Article

The Effective Management of Organic Waste Policy in Albania

Ionica Oncioiu 1,* , Sorinel Căpușneau 1 , Dan Ioan Topor 2 , Marius Petrescu 3 , Anca-Gabriela Petrescu 3 and Monica Ioana Toader 2

1 Faculty of Finance-Banking, Accountancy and Business Administration, Titu Maiorescu University, 040051 Bucharest, Romania; capusneanu.sorin@gmail.com
2 Faculty of Economic Sciences, 1 Decembrie 1918 University, 510009 Alba-Iulia, Romania; topor.dan.ioan@gmail.com (D.I.T.); monica.ioana.toader.edu@gmail.com (M.I.T.)
3 Faculty of Economic Sciences, Valahia University, 130024 Targoviste, Romania; petrescu.marius_m@yahoo.com (M.P.); anki.p_2007@yahoo.com (A.-G.P.)
* Correspondence: nelly_oncioiu@yahoo.com; Tel.: +40-744-322-911

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Abstract: Following a recycling or continuous recycling process, there is always waste with no material or market value that can be converted into energy or other fossil fuel substitutes. The present study aimed to evaluate the management of organic waste policy and to predict the trend of organic waste generation in Albania. The research used an appropriate Box–Jenkins Auto Regressive Integrated Moving Average (ARIMA) to determine the quantification of organic waste to be generated. The main results obtained can support the decision-making process in the planning, change and short-term implementation of organic waste management, and the information provided is very useful in collecting, transporting, storing and managing waste in Albanian cities (Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan). Furthermore, the high percentage of the organic waste generation until 2025 constitutes good premises to raising public awareness related to their energy recovery.

Keywords: environment technologies; waste management; organic waste; organic waste projection

1. Introduction

In the current context of the transition to the bio economy, the biggest environmental issue for all countries is organic waste management [1–5]. One of the main driving forces for this trend in all countries is the general increase in consumption [6–8]. The level of organic waste production in cities seems to be correlated with the level of income as well as with economic growth [9–11].

In this context, the European Union’s new waste management guidelines include measures aimed at greater recycling and reuse during the life cycle of products to benefit both the environment and the economy [12–14]. Withal, most countries understand that the recycling strategy—that is, the 4Rs (recovery, reuse, regeneration and recycle)—can lead any country to transition to a circular economy [15–18].

Specialized studies have highlighted the importance of the social aspect in the efficiency of organic waste management systems [19–22]. Regarding recycling, some authors showed that social influences and economic factors are only some of the reasons some communities are developing strong recycling habits [15,23]. Additionally, in most cases, as the distance to recycling bins decreases, the number of citizens who collect waste at home increases while the government should support markets for recycled materials to increase recycling rates [17,24].

Other studies have indicated various advantages offered by Waste To Energy (WTE) technologies: (1) reduces the amount of waste disposal with an impact on climate change [25,26]; (2) helps to
improve recycling rates; (3) reduces dependence on fossil fuels to generate electricity; and (4) prevents contamination of air/water content [27–30].

The aim of our research was to develop a prognosis model for organic waste generation in Albania to help evaluate organic waste management options from the point of view of environmental implications. Furthermore, this study should arouse the consciousness of the municipal decision makers to implement ecologically sustainable measures (e.g., increasing recycling quotas). Our research was based on numerous studies and reports that have examined waste recycling and organic waste management to reduce negative environmental impact. This study provides the possibilities of developing alternate solutions for the issue of urban organic waste management in Albania.

The structure of the paper is as follows. Section 2 presents the literature review. Section 3 presents the potential of organic waste recycling in Albania. Section 4 provides the proposed methodology and data. Section 5 analyzes the empirical results and discusses implications. Section 6 draws the conclusions.

