Municipal solid waste in Central Macedonia: A review

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I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

This dissertation was written as part of the MSc in International Accounting, Auditing and Financial Management at the International Hellenic University.

The management of Municipal Solid Waste (MSW) represents one of the greatest challenges faced during the recent years. Waste causes severe environmental externalities. The planet's natural resources are limited, thus, proper MSW treatment attracts the increasing attention of policy makers. It is important to review the benefits and the costs of waste related policies.

Since 2019 a new pricing regulation is in force and will be applied in 2020 for the first time. This regulation ties more closely the levies to the waste performance of each Municipality and is set to ensure that disposal will always be the most expensive treatment choice. This dissertation aims to indicate the elements which will help understand the present situation and assess the impact of the pricing regulation on Municipal Budgets. The levies have been calculated according to the new regulation using the most recent annual data available; those of the year 2019. This methodology showed that for the Region of Central Macedonia, the annual levies are 9% lower compared to the previous pricing status. Furthermore, while the unit cost for disposal services remains unchanged, the unit cost for waste recovery and transfer services is remarkably lower according to the new regulation (58% and 44% lower respectively).

Another aim of this dissertation is to evaluate the impact of MSW treatment on the financial stability of the Municipalities of Central Macedonia, by examining the volume of waste treatment costs compared to the relevant Municipal revenues. The relation between revenues and costs is depicted for each Regional Unit. The average ratio of costs to revenues has been calculated at 11%. Findings indicate that waste treatment costs don't impose a significant burden on Municipal waste related budgets.

Keywords: Waste Treatment, Municipal Solid Waste, Pricing Policy, Central Macedonia, Levies

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Preface

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Contents

1. Introduction

"There is only one planet Earth, yet by 2050, the world will be consuming as if there were three" (European Commission 2020).

Although many attempts have been made both on National and European level the amount of waste generated is not decreasing. A significant percentage of MSW originates from household activities (Sikalidis, Emmanouil, 2019). Till lately (2019 for Central Macedonia, 2017 for the Dominion) sanitary landfilling was practically the only management approach to municipal solid waste. From an optimistic point of view this can be considered a progressive step from open dumping. Nevertheless, this method turned to affect negatively the environment, the public health and the economy. As an example we can mention leachate production, hazardous gas emissions, and useful raw materials withdrawn from the economy (Akkaya, Demir, 2009). Furthermore, setting landfilling areas is very difficult due to citizen's oppositions. These are some of the indications that make waste management a necessity. The current National Waste Management Plan (ESDA) for the period 2015 – 2020 (FEK 174/A/15.12.2015) failed to meet its targets. According to the new ESDA for the period 2020 – 2030 that has just been approved (FEK 185/A/29.09.2020), several issues raised barriers which caused the delay in implementing the ESDA 2015 - 2020. The targets were extremely optimistic and the timeline too short.

MSW is produced because of citizens' activities or living habits. A country's waste generation and GDP are closely related (Suwa, Usui, 2015). Generally, the greater the economic prosperity and higher the percentage of urban population the larger the amount of solid waste produced (Chu, Wu, Zhuang, 2017). The country's level of development affects its waste generation characteristics as well. It is possible to estimate the economic development of a country by analyzing the physical composition of its MSW. The greater the prosperity of the community, the higher the purchasing power of people and therefore, the amount of waste generated. Less developed areas generate less packaging waste and more organic fractions. Landfilling is the most widely used technology, despite the fact that it is not considered the most appropriate practice (Alfaia, Costa, Campos, 2017).

Waste management in Greece is no exception to this. The predominant reliance on landfilling (European Commission 2013) and the insufficient waste management in Greece compared to the corresponding average of the European Union can be shown in the following Table 1:

Table 1: Municipal waste generated per person

Year: 2018	Waste Generated (kg/person/year)	Sanitary Landfilling
Greece	514	78.4%
EU-28	489	22.6%

Source: ESDA 2020 - 2030

In this context it is reasonable to consider the economic charges imposed to the citizens (the producers of waste) as the motive for proper waste management and waste prevention. In this dissertation we will attempt to determine the effect of Waste Treatment Cost which is the burden imposed to Municipalities by Waste Management Organizations, on Municipal economic stability and robustness. Therefore, a model is applied for estimating the pricing policy according to waste treatment and waste sorting information. This work is interesting for both the Municipal Authorities (they can review their waster related budgets) and the citizens (knowing the unit cost of their waste generation activities).

An understanding of the relationships between the levies imposed by Waste Management Organizations to Municipalities and waste treatment characteristics is a prerequisite for planning, decision making and assessing the present situation in order to implement strategies for sustainable waste management in the future. "*Sustainability means making economic prosperity long-lasting, more socially inclusive and less dependent on exploitation of finite resources and the natural environment."* (European Commission 2018). Waste minimization is part of the EU sustainability taxonomy framework.

The new pricing policy regulation (FEK 1277/B/15.04.2019) intends to change the pricing environment. From a simple calculation that used to take into consideration only the amount of waste (calculated in tons) and the waste treatment cost, a new philosophy has been adopted. The rationale is to provide motives to waste producers to minimize their amounts and change their environmental behavior. Waste avoidance

will be rewarded with discounts in waste prices giving economic benefits. As technology evolves, waste treatment gets more expensive, while at the same time resources are becoming insufficient for the demand and consequently more expensive too. These two problems can be addressed by applying the principles of circular economy to MSW (Struk, Soukopová, 2016). More and more, recovering useful materials like raw materials, secondary products etc., from MSW is not only feasible, but is optimal for both the environment and the economy. Thus, sorting at source and waste treatment is of high importance. To this direction, a pricing policy can be used as a tool giving motives to the citizens to reduce waste generation. The new pricing policy hasn't been adopted yet in Central Macedonia (CM). The new pricing model will be applied and its effect on the levies imposed by Waste Management Organizations to Municipalities and consequently to the citizens, will be examined. It will be calculated and compared to the former pricing policy, in order to be able to understand and interpret how this new methodology will help minimize waste disposal and maximize waste recovery. Therefore, the focus is on the Municipalities of CM. There are several parameters that predetermine the cost of waste management. Nevertheless it is shown that waste disposal services will always be more expensive than the services provided for waste recovery and waste transfer.

The impact of MSW treatment costs on the Municipal waste related budgets have been evaluated on a Regional Unit basis. Considering differences among Regional Units, the outcome shows that there aren't significant deviations, except from Chalkidiki and Thessaloniki. The first, due to its strong touristic characteristics and the second, due to its magnitude and population density. The research included waste related data and a range of influencing parameters (social, economic, demographic). A database was created with annual time series for 9 years (2011 - 2019), from 38 municipalities and 7 Regional Units.

At this point it is important to mention that the Municipalities in Greece were established in the way they exist today on January 2011 (Law 3852/2010) and in CM participate 38 Municipalities. Therefore, we can see that this work covers the period from day 1 till present. CM is the largest Region in extent and the second Region in population in Greece representing almost 2million citizens. The outcome of this time

series has indicated significant relationships between the waste treatment costs and the Municipal waste related revenues. These relationships have been studied and the results indicate that the effect of MSW treatment cost compared to the relevant Municipal revenues isn't as pronounced as might be expected.

The remainder of this dissertation is structured as follows: the legal frame is included in chapter 2, to provide the foundations of waste and to direct the practice. The methodology is described in chapter 3 indicating the path that will be followed, while in chapter 4 information is being provided regarding the data in order to understand problems and interpret them in meaningful ways. The conclusions are summarized in chapter 5.

2. Legal Frame

"Municipal waste consists of mixed waste and separately collected waste from households and from other sources, where such waste is similar in nature and composition to waste from households" (European Commission 2019). As defined in Article 3 of European Council Directive 2008/98/EC on waste, "Treatment" means recovery and disposal operations, including preparation prior to recovery or disposal. "Recovery" means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function, in the plant or in the wider economy. "Disposal" means any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy.

2.1. The Waste Management Organizations

According to the "polluter pays" principle, those who produce waste, bare the cost of collection and processing of waste. This principle led, amongst others, to the introduction of weight-based pricing systems, according to which, municipalities have to pay a levy per ton of waste led for further management. The origins of the weight based pricing system can be traced back in 2009, when according to the Joint Ministerial Decision 2527/2009 (FEK 83/B/23.01.2009) the cost for the services offered by Waste Management Organizations are calculated in Euros per ton. The levies imposed to Municipalities are being paid by the relevant revenues they collect from the citizens as cleaning fees. Prior to this, the pricing system was calculated as a flat rate proportion of the ordinary Municipal revenues; usually 2% (FEK 743/B/1970).

