

# Sustainable cities perspectives by municipal waste sustainability indicators assessment.

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## Abstract

The technological development and improvement of living standards through the global economic prosperity of the past decades have developed enormous needs for goods and products [1], resulting in several environmental impacts such as the greenhouse effect, the climate change phenomenon, the reduction of natural resources, *etc.* [2], [3]. Those damages arose from the lack of a proper institutional framework as, until recently, our society ignored the dangers of prosperity and did not hold the necessary ecological consciousness [4]. Waste management nowadays, is considered one of the most social and significant issues, which is often an element of conflict between social and political aspects especially in local level [5]. Additionally, using a rational and sustainable waste management method, involves the co-operation of the local and regional competent bodies while at the same time, it should be governed by the requirements of the national environmental policies and legislation [6], [7].

The sustainable management of the municipal solid waste, should take under consideration all the economic, social and environmental constraints along with the carrying capacities of the ecosystem, aiming towards autonomy [8]. More specifically it is considered necessary to conduct relative qualitative and quantitative analysis of the municipal waste produced [9]. The heterogeneity of the materials and their quantities is a function of the geographic and demographic characteristics of each region, the GDP, the technology used, the seasoning, the consumption patterns, *etc.* [10].

This research indicated that sustainable development is addressing economic growth, as studied and implemented, considering the environment and the society, and that possible decision, planning and activation of the sustainable development mechanisms require both qualitative and quantitative assessment [11], and in order to highlight the most important aspects of sustainability, methodologically, an indicators system is applied. Indicators are computational sets seeking at simplifying, quantifying and transmitting certain information, contributing towards identifying information that is not easily perceptible and those are developed to measure the environmental performance of actions and/or procedures implemented at a city or by an organization [12]. Sustainability indicators are developed, using the latest official data available for three major municipalities in Attica Prefecture, Greece. The research proceeds comparing practices, procedures and results obtained in order to determine whether the municipal solid waste management implemented, may be considered to be viable and sustainable, or not. In this research Municipalities of Nea Smirni, Vyronas and Piraeus took place. The developed sustainability indicators were i) the Municipal Solid Waste Production (MSW-P) indicator representing the ratio of the amount of municipal solid waste produced to the municipal population at a given time. This indicator provides a measure of the average waste quantity, a figure that is quite usable and comparable, ii) the Municipal Solid Waste Composition (MSW-C) indicator recording the weight percentage of the most known materials included in the reported amount of municipal solid waste. The indicator provides information on the economic and ecological utility of the waste as well as the disposal methods provided, and iii) the Municipal Solid Waste Recycling (MSW-R) indicator measuring the percentage of the municipal solid waste that is recycled compared with the total amount of municipal solid waste. Additionally, the percentage of all type of waste (*i.e.* glass, paper, plastic, *etc.*) is estimated in relation to the total amount of waste recycled.

The results indicated that for whatever reason, municipal solid wastes in Greek cities have reduced over the last years. However, the same applies to the recycled waste, which is to be found well below the targets set by the EU and enacted in Greek Legislation 4042 in 2012. The main municipal solid waste management method is disposal in the Sanitary Landfill of Fili (Attica region), while recyclable materials are subject to undertakings entrusted by the municipal authorities with the operation of recycling services. The municipal solid waste composition differs considerably from municipality to municipality, and it changes with time. Comparing the three local municipal waste plans, which by definition indicate, that the Greek municipalities operated independently, it is noted that

they are -strangely enough- quite similar, they present similar projections, and they are developed with estimation methods. In addition, a centralized national waste data system evidently does not yet exist, clearly making the collection of reliable figures and information a challenging task, thus setting the solid waste management objectives, assessment and results -conveniently- into question.

Conclusively, this research indicates that there is currently room for improvement in the municipal solid waste management plans implemented by the three Municipalities, thus it cannot be considered to be viable and sustainable. Although bottlenecks preventing a more integrated approach are perfectly understandable (political orientations, budgets, *etc*), a cooperative, measurable, applicable and effective municipal solid waste system shall be applied in full compliance with the requirements set by the EU, reflecting contemporary scientific standards.

**Keywords:** sustainable development, urban sustainability, indicators, waste management, solid waste.

## References

- [1] M. Zavali and E. Theodoropoulou, "Investigating determinants of green consumption: evidence from Greece," *Soc. Responsib. J.*, vol. 14, no. 4, pp. 719–736, 2018.
- [2] R. J. Baumgartner, "Critical perspectives of sustainable development research and practice," *J. Clean. Prod.*, vol. 19, no. 8, pp. 783–786, May 2011.
- [3] Z. Kyramargiou and I. Vardopoulos, "Ships' waste reception facilities. Studying the port of Corinth.," in *5th International Conference on Sustainable Solid Waste Management*, 2017.
- [4] A. A. Zorpas, *Sustainability behind sustainability*. Nova Science Publishers, 2014.
- [5] G. T. Miller and J. S. E. Spoolman, *Living in the environment: principles, connections, and solutions*. Cengage Learning, 2008.
- [6] O. Eriksson *et al.*, "Municipal solid waste management from a systems perspective," *J. Clean. Prod.*, vol. 13, no. 3, pp. 241–252, Feb. 2005.
- [7] G. Poulos, C. Stamopoulos, I. Vardopoulos, and E. Theodoropoulou, "Inconsistencies and Deficiencies in the Waste Management Practices in Athens. An Intersectional Approach.," in *4th International Conference Sustainable Development*, 2018.
- [8] A. A. Zorpas, I. Voukkali, and P. Loizia, "Socio Economy Impact in Relation to Waste Prevention," Springer, Cham, 2017, pp. 31–48.
- [9] V. Inglezakis *et al.*, "Municipal solid waste experimental studies in Romania and Bulgaria," *Int. J. Chem. Environ. Eng. Syst.*, vol. 3, no. 3, pp. 64–73, 2012.
- [10] G. Tchobanoglous, H. Theisen, and S. A. Vigil, "Integrated solid waste management: engineering principles and management issues," *Management*. 1993.
- [11] I. Vardopoulos, "Multi-Criteria Decision-Making Approach for the Sustainable Autonomous Energy Generation through Renewable Sources. Studying Zakynthos Island in Greece," *Environ. Manag. Sustain. Dev.*, vol. 7, no. 1, pp. 52–84, Dec. 2018.
- [12] V. J. Inglezakis and A. A. Zorpas, "Environmental indicators," in *Sustainability behind Sustainability*, A. A. Zorpas, Ed. Nova Science Publishers, 2014, pp. 17–33.