
Cost Calculation of Waste Disposal Fees: Example of Polish Municipalities

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Abstract:

Purpose: The main purpose of the research was to identify the manner in which selected municipalities apply municipal waste-management calculations. Additional objectives entailed: establishment of a relationship between the cost accounting of waste-management fees applied and such municipality attributes as, the wealth of the municipality, calculated as the budgetary income per capita; the number of inhabitants; the number of the people in the municipal local government who deal with waste management; establishment of the share of municipal waste-management fees in the budget structure; analysis of the relationship between the level of waste segregation obtained and the amount of the fee for segregated and unsorted waste, in the municipalities under examination.

Design/Methodology/Approach: In order to achieve the objectives, the following research questions were formulated: RQ1: How do selected municipalities apply municipal waste management calculations? RQ2: What are the relationships between the cost account of waste management fees and selected attributes of the municipality (number of inhabitants, budget revenues). A qualitative approach based on the methodology characteristic of the case study was used to obtain the answers.

Findings: Based on the municipalities examined, it has been observed that municipalities use various methods to calculate the fees for municipal waste management and they apply various, different rates. The presented results derive from the unique and individual nature of each municipality. The multi-faceted diversity of municipalities prevents the creation of one, best municipal waste-management system. Selection of a system for a specific local unit should be optimized in accordance with the regional economic, ecological and social criteria. A correctly calculated municipal waste-management fee must be bona fide and insightful. It should also cover the costs associated with this process and ensure self-balancing of the entire system. In this context, it is necessary to continue the research enabling formulation of the criteria shaping appropriate cost accounting since the analysis of the source data did not show any significant relationships between the examined attributes of the municipality and the method of calculating the costs of waste management adopted by it. Thus, it was possible to obtain a clear answer to RQ2 – this requires more in-depth research.

Practical implications: The research indicates the legitimacy of conducting research on strategies and the practice of calculating waste management costs implemented by municipalities. This will allow to indicate the right directions for modifying the system of accounting for these costs. Also, it is worth paying attention to the microeconomic context of research on the calculation of waste management costs - application of cost accounting

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taking into account the possibility of calculating unit costs of waste acceptance services or recovered raw materials

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1. Introduction

The basis for the development of civilization and the proper functioning of the natural environment is the concept of "sustainable development". It is one of the basic principles of the ecological policy of the European Union. These principles also include a high level of environmental protection, prevention and prevention of pollution and its elimination at source, covering the costs of eliminating damage by its perpetrators - "the polluter pays" (*Gospodarka odpadami w przedsiębiorstwie...*,).

The idea of "sustainable development" includes solutions aimed at protecting the development of: society, nature and economy. It counteracts processes harmful to the environment and human health and promotes environmentally friendly methods of management (Skowroński, 2006).

An indispensable element accompanying human life is the generation of waste. Along with the development of civilization, the amount of waste, as well as its structure, is increasing. Unfortunately, more and more waste with a complex structure and difficult to decompose is being created. Improper management of municipal waste poses a serious danger and threat to the natural environment. Waste management is one of the most important areas of environmental protection and human health. Waste has a degrading effect on the environment, which is why it is one of the greatest threats to the surface of the earth.

However, through appropriate management, its excessive generation can be prevented, it can be neutralized and reused. Upon accession to the European Union, Poland declared itself to organize waste management, in particular to: reduce to a minimum the amount of municipal waste stored and limit the share of biodegradable waste in it in subsequent time intervals. The principles of sustainable development force countries to implement ecological policies, which must be implemented by local governments, e.g., through waste management. Its task is to create systems that will safely eliminate or neutralize the waste produced.

According to legal regulations, any substance or item that the owner disposes of, intends to dispose of or is obliged to dispose of is treated as municipal waste. In turn, municipal waste includes waste generated in households (except for end-of-life