2. Literature Review

In the circular economy, waste must be properly treated and converted into natural resources in order to protect the environment and the public health using different WTE technologies. These technologies are responsible for converting non-recyclable waste (semi-solid, liquid and gaseous) into valuable products such as different fuels, heat and electricity, which are part of the waste management hierarchy [31]. Considered unnecessary long ago, these WTE technologies have become the main source of saving landfills, reducing costs by disposing and managing organic waste and transforming it into valuable fuels, fertilizers and electricity [32]. Specialists have identified two categories of WTE technologies: thermochemical technologies and biochemical technologies [33].

Thermochemical technologies are those technologies by which a sufficient amount of thermal energy is applied to organic waste components in a closed vessel and the bonds of molecular structures are broken and broken down into smaller molecules. Following this process occurs the recombination by which the carbon and hydrogen atoms released from the decomposed molecules combine with oxygen, releasing more energy than that consumed to decompose the molecular structure of waste components [34]. The most well-known thermochemical technologies are incineration, gasification, pyrolysis, plasma arc gasification, thermal depolymerization and hydrothermal carbonization [35].

2.1. Incineration

Incineration is the technique by which organic substances present in waste are burned and as a result of this process heat is recovered to reduce the volume of Municipal Solid Waste (MSW) [36,37] and reduce the infectious properties and potential toxicity of hazardous medical waste [38]. A very large quantity of oxygen is needed to ensure the complete oxidation of the waste incineration, and the combustion temperature in the incineration plant is about 8500 °C, forming CO₂ and H₂O. The incineration process consists of the fuel system, the combustion chamber, the exhaust system and the waste disposal system. Before incineration, it is necessary to separate the non-combustible substances (glass, metal, etc.) from MSW because after incineration the bottom ash of the incinerator or solid slag results [37]. According to the studies of specialists [38–45], several thermochemical incineration technologies have been identified: (1) the principle of the process involving the complete oxidation of waste; (2) the type of exothermic reaction; (3) requirements for raw materials taking into account dry waste of biological and synthetic origin; (4) the method of pre-processing the raw material by drying and pelleting; (5) the permitted moisture content of the raw material of 25–30%; (6) temperature (700–14,000 °C); (7) endurance time (minutes/seconds); (8) final products (heat and ash); (9) environmental issues (ash leakage and toxic gases); (10) cost of capital (medium-high); (11) degree of efficiency (50–60%); (12) product applications (heat and power applications, aggregate and filler); and (13) future (moderate) potential. The advantages of thermochemical incineration technology include: (1) the resulting ash can be used as a low-cost aggregate or filler for construction works on
bridges, roads and highways; (2) it has relatively low capital requirements, requires less skilled labor compared to other WTE technologies and is more suitable for rural and urban areas; (3) it significantly reduces waste storage space; and (4) it has high energy generation efficiency and low emission rates due to the installation of pollution content control devices in incinerators that help maintain the emission limits required by law [44,46–51].

As disadvantages, the specialists identified the following: (1) the modifications made to the combustion and pollution control equipment to reduce emissions contribute to the increase of construction and operating costs; (2) the impossibility of avoiding the emission of toxic gases (dioxins and furans) even if some incineration plants have been modified and developed; (3) some risks of emission of flue gases due to incorrect handling of heavy metals produced by incineration; and (4) lack of professional staff and variety of waste can cause problems over time in the waste incineration process [44,47,51–54].

2.2. Gasification

Gasification is a way of transferring organic material or converting (liquid and solid materials) into clean and useful syntheses [32,55,56] or other forms of energy through a cleaning reaction. Before entering the raw material processing, it is necessary to extract all inorganic materials (glass, metal, contaminants and inert materials) that cannot be transformed into gaseous products [32,57] and then grind them into very small particles. Types of waste that act as raw material for gasification include: MSW, RDF, coal, sludge, black liquor, organic waste streams, tires, PVC, biomass, refinery waste and shredded car waste (ASR) [58]. According to specialist studies, gasification as a thermochemical technology offers several advantages: (1) reduces the formation of dangerous products (furans and dioxins) because the chemical reaction occurs in an environment with low oxygen consumption; (2) an energy efficient method using only a small part of the stoichiometric amount of oxygen; (3) requires low equipment cleaning costs; (4) the gas obtained can be used in combined cycle turbines or fuel cells, which have a tendency to convert combustible energy into electricity compared to conventional steam boilers; and (5) contributes to the significant reduction of waste storage space (by about 90%) and slag content (about 10%) [47,59].

