

Qualitative and quantitative comparison of Italian regions' performances in the waste management

A. Marino¹, P. Pariso¹

¹Department of Engineering, University of Campania "Luigi Vanvitelli", Aversa, Campania, 81031, Italy

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Presenting authors email: paolo.paris@unicampania.it; alfonso.marino@unicampania.it

This paper aims to benchmark performance of solid waste management and recycling systems in Italian regions. A qualitative analysis, elaborated on Italian National Institute of Statistics was used to present a detailed systems analysis for the twenty regions. In order to confirm the displayed trend in the qualitative analysis, a quantitative analysis was performed with the use of indicators (Produced Solid Municipal Waste, Solid Municipal Waste Recycles rate) and a subsequent their correlation with the regional Growth Domestic Products expressed in Purchasing Power Standards. The analysis allows to assess the progress level achieved by the Italian Regions in the implementation of an effective waste management. The analysis shows that different strategies were adopted by the 20 regions and that only a few of these could be considered effective in meeting the challenges of the twelfth Sustainable Development Goal.

1. Introduction

The European material consumption is about 16 tonnes per person per year and about 6 tonnes become waste (EC, 2019). Despite in the EU the waste management continues to enhance, there are great margins of improvement to avoid losing a significant amount of potential secondary raw materials that currently contribute to the waste streams (Iacovidou et al., 2017; Horodytska et al. 2018; Hahladakis and Iacovidou, 2019). With reference to the waste management, in the last ten years, several European countries have focused their efforts from collection methods to reduction, prevention and recycling (Minelgaitė, & Liobikienė, 2019). Addressing the municipal waste management through the "waste hierarchy" (Pires, et al., 2019) become fundamental to obtain more value from resources (Iacovidou et al., 2017) while, on the one hand, by reducing the environmental pressures, and on the other hand, creating new opportunities in the work market (EEA, 2016). One of the main objectives of the Circular Economy Package (EC, 2015a), adopted by the European Commission, is to cover the whole cycle from production and consumption to waste management. The EU identifies separate waste collection as a key factor and sets as EU Member States target the achieving of a separate waste collection rate of 50% by 2020 (EC, 2015b). The Italian municipal waste production settles down to around over 30 million tonnes of waste (ISPRA, 2019). Despite, Italy is close to the European target, the country shows a wide variability, at regional level, linked to the effectiveness waste management. The aim of the present research is to compare the performances in the waste management of the 20 Italian regions. This study overviews the conceptual background, that informed the implemented measures by each region so as to create an accumulation of knowledge which focuses on the strategic actions aimed to an effective

waste management in Italy. Starting from the analysis of the implemented actions by the regions, this study elaborates a qualitative analysis by comparing qualitative elements in the municipal waste management of Italian regions. Furthermore, in order to confirm the qualitative analysis, the evaluation of these actions and their impacts were carried out correlating the Growth Domestic Products expressed in Purchasing Power Standards with two quantitative indicators (Awasthi et al., 2018): Produced Solid Municipal Waste – SPMW and Solid Municipal Waste Recycles rate – SMWRr. The present analysis will be of interest for researchers, policy makers and government planners, who can acquire information for the development of waste management strategies in long term plans. The analysis allows to assess the progress level achieved by the Italian Regions in the implementation of an effective waste management. The analysis shows that different strategies were adopted by the 20 regions and that only a few of these could be considered effective in meeting the challenges of the twelfth Sustainable Development Goal.

The paper is organized as follow: sections two outlines the elaborated methodology. Moreover, section 3 displays the results and related discussion. Finally, section 4 shows the conclusions of the paper.

2.Methodology

The study elaborated a qualitative analysis based on the implemented actions by the regions comparing the strategic elements in the municipal waste management, based on on Italian National Institute of Statistics data set (ISTAT, 2019):

- Presence of initiatives aimed at the prevention, reduction and recycling of municipal waste in the capital municipalities ;
- Presence of facilities or actions aimed at encouraging self-composting in households in the capital municipalities ;
- Facilities or actions and controls to encourage self-composting in the capital municipalities
- Use of urban waste collection methods aimed at allowing the application of the PAYT in the capital municipalities
- Presence of activities or services and controls aimed at encouraging the correct delivery of municipal waste in the capital municipalities
- Methods of collection of municipal waste by type of material in the
- Presence of separate collections in the
- Methods for collecting municipal waste for domestic use in the
- Waste subject to multi-material collection in the

GDP per capita is expressed in Purchasing Power Standards (PPS) in which the volume index is correlated to the Italian average which is set as equal to 100. Values higher than 100 show that the regions' level of GDP per capita is higher than the EU average and vice versa. PPS can be considered as a sort of common currency that eliminates the differences in price levels between regions therefore allows for meaningful volume comparisons of GDP between different geographical areas.