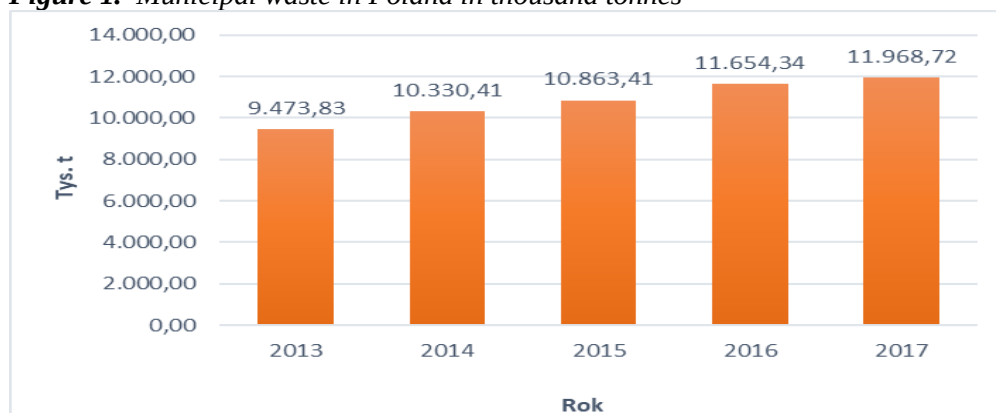
vehicles) and waste similar to waste generated in households, not containing hazardous waste from other waste producers. (Ustawa z 14 grudnia, 2012...).

In turn, the concept of waste management according to the aforementioned act is understood as the collection, transport, processing of waste, including supervision of such activities, as well as subsequent handling of waste disposal sites and activities performed as a waste seller or intermediary in waste turnover. The amount and morphological composition of municipal waste is influenced by many factors, including the place of its generation, the wealth of society and the related level of consumption of products, as well as the seasons.

The amount of municipal waste collected per capita per year is strongly correlated with the economic condition of individual regions. The type of area (city, village), population density, type of development (single-family, multi-family), number of tourists, presence of public utility facilities and many other factors affect the type and amount of waste generated. Poland experiences typical problems related to waste management: underfunding, high costs of organizing waste collection, problems with the location of landfills, increase in the amount of waste as a result of the wealth of society.

In 2020, a total of 144 million tons of waste was generated in Poland, 14 million tons (8%) were municipal waste. The generation of 128 million tons of non-municipal waste means a 2% decrease compared to 2019. The main source of waste was mining and quarrying (52%), industrial processing (21%) and electricity generation and supply (16%). In the last decade, the largest share in the generated waste was waste generated during the exploration, extraction, physical and chemical processing of ores and other minerals (56%) and waste from thermal processes (22%). In total, 49% of the waste generated in 2019 was recovered, 42% - disposed of by landfilling, 4% - disposed of in another way (GUS, 2021).

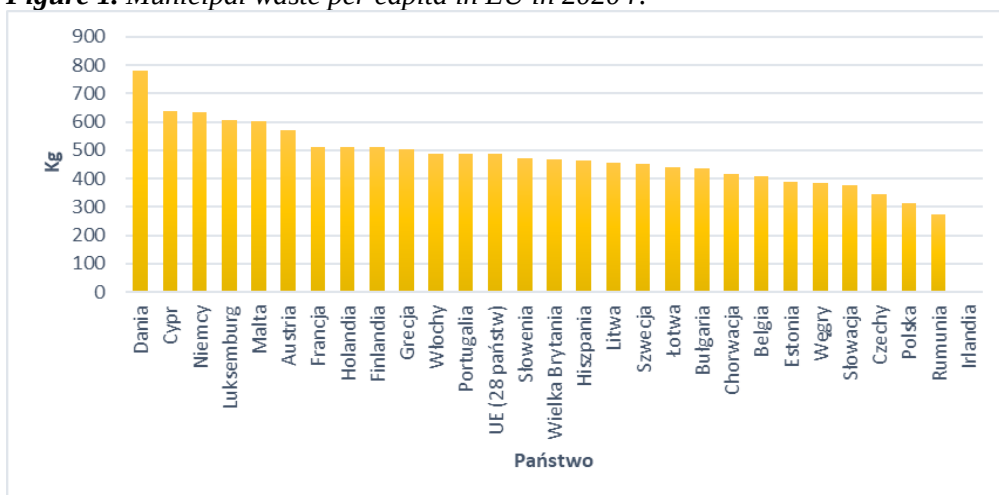
Figure 1. Municipal waste in Poland in thousand tonnes



Source: Own study based on the Local Data Bank (<https://bdl.stat.gov.pl/BDL/dane/podgrup/tablica>).

