

*Short Communication*

# Determinants of Municipal Waste Management in Sustainable Development of Regions in Poland

Agnieszka Ulfik\*, Stefan Nowak\*\*

Faculty of Sport and Tourism Management, Jerzy Kukuczka Academy of Physical Education in Katowice,  
Mikołowska 72A, 40-065 Katowice, Poland

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## Abstract

Our work concerns of the determinants that affect the management of municipal waste in sustainable regional development in Poland by analyzing the adequacy of income covering the costs of the new legal environmental waste management systems. We also present the results of research on the impact on local residents and the environment of the largest landfill in Europe, demonstrating a small influence on the life and health of local residents. This impact was much more correlated with smoking. We analyzed the choice of method for calculating charges for waste disposal and discuss the consequences of the introduction of the different options.

**Keywords:** municipal waste, municipal waste management, municipal reform, waste management, sustainable development

## Introduction

Sustainable development is a combination of environmental protection, economic growth and social responsibility. It is crucial to apply the principle of sustainable development in the context of municipal waste management. The need for this is quite understandable in view of environmental protection and social responsibility. The economic aspect of waste management, however, brings with it many problems.

The research presented in this paper focuses on the analysis of the adequacy of revenue to costs incurred in municipal waste management, including possible technical solutions for their restatement. In accordance with the act of 1 July 2011 amending the act on maintaining cleanliness and order in municipalities and certain other acts [1], local government took over responsibility for development occurring in their areas regarding waste. Adopted by the local government unit, billing methods and the amount

thereof may limit the best environmental and public waste management options.

Our studies also include analysis of the economic, environmental, and social impact of reform in select municipalities in Upper Silesia, possible implications of the operation of the largest utility companies in that region, and the validity of the adopted division of the region into subregional waste.

## The Tasks of Local Government and Sustainable Development in the Context of Municipal Economy

According to the Act of Law on Municipal [2] – municipal services is to carry out the tasks of a local government's own public utility, or those whose goal is to meet the current and ongoing collective needs of the local community through the provision of accessible services [3].

In particular, municipal includes a public service with technical nature. They consist mainly of [3-5]:

- residents in the water supply and sanitation (water and sewer)

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\*e-mail: aulfik@gmail.com

\*\* e-mail: nowakstef@gmail.com

- supply of electricity, heat and gas (electricity, heat and gas)
- treatment of urban and waste management
- local public transport (public transport)
- maintenance of roads
- maintenance of cemeteries
- management of municipal buildings
- management of urban greenery.

Among the tasks of the municipality, we also noted tasks that do not have a technical character, and their fulfillment is also clear from the valid legislation. Stressed here to ensure, *inter alia*, [4-6]:

- health services
- social assistance in centers and institutional care
- education
- culture, including municipal libraries and other institutions to disseminate culture
- physical education and recreation, including maintenance, facilities, and recreational areas.

The provision of municipal services are often associated with dilemmas of an economic nature. Municipalities are at the same time as the founding body, the municipal entity (often the only owner), on the other hand are representatives of the local community. Very often there are significant differences between the needs of the public and the requirement for cost-effectiveness of microeconomic entities providing these services [7]. The possibility of a conflict of objectives between municipal bodies and the municipality becomes particularly evident if we assume that the objective function of the former is profit and to others – meeting the needs of the local community [8].

Therefore, local authorities specifying the objective function in the area of public services, must decide on the superiority of economic and market functions or social functions. The decision in favor of social services may require subsidies for services from the municipal budget [8]. These relationships perfectly illustrate the difficulties facing the implementation of sustainable development, in this case in the context of municipal management.

An additional condition is the fact that the activities of the municipality are dominated by the prospect of ongoing activities or long-term actions – aimed at long-term growth and development of requested standards of service and technical progress [8]. In the other case, the model should be implemented in the organization and development of municipal services, taking into account the relevant mechanisms of the market economy.