Among the disadvantages of gasification, the specialists mentioned: (1) the release of polluting compounds (alkaline, tar, halogens and heavy metals) in the syngas produced can cause operational and environmental problems; (2) causing acid rain (if corrosive halogens are released into the atmosphere) or the accumulation of heavy metals (if emitted into the environment); (3) gas turbines may be destroyed during combustion due to alkalis; and (4) thick (tar) and high molecular weight organic gases spoil ceramic filters, sulfur removal systems, reform catalysts and increase the existence of shakes in refractory surfaces, metals and boilers [59].

2.3. Pyrolysis

By using oxygen-free thermochemical decomposition or other reactive materials, pyrolysis consists of the transformation of carbonaceous materials into syngas (combination of CO, H2, CO2 and CH4) at higher temperatures, the association of solids (char) and at lower temperatures of liquids (oxygenated oils) [58,60–62]. The pyrolysis process requires constant raw materials, where the feed particles for a longer or shorter period of time have the same moisture content, size and composition [41]. The types of waste that act as raw materials for pyrolysis include: MSW, RDF, coal, sludge, tires, wastewater, biomass, ASR, chloride and polyvinyl [58,60,63]. The final products of pyrolysis depend on the heating contribution, the pyrolysis temperature, the dimension of the waste particles and the vapor resistance time [60,64].

According to the studies of specialists, the advantages of pyrolysis as a thermochemical technology include: (1) reduced pollution and good environmental values compared to other thermochemical technologies (except for gasification with plasma arc); (2) in the absence of oxygen, it contributes to the formation of dangerous products (ransom and dioxin); (3) contributes to the reduction of the volume
of MSW type waste (70–90%); (4) the use in oil or powerplants of the oils and syngas produced by MSW pyrolysis for the production of electricity; (5) the use of pyrolytic products as fuels for boilers and other products (adhesives, chemicals, motor fuels and other products after refining); and (6) the low temperatures allow the recovery of metals and reduction of flue gas [60].

Among the disadvantages of pyrolysis specialists are the following: (1) causes pollution, destruction of nature, natural resources and climate change by releasing toxic residues into the air, toxic ash and tarring; (2) risks of explosive reactions due to accidental air intrusions or installation failures due to tarsal deposits; (3) pyrolysis products contain low energy and commercial scale pyrolysis plants that accept MSW are very limited in the world; and (4) requires high operational and capital costs [37,47,50,60].

2.4. Plasma arc Gasification

Plasma arc gasification is the process that takes place in an oxygen-free atmosphere by decomposing waste by partial oxidation into molecules of $\text{H}_2\text{O}$, $\text{H}_2$ and $\text{CO}$ [65], using a plasma torch reactor for processing MSW carbon materials [66]. As a heat source, it uses a plasma arc flame and an electric arc provides power to the plasma torch for the ionization of gases and organic matter that decompose into syngas and solid waste. The plasma torch converts electricity into intense thermal energy [65]. Almost all types of waste act as raw materials for plasma arc gasification, such as MSW, dangerous waste, RDF, coal ash, tires, biomass, ship waste and ASR [59,65]. No initial processing of the raw materials is required for plasma arc gasification because almost all types of waste (except nuclear) can be treated and processed directly [66].