SPMW displays the amount of waste produced by final consumers. This includes households waste and other kinds of waste similar in nature and composition to household waste. Based on

Italian National Institute of Statistics data set (ISTAT, 2019), the indicators were calculated as follow:

$$SPMW[t] = (\sum_i SC_i) + UW + BWD$$

SC – Separate Collection

UW – Unsorted Waste

BWD – Bulky Waste Disposal

SMWRr detects how much of the waste produced by the final consumers is recycled and it results from:

$$MWRr = \frac{\text{Total MWR}}{SPMW[t]}$$

MWR – Municipal Waste Recycled

With reference to the amount of Municipal Waste recycles the study focused on the calculation methodology provided by the European directives 2008/98/CE (EP, 2008) and 2018/851/UE (EP, 2018) and in particular on the methodology also adopted by Italian Government (methodology n.2 of Directive 2008/98/CE art. 11 par. 2) and on Italian Institute for Environmental Protection and Research data set (ISPRA 2019). The performances of the 20 Italian regions was analyzed in the period 2009-2018.

3.Results and Discussion

The Circular Economy Action Plan (EC, 2015a) encourages the innovation of production, distribution and consumption models, by promoting a cultural and structural change that allows us to abandon the model of economic growth based on the extraction of raw materials, on mass consumption and on the production of waste. The proposals on waste provide for an increase in recycling and a reduction in landfilling and, at the same time, concrete measures to improve waste management, by taking into account the different situations of the Member States. The new directives are aimed to a comprehensive revision of the European legislation on waste management. In order to investigate waste management awareness in the Italian context, it is necessary to understand how the regions are implementing and should implement actions on three R's actions able to facilitate a waste strategy more in line with the European targets. These actions also represent a fundamental tool aimed at speeding the transition towards the Circular Economy (Marino and Pariso, 2020).

From Table n. 1 to Table n.9 the research shows the implemented actions in reduction, reuse and recycling of solid municipal waste by Italian regions. The unit of measurement is expressed through the number of capital municipalities out of their total number for each individual region that have implemented the examined activities for each table.

Table 1 - Presence of initiatives aimed at the prevention, reduction and recycling of municipal waste in the Period 2018

<i>Regions/ Capital municipalities number</i>	Implementation of good practices in offices and schools	Flea markets, exchange points and / or reuse centers	Repair centers and/or centers for preparation for reuse centers	Activities to promote the supply of quality drinking water in public spaces	Promotional actions of the use of biodegradable or washable dishes in festivals and/or temporary events	Agreements with large retailers	Reduction of food waste at markets, restaurants, canteens and grocery stores	Specific awareness campaigns on prevention	Distribution or facilities for the purchase of washable nappies	Discounts on the tariff for the municipal waste management to non-domestic users that implement policies for the	Other initiatives of prevention and reduction of municipal waste
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											prevention, reduction or start of municipal waste recycling	
Piemonte 8	9/9	4/9	1/9	9/9	4/9	3/9	4/9	5/9	0/9	5/9	1/9	
Valle d'Aosta 1	1/1	0/1	0/1	1/1	1/1	0/1	0/1	1/1	0/1	1/1	1/1	
Liguria 4	3/4	2/4	1/4	3/4	3/4	2/4	2/4	1/4	0/4	3/4	0/4	
Lombardia 12	9/12	9/12	0/12	8/12	5/12	5/12	5/12	6/12	2/12	8/12	0/12	
Trentino Alto Adige 2	2/2	2/2	0/2	0/2	0/2	2/2	2/2	2/2	1/2	1/2	0/2	
Veneto 7	7/7	4/7	2/7	3/7	4/7	2/7	2/7	6/7	5/7	4/7	1/7	
Friuli Venezia Giulia 4	4/4	0/4	0/4	3/4	1/4	0/4	2/4	4/4	1/4	3/4	0/4	
Emilia Romagna 9	7/9	7/9	4/9	7/9	6/9	5/9	2/9	8/9	3/9	5/9	3/9	
Toscana 10	4/10	3/10	1/10	6/10	4/10	3/10	3/10	5/10	1/10	8/10	1/10	
Umbria 1	1/1	1/1	0/1	1/1	1/1	1/1	0/1	1/1	0/1	0/1	0/1	
Marche 6	3/6	4/6	2/6	3/6	1/6	0/6	1/6	3/6	0/6	2/6	1/6	
Lazio 5	2/5	0/5	0/5	2/5	0/5	1/5	1/5	2/5	0/5	1/5	0/5	
Abruzzo 4	0/4	0/4	0/4	2/4	0/4	1/4	0/4	1/4	0/4	2/4	1/4	
Molise 2	1/2	0/2	0/2	1/2	0/2	1/2	0/2	0/2	0/2	0/2	0/2	
Campania 5	2/5	0/5	0/5	0/5	1/5	0/5	0/5	1/5	0/5	2/5	0/5	
Puglia 8	4/8	2/8	1/8	2/8	0/8	2/8	1/8	4/8	0/8	3/8	0/8	
Basilicata 2	0/2	0/2	0/2	1/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	
Calabria 5	1/5	1/5	0/5	0/5	0/5	1/5	0/5	2/5	0/5	2/5	1/5	
Sicilia 9	1/9	3/9	0/9	5/9	1/9	0/9	0/9	3/9	0/9	4/9	0/9	
Sardegna 5	2/5	2/5	0/5	1/5	2/5	0/5	1/5	1/5	0/5	1/5	0/5	