In the case of municipal waste management the issue is relatively complex. Waste is generated by people of all communities, and under the laws, a community must provide the necessary waste management. These tasks were previously partially realized in the form of business communities and private companies. In the case of state-owned companies, full supervision of the management board of directors is acting on behalf of the owner. Composition of the supervisory board is governed by municipal enterprises to ensure, among others, a place on the supervisory boards for representatives of company employees [9].

Contacting the municipal and private enterprises caused problems arising from the different setting business objectives. The purpose of business is to secure the needs of urban residents, even at the cost of subsidies from the municipal budget. The purpose of private companies is to achieve maximum profit. The market for municipal waste is often abused and prohibited practices mainly related to the lack of adequacy of income to the cost of what the activity is associated with. Waste management in accordance with the legislation in force is extremely expensive and requires large, often long-term investment in infrastructure. For these reasons and because of the laws of the European Union, Poland has introduced a new way of managing waste.

### New Law Regulations Related to Waste Management

From 1 January 2012, the Act of 1 July 2011 amending the act on maintaining cleanliness and order in the communities [1] amended the current law of 13 September 1996 on maintaining cleanliness and order in the communities [10]. These changes were intended to bring Polish legislation up to the European standards of municipal waste management.

The EU directives on waste (among others, [11]) are priority measures to prevent waste and all activities associated with the management of already established and the recovery of waste materials, re-use, recovery, or other means to allow the recovery of recyclable materials. In addition, a huge emphasis is placed on the use of waste as non-conventional energy sources. The definition of recycling has been changed to include both recycling technologies: traditional – mechanical recycling, and new – recycling raw materials. The concept of recovery is now understood as each operation, whose main goal is to use waste to replace other materials that would be used to fulfill a specific function.

Under the amended legislation from 1 January 2012, all communities in Poland have one and a half years to adapt to the new rules. The most significant is the fact that under the new law, the municipality is obliged to collect waste and to properly manage all municipal waste. Citizens will no longer enter into contracts with individual companies for garbage collection, but they will pay waste disposing fees as determined by the municipality. Garbage from residents will receive the company selected by the municipality by tendering procedure. These changes will make wild landfills disappear because no one will profit due to the pressure of making the payment obligation waste disposal fee and municipalities to disposal regardless of their number.

Municipalities also will be required to allow residents to segregate waste. Separate collection of waste requires municipalities to put in suitable containers that will prompt ecological behavior. The recovery of secondary raw materials for municipalities can provide additional savings in terms of reduced waste disposal costs.

Introduced changes also require a community to build and maintain a system of recycling and waste disposal. In the case of municipalities that do not have such systems, it

is impossible to fulfill statutory duties independently. Therefore, after the adoption by the province, parliaments update provincial waste management plans and resolutions on the implementation of the regional waste management plan, municipalities can sign an agreement with each other. Provincial plans define the regions and regional systems for waste management that will indicate the place where waste will be processed and stored.

By 1 January 2013 the community had time to adopt local regulations to maintain cleanliness and order in their areas. By this date should be set fees and how they are incurred. Since that time should also begin educational and information campaigns for residents, the new rules take into account the waste in individual municipalities. From 1 July 2013, Poland will join the European standard on waste.

New solutions bring the responsibility of municipalities for waste from around the community and of every citizen. This will lead to the natural extinction of wild dumps and thus promote cleanliness and order. In addition, the possibility of separating waste will reduce the cost of further waste management and will promote pro-environmental behavior. Such a functioning waste management system fits in perfectly with the idea of sustainable regional development.