The advantages offered by this thermochemical technology include: (1) it offers the highest energy efficiency in terms of technology and the most advantages in terms of storage surface requirements (approximately 99% by transforming the residual waste into vitrified slag); (2) converts into syngas-type products any type of waste that is difficult to treat (toxic ash from incinerators, electronic components, hazardous medical waste, etc.); (3) the use of syngas-type products for the production of electricity by means of gas turbines or the production of transport fuels; (4) production of 0.1 tons of waste per 1 tons of waste introduced (depending on the waste structure); (5) the absence of methane and low environmental (carbon) emissions compared to other facilities; and (6) converts inorganic components into vitrified slag used in varicose applications (roofing materials and road construction) [50,60,64–67].

Specialists have also identified a series of disadvantages of plasma gasification: (1) high costs with high electricity consumption through the use of plasma; and (2) high capital costs due to the use of plasma torch being one of the most expensive WTE technologies compared to other facilities [50,60,66].

2.5. Thermal Depolymerization

Thermal depolymerization consists in the depolymerization of various organic materials using water at high temperature and pressure to form petroleum products. In this process, the long polymer chain is broken down into a shorter monomer chain, simulating natural geographic processes that produce fossil fuels [68]. In other words, this process involves chopping the fodder into very small pieces which are then combined with water and heated to a temperature of 2500 °C and subjected to high pressure [36].

The products obtained (solid carbon, gaseous components, water, light oils and heavy oils) following this process are separated using a fractional distillation technique from an oil refinery [68]. The water resulting from obtaining the products is returned to the front, where it is mixed with the next unit of waste, forming a gas that is used to heat it. Therefore, 15% of the energy produced from thermal depolymerization is used to run the process, which makes thermal depolymerization a process with an efficiency of 85% [69].

The raw materials used in thermal depolymerization are varied and include carbon waste (except nuclear waste), plastic bottles, agricultural biomass, tires, electronic waste, medical waste and municipal liquid waste [69–71].
Thermal depolymerization involves the following steps [71]: (1) After introducing the raw materials into the chamber, they are combined with water and heated under high pressure to a temperature of 200–300 °C. (2) The pressure of the combination is rapidly reduced, which allows the oils to be separated from the water and the volatile gases are removed and used for heating boilers or rotating turbines. (3) The remaining oil is heated to 5000 °C to obtain light hydrocarbons.

According to specialists, thermal depolymerization brings a number of advantages: (1) recovery of polyamides, polyurethanes and PETs; (2) recycles the energy of organic components by easily separating liquid fuel from water without pre-drying; (3) removal of heavy metals by transforming the ionized form of metals into stable oxides; (4) aids in the processing of shales, tar sands and heavy metals (considered profitable) and a modified version of thermal depolymerization could extract a variety of minerals from coal treatment; (5) the generated gases have low temperature, avoiding energy loss for gas cleaning; and (6) the fuel produced is not harmful to gas turbines and does not contain alkali metals [68,69,72].

The disadvantages of thermal depolymerization include: (1) high processing costs, which influences the production of liquid crude oil; (2) generates risks of the release of dioxins, furans, CO₂ and CH₄ at temperatures above 4000 °C; and (3) requires additional refining steps because monomers cannot be transformed by this process into oil [68].

2.6. Hydrothermal Carbonization

Hydrothermal carbonization is the process that transforms organic substances into hydrocarbons (with mesoporous texture, aromatic structure and moderate caloric value) [73] under moderate pressure (2–10 MPa) and temperature (180–3500 °C) in the presence of water.

The raw materials used in the hydrothermal carbonization process are: wood, food and poultry waste with high carbon content and humidity over 20%; cardboard and paper; biomass; MSW; and sewage sludge [74]. The raw materials go through a succession of stages: hydrolysis, dehydration, decarboxylation, flavoring and condensation. The result consists in the formation of products in liquid, solid and gaseous state [40].