Up to now the pricing policy decision used the tons of waste treatment as the denominator for the calculation of each waste service separately (G.A. 8/2016 IUN: 6ΨΕΩΟΞΧΝ-ΟΒ1). Thus, the impact of recycling, waste and organic waste treatment, waste transfer as well as other factors (e.g. reusing and sorting at source) was not taken into consideration for the more fair distribution of the waste related economic

burden to the Municipalities and the citizens by extension according to their performance.

Since 2019 the new pricing regulation is in force (FEK 1277/B/15.04.2019). This regulation is future oriented as it takes into consideration a set of parameters (waste services) that the Organizations are not yet ready to use but their appliance is in progress (parameters like separately collected organic waste and recovery of materials). The performance of Waste Management Organizations is depicted on their pricing policy. The revenues collected in the form of levies imposed to the Municipalities, consist their major source of income. This can be perceived if we take into account that for the Waste Management Organization of Central Macedonia, Municipal levies represent the 96% of the total ordinary revenues and the 72% of the overall revenues (ordinary and extraordinary) (average rates of years 2017 – 2019). According to the new regulation, every year the total cost of waste management is calculated. When determining the annual management cost, grants and any other income received is taken into account (art, 237, Law 4555/2018). This cost must be recovered by the affiliated Municipalities taking into consideration the performance of each one in waste avoidance, reuse, recycling, sorting at source etc (art. 9, Law 2939/2001[1]). According to the new regulation the annual levies are determined for the full recovery of the waste management cost. In the minimum requirements of the new regulation are:

a. quantitative data per each waste service (for Central Macedonia the most recent annual available data are those of year 2019),
b. financial information regarding the annual cost of the Waste Management Organization (in our case we'll take into consideration the budgeted costs for the year 2021),
c. the methodology for the calculation of the annual levy and
d. brief description of the services provided by the Waste Management Organization.

The regulation is set to ensure that disposal will always be the most expensive treatment choice, even three times more expensive that sorting at source [5]. Apart from the costs for landfill operations and necessary investments, factors as air, water and soil pollution are taken into consideration as important factors for selecting other

[1] As amended by art. 9, Law 4496/2017

treatment solutions. The new regulation ties more closely the levies to the waste performance of each Municipality.

To sum up, regarding waste pricing policies, we can identify three different periods. Period A, covering the years prior to 2009 where costs were reimbursed through a flat-rate fee over ordinary Municipal revenues. Period B, covering the years 2009 to 2019 where costs were reimbursed through levies calculated in Euros per ton for each waste treatment service separately. Period C, covering the years after 2019, where costs will be reimbursed through levies calculated on the basis of a single reference price, multiplied by specific parameters and coefficients. The evolution of the pricing policies during the three periods according to important elements is shown in the following Table 2:

Table 2: The evolution of the pricing policies

Elements	Period A	Period B	Period C
Takes into account the amount of waste		√	√
Takes into account the cost of waste		√	√
Fair and equal burden to Municipalities		√	√
Motivates waste reduction			√
Serves “the polluter pays” principle		√	√
Serves the “pay as you through” principle			
Simple model for fees calculation	√	√	
Multi-parametric model for fees calculation			√
Charges waste disposal and rewards any other treatment			√
Waste treatment costs are paid by the Municipal Budget	√		
Waste treatment costs are paid by the Citizens		√	√

2.2. The Municipalities

According to par. 11, art. 25, Law 1828/1989, the Municipal revenues for cleaning and lighting services have been merged in one single levy. The magnitude of this levy is being decided by the Municipal Council according to the expenses occurred while offering the relevant services. It is being imposed through the electricity bills and

is calculated by multiplying the square meters of the establishment times a specific coefficient expressed in Euros (art. 1, Law 25/1975).

Municipal levies should be fair, objective and corresponding to the services provided. Any change in the levies must be in accordance with the cost of the services provided. If this criterion is not satisfied then the decision of the Municipal Council lacks legal effect (YPESDDA 2/2077/2005). However, this system takes into consideration neither the amounts of waste generation, nor the amounts of waste separation.

According to art. 2, Law 4555/2018, Municipalities, based on their population, their particular geomorphologic characteristics, the basic characteristics of economic activity within their boundaries, their degree of urbanization, their inclusion or not in wider metropolitan urban complexes and their position in the administrative division of the Country, are classified into six categories. The Municipalities of Central Macedonia correspond to the following four (for detailed reference see Appendix Table 16):

a. Municipalities of Metropolitan Centers
b. Large Mainland Municipalities and Prefecture Capitals
c. Medium Mainland Municipalities
d. Small Mainland Municipalities

According to the National Waste Management Plan for the period 2020 – 2030 (FEK 185/A/29.09.2020) Greece's objective is to reach the threshold of less than 10% disposal by 2030. This thesis aims to indicate the elements which will help understand the present situation and assess the impact of the new pricing regulation to the National objective. The intention is to better understand the different waste management options considering environmental, economic, and social criteria and to measure the impact of waste treatment levies on the financial stability of the Municipalities. This will help Municipalities better understand the importance of taking actions regarding recycling, sorting at source and waste prevention, which according to art. 228, Law 4555/2018 is their responsibility.

3. Methodological Approach and Considerations

In Greece, waste collection and treatment of MSW is locally organized by Municipalities and Waste Management Organizations. This chapter is separated in two units. In the pricing regulation unit, the new methodology is being analyzed and finally calculated according to real data referring to year 2019. Useful conclusions are being extracted and correlations are being interpreted. In the second unit the situation of waste treatment in the Region is being described and important clarifications are being provided.

Across EU, there are different ways of charging waste management costs and by different entities, some of which are presented in the following Table 3:

Table 3: Financing and Incentive Schemes for Municipal Waste Management

European Member	Ways of charging waste management costs
Belgium:	pay-per-bag scheme
	BEBAT scheme for battery collection
	systems to deal with unsolicited mail
	white- and brown- goods collection
	residual waste levy in Wallonia
Denmark:	weight-based schemes
Germany:	weight- and volume-based schemes at apartment blocks
Italy:	tagged bag schemes
	pay-per-bag scheme
Luxembourg:	combined weight and volume based scheme
	household hazardous waste management
Sweden:	weight-based scheme
	schemes to promote home composting
Finland:	paper collection by Paperinkays Ltd
	benchmarking competition between companies, Helsinki
Netherlands:	paper and fiber covenant
France:	systems to deal with unsolicited mail
UK:	local public service agreements in England
	community Re>paint schemes
	Real Nappy Initiative, West Sussex

Source: European Commission

The most significant difficulties faced were two. The first one has to do with the new pricing regulation and the fact that it hasn't been applied yet in the Region and since 2020 is the first year that this methodology should be applied, no prior experience exists. A second difficulty was the fact that Waste Management Organizations in Greece have been established in their current form in 2012 (according to art. 13-17, Law 4071/2012). Many of them have delayed very much to begin their operations. The Waste Management Organization of Central Macedonia began operating on January 1st 2014. This is a limitation of the study, as the historical data that can be used either regarding financial figures, or amounts of waste treatment services cannot go many years back. Nevertheless, the waste related information provided prior to 2013 refers to the Regional Unit of Thessaloniki which represents on average more than 66% of the total MSW treatment.

3.1. The pricing regulation

In Greece, Waste Management Organizations regardless of their legal form have a non-profit character and operate in favor of the public interest and public benefit (par. 2, art. 225, Law 4555/2018). They serve a special purpose and at the same time their objective is exclusive. This means that they represent the main Government Body appointed for the management of MSW and at the same time, solid waste management is the only objective they serve. Having that in mind, full cost accounting is the appropriate methodology to calculate the cost of waste management. Fixed and variable, direct and indirect, controllable and uncontrollable costs are all part of the Waste Management Costs (Hogg D 2002). Waste treatment charges are allocated into waste services.