### The Impact of Landfills on the Environment and Nearby Residents

Waste, especially unsecured and improperly stored, can pose a threat to the environment and to human health, particularly as a result of direct contact with their constituents or through contaminated environmental media. The impact of landfills on population health in their environment can occur through exposure to chemical and microbiological contaminants in air, water, and soil. Many of these impurities are combined in the food chain, which in some cases may cause exposure to food products. Additional risk for a sanitary nature resulting from the presence of a large number of birds, rodents, and insects, especially where operating disordered sites. Additional problems also create waste transport itself, causing air pollution, noise, and the ability to spread dirt on the wheels of landfill vehicles not equipped with a device for cleaning the wheels. In addition, there is also a nuisance odor.

The scale of the impact of landfills on nearby residents depends on many factors. First of all, it is important to determine the type of storage, the condition and quality of life, and the composition of the waste collected.

The landfill can affect the composition of the groundwater and surface water. The biggest role played here is tightness of storage and an effective drainage effluent. The effluent typically includes mineral (ammonia, sulfur, nitrogen), the organics and micro-organisms such as viruses, bacteria, and fungi. In the case of contact with such effluent from the groundwater, it is possible microbial contamination, among others. The most dangerous thing is if you are using the site in the immediate vicinity of the active wells. The deterioration may also be subject to surface water.

In the case of the impact of landfills to the atmosphere, the most important is chemical contamination dust, landfill gas emissions), and fungal and bacterial bioaerosol, which are a source of nuisance odor. The research shows that dust, odor, and noise have a range of several hundred meters, up to 2 km. In the case of a residence in the proximal neighborhood, it can be subject to microbiological contaminants (bacteria and fungi) that are present in the biodegradation of organic wastes. Another danger is derived pyrolysis and decomposition of products: hydrocarbons, carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, hydrogen chloride, fluorine compounds, dioxins, and others.

Soil contamination can be caused mainly by migration of toxic substances from the landfill, transmitted by air and by water pollution. Especially dangerous to human health is soil contamination by heavy metals such as lead, cadmium, and mercury.

Assessment of the impact of landfills on the health of residents surrounding the site is complex and requires careful analysis. Health effects of exposure to pollution of the body can be divided into:

- Functional or structural changes of DNA (damage as a result of the substance geotoxic, changes in liver enzymes as a result of organic solvents, kidney problems as a result of exposure to cadmium, disorders and neurological disease in persons exposed to lead)
- Prevalence (deficits in intellectual development of children exposed to lead, the incidence of congenital malformations associated with exposure to pesticide and overall birth defects and reproductive problems, select cancers, immune disorders, liver problems, kidney problems, respiratory dysfunction, and neurological disorders),
- mortality
- reduced quality of life

In 2009 a study was carried out on the impact assessment of the largest landfill in Europe on the health of residents living near. Sobuczyna landfill, located about 10 km from Czestochowa. The research was carried out and developed by the Institute of Occupational Medicine and Environmental Health in Sosnowiec. The landfill in Sobuczyna was founded in 1983 and is a landfill for non-hazardous and inert waste.

The study involved 632 adults above 18 years of age, including 399 women and 233 men. The average age was 49 years. The average distance of residence from the site was 3 km. Most people in the study population lived above 2,500 m. 11% of the respondents reported on-farm deaths of animals for unknown reasons was increased number of rodents in the past five years reported by 47%. The subjects complained of headache (56.8%), tingling and numbness in the extremities (48.4%), and burning and itching eyes (44%).

There were no deviations from the standards adopted for the general population for blood cell count. In the case of blood chemistry, abnormalities were found in 19.3% in relation to blood glucose levels.

For toxicological studies, the analysis showed:

- In the case of lead exceeded what is considered a benchmark in 3 patients

- Excess mercury in 3 patients
- Cadmium exceeded what is considered a benchmark in 287 people.

In the case of cadmium, the majority of exceedances related to a mild increase above normal. In only 9 patients was there a significant increase in the level of cadmium above normal. It is also observed that elevated levels of cadmium were found in smokers; a statistically significant relationship was found at the level of  $p < 0.0001$ .