Pre-processing of raw materials consists in crushing the raw material, mixing it with water (75–90%) and subjecting it to a saturation pressure that allows carbonization. The presence of adequate water in the hydrothermal carbonization process is essential because, as the temperature increases, their physical and chemical properties change, favoring the stimulation of organic solvents [40].

The products obtained from the hydrothermal carbonization process consist of higher solid yields (hydro char with 75–90% carbon content), products in the aquatic phase (residues, organic acids and sugars with 15–20% carbon) and gases (CO₂ and 5% carbon-rich hydrocarbons) [75]. Most of the carbon content of the raw material is produced in hydrocarbons, which improves the energy density of hydro char [40] that provides various alternative energy sources, soil growth and environmental remediation. HTC’s gaseous and liquid products also provide energy [76].

According to specialists, hydrothermal carbonization offers a number of advantages: (1) modifies hybrid nanostructures and designer carbons along with practical applications replacing petrochemical processes with a scalable green process; (2) completely separates the physical structure of the waste compared to other WTE techniques and does not require an intensive drying process; (3) hydrocarbons improve water retention capacity, increase hydraulic conductivity and reduce the tensile strength of hard fixing soils; (4) increased reactivity compared to natural coal due to the chemical structure of hydrocarbons including olefin and aliphatic construction units; (5) significant reduction in GHG emissions and odor due to the preservation in the solid material of a carbon content of 75–90%; and (6) energy efficient (energy inputs) compared to other WTE technologies [40,72–77].

The disadvantages of hydrothermal carbonization include: (1) high costs due to the supply of pressure in a continuous regime to which are added the safety and material aspects of the reactor; (2) requires subsequent treatments for the separation of solid water products but also treatments for water processing; (3) energy inefficiency when processing raw materials with a moisture content of
less than 40%; (4) risks of dust formation and fungal degradation of hydrocarbons in the absence of a water content of at least 10–15%; (5) high hydrocarbon acidity due to high ash content; and (6) negative impact caused by water emissions from processing [74,76].

3. The Waste Management in Albania

3.1. The Status and Waste Morphology in Albania

In Albania, renewable energy is composed of geothermal energy, solar energy, wind energy, hydroenergy and biomass. Relying mainly on hydroenergy resources (geographically advantageous), Albania faces problems due to prolonged droughts and declining river water flows [78]. Albania also benefits from year-round solar energy (about 2100–2700 h of sunshine) [79], with a United Nations Development Program (UNDP) program installation of about 50,000 m² of solar panels at the end of 2018 [80].

According to the studies of specialists, from the point of view of waste management, Albania has a deficient and unsatisfactory infrastructure, not being able to keep up with rapid economic growth and urban expansion [81]. Although considerable efforts have been made, the state of waste management in Albania remains sub-standard and partial as there is no separate or segregated waste collection [82,83]. In 2016, Albania made legislative progress through assistance from European Commission regulatory agencies by adopting legislation, standards and compliance on waste management aligned with that of the EU [84]. Waste to Fuel (WTF) Transformation is a direct form of energy recovery, being practically the process by which fuel is obtained from the primary treatment of waste. At the local level, the recycling of biomass is considered by transforming organic products (food, wood, paper and textiles) into biofuels (bioethanol and biodiesel), and, at the industrial level, it is obtaining them from other organic products such as corn, sugar cane and cereals.

According to an Albanian study, municipal and urban waste is composed of 66% biodegradable waste (of which 47% is organic: cardboard, paper, wood and certain textile waste), 7% glass and metal and 31% energy-convertible waste (pyrolysis oil and industrial synthetic diesel) and other general components (rubber, paper and plastics) [81]. Based on the above, Albania has viable options for recycling waste and converting it into fuel. Several specialists have dedicated their studies to exploring the use of Biomass to Energy (BTE) and the potential of renewable energy in Albania [85,86] and indicating the methods of evaluation, implementation and benefits of following the use of recycling their own organic waste [87]. In addition, inorganic waste such as plastic waste and rubber waste can be reprocessed according to WTF producing pyrolysis oil, industrial diesel not taking into account the reprocessing of oil-based waste or the import of plastic materials or packaging [83]. Using waste management practices, Albania can rely on renewable resources for biofuel and pyrolysis fuel. This can lead to a reduction in energy imports by increasing domestic production of fossil fuels with a negative impact on the average consumer [81].