According to the new regulation (FEK 1277/B/15.04.2019) the levies are calculated on annual basis for the full recovery of the annual management cost. Analytical records are needed for all the waste treatment services provided, per Municipality. Waste quantities concern the most recent annual available data (in our case it is year 2019). The cost of each service provided is scaled with the use of coefficients times the amount of waste (the parameters) and based on a single

reference value expressed in Euros per ton, for each Municipality and according to the waste services they receive. To calculate the total annual levies per Municipality and the single reference value the following two models are used:

$$E_{OTA\text{-}v} = ETA \times (100\%\text{-}M_{OTA\text{-}v}) \times (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_{1\beta} \times \Sigma_{1\beta} + \Pi_2 \times \Sigma_2 + \Pi_{3\alpha} \times \Sigma_{3\alpha} + \Pi_{3\beta} \times \Sigma_{3\beta} + \Pi_{3\gamma} \times \Sigma_{3\gamma} + \Pi_4 \times \Sigma_4)_{OTA\text{-}v} \quad \text{(Model 1)}$$

$$ETA = AWMC / \{[(100\%\text{-}M_{OTA\text{-}1}) X (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_{1\beta} \times \Sigma_{1\beta} + \Pi_2 \times \Sigma_2 + \Pi_{3\alpha} \times \Sigma_{3\alpha} + \Pi_{3\beta} \times \Sigma_{3\beta} + \Pi_{3\gamma} \times \Sigma_{3\gamma} + \Pi_4 \times \Sigma_4)_{OTA\text{-}1}] + ... + [(100\%\text{-}M_{OTA\text{-}V}) \times (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_{1\beta} \times \Sigma_{1\beta} + \Pi_2 \times \Sigma_2 + \Pi_{3\alpha} \times \Sigma_{3\alpha} + \Pi_{3\beta} \times \Sigma_{3\beta} + \Pi x \Sigma_{3\gamma} + \Pi_4 \times \Sigma_4)_{OTA\text{-}v}]\} \quad \text{(Model 2)}$$

Where:

AWMC =	Annual Waste Management Cost
ETA =	Single reference value expressed in Euros per ton
$M_{OTA\text{-}V}$ =	% of discount according to recycling performance of Municipality -v
Π =	The quantity of waste for each category of waste service provided
Σ =	The coefficient for scaling each different waste service provided
$E_{OTA\text{-}V}$ =	Annual levy for Municipality -v

AWMC calculation takes into consideration:

a. Total annual operating costs including production expenses, administrative expenses, dissemination and R&D
b. Special reserve for future restoration and after-care costs of disposal sites
c. Total annual investment costs

In order to calculate the pricing policy for the year 2021 according to the new pricing regulation for Central Macedonia, we take into consideration the Budgeted waste management costs for the year 2021 as expressed in the decision of the General Assembly No 5/03.12.2020 (IUN: ΨΒΘΔΟΞΧΝ-946). According to this, the AWMC is almost 24,500,000 as show in Table 4:

Table 4: Annual Waste Management Cost Calculation

	Total cost	Of which funded*	Remaining cost
Operating costs	34,463,223	22,136,072	12,327,151
Special reserve	938,770	0	938,770
Investment costs	30,857,196	19,655,618	11,201,578
Total	**66,259,189**	**41,791,690**	**24,467,499**

*Funding includes both National and EU development programs and own recourses from cash available

For the variable M_{OTA-V} no discount will be calculated, since the information regarding recycling performance on Municipal level is not being systematically monitored yet and therefore no reliable data are available. Thus, M_{OTA-V} is 0.

According to the most recent annual available data (year 2019), waste quantities per category (Π) and the relevant coefficients (Σ) is shown in the following Table 5:

Table 5: Quantities of waste (tn) per category and coefficients for Central Macedonia

Waste service	Π	Σ	Category
Waste disposal	724,151	1	$\Pi_{1\alpha}$
Residual waste disposal	0**	1	$\Pi_{1\beta}$
Material recovery of mixed waste	17,152	0.7≤ and ≤0.9*	Π_2
Recovery of organic waste	0**	≤0.5	$\Pi_{3\alpha}$
Alternative recovery services	0**	≤0.3	$\Pi_{3\beta}$
Recovery from recycling	0**	≤0.3	$\Pi_{3\gamma}$
Waste transfer services	252,211	≤0.3	Π_4
Total	**993,514**		

*Can take value 1 till all the predicted waste treatment units are constructed which in our case is a fact

**The value is zero as no such services are being provided yet

Since $\Pi_{1\beta}$, $\Pi_{3\alpha}$, $\Pi_{3\beta}$ and $\Pi_{3\gamma}$ are zero, Model 2 for Central Macedonia is as follows:

$$ETA = AWMC / \{[100\% \times (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_2 \times \Sigma_2 + \Pi_4 \times \Sigma_4)_{OTA-1}] + ... + [100\% \times (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_2 \times \Sigma_2 + \Pi_4 \times \Sigma_4)_{OTA-v}]\}$$

After the calculations ETA = 30 €/tn

Model 1 for Central Macedonia is as follows:

$E_{OTA\text{-}v} = ETA \times (\Pi_{1\alpha} \times \Sigma_{1\alpha} + \Pi_2 \times \Sigma_2 + \Pi_4 \times \Sigma_4)_{OTA\text{-}v}$

After the calculations $E_{OTA\text{-}v}$ = 24,467,500

The analysis showed that according to the new pricing regulation the levy for: a) waste disposal services is 30€/tn b) material recovery of mixed waste services is 30€/tn and c) waste transfer services is 9€/tn as shown in Table 6.

Table 6: Annual levies according to the new pricing regulation

Waste service	Tonnage	Unit cost (€/tn)	Total levies
Waste disposal	724,151	30	21,687,739
Material recovery of mixed waste	17,152	30	513,702
Waste transfer services	252,211	9	2,266,058
Total	**993,514**	*	**24,467,500**
*The weighted average of the unit cost is 25€/tn (24,467,500/993,514)			

The relevant levies for the Waste Management Organization for the Prefecture of Attica (EDSNA), which is by far the greatest Waste Management Organization in Greece, as calculated with the same pricing regulation for the same year, is as follows: The unit cost for waste disposal services and for material recovery services of mixed waste is 53.82€/tn and after the adjustment of the $M_{OTA\text{-}V}$ variable this value ranges from 40.36€/tn to 53.82€/tn for the 66 affiliated Municipalities of Attica. The unit cost for waste transfer services is 4.31€/tn and after the adjustment of the $M_{OTA\text{-}V}$ variable this value ranges from 3.23€/tn to 4.31€/tn for the same Municipalities (G.A. 6/2020 IUN: ΨΧΜ8ΟΡ05-1ΤΨ).

The average total unit cost for disposal services in Greece is approximately 45€/tn, for material recovery is 32€/tn and the depreciated investment cost of waste transfer ranges from 0.5€/tn to 28€/tn (Komilis, Liogkas, 2014).

In order to criticize the new regulation and examine whether it motivates Municipalities to reduce waste production, to recycle – reuse or to apply sorting at source methods, we will compare it to the previous pricing policy. For the Region of Central Macedonia the previous pricing policy had been agreed in 2016 and covered the period 2017 - 2020 (G.A. 8/2016 IUN: 6ΨΕΩΟΞΧΝ-ΟΒ1). According to the costing

model that had been approved by the G.A., total unit cost accounting was performed for the existing waste management facilities. For the year 2020 the unit cost for a) waste disposal services is 30€/tn and b) waste transfer services is 16€/tn. By the time of the G.A. decision, no waste recovery infrastructures were operating, so there was no provision for the cost of material recovery services. The waste recovery unit began its productive operation on October 2019 and levies will be charged retrospectively. The total unit cost for this new service can be easily determined as the facility operates under Public Private Partnership (PPP) for 27 years and the unit cost has been agreed at 71€/tn (Contr. 17SYMV001761002). Keeping the same amounts of waste provided above and applying these unit costs, we can calculate the levies according to the previous pricing policy as shown in Table 7:

Table 7: Annual levies according to the pre-existing pricing model

Waste service	Tonnage	Unit cost (€/tn)	Total levies
Waste disposal	724,151	30	21,687,739
Material recovery of mixed waste	17,152	71	1,215,890
Waste transfer services	252,211	16	4,035,379
Total	**993,514**	*	**26,939,008**
*The weighted average of the unit cost is 27€/tn (26,939,008/993,514)			

From Table 6 and Table 7 we observe that for the Region of Central Macedonia:

a. The annual levies according to the new pricing regulation are 9% lower
b. While the unit cost for disposal services remains the same, the unit cost for waste recovery and transfer services is remarkably lower according to the new regulation (58% lower for recovery and 44% lower for transfer services).

Following the same methodological approach for EDSNA and the Region of Attica we can see that the unit cost according to the previous pricing policy had been calculated at 54.0436€/tn (G.A. 2/2019 IUN: ΩΤΛΔΟΡ05-Χ60), while the unit cost according to the new regulation is calculated at 53.82€/tn (G.A. 6/2020 IUN: ΨΧΜ8ΟΡ05-1ΤΨ). Levies again are slightly lower with the new regulation.

The new pricing regulation motivates Municipalities to select environmental friendlier solutions for MSW, as this regulation will always lead to more expensive disposal services and more attractive any other alternative waste treatment service.

The pre-existing pricing model would lead to very expensive recovery services as these facilities are technologically advanced and therefore costly. From an economic point of view disposal would seem more attractive and this might cause Municipalities to overlook the severe consequences on the environment and public health.

Changes in waste treatment technologies require important initial investments, while the benefits are evident after a longer period of time. Therefore, in order to evaluate such policies this time horizon should be taken into account (Jaeger, Rogge, 2013). The new pricing regulation takes into consideration this dimension and secures that disposal will always have the higher unit cost.

