; Moraga, P.; Ghazi, H.; Madad, S.; Hotez, P.J. The emergence and transmission of COVID-19 in European countries, 2019–2020: A comprehensive review of timelines, cases and containment. *Int. Health* 2021, 13, 383–398. [CrossRef] [PubMed]

33. COVID-19 Pandemic in Europe. Available online: https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Europe (accessed on 17 January 2022).

34. Romania: Government Announces lockdown Measures on March 25/Update 2. Available online: https://www.garda.com/fr/crisis24/alertes-de-securite/326626/romania-government-announces-lockdown-measures-on-march-25-update-2 (accessed on 17 January 2022).

35. Tigu, G.; Ciora, C.; Petcu, M.A.; Boboc, D.; Crismariu, O.D.; Curteanu, A.B. Restart the Hotel, Restaurant and Travel Industry in Romania after the COVID-19 Pandemic. Economic Recovery after COVID-19; Dima, A., Anghel, I., Dobrea, R.C., Eds.; Springer: Berlin/Heidelberg, Germany, 2021; p. 87.

36. García-Madurga, M.-A.; Esteban-Navarro, M.-Á.; Morte-Nadal, T. COVID key figures and new challenges in the HoReCa sector: The way towards a new supply-chain. *Sustainability* 2021, 13, 6884. [CrossRef]

37. Hasan, S.E. Public awareness is key to successful waste management. *J. Environ. Sci. Health A Tox Hazard Subst. Environ. Eng.* 2004, 39, 483–492. [CrossRef]

38. Romer, D. *Advanced Macroeconomics*; McGraw-Hill, Inc.: New York, NY, USA, 1996.

39. World Health Organization. *Fuel for Life—Household Energy and Health*; World Health Organization: Geneva, Switzerland, 2006; p. 8.

40. European Parliament. The Impact of Textile Production and Waste on the Environment (Infographic). 2020. Available online: https://www.europarl.europa.eu/news/en/headlines/society/20201208STO95327/the-impact-of-textile-production-and-waste-on-the-environment-infographic (accessed on 15 February 2022).

41. European Commission. Changing How We Produce and Consume: New Circular Economy Action Plan Shows the Way to a Climate-Neutral, Competitive Economy of Empowered Consumers; European Commission: Brussels, Belgium, 2020.

42. Food Loss and Waste Database. Available online: https://www.fao.org/food-loss-and-food-waste/flw-data (accessed on 15 February 2022).

43. Official Journal of the European Union. Directive (Eu) 2018/851 of The European Parliament and of The Council of 30 May 2018 Amending Directive 2008/98/EC on Waste. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&rid=5 (accessed on 17 February 2022).

44. Ozturk, I. The Role of Education in Economic Development: A Theoretical Perspective. 2001. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1137541 (accessed on 2 March 2022).

45. Colin Power Junior Sophister. Education Development: Importance, Challenges and Solutions. The Student Economic Review Vol. XXVIII. Available online: https://www.tcd.ie/Economics/assets/pdf/SER/2014/Colin_Power.pdf (accessed on 3 March 2022).