The presented Figure 1 shows the amount of municipal waste collected in Poland over the years 2013-2017. The breakthrough value of over 10 thousand tons of collected municipal waste was achieved in 2014, in the same year the highest increase was also recorded, compared to the previous year, in the amount of 857 tons. In 2017, the increase in the amount of municipal waste reached a value of less than 3% compared to 2016.

Figure 1. Municipal waste per capita in EU in 2020 r.



Source: Own study based on Eurostat data,

https://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=cei_pc031

Analysing the above Figure 2 it can be seen that in 2020 Poland achieved one of the lowest rates of municipal waste generation per capita in the European Union at 315 kg. The highest value was recorded in Denmark - 781 kg, the EU average is 486 kg, and the lowest result belongs to Romania - 272 kg per capita. Both the researchers and the practitioners dealing with waste management agree that the primary orientation of State policy, with regard to waste management, entails the principle of sustainable development and an integrated approach to environmental protection, taking into account the responsibility of all entities participating in this system.

The overarching goal, however, is to prevent generation of waste, first and foremost "at the root", raw material recovery, reuse of waste, and environmentally-safe disposal of unused waste. These objectives should be achieved through: reduction of material and energy consumption in production (using clean technologies), use of alternative, renewable energy sources, use of a full Product Life Cycle Analysis (design - production - transport - packaging - use - reuse - disposal), an appropriate system of financial settlement, which, in an optimal manner, determines the method of financing utilization and recycling

An essential element of an efficiently functioning waste management system is the selective collection of waste through its segregation. Another important condition for proper waste management is its recycling, understood as the reprocessing of substances or materials contained in waste in order to obtain substances or materials that can be reused. (*Gospodarka odpadami w pigułce, czyli o postępowaniu odpadami w twoim domu*, 2010).

In turn, waste recovery is carried out primarily through: reuse - the waste is directed to use in its original form and for the same purpose after possible cleaning, disinfection and other operations restoring its utility value, transformation, i.e., changing the material of the component during processing into a new product (composting, fermentation) and recovery - the material constituting a given waste component is used through pre-treatment and proper treatment, as a result of which the same material is obtained, but it may have a different form and serve a different purpose (Alwaeli, 2005).

It should be noted that both property owners and businesses are becoming increasingly aware of the benefits of recycling. This applies to both ecological and financial benefits. This is facilitated by increasing recycling standards and improving waste management standards, as well as improving the ecological awareness of entities generating waste. The implementation of the above objectives is to be facilitated by proper waste management enabling its reprocessing. The basic guidelines for waste management are included in the EU's 2020 Environmental Action Programme "Good quality of life within the limits of our planet" (Decision of the European Parliament, 2013).

The main guideline for proper waste management should be "protection of the environment and human health by preventing or reducing the negative impact of waste generation and management, and by reducing the overall impact of resource use and improving the efficiency of such use by applying the following hierarchy of waste management methods: prevention, preparation for reuse, recycling, other recovery methods and disposal". At the same time, recycling must be of the highest possible quality if the use of recycled material does not lead to overall negative effects on the environment or human health.

In turn, according to the Waste Act (Ustawa z 14 grudnia, 2012), waste management should be conducted in such a way as to ensure the protection of human life and health and the environment. First of all, waste management must not pose a threat to water, air, soil, plants, animals, or create a nuisance through noise or smell, or cause adverse effects on rural areas or places of special cultural and natural importance. The above act introduces the so-called proximity principle: the polluter pays and extended producer responsibility. According to the proximity principle, waste should be processed at the place where it is generated. If it cannot be processed at the place where it is generated, it should be transferred to the nearest place where it can be processed (Jerzmański, 2010).

The polluter pays principle means that all costs related to the elimination of pollution should be borne by the polluter, i.e. the entity that caused damage to the environment. The principle of extended producer responsibility means that each company is responsible for both production waste and waste generated after the end of use of its product. This rule influences the product design stage and helps to minimize the amount of waste generated.

In order to implement the above-mentioned tasks within the national "Waste Management Plan" (Uchwała Rady Ministrów, 2016), waste was classified taking into account the specificity of waste generated in Poland, especially in the scope of municipal, hazardous, packaging waste and in the marine environment (Table 1).

Table 1. Classification of waste according to the Waste Management Plan. It concerns waste groups distinguished by the Regulation of the Minister of Environment on the waste catalogue (Rozporządzenie z 9 grudnia 2014).