3.2. The situation in the Study area

Waste management in Central Macedonia seems to be moving towards a more integrated orbit. This is presumed by the construction and operation of waste treatment infrastructures. The waste transfer station facility at Efkarpia began its productive operation early in 2017. It's the greatest transfer facility in the Region representing the 89% of the total service (for the year 2019). The waste recovery station at Serres began its productive operation late in 2019. Two more waste recovery stations are in progress as well as one organic waste treatment station. This evolution changes both the quality and the quantity of the waste treatment services provided by the Waste Management Organization, while the quantity of waste generation remains almost unchanged. In this study we are interested on the impact of waste treatment not on waste generation. As waste management becomes more integrated, these two quantities present remarkable differences as shown in Figure 1. The total tonnage of waste treatment increases as well as the relevant costs. Waste generation, from 2015 onwards annually increases as a consequence of the increase of the Greek GDP (IOBE Greece 2020). For the years 2011 - 2012 the data reflect only the Regional Unit of Thessaloniki. From 2011 to 2016 the Waste Management Organization offered only

disposal services. That's why waste treatment and waste generation quantities are identical. From 2017 to 2019 waste transfer and recovery services are also provided. That's why the waste treatment tonnage is much more than the waste generation.

After the construction of the facilities that are in progress, these differences will grow larger. The costs will follow the same path but we have to think the benefits for the environment and public health as well as the social cost of landfilling, together with the penalties being imposed by the EU to Greece for failing to meet the European thresholds. Eventually, the implementation of integrated waste management technologies will lead to less waste disposal (because of recovery and organic waste treatment services) helping Greece to reach its National objective which is set to less than 10% disposal by 2030. The waste recovery station at Serres began its productive operation on October 2019, that's why we don't see any difference in the waste disposal activity yet.

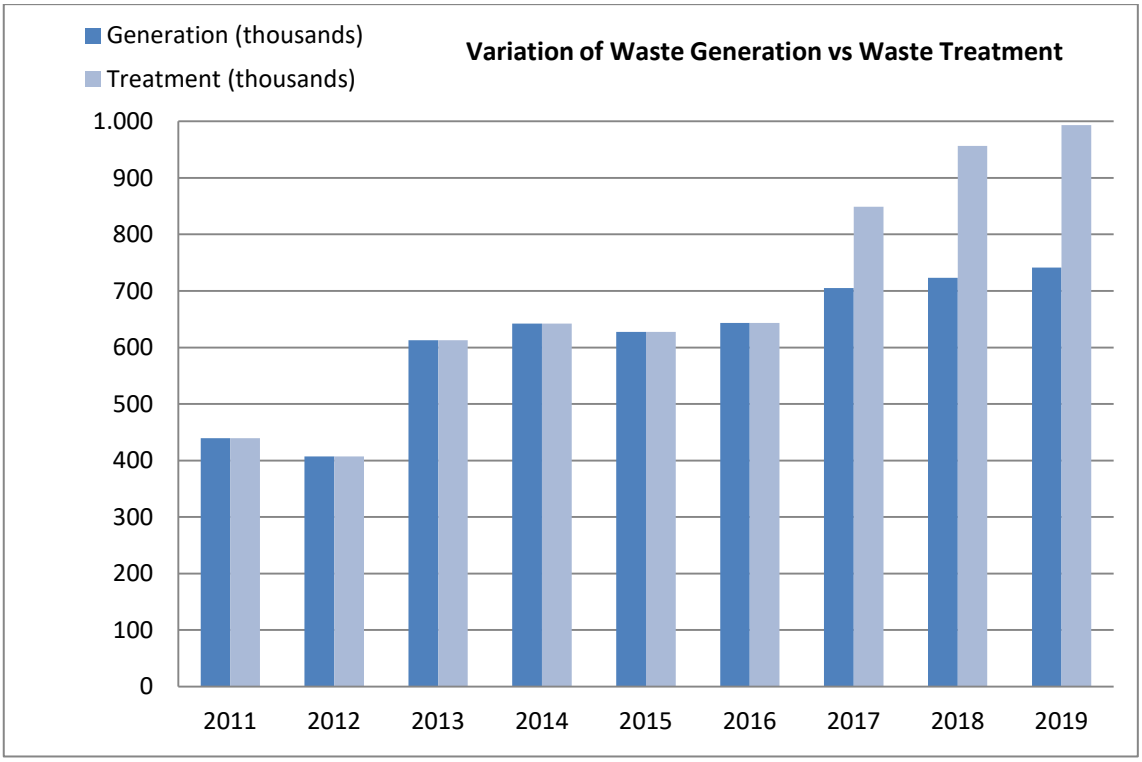

Figure 1: Variation of Waste Generation vs. Waste Treatment in tons

Aiming to evaluate the impact of MSW treatment on the financial sustainability of the Municipalities, we examine the relation of waste treatment cost to Municipal

Budgets. Municipalities are included in the Register of General Government Entities of the Hellenic Statistical Authority; subsector Local Authorities (S1313) according to the European System of Accounts, (ESA 2010) [4]. Budgeting is mandatory according to art. 64, Law 4270/2014. Municipalities reimburse their expenditures from the revenues they collect through the electricity bills of each electrified building or installation. This figure is depicted explicitly on their Budgets as Cleaning and Lighting Levies (C&L revenues). Out of this account Municipalities have to cover all the MSW expenses.

In the following chapter, when we consider population criteria in order to calculate per capita values, we take into consideration permanent residents only. Seasonal population (mainly tourists) although contribute in waste generation, nevertheless, doesn't pay the electricity bills of its settlement and therefore don't pay any waste related fees. Regarding the population, we used data available at Eurostat [3]. The population of each Regional Unit remains relatively stable during the period 2011 – 2019. Therefore, the annual MSW treatment (tn/y) is mainly affected by the waste services provided each year.

4. Data analysis and Discussion

Grate effort has been put in getting accurate data representing the real situation. Waste related data have been used, as well as economic and demographic data for the Municipalities of Central Macedonia. A very large number of documents have been collected and studied in order to create the database necessary for the research. These include documents (mainly the annual evaluation reports) downloaded from the websites of the Municipalities (Appendix Table 16), documents downloaded from "Transparency Portal" [1], data available at the Electronic Waste Register [2] and unpublished data supplied by the Waste Management Organization of Central Macedonia. All Internet Uploading Numbers (IUN) from the Transparency Portal are listed in the Appendix Table 17. The demographic data were collected by Eurostat [3].

The data covered the period 2011 – 2019. As mentioned in chapter 1, the Municipalities in Greece were established in the way they exist today on January 2011 (Law 3852/2010). Thus, the data processed is not a sample but the whole population for Central Macedonia representing 7 Regional Units, 38 Municipalities and almost 2 million citizens. The database has been created from point zero and in an attempt to have accurate data with the less possible degree of errors that might occur; we standardized the process to increase the reliability as much as we could.

Municipalities in CM have different geographic characteristics, mainland areas, touristic areas, industrial areas and high populated areas. A thorough investigation per Regional Unit will help reveal important dimensions in order to evaluate the potential impact of waste treatment levies to the financial stability of the Municipalities of CM. This framework has two components: a) the financing that takes into consideration the revenues and the costs and b) the waste management meaning that the costs can be minimized by decreasing the waste generated. Financial stability in our case means that MSW treatment costs don't capture a vast amount of the Municipal revenues.

This research encountered several difficulties and limitations. For a few Municipalities some data aren't available for several reasons that are beyond the scope of this study. Therefore, waste related data for the years 2011 and 2012 refer only to the Regional Unit of Thessaloniki which represents on average more than 66%

of the total Region. For the Regional Unit of Pieria the data cover only the period 2017 – 2019. For our research, we need to know the amount of waste generated, the waste treatment services (transfer stations, waste recovery units and disposal), the total waste management cost and the total C&L revenues. Therefore, we need accurate and reliable information on a disaggregated level (quantity and category). Up to now, the generation of each single waste producer cannot be measured directly. Thus, waste generation cannot be measured on a detailed level per citizen. The Government in an attempt to monitor waste production by category and in compliance with the article 26 of the Directive 2008/98/EC has established the Electronic Waste Register (art. 157, Law 4389/2016). However, the data that are available till now (accessed December 2020) include information only for the years 2017 and 2018.

In the following seven sections the relationship between revenues and costs is depicted for each Regional unit of Central Macedonia. We examine fluctuations in Municipal C&L revenues and waste treatment expenditures. Our interest is on the volume of waste treatment expenditures compared to the Municipal revenues collected in the form of levies imposed to the citizens. Data regarding revenues were taken from the Municipal Budgets. Data regarding waste amounts and the relevant costs were calculated according to information taken from the Waste Management Organization of Central Macedonia and the pricing policy. We calculate per capita values for revenues and costs in order to have comparable results among the Regional Units (Struk, 2019).