Table 2 - Presence of facilities or actions aimed at encouraging self-composting in households in the capital municipalities

Regions/ Capital municipalities number	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Piemonte 8	4/8	5/8	5/8	6/8	7/8	7/8	6/8	6/8	7/8	7/8
Valle d'Aosta 1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
Liguria 4	2/4	2/4	2/4	4/4	3/4	4/4	4/4	4/4	3/4	3/4
Lombardia 12	4/12	4/12	4/12	4/12	4/12	6/12	6/12	6/12	5/12	6/12
Trentino Alto Adige 2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Veneto 7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7
Friuli Venezia Giulia 4	3/4	3/4	3/4	3/4	3/4	3/4	4/4	4/4	4/4	4/4
Emilia Romagna 9	7/9	8/9	8/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9
Toscana 10	6/10	6/10	6/10	6/10	7/10	7/10	7/10	9/10	10/10	9/10
Umbria 1	0/1	0/1	0/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
Marche 6	1/6	2/6	2/6	4/6	3/6	4/6	4/6	4/6	3/6	5/6
Lazio 5	3/5	3/5	4/5	4/5	4/5	5/5	4/5	3/5	5/5	4/5
Abruzzo 4	0/4	0/4	1/4	2/4	3/4	4/4	4/4	4/4	4/4	4/4
Molise 2	0/2	0/2	0/2	0/2	0/2	0/2	1/2	1/2	2/2	2/2
Campania 5	3/5	3/5	3/5	3/5	3/5	2/5	3/5	3/5	3/5	3/5
Puglia 8	2/8	2/8	3/8	3/8	5/8	6/8	4/8	3/8	4/8	5/8
Basilicata 2	0/2	0/2	0/2	0/2	0/2	1/2	0/2	1/2	1/2	1/2
Calabria 5	1/5	1/5	1/5	1/5	1/5	3/5	3/5	3/5	2/5	3/5
Sicilia 9	2/9	2/9	3/9	4/9	5/9	7/9	7/9	7/9	6/9	6/9
Sardegna 5	0/5	1/5	1/5	1/5	3/5	3/5	3/5	4/5	4/5	2/5

Table 3 - Facilities or actions and controls to encourage self-composting in the capital municipalities Anno 2018

Regions/Capital municipalities number	Facilities for domestic users			Community composting		Discounts for non-domestic users who practice self-composting	Carrying out checks to ensure the effective application and use of auto-composting
	Reduction of waste tariff	Free distribution of composter	Free home composting courses	For domestic users	For non domestic users		
Piemonte 8	7/8	2/8	0/8	0/8	0/8	1/8	3/8
Valle d'Aosta 1	1/1	1/1	0/1	0/1	0/1	0/1	1/1
Liguria 4	3/4	2/4	0/4	1/4	1/4	0/4	1/4
Lombardia 12	4/12	4/12	1/12	0/12	0/12	2/12	4/12
Trentino Alto Adige 2	1/2	1/2	0/2	0/2	0/2	1/2	1/2
Veneto 7	7/7	1/7	0/7	0/7	0/7	2/7	2/7
Friuli Venezia Giulia 4	4/4	2/4	0/4	0/4	0/4	1/4	2/4
Emilia Romagna 9 p	9/9	5/9	1/9	2/9	1/9	2/9	7/9
Toscana 10	10/10	8/10	4/10	0/10	0/10	2/10	8/10
Umbria 1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Marche 6	4/6	5/6	2/6	0/6	0/6	0/6	4/6
Lazio 5	3/5	1/5	0/5	0/5	0/5	0/5	0/5
Abruzzo 4	4/4	2/4	1/4	0/4	0/4	0/4	0/4
Molise 2	2/2	2/2	0/2	0/2	0/2	0/2	1/2
Campania 5	4/5	3/5	2/5	1/5	1/5	1/5	3/5
Puglia 8	1/8	3/8	0/8	0/8	0/8	0/8	0/8
Basilicata 2	1/2	1/2	0/2	0/2	0/2	0/2	0/2
Calabria 5	2/5	1/5	0/5	0/5	0/5	0/5	0/5
Sicilia 9	6/9	3/9	0/9	1/9	0/9	0/9	4/9
Sardegna 5	2/5	2/5	1/5	1/5	0/5	0/5	0/5

Table 4 - Use of urban waste collection methods aimed at allowing the application of the PAYT in the capital municipalities - Anno 2018

Regions/Capital municipalities number	Collection methods				Effective implementation of PAYT	
	Presence	Roadside containers equipped with identification systems	Identification codes / microchips on individual bags / containers	Other methods	For domestic users	For non domestic users
Piemonte 8	2/8	1/8	2/8	0/8	1/8	1/8