Respondents reported headache, dizziness, and burning and itching of the eyes. 47% of respondents assessed their health as good. Deviations from the norm in toxicological concern individual cases of context of lead and mercury. The level of cadmium in urine was elevated slightly, but for the entire population was less than in the study of literature with other Polish regions and the world [12]. There was no correlation between the distance of residence from landfills and cadmium levels in urine. There was found a correlation in the case of smoking.

### Economic Assessment of the Waste Management System

As a result of the introduction of new laws and regulations, the rules of waste management in the areas of municipalities have changed. New regulations have introduced a number of mandatory responsibilities. The first duty is to extend the system of waste management of all residential properties with effect from 1 July 2013, the second mandatory obligation is an obligation separating collection divided into at least the following waste fractions:

- paper
- glass
- metal
- plastics
- composite packaging
- biodegradable waste

Another mandatory obligation introduced by the new legislation is the creation of separate waste collection points. The last is to achieve appropriate levels of recycling in each year and reduce the weight of biodegradable waste transferred for disposal. The legislation gives municipalities the possibility. Optional: enter into a scheme of all non-resident property and to identify additional services provided by the municipality in waste collection and management. The waste management systems and waste fees are not included and the disposal of liquid waste and clean-up of mud, snow, ice, and other debris from sidewalks.

The limitations of the act [1] on recycling refers to the weight of waste generated in 1995. In the case of paper, metal, plastic, and glass, recycling necessitates at least 50% by weight by 31 December 2020. In the case of biodegradable waste, the amount transferred to storage is to be reduced to not more than 50% by weight by 16 July 2013 and to no more than 35% by weight of the total weight of biodegradable municipal waste landfill submitted by 16 July 2020.

These constraints are difficult to obtain without adequate waste management technologies. These technologies

are mainly used in the appropriate waste sorting and separation of waste at source. In addition to sorting, landfills must meet the following requirements; they must be tight and secure environments against the ingress of contaminants into the soil; they must be equipped with systems to discharge effluent, and the effluent must then be disposed of in an appropriate manner, thus reducing the harmful effects of the waste on the environment; and is vital to reduce landfill odor nuisance to residents living nearby.

Another possibility is to build a closed bioreactor technology, used for composting of biodegradable waste. It is essential to the recovery of biogas from landfills, although due to the decreasing amount of landfilled biodegradable, this does not always make economic sense. These solutions are commonly used in practice. There are a number of solutions rarely used, such as the method of waste incineration [13]. The use of such innovative solutions makes it possible to implement sustainable development [14]. Of all these solutions, the first is necessary to use a second associated with large financial outlays that from 1 July 2013 will have to be covered by the fees for collection and disposal of waste. A reasonable question becomes the method of estimating the costs and determine the real rate, which may cover the costs generated by the waste management system that meet all the requirements.

According to the legislation in the case of residential property, the fee for municipal waste management is a product of the rate and the base, and the base can be:

- the number of people living in a property
- the quantity of water used from the property
- the surface of a dwelling

The rate shall be adopted by the municipal council with a choice of methods for calculating charges.

Each of these methods of calculation of the fee for disposal of waste has advantages and disadvantages. In the case of dependence of the rate of charges on water consumption, many municipalities have found that consumption is well metered and there will not be great bother for the calculation of fees (in addition to households with their own wells). However, this would lead to a situation in which the highest charge that involved people living with high standards of hygiene. This would lead to massive water conservation. Although the global drinking water resources are very limited and is lacking many places in the world, in the case of Polish municipalities, such an argument is not always justified. Saving water due to the amount of water used to correlate to the waste disposal fees would significantly reduce the income of companies dealing with water supply and this would raise the price of water. In addition, reduce the amount of waste, but they contain the same litter. As a result, we would get more concentrated effluent. This solution is often to oblige wastewater treatment technologies used to change the treatment of the reasons for changing the morphology of the drain. These changes often need to be an expensive investment. Accordingly, waste disposal charged depends on the amount of water used, which would result in large changes in forcing the price structure of water and wastewater. In addition, a fee of waste, depending on the waste water, also

introduced doubt, where the water consumption is not related to the production of waste, such as car washing and filling of pools and ponds in the gardens. The fee depends on the amount of water used, and could be a convenient option for local governments due to the charging of fees in households connected to the water supply system. However, this would involve a lot of disruption.