4.1. Regional Unit of Thessaloniki

In Table 8 the data for the Regional Unit of Thessaloniki are being available for the period 2011 - 2019. In this area 14 Municipalities participate. It is the largest in Central Macedonia and represents the 66% of the total Region (for the year 2019). The average per capita tons of MSW treatment is 0.4270tn/y, while the average per capita revenues is 92€. The average per capita cost is 10€. The cost dropped during the years 2013 – 2016 due to the economic recession in an attempt to support the Local Authorities facing ongoing economic hardships (G.A. 10/2012 IUN: ΒΕΙ7ΟΡΘΦ-ΟΚΝ and 7/2013 IUN: ΒΕΑΛΟΡΘΦ-5Α3). The ratio of cost to revenues ranges from 8% to 16% with an average of 11%. This ratio reflects the burden imposed by the Waste

Management Organization for the treatment of the MSW. After 2017 the ratio increases as apart from the disposal services, waste transfer services are also provided. By the outcome we can see that this number is quite low meaning that Municipality Budgets are not significantly affected by the levies paid to the Waste Management Organization. On the other hand, this ratio is quite low to incentivize waste generation reduction. The average waste fee for the period is 23€/tn.

Table 8: MSW in the Regional Unit of Thessaloniki

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2011	1,139,647	439,695	0.3858	120,453,432	106	11,871,768	10	10%
2012	1,137,093	406,994	0.3579	113,262,559	100	10,988,851	10	10%
2013	1,130,229	385,869	0.3414	103,633,290	92	8,489,127	8	8%
2014	1,123,676	405,713	0.3611	101,421,702	90	8,925,686	8	9%
2015	1,117,094	400,414	0.3584	98,977,768	89	8,809,117	8	9%
2016	1,109,969	403,305	0.3633	101,534,617	91	8,872,719	8	9%
2017	1,108,085	545,281	0.4921	94,574,881	85	12,182,958	11	13%
2018	1,105,663	650,533	0.5884	93,305,575	84	14,946,925	14	16%
2019	1,104,690	657,145	0.5949	96,370,892	87	15,274,288	14	16%

Source: own calculation

4.2. Regional Unit of Imathia

In Table 9 the data for the Regional Unit of Imathia are being available for the period 2013 - 2019. In this area 3 Municipalities participate and represents the 4% of the total MSW treatment (for the year 2019). The average per capita tons of MSW treatment is 0.3137, while the average per capita C&L revenues is 57€. The average per capita cost is 8€. The ratio of cost to revenues ranges from 14% to 16% with an average of 15%, reflecting the burden imposed by the Waste Management Organization for the treatment of the MSW. The average waste fee for the period is 26€/tn. This number is higher than the corresponding for the Regional Unit of Thessaloniki. This indicator is affected by waste fees and per capita revenues. Waste fees in Imathia are 12% higher than the corresponding in Thessaloniki, while per capita revenues in Imathia are 38% lower than the corresponding in Thessaloniki, affecting the result accordingly. The rate is mostly being affected by the low flat-rate Municipal fees collected through the electricity bills (the C&L revenues). The outcome indicates

again that the levies paid to the Waste Management Organization are not a significant burden on Municipality Budgets.

Table 9: MSW in the Regional Unit of Imathia

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2013	142,898	42,523	0.2976	7,752,669	54	1,063,087	7	14%
2014	142,559	46,941	0.3293	7,884,303	55	1,173,530	8	15%
2015	142,063	46,747	0.3291	7,695,775	54	1,168,685	8	15%
2016	141,436	44,264	0.3130	7,589,520	54	1,191,398	8	16%
2017	141,517	42,694	0.3017	7,989,697	56	1,110,051	8	14%
2018	141,403	46,053	0.3257	8,491,952	60	1,289,497	9	15%
2019	141,585	42,413	0.2996	8,741,776	62	1,187,571	8	14%

Source: own calculation

4.3. Regional Unit of Kilkis

In Table 10 the data for the Regional Unit of Kilkis are being available for the period 2013 - 2019. In this area only 2 Municipalities participate and represents the 3% of the total MSW treatment (for the year 2019). The average per capita tons of MSW treatment is 0.3066, while the average per capita revenues is 70€. The average per capita cost is 8€. The ratio of cost to revenues ranges from 10% to 13% with an average of 11%, reflecting the burden imposed by the Waste Management Organization for the treatment of the MSW. The average waste fee for the period is 25€/tn. In this case as we mentioned for Imathia as well, the indicator is affected mainly by the fees collected through the electricity bills, as this is the indication that fluctuates, while per capita cost remains unchanged.

Table 10: MSW in the Regional Unit of Kilkis

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2013	81,397	22,844	0.2806	5,138,072	63	542,981	7	11%
2014	81,017	22,903	0.2827	5,054,278	62	529,393	7	10%
2015	80,616	23,469	0.2911	5,603,730	70	542,976	7	10%
2016	80,173	26,034	0.3247	5,752,769	72	618,470	8	11%
2017	80,762	25,586	0.3168	5,648,487	70	665,235	8	12%
2018	80,576	26,059	0.3234	5,594,513	69	729,656	9	13%
2019	80,475	26,311	0.3269	6,472,893	80	736,699	9	11%

Source: own calculation

4.4. Regional Unit of Pella

In Table 11 the data for the Regional Unit of Pella are being available for the period 2013 - 2019. In this area 4 Municipalities participate and represents the 5% of the total MSW treatment (for the year 2019). The average per capita tons of MSW treatment is 0.3052, while the average per capita revenues is 55€. The average per capita cost is 7€. The ratio of cost to revenues ranges from 11% to 16% with an average of 13%, reflecting the burden imposed by the Waste Management Organization for the treatment of the MSW. The average waste fee for the period is 24€/tn. The average numbers of Pella are very much alike those of Imathia and thus the remarks are the same.

Table 11: MSW in the Regional Unit of Pella

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2013	141,193	44,220	0.3132	7,735,419	55	977,877	7	13%
2014	140,495	40,899	0.2911	7,970,593	57	914,865	7	11%
2015	139,818	42,259	0.3022	7,224,706	52	945,814	7	13%
2016	139,105	41,641	0.2994	7,116,680	51	933,247	7	13%
2017	138,583	41,447	0.2991	7,733,146	56	1,005,351	7	13%
2018	137,872	41,934	0.3041	7,910,984	57	1,174,139	9	15%
2019	137,181	44,880	0.3272	7,911,161	58	1,256,647	9	16%

Source: own calculation

4.5. Regional Unit of Serres

In Table 12 the data for the Regional Unit of Serres are being available for the period 2013 - 2019. In this Regional Unit 7 Municipalities participate and represents the 6% of the total MSW treatment (for the year 2019). The average per capita tons of MSW treatment is 0.3190, while the average per capita revenues is 60€. The average per capita cost is 7€. The ratio of cost to revenues ranges from 9% to 15% with an average of 11%, reflecting the burden imposed by the Waste Management Organization for the treatment of the MSW. The average waste fee for the period is 21€/tn. During the period 2013 – 2016 Serres had the lowest per capita cost, due to the very low waste fees in the Region (18€/tn). After 2016 the Waste Management

Organization considered significant to normalize the waste fees across the Regional Units and gradually reach a point of a single fee addressing thus, Regional disparities. So, from 2017 to 2019 the waste fees increased (to 28€/tn in 2019) in order to reach the levels of the Region.

Table 12: MSW in the Regional Unit of Serres

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2013	176,604	55,635	0.3150	9,695,027	55	984,741	6	10%
2014	174,686	55,740	0.3191	9,471,031	54	986,591	6	10%
2015	172,909	53,607	0.3100	9,516,007	55	948,846	5	10%
2016	170,929	53,062	0.3104	10,336,857	60	939,197	5	9%
2017	169,242	53,320	0.3151	10,958,786	65	1,226,364	7	11%
2018	168,245	52,890	0.3144	11,519,074	68	1,480,920	9	13%
2019	167,374	58,392	0.3489	10,810,275	65	1,615,423	10	15%

Source: own calculation

4.6. Regional Unit of Chalkidiki

In Table 13 the data for the Regional Unit of Chalkidiki are being available for the period 2013 - 2019. In this area 5 Municipalities participate and represents the 11% of the total MSW treatment (for the year 2019). The average per capita tons of MSW treatment is 0.7359, while the average per capita revenues is 193€. The average per capita cost is 23€. The ratio of cost to revenues ranges from 10% to 15% with an average of 12%, reflecting the burden imposed by the Waste Management Organization for the treatment of the MSW. The average waste fee for the period is 31€/tn.