Valle d'Aosta 1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Liguria 4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
Lombardia 12	1/12	1/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12
Trentino Alto Adige 2	2/2	1/2	2/2	0/2	2/2	0/2	2/2	0/2	2/2	0/2	2/2	0/2	2/2	0/2
Veneto 7	6/7	4/7	5/7	0/7	6/7	0/7	5/7	0/7	6/7	0/7	5/7	0/7	6/7	0/7
Friuli Venezia Giulia 4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4
Emilia Romagna 9 p	4/9	1/9	4/9	1/9	4/9	1/9	4/9	1/9	4/9	1/9	4/9	1/9	4/9	1/9
Toscana 10	3/10	0/10	2/10	2/10	3/10	0/10	2/10	2/10	3/10	0/10	2/10	2/10	3/10	0/10
Umbria 1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Marche 6	4/6	0/6	3/6	1/6	4/6	0/6	3/6	1/6	4/6	0/6	3/6	1/6	4/6	0/6
Lazio 5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5
Abruzzo 4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4
Molise 2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2
Campania 5	1/5	1/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5	1/5	0/5
Puglia 8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8
Basilicata 2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2	1/2	0/2
Calabria 5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5
Sicilia 9	2/9	1/9	1/9	0/9	2/9	1/9	1/9	0/9	2/9	1/9	1/9	0/9	2/9	1/9
Sardegna 5	2/5	0/5	2/5	0/5	2/5	0/5	2/5	0/5	2/5	0/5	2/5	0/5	2/5	0/5

Table 5 - Presence of activities or services and controls to encourage the correct municipal waste collection in the capital municipalities - Year 2018

Regions/ Capital municipalities number	Bulky collection on call	Collection of other types of waste on call (i.e. toner)	Implementation of mobile ecological stations	Mini ecological islands	Collection centers	Ecological days of waste collection	Separate collection in schools	Roadside containers for tourists or seasonal users	Supply of containers or bags for separate collection	Supply of dog waste bags	Awareness and promotion campaigns relating to the correct waste collection	Actions of abandoned waste collection	Application of penalties for infringements of the regulation on municipal waste management	Other services for the correct collection
Piemonte 8	7/8	6/8	1/8	1/8	8/8	3/8	7/8	1/8	5/8	3/8	7/8	8/8	8/8	0/8
Valle d'Aosta 1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	0/1	1/1	1/1	1/1	1/1	1/1	1/1
Liguria 4	4/4	3/4	3/4	1/4	4/4	1/4	4/4	2/4	3/4	1/4	3/4	4/4	4/4	1/4
Lombardia 12	12/12	10/12	4/12	3/12	11/12	7/12	11/12	0/12	11/12	8/12	9/12	12/12	9/12	1/12
Trentino Alto Adige 2	2/2	2/2	1/2	0/2	2/2	2/2	2/2	0/2	1/2	1/2	2/2	2/2	2/2	0/2
Veneto 7	7/7	7/7	5/7	1/7	7/7	2/7	6/7	1/7	5/7	3/7	7/7	7/7	6/7	0/7
Friuli Venezia Giulia 4	4/4	4/4	1/4	0/4	4/4	0/4	4/4	0/4	3/4	1/4	4/4	4/4	4/4	1/4
Emilia Romagna 9 p	9/9	8/9	3/9	4/9	9/9	2/9	9/9	3/9	6/9	1/9	9/9	9/9	7/9	0/9
Toscana 10	10/10	10/10	4/10	4/10	10/10	7/10	10/10	3/10	7/10	3/10	9/10	10/10	10/10	2/10
Umbria 1	1/1	1/1	0/1	1/1	1/1	0/1	1/1	0/1	1/1	0/1	1/1	1/1	1/1	0/1
Marche 6	6/6	5/6	2/6	2/6	6/6	1/6	6/6	1/6	5/6	1/6	5/6	6/6	6/6	0/6
Lazio 5	5/5	3/5	4/5	0/5	3/5	5/5	4/5	1/5	4/5	1/5	2/5	4/5	3/5	0/5
Abruzzo 4	3/4	3/4	2/4	1/4	4/4	2/4	3/4	2/4	3/4	3/4	4/4	4/4	1/4	1/4
Molise 2	2/2	1/2	1/2	1/2	2/2	0/2	2/2	0/2	2/2	1/2	2/2	2/2	2/2	0/2
Campania 5														
Puglia 8	5/5	2/5	2/5	1/5	5/5	2/5	3/5	2/5	2/5	0/5	5/5	5/5	4/5	1/5
Basilicata 2	2/2	1/2	0/2	0/2	2/2	2/2	2/2	2/2	2/2	0/2	1/2	2/2	2/2	0/2
Calabria 5	5/5	4/5	2/5	0/5	4/5	2/5	4/5	1/5	4/5	0/5	3/5	5/5	4/5	0/5
Sicilia 9	8/9	7/9	6/9	2/9	9/9	2/9	7/9	3/9	7/9	1/9	7/9	9/9	8/9	0/9
Sardegna 5	5/5	5/5	5/5	0/5	4/5	1/5	4/5	1/5	4/5	2/5	5/5	5/5	5/5	2/5

Table 6 - Methods of municipal waste collection by type of material in the capital municipalities Year 2018