3.2. The Potential of Organic Waste Recycling in Albania

The concept of green growth gained importance in Albania with the search for a new growth model that started on a global scale in order to achieve sustainable development goals. By using this concept, the environment is protected and the competitiveness is increased by obtaining in the production sectors a clean production and eco-efficiency.

In the Second Environmental Assessment Report-Albania-Second Review [88], the UN Economic Commission for Europe states that the state of waste management in Albania is at a low level, with waste collection systems being implemented only in cities. The disparity is based on the inability of national, regional and local administration to achieve a sustainable waste collection and on limited human resources, even if the legal framework in accordance with European Union Acquis Communautaire exists [89].
The responsibility of applying the policies and legislation on waste management is on the Ministry of Environment, Forests and Water Administration [90]. Decentralization predominates in organic waste management: the financing of waste collection and transport to disposal facilities is done by the municipality and undertaken by private companies. The municipality selects on the basis of public auction private companies (about 2/3) with which it concludes contracts for a period of 3–5 years [91]. Albania provides waste collection services using its own companies to 1/3 of municipalities [92].

On the other hand, this strategy involves expertise at national level to prepare and implement the waste management plan, focusing on source waste decomposition, increasing producer responsibility and the improvement the waste information system. However, the lack of collection education exists because collectors and individual companies have difficulty identifying clean and decomposed waste. Recyclable waste comes from most urban areas and only partially from the industrial sector.

The evolution of the organic waste in Albania is the consequence of rapid development (Figure 1).

![Figure 1. Total generation of organic waste (thousand tones) [91,92].](image)

As a consequence of these statistics, Albania developed the National Waste Management Strategy for 2010–2025, which sets the direction of the Albanian government’s policy for sustainable waste management by 2025. This strategy is divided into three operational phases of five years each, as follows: by 2020, it aims to stop the growth of municipal waste produced (recycling/composting 55% of organic waste); by 2025, it aims to recover energy from 15% of organic waste [93]. Nevertheless, some progress has been made in Albania [94], notably:

- **Organic waste**: Dumping in uncontrolled sites is the main method of organic waste disposal. The municipality has led considerable work to improve the separate collection through awareness campaigns of citizens.

- **Hotspots**: The waste deposits are a priority for Albania. The United Nations Development Programme Project Identification and Prioritization of Environmental Hotspots in Albania (January 2008–August 2011), funded by the Government of the Netherlands, identified 35 hotspots, while nine priority hotspots were selected for assessment and the preparation of remediation action plans.

On the economic side, the opportunity cost of depositing the wastes is considerably high when considering the fact that Albania is producing more than 10 MW installed capacity from 1500 tons of household waste per day and that 300 tons of packaging waste can be recycled daily [95]. As a result, recycling of packaging wastes and recycling of organic wastes through legal regulations are encouraged; it is understood that only wastes which are not recoverable and pre-treatment residue should be stored regularly.
4. Data and Methodology

Based on the direction of the Albanian government’s policy for sustainable waste management and the dates collection, we formulated the objective of the study by which we developed an appropriate Autoregressive Integrated Moving Average (ARIMA) model for time models for organic waste collection in Albanian cities (Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan). We marked five-year forecasts with an appropriate prediction interval. Through this model, we aimed to identify the stochastic process of the time series and accurately forecast future values.

For our study, we selected the period between 2000 and 2019 for organic waste collection in Albanian cities (Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan) from datasets on the Eurostat website [96], the Albania Institute of Statistics [97], the European Environment Agency data portal [93] and the data provided by the Center for Regional and Local Development Studies Albania (CRLDS).