Chalkidiki has by far the greatest per capita tons of MSW treatment as well as the highest cost per capita. Although it has the highest waste fees as well, the relevant ratio of cost to revenues is among the low in the Region. Chalkidiki has very strong touristic characteristics. As mentioned before, the population indicated, includes only resident citizens, as they are the ones that pay the electricity bills. So for the waste that is generated during the touristic period by the seasonal population, the relevant treatment cost is allocated among the regular residents, adding an “ad hoc” extra charge. Due to the very demanding program for keeping the area clean especially during the touristic season, the per capita Municipal revenues are very much increased

and this explains the low ratio of cost to revenues. In this case, it is more evident that the waste treatment costs which are part of the total cleaning expenses of the Municipalities don't impose a remarkable burden. The remaining cleaning expenses influence the volume of the fees collected through the electricity bills and consumes the Municipal cleaning revenues, but this is beyond the scope of this research to analyze.

Table 13: MSW in the Regional Unit of Chalkidiki

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2013	110,031	61,888	0.5625	17,517,902	159	2,042,302	19	12%
2014	110,198	70,062	0.6358	15,737,713	143	2,312,038	21	15%
2015	110,337	60,799	0.5510	20,577,213	186	2,006,379	18	10%
2016	110,418	74,766	0.6771	24,722,565	224	2,467,276	22	10%
2017	110,545	95,301	0.8621	22,605,449	204	2,859,022	26	13%
2018	110,587	92,673	0.8380	22,071,652	200	2,780,180	25	13%
2019	110,593	113,349	1.0249	25,937,066	235	3,058,118	28	12%

Source: own calculation

4.7. Regional Unit of Pieria

In Table 14 the data for the Regional Unit of Pieria are being available for the period 2017 - 2019. In this area only 3 Municipalities participate and represents the 5% of the total MSW treatment (for the year 2019). Although the availability of data covered only 3 years, we choose to present them for more complete information. The average per capita tons of MSW treatment is 0.3620, while the average per capita revenues is 76€ and the average per capita cost is 11€. The ratio of cost to revenues on average is 14%. No additional input can be mentioned, other than already said.

Table 14: MSW in the Regional Unit of Pieria

Year:	Population	MSW treatment (tn/y)	Per capita tons of MSW treatment	C&L revenues	Per capita revenues	MSW treatment expenditure	Per capita cost	Cost to revenues ratio (%)
2017	131,388	45,429	0.3458	9,803,457	75	1,333,029	10	14%
2018	131,650	46,512	0.3533	10,016,672	76	1,395,354	11	14%
2019	131,879	51,025	0.3869	10,216,620	77	1,530,756	12	15%

Source: own calculation

4.8. Region of Central Macedonia

The overall correlations between the parameters explained in the previous units and the overall average indications for the whole Region are aggregated in the following Table 15:

Table 15: The correlation of the parameters (average annual indications)

Regional Unit	Per capita tons of MSW treatment	Waste fee €/tn	Per capita revenues	Per capita cost	Cost to revenues ratio (%)
Thessaloniki	0,4270	23	92	10	11%
Imathia	0,3137	26	57	8	15%
Kilkis	0,3066	25	70	8	11%
Pella	0,3052	24	55	7	13%
Serres	0,3190	21	60	7	11%
Chalkidiki	0,7359	31	193	23	12%
Pieria	0,3620	30	76	11	14%
Total Region	**0,4072**	**24**	**90**	**10**	**11%**

Source: own calculation

The average annual cost of MSW treatment for the whole Region of Central Macedonia is nearly the 1/10th of the relevant Municipal C&L revenues.

The average MSW treatment cost in Euros per capita for the Region of Epirus for the six year period 2011 – 2016 has been calculated to 10 (Kotsios, 2018). This value is exactly the same from what we've found in our research.

5. Conclusion and Recommendations

The present dissertation has examined the financial dimensions and the relevant implications of MSW Management. It has reviewed:

a) The new regulation of the Central Government of Greece which is in force since 2019 establishing a pricing policy that will encourage sorting at source, recycling and waste reduction. The new pricing regulation will be used as a vehicle to drive waste management to a more integrated and prosperous direction, aiming to address the most significant facets of waste; environment, public health and economy.
b) The MSW Management in Central Macedonia:
    i. From the Waste Management Organization point of view
    ii. From the Municipalities of Central Macedonia point of view

For the first time in Central Macedonia the new pricing regulation has been applied, calculated using full cost accounting and the results were compared to the pre-existing status, calculated using unit cost accounting. The results indicate that the total annual levies according to the new pricing regulation are 9% lower than the pre-existing model. Furthermore, the levies for waste recovery services are 58% lower and the levies for waste transfer services are 44% lower, while the levies for disposal services remain unchanged.

The relation between waste treatment costs and waste related Municipal revenues has been examined and the impact of the first to the latest has been measured, aiming to put some light on important sites of MSW management, which are important especially on local level. This relation has been reviewed for each Regional Unit of Central Macedonia. The cost to revenues ratio ranges from 11% to 15% with an average cost for the whole region calculated at 11%. The Regional Unit of Thessaloniki is the largest and represents the 66% of the total Region. The Regional Unit of Chalkidiki has very strong touristic characteristics and for this reason the tons of MSW treatment per capita are the highest in the Region, along with the waste fees, the revenues and the costs per capita. Nevertheless, the Regional Unit of Imathia has the highest cost to revenues ratio in the Region. The results for the rest of the Regional Units are indifferent. The research demonstrates that Municipal waste related Budgets

are not significantly affected by the waste treatment costs paid to the Waste Management Organization. These costs are not the predominant factor causing increase or decrease in Municipal revenues. The average ratio of cost to revenues that has been calculated at 11% for the Region takes into consideration the pre-existing pricing model. Having in mind that the levies as calculated according to the new pricing policy are 9% lower than those of the previous status, it can be inferred that the impact of waste treatment costs on Municipal Budgets will, ceteris paribus, be even lower than 11% in the future.

The difference between waste treatment and waste generation has been highlighted and it has been shown that as waste management becomes more integrated, waste treatment quantities and waste generation quantities will differ, increasing the relevant costs. The financial stability can be achieved not only by low waste costs compared to the revenues, but also by minimizing waste generation through recovery, reuse and recycling bringing thus, “green revenues” to the Municipalities and offsetting a portion of the waste costs.

As mentioned in unit 2.2, the Municipal waste related revenues have been merged with the revenues for the Municipal lighting in one single levy. This is a limitation to this research. Further investigation is suggested in order to estimate and segregate only the cleaning revenues out of this levy for the Municipalities of Central Macedonia. This could be done by estimating the waste related Municipal expenses.

Greece is far from applying a Pay-As-You-Through policy. User charges are, calculated based on the property size and location (Frantzis 2020). Nevertheless, the overall costs must be fair especially during periods of economic recession and during the pandemic of Covid-19. According to the Commission 2020 autumn forecast, *“the Greek economy is expected to face one of the largest falls in economic activity in the EU, on account of its high exposure to tourism and the large share of small enterprises, which have a limited adjustment capacity”* (European Commission November 2020). Any unreasonable increase in the costs could lead to illegal use of open dumping, departing Greece from the National and European goals, causing severe environmental damages.

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Appendix

Table 16: Municipalities of Central Macedonia by Regional Unit, Population and Category

Municipalities Participating in Central Macedonia					
	Municipality	**Regional Unit**	**Population***	**Website**	**City Classification**
1	Thessaloniki	Thessaloniki	325.182	https://thessaloniki.gr/ https://gaiacrmkea.c-gaia.gr/city_thessaloniki/index.php	Metropolitan
2	Ampelokipi - Menemeni	Thessaloniki	52.127	http://www.ampelokipi-menemeni.gr/	Metropolitan
3	Volvi	Thessaloniki	23.478	https://www.dimosvolvis.gr/	Medium
4	Delta	Thessaloniki	45.839	https://www.dimosdelta.gr/	Large
5	Thermaikos	Thessaloniki	50.264	http://www.thermaikos.gr/	Large
6	Thermi	Thessaloniki	53.201	http://www.thermi.gov.gr/	Large
7	Kalamaria	Thessaloniki	91.518	https://kalamaria.gr/	Metropolitan
8	Kordelio - Evosmos	Thessaloniki	101.753	http://www.kordelio-evosmos.gr/	Metropolitan
9	Lagkadas	Thessaloniki	41.103	https://www.lagadas.gr/	Large
10	Neapolis - Sykeon	Thessaloniki	84.741	http://www.dimosneapolis-sykeon.gr/web/guest/home	Metropolitan
11	Pavlou Mela	Thessaloniki	99.245	https://pavlosmelas.gr/	Metropolitan
12	Pilea - Hortiatis	Thessaloniki	70.110	https://www.pilea-hortiatis.gr/web/guest/home	Metropolitan
13	Chalkidonos	Thessaloniki	33.673	http://dimos-chalkidonos.gr/	Large
14	Oraiokastro	Thessaloniki	38.317	http://www.oraiokastro.gr/ http://84.205.252.188:39999/accounting/opendata/budgetView	Large
15	Veria	Imathia	66.547	https://www.veria.gr/new/ http://84.205.238.156:8080/accounting/opendata/budgetView	Capital
16	Alexandria	Imathia	41.570	https://www.alexandria.gr/	Large
17	Naoussa	Imathia	32.494	https://www.naoussa.gr/	Large
18	Kilkis	Kilkis	51.926	http://www.e-kilkis.gr/	Capital
19	Paionia	Kilkis	28.493	http://paionia.gov.gr/	Large
20	Edessa	Pella	28.814	http://www.dimosedessas.gov.gr/	Capital
21	Almopia	Pella	27.556	http://www.dimosalmopias.gov.gr/	Large
22	Pella	Pella	63.122	https://www.giannitsa.gr/	Large
23	Skydra	Pella	20.188	https://www.skydra.gr/	Medium
24	Katerini	Pieria	85.851	https://katerini.gr/	Capital
25	Diou - Olymbou	Pieria	25.668	https://www.dion-olympos.gr/	Large
26	Pydnas - Kolindrou	Pieria	15.179	https://www.pydnaskolindrou.gr/	Medium
27	Serres	Serres	76.817	https://www.serres.gr/	Capital
28	Amfipoli	Serres	9.182	https://sites.google.com/site/technicaldepartmentamfipoli/dimosamfipolis	Small
29	Visaltia	Serres	20.030	http://www.dimosvisaltias.gr/	Medium
30	Emmanouil - Pappa	Serres	14.664	http://edemocracy-empapas.gr/	Medium
31	Iraklias	Serres	21.145	http://www.dimosiraklias.gr/	Medium