Regions/Capital municipalities number	Organic		Paper and cardboard		Glass		Plastic		Metals		Wood		Green		Mixed Waste		Other materials	
	DiD	R	DiD	R	DiD	R	DiD	R	DiD	R	DiD	R	DiD	R	DiD	R	DiD	R
Piemonte 8	8	3	8	3	7	6	7	6	8	6	1	1	3	8	8	3	0	0
Valle d'Aosta 1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	0
Liguria 4	4	4	4	4	3	4	2	3	2	3	1	2	2	2	3	4	0	1
Lombardia 12	11	4	12	4	12	6	11	4	5	3	1	0	3	2	11	4	0	0
Trentino Alto Adige 2	2	1	2	2	1	2	0	1	0	1	0	0	1	1	2	2	0	0
Veneto 7	6	6	7	6	5	5	5	5	5	5	0	1	3	5	7	7	0	0
Friuli Venezia Giulia 4	1	4	3	3	2	4	3	3	2	2	1	0	0	3	3	3	0	0
Emilia Romagna 9	9	8	9	7	5	8	7	7	5	4	0	1	3	7	9	8	0	2
Toscana 10	9	7	10	7	6	8	8	6	7	5	2	0	5	2	10	8	1	1
Umbria 1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0
Marche 6	4	5	6	5	4	5	6	5	3	3	0	0	1	2	6	5	0	0
Lazio 5	5	3	5	4	5	4	4	5	4	3	0	0	1	1	5	4	0	0
Abruzzo 4	4	1	4	2	4	2	4	2	3	1	1	0	3	0	4	2	0	1
Molise 2	2	2	2	2	2	2	2	2	0	0	0	0	0	1	2	2	0	0
Campania 5	5	3	5	3	3	3	4	3	5	3	2	1	2	2	4	2	1	0
Puglia 8	7	4	7	6	6	6	6	6	5	2	2	1	2	3	7	6	0	0
Basilicata 2	2	2	2	2	2	2	2	2	2	2	0	1	2	0	2	2	0	0
Calabria 5	4	3	4	4	4	3	4	3	4	3	1	2	3	2	4	3	0	0
Sicilia 9	9	6	9	8	8	8	9	8	8	6	1	2	4	4	8	7	0	0

DiD – Door to Door

R – Roadside

Table 7 - Presence of selective collections in the capital municipalities - Year 2018

Regions/Capital municipalities number	Drugs	Batteries	Old clothes	Edible oil	Nuppies	Other
Piemonte 8	8/8	8/8	8/8	5/8	0/8	2/8
Valle d'Aosta 1	1/1	1/1	1/1	0/1	0/1	0/1
Liguria 4	4/4	4/4	4/4	2/4	1/4	2/4
Lombardia 12	12/12	12/12	11/12	9/12	4/12	6/12
Trentino Alto Adige 2	1/2	1/2	1/2	0/2	0/2	0/2
Veneto 7	7/7	7/7	7/7	6/7	3/7	0/7
Friuli Venezia Giulia 4	3/4	4/4	3/4	2/4	1/4	1/4
Emilia Romagna 9	9/9	9/9	8/9	6/9	1/9	0/9
Toscana 10	8/10	8/10	8/10	6/10	4/10	2/10
Umbria 1	1/1	1/1	1/1	1/1	1/1	1/1
Marche 6	5/6	5/6	6/6	6/6	6/6	6/6
Lazio 5	5/5	5/5	3/5	3/5	2/5	0/5
Abruzzo 4	2/4	2/4	2/4	3/4	2/4	1/4
Molise 2	2/2	2/2	1/2	0/2	2/2	0/2
Campania 5	5/5	5/5	3/5	3/5	1/5	1/5
Puglia 8	8/8	8/8	8/8	3/8	3/8	0/8
Basilicata 2	2/2	2/2	1/2	1/2	1/2	0/2
Calabria 5	3/5	3/5	4/5	4/5	4/5	0/5
Sicilia 9	9/9	7/9	6/9	1/9	7/9	2/9
Piemonte 8	5/5	4/5	3/5	3/5	3/5	0/5

Table 8 - Methods of municipal waste collection for domestic use in the capital municipalities - Year 2018