The ARIMA methodology was developed in this research because it uses a combination of autoregressive (AR), integration (I) (referring to the reverse process of differencing to produce the forecast) and moving average (MA) operations, which is usually stated as ARIMA (p, d, q), where p is the number of autoregressive terms, d is the number of nonseasonal differences needed for stationarity and q is the number of lagged forecast errors in the prediction equation).

To predict the trend of organic waste generation in Albanian cities (Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan), an ARIMA is expressed in the form:

\[ \omega_t = (1 - X)^d r_t, \]  

Then,

\[ \omega_t = \beta_0 + \beta_1 \omega_{t-1} + \beta_2 \omega_{t-2} + \ldots + \beta_p \omega_{t-p} + \epsilon_t - \mu_1 \epsilon_{t-1} - \mu_2 \epsilon_{t-2} - \ldots - \mu_p \epsilon_{t-p}, \]  

where \( \omega_t \) is regressors, \( \beta_0, \beta_1, \beta_2, \ldots, \beta_p \) are model parameters, \( \epsilon_t \) is an error term and \( \mu_1, \mu_2, \ldots, \mu_p \) are the moving average parameters to be estimated.

The first thing to note is that the ARIMA model refers only to a stationary time series, thus the first stage of this model is reducing non-stationary series to a stationary series by taking first-order differences.

The stationary verification of the time series data was followed by the identification of the candidate ARIMA models by finding the initial values for the orders of the parameters “p” and “q”. Then, the accurate estimation of the model parameter was obtained by at least squares, low Akaike information criteria (AIC) were selected and Schwartz Bayesian Criterion (SBC) was used and estimated by \( \text{SBC} = \log \sigma^2 + (m \log n)/n \). Therefore, \( \text{AIC} = -(2 \log L + 2 m) \), where \( m = p + q \) and L is the likelihood function.

To examine the trend over time, the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were used. The accuracy was checked using two measures, namely RMSE and MAPE, and the generation of organic waste model parameters were estimated using SPSS package.

5. Results and Discussion

Following the proposed model and data presented above, the first step in the analysis was to plot the given data. Figure 2 shows generation of organic waste centralized data, Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF). After checking the AIC and BIC of the tentative ARIMA models, we selected the suitable model ARIMA (0, 1, 1) for generation of organic waste.

The model verification was concerned with investigating thoroughly the auto correlations and partial auto correlations of the residuals to see if they contain any systematic pattern which could still be removed to improve on the chosen ARIMA (Figure 3).
Figure 2. ACF and PACF plots for generation of organic waste.

The model verification was concerned with investigating thoroughly the auto correlations and partial auto correlations of the residuals to see if they contain any systematic pattern which could still be removed to improve on the chosen ARIMA (Figure 3).

Figure 3. Residuals ACF and PACF plots for generation of organic waste.
On the other hand, forecasting of generation of organic waste in Albania was done for the six years using the ARIMA (0, 1, 1) model with 95% confidence level (Table 1).

Table 1. Forecasted values of generation of organic waste in Albania with 95% confidence level (CL).

| Year | Forecasted Value | LCL     | UCL     |
|------|------------------|---------|---------|
| 2020 | 1,325,020        | 1,317,595 | 1,325,265 |
| 2021 | 1,279,380        | 1,272,186 | 1,287,038 |
| 2022 | 1,296,788        | 1,288,770 | 1,305,358 |
| 2023 | 1,296,400        | 1,287,225 | 1,305,794 |
| 2024 | 1,297,969        | 1,287,818 | 1,308,120 |
| 2025 | 1,299,323        | 1,288,468 | 1,310,178 |

LCL, Lower Confidence Level; UCL, Upper Confidence Level.