The fee depends on how the residential area would introduce large disparities in the level of charges, not necessarily related to the actual amount of waste produced. Especially large disparities could arise in the case of differences with low headroom (cottages) and high (blocks). The living area is relatively easy to examine and will also charge for garbage, which would be easy to calculate. In this case, however, there would be no connection with the fee charged and the actual amount of waste produced as waste people generate rather than the surface on which they live. Such a solution would be unjust for those with a large footprint and extremely beneficial for families living in a small space.

Introducing the waste disposal fees per capita seems the most reasonable. Every inhabitant of the waste produced statistically close quantities, regardless of the surface on which he or she lives and which maintains hygiene. A problem arises, however, from verifying the actual number of local residents living within the municipality. Soon Poland will abolish compulsory registration, but already now many people do not reside at the place of their arrival. A perfect example are those studying outside their place of residence. Most municipalities that have opted for this solution have introduced declarations that declare the number of people living on a farm. In the case of dissolution dependence on waste fee on the amount of people, it is necessary to count on the integrity of the citizens and residents to declare the truthful amount.

Each of the solutions for waste disposal fee calculation has advantages and disadvantages, but charging numerous people seems the most logical economical and socially.

## Conclusions

Waste management is not only possible, but necessary. The changing legal regulations in Poland cause the need to change the approach of waste management. It is also a great opportunity to continue to give full effect to sustainable regional development in Poland.

In order to effectively manage waste management, it is necessary to take into account the economic aspect. Waste management systems should preserve adequacy of income and the costs generated by the system. This applies not only to covering the costs of waste collection and transport, but also to manage them in accordance with the EU standards. It is necessary to exercise supervision over the management of waste and the companies, as well as appropriate evaluation.

The impact of landfills on local residents and the environment can already be effectively mitigated, as demonstrated by studies conducted in a landfill in Sobuczyna.

Toxicological studies showed no significant deviations from the norm, with one exception – cadmium. This case, however, showed significant levels of cadmium compound in urine with cigarette smoking of the respondents. In addition to the clinical symptoms that reduce quality of life due to the increased amount of odor and rodents, no significant adverse changes in the landfill impact on the environment were determined. The research was carried out in 2009. After this time, the landfill has already been significantly upgraded. Gradually, quarter I was covered, sealed, and stored in the waste from the beginning of the landfill. Today it operates quarter II, which was used in the construction of the highest environmental standards, thereby reducing the negative impact of landfill on the environment.

Among the determinants that affect waste management, we should take into account the economic aspect. Due to changes in legislation, Poland will by 2020 significantly reduce the amount of landfilled waste – in the case of biodegradable waste up to 35% of 1995 levels. Costs of construction of modern waste treatment installations will have to be incurred from charges for disposal of waste from its own funds or municipalities. Therefore, it is essential to the proper selection method of calculation of the fee and precise quantification of the rates for the selected method. The experience of other countries that already implement such systems show that in the first year of the scheme, the amount of waste significantly increased. This may be due to the fact that people doing general housework are getting rid of unnecessary things, lingering in attics, basements, and backyards. This attitude stems from the need to receive from the people any amount of municipal waste that the propriety produces. The increased amount of waste is a burden on the entire system and must be taken into account.

All changes related to waste management lead to improve the situation in the context of sustainable regional development in Poland. These changes, however, require a different approach to waste management at every level of the system. It is crucial to separate waste at the source of manufacture, which further reduces the cost of waste management. All the changes will improve the quality of waste management and reduce the impact of waste on the environment.

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