Regions/Capital municipalities number	Door to door				Roadside			
	Presence	Collection methods			Presence	Collection methods		
		With bags or containers placed in private areas	With bags or containers placed in public areas	Other door to door collection method		with traditional containers	With underground containers	Other roadside collection method
Piemonte 8	8/8	8/8	4/8	4/8	7/8	5/8	3/8	1/8
Valle d'Aosta 1	1/1	1/1	1/1	0/1	0/1	0/1	0/1	0/1
Liguria 4	2/4	2/4	1/4	2/4	4/4	4/4	0/4	0/4
Lombardia 12	12/12	12/12	1/12	2/12	6/12	5/12	2/12	0/12
Trentino Alto Adige 2	2/2	1/2	2/2	0/2	2/2	2/2	1/2	0/2
Veneto 7	7/7	6/7	2/7	0/7	6/7	5/7	1/7	2/7
Friuli Venezia Giulia 4	3/4	3/4	3/4	0/4	4/4	4/4	2/4	0/4
Emilia Romagna 9 p	9/9	9/9	6/9	0/9	9/9	9/9	5/9	1/9
Toscana 10	10/10	10/10	4/10	2/10	10/10	8/10	4/10	0/10
Umbria 1	1/1	1/1	1/1	0/1	1/1	1/1	0/1	0/1
Marche 6	6/6	5/6	3/6	2/6	5/6	4/6	1/6	1/6
Lazio 5	5/5	5/5	1/5	0/5	4/5	4/5	0/5	1/5
Abruzzo 4	4/4	4/4	2/4	1/4	3/4	3/4	2/4	1/4
Molise 2	2/2	2/2	1/2	0/2	2/2	1/2	0/2	1/2
Campania 5	5/5	5/5	0/5	0/5	5/5	4/5	0/5	1/5
Puglia 8	8/8	8/8	4/8	0/8	6/8	4/8	2/8	0/8
Basilicata 2	2/2	2/2	1/2	0/2	2/2	2/2	0/2	0/2
Calabria 5	4/5	4/5	2/5	0/5	3/5	3/5	0/5	0/5
Sicilia 9	9/9	8/9	5/9	0/9	7/9	7/9	1/9	1/9
Sardegna 5	5/5	5/5	0/5	1/5	3/5	2/5	1/5	0/5

Table 9 - Multi-material waste collection in the capital municipalities - Year 2018

Regions/Capital municipalities number	Paper	Glass	Plastic	Metals	Other
Piemonte 8	0/8	3/8	3/8	6/8	0/8
Valle d'Aosta 1	0/1	0/1	1/1	1/1	0/1
Liguria 4	0/4	1/4	3/4	4/4	0/4
Lombardia 12	1/12	6/12	5/12	11/12	1/12
Trentino Alto Adige 2	0/2	1/2	1/2	2/2	1/2
Veneto 7	0/7	4/7	7/7	7/7	0/7
Friuli Venezia Giulia 4	1/4	1/4	2/4	3/4	0/4
Emilia Romagna 9 p	6/9	5/9	8/9	9/9	5/9
Toscana 10	0/10	6/10	10/10	10/10	4/10
Umbria 1	0/1	1/1	1/1	1/1	0/1
Marche 6	0/6	1/6	3/6	4/6	0/6
Lazio 5	0/5	1/5	4/5	4/5	0/5
Abruzzo 4	1/4	1/4	3/4	3/4	0/4
Molise 2	1/2	1/2	1/2	1/2	0/2
Campania 5	1/5	0/5	5/5	5/5	1/5
Puglia 8	2/8	2/8	5/8	6/8	1/8
Basilicata 2	0/2	0/2	2/2	2/2	0/2
Calabria 5	0/5	0/5	5/5	5/5	0/5
Sicilia 9	0/9	0/9	4/9	4/9	0/9
Sardegna 5	0/5	4/5	0/5	4/5	0/5

The qualitative analysis reveals that the 20 regions show marked differences in the approach of waste management that affect on the achieved results. The analysis elaborates an identification based on the geographic area of each region. In this way, we can identify a northern area (Piemonte, Valle d'Aosta, Liguria, Lombardia, Trentino Alto Adige, Veneto, Friuli Venezia Giulia, Emilia Romagna), a central area (Toscana, Umbria, Marche, Lazio), and a southern area (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna).

The data show that Local administrations play a fundamental role in the implementation of policies for the prevention, reduction and recycling of municipal waste and in services aimed at encouraging its correct disposal. The policies adopted by the 109 capital municipalities (table 1 and Table 5) show a greater awareness about the importance of these actions in the northern area. In fact, out of total 25 examined policies, if we consider the capital municipalities that implemented at least 16 of these, the data displays the greatest concentration in the northern area. In the range between 12 and 15 implemented policies we find a greater concentration of capital municipalities belong to the central area, and in the range under 12 implemented policies there are the great part of these that belong to the southern area. With reference to the recycling, many capital municipals implemented self-composting actions (Table n.2 and Table n.3), with the aim at increasing direct involvement and environmental awareness. Many efforts are aimed at promoting incentives to domestic users who carried out home composting. This policy is adopted on the entire national territory with slight differences (86% for Central area, 79% for northern area, and 65% for southern area). Users who chose to make compost did not give the traditional collection systems the organic fraction of their household waste, but used it for the self-production of natural fertilizers of high ecological quality, which they directly re-used. Many of the municipalities decided to reduce municipal waste management fees as an incentive for domestic and non-domestic users to practice composting. The policies on separate waste collection were adopted for a long time on entire national territory with significant increments year by year. The data, displayed from the table n.4 to table n.9, reveal the different surveyed aspects of the implemented policies on the separate collection in Italian regions. Despite in the last years significant steps forward were made in terms of waste sorting habits, there is still a great difference in behaviors of the three geographic areas. In fact, in the northern area there is the greatest concentration of the implemented policies on plastic (northern area 87%, central area 83% and southern area 72%), glass (northern area 93%, central area 86% and southern area 69%) and paper (northern area 92%, central area 85% and southern area 82%). Although the gap persisted, the Southern area are showing a significant increase also thanks to the progressive spread of the door-to-door collection service, implemented in many Italian capital municipalities. This practice contributes to the improvement of the separate collection of organic waste that in the last years is increased at least of 20% percentage points in all areas. Moreover, the data on the use of collection methods aimed at applying the PAYT, according to the quantities, show a still very little use on the entire national territory. But also, in this case, the widespread use of this kind of policies is located in the northern area (32%).