32	Nea Zixni	Serres	12.397	http://www.dimos-neaszixnis.gr/	Medium
33	Sintiki	Serres	22.195	https://www.sintiki.gov.gr/	Medium
34	Polygyros	Chalkidiki	22.048	http://www.polygyros.gr/index.php/el/	Capital
35	Aristoteli	Chalkidiki	18.294	http://www.dimosaristoteli.gr/	Medium
36	Kassandra	Chalkidiki	16.672	https://kassandra.gr/	Medium
37	Nea Propontida	Chalkidiki	36.500	http://www.nea-propontida.gr/ http://84.205.254.174:8080/accounting/opendata/budgetView	Large
38	Sithonia	Chalkidiki	12.394	https://www.dimossithonias.gr/	Medium
Total Population**			**1.880.297**		par. 1, art. 2, Law 4555/2018
* According to ELSTAT FEK 698/B/2014					
** (The area of Agion Oros is not included)					

Table 17: List of IUN per Regional Unit

List of IUN per Regional Unit		
	Regional Unit	**Internet Uploading Numbers (IUN) Downloaded from the Transparency Program**
1	Thessaloniki	6ΗΩΡΩΡ5-7ΒΦ, ΩΒΟΞΩΡ5-0ΥΞ, ΩΑ96ΩΡ5-ΥΗΩ, Ψ4Λ0ΩΡ5-Ψ13, 6Ρ1ΒΩΡ5-8Τ4, 67Σ5ΩΡ5-3ΨΧ, 7ΦΙΠΩΨΕ-Σ1Θ, 6Ν4ΨΩΨΕ-ΗΨΙ, 94Τ2ΩΨΕ-5ΡΧ, ΨΨ4ΗΩΨΕ-Ι4Σ, ΩΕ7ΚΩΨΕ-ΖΙΦ, 9ΤΗ5ΩΨΕ-ΒΤΙ, ΒΕ26Ω9Ω-2Τ8, ΒΙΨΗΩ9Ω-Ε1Ν, ΩΨΕΥΩ9Ω-ΤΓΠ, ΩΤ8ΙΩ9Ω-85Α, ΩΚΖΦΩ9Ω-3ΛΒ, ΨΕΝ3Ω9Ω-ΗΡ2, 6ΞΩΥΩ9Ω-85Λ, 9ΨΜΒΩ9Ω-8ΒΧ, Β491Ω9Ι-Ο1Ο, ΒΕΔΞΩ9Ι-ΝΕ9, ΒΙ0ΒΩ9Ι-ΚΨΥ, ΒΧΘΑΩ9Ι-8ΞΔ, ΩΠΟ8Ω9Ι-ΦΔ1, ΩΚ59Ω9Ι-ΜΗΨ, 7ΜΤ3Ω9Ι-Ξ57, 6ΥΡΛΩ9Ι-ΛΚ7, ΩΙΟΘΩ9Ι-ΣΛΣ, Β44ΡΩΡ2-ΨΘΗ, ΒΕΙ7ΩΡ2-Α65, ΒΙΡΜΩΡ2-7ΨΑ, 7ΦΨΡΩΡ2-Β7Ξ, ΨΕΒΟΩΡ2-ΜΗ8, 7Η2ΨΩΡ2-ΡΧΡ, 6Ε6ΟΩΡ2-ΖΚ0, ΩΣΕΨΩΡ2-7ΓΠ, 65ΝΨΩΡ2-3Υ3, Β4ΩΕΩΡΣ-ΩΔΣ, ΒΕΤΟΩΡΣ-ΜΚΙ, ΒΙΦ1ΩΡΣ-8ΥΓ, 7Τ9ΡΩΡΣ-ΠΟΛ, ΩΚΘΛΩΡΣ-ΥΟΗ, 7ΣΙΡΩΡΣ-ΝΜ4, ΩΞΒΟΩΡΣ-ΕΕΗ, 784ΡΩΡΣ-Γ0Π, Ω8Η8ΩΡΣ-ΦΓ1, ΒΟΖΛΩΕΡ-ΕΥΑ, ΒΕΥΦΩΕΡ-ΚΘΣ, ΒΙΨΕΩΕΡ-ΡΕΒ, ΒΝΜΨΩΕΡ-Ν6Η, 6ΑΟΘΩΕΡ-ΙΜΤ, 614ΔΩΕΡ-ΜΝΗ, 67ΨΛΩΕΡ-ΨΕΚ, ΩΓΜ3ΩΕΡ-Δ3Τ, ΩΕΥΗΩΕΡ-ΓΑΟ, ΒΙΕΒΩΛΒ-ΧΘΝ, 6Ψ0ΥΩΛΒ-08Ο, 70ΚΥΩΛΒ-Ψ6Ο, 6Λ3ΡΩΛΒ-ΨΝΦ, 9ΠΘΠΩΛΒ-Ρ7Μ, ΨΔΑΑΩΛΒ-50Η, ΨΙ2ΘΩΛΒ-ΧΨ8, Β4ΛΒΩΛΛ-ΟΘΙ, ΒΕΑΚΩΛΛ-Ω4Σ, ΒΙΦΦΩΛΛ-3ΡΞ, 6Ι79ΩΛΛ-9Ω8, 78ΔΜΩΛΛ-ΖΟ4, ΩΕΠΡΩΛΛ-2Ψ9, 6385ΩΛΛ-ΚΨ0, ΨΤΝ6ΩΛΛ-5ΩΗ, ΨΨΕΙΩΛΛ-78Π, Β41ΩΩΚΙ-6ΜΖ, ΒΛ45ΩΚΙ-ΧΑΞ, ΒΙΡ3ΩΚΙ-Γ1Φ, 72ΝΞΩΚΙ-Π74, Ω1ΨΕΩΚΙ-ΗΙΖ, ΩΟ9ΦΩΚΙ-6ΧΠ, ΩΙΤ4ΩΚΙ-2ΑΚ, 6ΖΜΜΩΚΙ-ΦΦΧ, Ψ7ΖΔΩΚΙ-ΡΤ6, ΒΟΖΛΩΞΘ-Ν99, ΒΕΔΘΩΞΘ-Ι77, ΒΙΚ3ΩΞΘ-ΡΩΦ, ΒΧ00ΩΞΘ-79Υ, Ψ0Φ4ΩΞΘ-ΓΤ1, 6ΒΙΘΩΞΘ-Ω63, 6ΧΨΕΩΞΘ-ΛΤΤ, ΨΠΤΖΩΞΘ-ΠΞΜ, 6ΕΕ7Ω5Θ-ΗΧ6, Β4ΛΕΩ1Ο-4ΡΙ, ΒΕΖΚΩ1Ο-Ξ4Ω, ΒΛΓ7Ω1Ο-6ΓΧ, 7ΣΔ2Ω1Ο-0ΞΘ, , 75ΥΖΩ1Ο-Ζ26, ΒΙΚΥΩΗ2-7ΨΤ, ΒΙΚΥΩΗ2-6ΕΟ, Β8ΘΦΩΗ2-ΠΜΔ, 74ΜΓΩΗ2-21Υ, 6ΒΝΣΩΗ2-ΤΑ0, ΩΖΜΚΩΗ2-ΕΗΔ, ΩΕΡ3ΩΗ2-9ΧΔ, 6ΗΧΣΩΗ2-ΔΧ6, 6Α9ΝΩΗ2-0Ξ1, 60ΡΤΩΗΖ-Ρ34