Obviously, the present prognosis model for organic waste generation is often used to provide justification for the adoption of waste policy measures and in the planning of recycling facilities and collection service. Accurate predictions of organic waste quantities can determine successful planning and operation of an organic waste management system in the countries included in the study. The prediction findings of future organic waste generation rates can facilitate significant changes in regulations regarding waste minimization and recycling. Thus, the projections on domestic waste disposal rates stated in this study will be valid only if there is no significant change in the Albanian environmental authorities (Tirana, Durrërë, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan) to promote waste recycling and reduction and that the assumed maximum number of housing estates participating in waste separation program is attained.

Taking this prediction into account requires progress in increasing recycling and composting by the widespread provision and relevant authorities of the segregated organic waste collection services and mechanized post collection separation across the country. However, in all Albanian cities (Tirana, Durrërë, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan), the responsibility for the provision of waste services has been delegated to local governments suffering from a lack of financial resources to support and improve public services, including the waste service.

In accordance with the data presented in Table 1, to reduce the gaps in the reuse and recycling of organic waste, Albanian authorities must provide the necessary resources to develop and implement effective waste management policies, establish the necessary infrastructure for the collection and recycling of waste and set up business partnerships that support and improve the recycling process.

Additionally, organic waste recycling involves costs that cannot be immediately recovered. Therefore, the way in which financial resources are managed, as well as the good management of infrastructure and appropriate maintenance of equipment, can ensure a sustainable modern recycling system that will contribute to the development of the economy and society.

Based on the results of this forecast, a strategic reflection should be made to build an efficient recyclable waste sector because even the privatization of this sector has led to social and urban problems.

Despite all these inherent limitations, the benefits observed in the organic waste management policy in Albania have not been verified across all the regions, because the interregional diversity observed in the management policy indicates that several regions are favored over others.

Moreover, this study contains elements that have the potential to open new avenues for future research. To analyse how to recycle organic waste after sorting, a study should be conducted that considers its composition, which depends on several factors (e.g., the degree of culture, the geographical area, the climatic zone and the total weight of residuals).

6. Conclusions

The circular economy creates added value through its benefits: (1) the potential to create new jobs, new products and new services; and (2) improved competitiveness of the economy [98–100]. To create added value, the circular economy has to be operational on a local or regional basis. Moreover,
circular economic initiatives: (1) reduce the level of dependence on fossil fuels of a region or a country; (2) reduce to a minimum waste production; (3) decrease carbon emissions; and (4) contribute to combating climate change [101].

The results of this model can be implemented as a useful decision support tool for organic waste of Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan. The public and the decision-makers must be aware that recycling brings benefits to both the environment and the economy by providing raw materials to create new products and fostering innovation and job creation. In this respect, Albania should pay more attention to forecast models of organic waste.

As this study demonstrated, WTE plays a key role in the circular economy by contributing to synergies in three EU policies, namely waste management, environment (climate change) and Member States’ energy union policies, which encourages meeting the targets related to these policies in the context of energy and resource efficiency.

In conclusion, Albanian authorities can learn several lessons from this study regarding organic waste disposal rates. First, it is recommended that Albanian authorities devote more resources to collecting statistics on waste recycling because accurate waste projections cannot be made without a source of data.

Second, the results generated by the study’s models merely show that the waste reduction is not impossible for Tirana, Durrës, Kukës, Berat, Shkodra, Dibër, Gjirokastër and Elbasan (and similar Albanian cities as well) because predictive models do not always determine the future. Moreover, the main objective of this model is to identify the stochastic process of the time series and predict the future values accurately.

Third, even when valid solutions are identified, empowering Albanian cities in the fight against organic waste also means disposing of charismatic politicians without a vision and with concerns related for their pockets. Local politicians are much more in the picture and more vulnerable to criticism. However, their capacity to change things quickly is much higher.

Based on the results of this forecast, a strategic reflection should be made to build an efficient recyclable waste sector because even the privatization of this sector has led to social and urban problems.

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