Fig. n.1 GdD pro capite in PPS average value 20019-2018

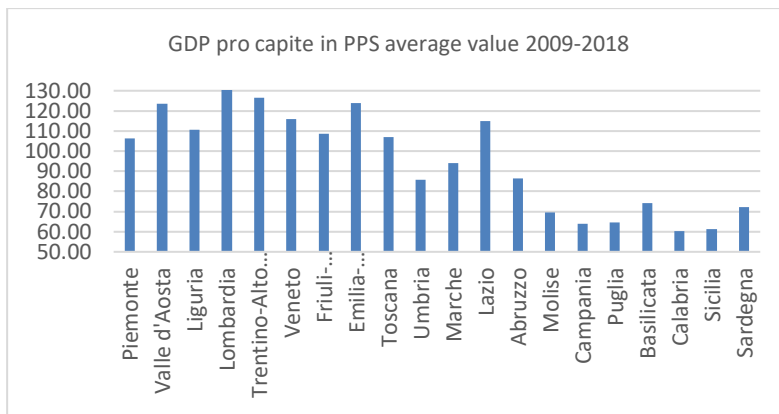


Fig.n.2 Produced Solid Municipal Waste average value 2009-2018 (detected KG per year per person)

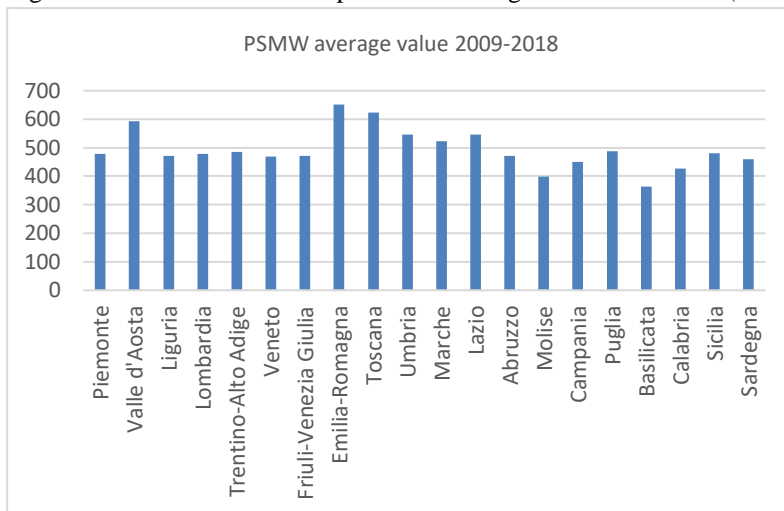
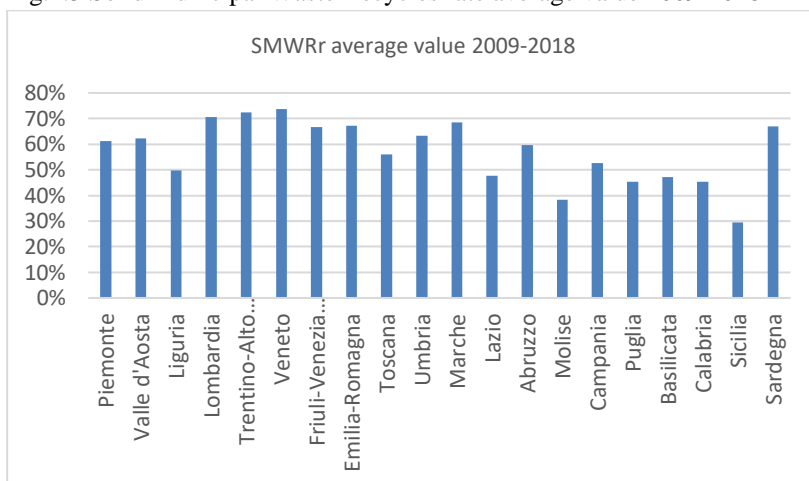