2	Imathia	ΒΙΡΧΩΨΠ-ΔΗ3, Β5ΚΜΩΨΠ-1ΣΝ, 61ΟΤΩΨΠ-Ω21, Ω4ΦΓΩΨΠ-Μ3Φ, ΨΜΑ1ΩΨΠ-ΛΩΓ, ΩΛΩΜΩΨΠ-ΔΔΤ, 6ΞΥΔΩΨΠ-ΕΙΔ, ΒΙΕ9ΩΚ0-ΠΗΞ, 6ΚΡ9ΩΚ0-43Ρ, 6ΓΠΩΩΚ0-Η0Ψ, ΩΞΠΚΩΚ0-ΗΕ8, 6Ψ5ΝΩΚ0-ΓΤΛ, 6ΞΜΠΩΚ0-9ΑΗ, ΨΩΝΣΩΚ0-ΛΚΞ
3	Kilkis	ΒΙΕΕΩΕΧ-0Θ4, 760ΧΩΕΧ-ΙΒ3, 72ΡΩΩΕΧ-33Ξ, 75Σ8ΩΕΧ-0ΩΡ, Ω1ΖΠΩΕΧ-2Ι2, ΩΗΓΥΩΕΧ-Δ09, 96ΖΥΩΕΧ-ΑΛΓ, ΒΙΡ5ΩΞΡ-3ΑΩ, 7ΣΨΝΩΞΡ-ΨΥΓ, ΩΓ3ΤΩΞΡ-9ΜΙ, Ω5ΟΠΩΞΡ-ΜΙΙ, 6ΕΛ3ΩΞΡ-ΜΧΜ, 7Ν07ΩΞΡ-Υ2Ο, 63Χ6ΩΞΡ-ΗΚΕ
4	Pella	ΒΙΕΟΩΡΠ-ΕΦΘ, Β578ΩΡΠ-2ΚΜ, ΩΙΑΝΩΡΠ-ΙΣ1, ΩΜΕΣΩΡΠ-Ξ38, ΩΧΘ0ΩΡΠ-ΞΦΦ, Ω7Β8ΩΡΠ-2ΣΑ, 63Π5ΩΡΠ-Θ12, 7ΑΧΗΩΨΩ-Γ70, 7ΤΤΔΩΨΩ-ΞΓΙ, 6ΑΔΗΩΨΩ-Μ6Μ, Ψ7Π6ΩΨΩ-ΡΨΛ, 7ΣΡΡΩΞΤ-ΩΣΣ, 7Ν5ΝΩΞΤ-3Ψ8, 6Υ8ΣΩΞΤ-ΝΔΤ, ΩΘ8ΛΩΞΤ-ΖΦΨ, 6ΟΤΣΨΞΤ-35Ι, Ψ9ΓΠΩΞΤ-5Ι6, 6Ε7ΡΩΞΤ-5ΘΒ, ΒΙΚΖΩ12-ΧΙΣ, Ω8ΣΡΩ12-0ΟΦ, Ω7ΗΕΩ12-ΔΙ8, Ψ9Ζ7Ω12-Ο0Δ, Ψ45Μ0Ω12-ΙΘΓ, ΩΦΠΥΩ12-Λ2Π, ΨΞΟΔΩ12-0Β6
5	Pieria	6Ψ7ΟΩΕΤ-ΟΡΨ, 670ΒΩΕΤ-ΙΘΟ, 6075ΩΕΤ-ΖΑ8, 63Γ6Ω9Δ-ΑΔΧ, Ψ4Ο6Ω9Δ-ΨΡΝ, 6ΕΒΦΩ9Δ-0Ξ2, 6ΜΙΖΩ1Π-Λ7Σ, ΩΥΙ9Ω1Π-00Ε, 6ΜΤΞΩ1Π-ΦΨΨ
6	Serres	ΩΒΙΟΩ10-ΚΤΔ, ΩΘΠΞΩ10-ΗΑΡ, 6ΣΧΨΩ10-33Μ, 62ΟΘΩ10-ΝΡΒ, ΨΞΘΕΩ10-9ΤΥ, Ω4ΛΤΩΨ1-Ν4Α, 6Λ50ΩΨ1-ΑΑ2, ΩΥΘΘΩΨ1-4ΥΕ, 7ΝΤΗΩΨ1-Φ87, ΨΦ52ΩΨ1-ΒΩΙ, 6ΝΓΜΩΨ1-ΘΒΒ, ΨΠΑ1ΩΨ1-ΠΓ9, ΩΔΝΣΩ9Β-7ΣΡ, 6ΘΣΧΩ9Β-461, Ω6ΕΚΩ9Β-ΙΦ9, 6Ρ0ΥΩ9Β-7ΕΦ, 7ΘΟΧΩ9Β-6Χ9, Ω94ΙΩ9Β-ΘΤΛ, 6ΖΤ9Ω9Β-Δ1Ι, ΩΟΦΓΩΡΩ-4ΛΦ, 6ΣΞ7ΩΡΩ-4ΟΛ, 7Ε1ΡΩΡΩ-ΔΙ6, 6ΗΩΦΩΡΩ-ΧΚΛ, ΨΔΠΚΩΡΩ-ΔΞΣ, 60ΧΙΩΡΩ-ΖΦΗ, 9Ε2ΤΩΡΩ-ΧΙΤ, ΒΙΨΡΩ1Υ-ΦΑ0, ΩΡΔΚΩ1Υ-ΥΤΩ, 6ΜΡ3Ω1Υ-Σ4Π, 7ΜΑΟΩ1Υ-Φ5Η, Ω6Η1Ω1Υ-54Ζ, 67Β2Ω1Υ-ΖΔΕ, ΨΨΜ4Ω1Υ-ΛΤΖ, ΒΙΕΒΩΡΤ-ΚΓΒ, 6Τ50ΩΡΤ-2ΣΔ, 6ΒΡΥΩΡΤ-ΒΩ3, 72Ζ2ΩΡΤ-ΕΦΟ, 725ΡΩΡΤ-ΥΥΗ, ΩΩ1ΜΩΡΤ-3Β0, ΨΡ5ΜΩΡΤ-ΘΓΕ, ΒΙΡ3ΩΚΘ-Ψ9Λ, 7ΛΘΓΩΚΘ-ΖΦ9, 7ΥΗΧΩΚΘ-ΑΡΡ, 7Ξ6ΩΚΘ-0ΔΤ, ΩΥΔΠΩΚΘ-ΡΛ0, 68ΨΤΩΚΘ-ΘΧ5, ΩΑΨΥΩΚΘ-948
7	Chalkidiki	7Τ8ΔΩΞΜ-Ι8Ο, ΒΝ4ΩΩΞΜ-ΩΔΧ, 7Β52ΩΞΜ-Σ2Τ, 6ΥΑΩΩΞΜ-ΚΘΞ, 69ΠΦΩΞΜ-6Δ3, ΨΟΡ7ΩΞΜ-ΕΥΝ, 6ΨΟ8ΩΞΜ-ΩΜΧ, ΒΙ0ΡΩΨ2-5ΞΩ, 6ΜΨΨΩΨ2-ΑΑΡ, ΨΤΙ8ΩΨ2-ΦΞ6, ΩΠΛΔΩΨ2-Ν1Ρ, Ω338ΩΨ2-99Κ, 6ΖΥΩΩΨ2-ΑΝΜ, ΩΡ2ΙΩΨ2-Υ39, ΒΙΡΥΩΕΘ-22Κ, ΩΙ9ΘΩΕΘ-ΑΙΦ, ΩΙΚΖΩΕΘ-ΑΧ2, ΩΑΚ4ΩΕΘ-ΔΔ3, ΨΟΔ1ΩΕΘ-2ΑΓ, 78ΕΓΩΕΘ-Ζ50, 9Ψ37ΩΕΘ-Μ7Φ, ΒΛ1ΒΩΚΤ-Ο0Μ, ΒΛ1ΤΩΚΤ-Μ0Θ, Ω8ΕΜΩΚΤ-ΘΚΛ, 7ΖΝΗΩΚΤ-ΠΛ7, ΨΕΗ7ΩΚΤ-1ΙΛ, 78Σ1ΩΚΤ-Ω4Χ, Ω4ΝΟΩΚΤ-7Ο5, 7956Ω1Φ-1ΚΨ, 7ΚΤΖΩ1Φ-Λ8Λ, ΩΥ7ΔΩ1Φ-Ρ98, 6ΔΑΛΩ1Φ-ΞΑΦ, 71ΕΣΩ1Φ-ΤΛΖ, ΨΟΤΚΩ1Φ-ΔΤΛ, Ω0ΒΠΩ1Φ-ΨΘ5