Fig.n.3 Solid Municipal Waste Recycles rate average value 2009-2018



Data that come from the quantitative analysis suggest that there is a direct correlation between the values of SPMW and the GDP per capita of the regions. In fact, those with higher GDP per capita averages show high values in SPMW (Emilia Romagna GDP 124 SPMW 652; Toscana GDP 107 SPMW 623; Valle d'Aosta GDP 124 SPMW 592; Lazio GDP 115 SPMW 547; Trentino Alto Adige GDP 127 SPMW 486; Piemonte GDP 106 SPMW 479). This would entail that the countries' waste management systems are strictly correlated to waste production. The

values of SMWRr, reveal another correlation with GDP per capita of the countries. In fact, the upper-middle- and high-income regions recycle more waste (Veneto GDP 176 SMWRr 74%; Trentino Alto Adige GDP 127 SMWRr 72%; Lombardia GDP 133 SMWRr 71%; Emilia Romagna GDP 124 SMWRr 67%; Friuli Venezia Giulia GDP 109 SMWRr 67%; Valle d'Aosta GDP 124 SMWRr 62%; Piemonte GDP 106 SMWRr 61%). These regions are endowed with a closed loop waste management system, by collecting and recycling almost all types of waste (i.e. plastic, paper, cardboard, metal, and glass). The elaboration of quantitative indicators confirms the trend displayed through the qualitative analysis in which it is possible to identify areas 'profiles deeply different. In fact, northern Italy represents the area that manages in a more effective way the municipal waste by supporting, in this way, the achievement of EU targets. In the central area, only Marche and Umbria show behaviours in line with the main part of the northern regions. The southern area shows a general slowdown compared to other areas probably also due to the failure to implement a complete vertical integration of services. In fact, in the absence of "integrated management", the southern regions have clearly limited a form of management that includes the entire waste cycle, by keeping upstream activities (collection, sweeping and transport) separated from those at downstream (treatment, disposal and recovery). Moreover, the gap between the analysed areas belongs to the government policies both at national and at local level that generated over time different regional performances. In particular, a different approach in entrusting the waste management service with prevalence of in-house providing management in southern area, rather than addressing the market by respecting public evidence procedures (i.e. outsourcing, contracting out or outsourcing); very long duration of contracts (central and southern areas), extensive and uneven use of the assimilation of special waste to municipal waste, a restrictive regulation of the activities that characterize the downstream phases, especially as regards the management chain of the undifferentiated fraction, are only some of the strategic bottlenecks to overcome.

4. Conclusion

The paper presented a comparison analysis on the waste management in the 20 Italian regions. Starting from a qualitative analysis, the study describes the implemented actions by the regions. Moreover, two quantitative indicators (PSMW, SMWRr) have been elaborated in order to confirm the different trend emerged from the qualitative analysis within three Italian macro areas (North, Centre, and South). In fact, the analysis shows a heterogeneous behaviour with regions in which the presence of higher GDP in PPS average values shows a good capacity of recycling (SMWRr). In conclusion, it can be observed that in order to reduce the gap within the 20 regions, it is necessary to develop ambitious and government actions to support the best possible homogeneous operative applications in each region. This necessitates a strong economic structure, a willingness of the governments in terms of policies, an entrepreneurial culture, and a population awareness and receptivity able to see in the effective waste management an opportunity to enhance its social context and environmental wellbeing. The waste management is an open question, and therefore in conclusion the output of discussion linked to research results, reject a stance whereby the transition must be seen as under constant development and re-interpretation.

References

Awasthi, A. K., Cucchiella, F., D'Adamo, I., Li, J., Rosa, P., Terzi, S., ... & Zeng, X. (2018). Modelling the correlations of e-waste quantity with economic increase. *Science of the Total Environment*, 613, 46-53

European Commission, (2015a) Closing the Loop: an Action Plan for the Circular Economy. European Commission, Brussels.http://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF (Accessed 10 February 2020)

European Commission. (2019). Towards a circular economy. European Commission. (2015b) https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/towards-circular-economy_en

European Environment Agency, 2016, Municipal waste management across European countries, Municipal waste, Resource efficiency and waste

European Parliament, 2008 <https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=celex%3A32008L0098>

European Parliament, 2018 <https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX%3A32018L0851>

Hahladakis, J. N., & Iacovidou, E. (2019). An overview of the challenges and trade-offs in closing the loop of post-consumer plastic waste (PCPW): Focus on recycling. *Journal of hazardous materials*, 380, 120887

Horodytska, O., Valdés, F. J., & Fullana, A. (2018). Plastic flexible films waste management—A state of art review. *Waste Management*, 77, 413-425
https://ec.europa.eu/environment/basics/green-economy/managing-waste/index_en.htm

Iacovidou, E., Millward-Hopkins, J., Busch, J., Purnell, P., Velis, C. A., Hahladakis, J. N., & Brown, A. (2017). A pathway to circular economy: Developing a conceptual framework for complex value assessment of resources recovered from waste. *Journal of Cleaner Production*, 168, 1279-1288

Istituto Nazionale di Statistica, 2019 <https://www.istat.it/it/archivio/234691>

Istituto Superiore per la Protezione e la Ricerca Ambientale, 2019 Rapporto Rifiuti Urbani.

Marino, A., & Pariso, P. (2020). Comparing European countries' performances in the transition towards the Circular Economy. *Science of The Total Environment*, 138142.

Minelgaitè, A., & Liobikienè, G. (2019). Waste problem in European Union and its influence on waste management behaviours. *Science of the Total Environment*, 667, 86-93

Pires, A., Martinho, G., Rodrigues, S., & Gomes, M. I. (2019). Prevention and Reuse: Waste Hierarchy Steps Before Waste Collection. In *Sustainable Solid Waste Collection and Management* (pp. 13-23). Springer, Cham. approach