Lp.	Basic groups	Subgroups
1	Municipal waste, including food waste and other biodegradable waste	
2	Waste generated from products	Waste oils. Used batteries and accumulators. Used electrical and electronic equipment. End-of-life vehicles, used tires, packaging and packaging waste
3	Hazardous waste	Medical and veterinary waste. Waste containing polychlorinated biphenyls Waste containing asbestos. Graveyards
4	Other waste	Waste from construction, renovation and dismantling of buildings and road infrastructure. Municipal sewage waste. Biodegradable waste other than municipal waste. Waste from selected branches of the economy, the management of which poses problems; - from group 01* – waste generated during the exploration, extraction, physical and chemical processing of ores and other minerals; - from group 06 – waste from the production and preparation, trade and use of inorganic chemical industry products - from group 10 – waste from thermal processes Waste in the marine environment

Source: own study

In turn, in accordance with the Regulation of the Minister of the Environment on the waste catalogue (Rozporządzenie, 2014) They are divided into 20 basic groups depending on their source. Group 20 consists of municipal waste, including fractions collected selectively, which include:

- 1) waste from chimney cleaning,

- 2) plant protection products,
- 3) waste from gardens and parks,
- 4) biodegradable waste,
- 5) soil and earth and stones,
- 6) waste from marketplaces,
- 7) waste from cleaning streets and squares,
- 8) waste from sewage manholes,
- 9) bulky waste.

Municipal waste can also be divided into (Toruński, 2010) due to its composition, properties and degree of harmfulness:

- 1) household waste,
- 2) bulky waste (e.g. household appliances, furniture, car bodies),
- 3) street waste collected continuously and seasonally,
- 4) waste from green areas and others,
- 5) debris from renovations and demolitions of houses and other construction works,
- 6) waste from municipal infrastructure facilities.

In order to achieve EU standards in waste management, a waste management hierarchy was established, distinguishing the following priorities:

- a) prevention,
- b) preparation for reuse,
- c) recycling,
- d) other recovery methods (e.g. energy recovery),
- e) disposal, including storage.

In accordance with the strategy "Energy Security and the Environment - a perspective to 2020", the most important actions to reduce the negative impact of waste on the environment include: (Uchwała Rady Ministrów, 2014):

- 1) improving the functioning of the selective municipal waste collection system,
- 2) reducing the number of non-selective, local landfills for waste other than hazardous and neutral,
- 3) implementing and supporting low-waste production technologies and economically and ecologically effective recovery and disposal technologies, including thermal waste treatment.

Waste management, i.e.. collection, transport, recovery, disposal, storage and final disposal of waste should be carried out in the least harmful way possible, i.e. in accordance with the principles of sustainable development.

In order to improve waste management, the Minister of the Environment issued a regulation on the detailed method of selective collection of selected waste fractions (Rozporządzenie Ministra Środowiska, 2016). The above regulations are to contribute to increasing the level of municipal waste collected selectively, unifying the principles of selective waste collection, increasing the share of funds from European funds for investments in waste management, which requires Poland to meet the recycling levels specified in EU regulations and preparation for reuse: paper, metals, plastics and glass (Draniewicz, 2017). This will require the division of waste into fractions, which are described in detail in Table 2.

Table 2. *Division of waste into fractions*

Type of fraction	Kolor pojemnika	content
Paper	Blue	Paper, cardboard, paper and cardboard packaging waste
Glass	Green	Glass, glass packaging waste
Coloured glass	Green	Coloured glass
Clear glass	White	Clear glass
Metals and plastics	Yellow	Metals, plastics, metal and plastic packaging waste and multi-material waste
Bio	Brown	Biodegradable waste, bio-waste.

Source: *Based on the Regulation of the Minister of the Environment of 29 December 2016.*

According to the guidelines of the European Union (Bourguignon, 2018), many waste processing methods cause many adverse effects. These include primarily:

- 1) their negative impact on the environment (especially on ecosystems);
- 2) landfills can be contaminated, depending on the method of their construction, with chemicals contained in the waste;
- 3) littering can have serious consequences for wildlife, especially through the ingestion of microplastics;
- 4) if waste is not recycled or recovered, the raw materials extracted and processed products are lost;
- 5) they affect the climate, because landfills release methane, a strong greenhouse gas;
- 6) the impact on human health, which is primarily related to storage, which causes the release of air pollutants into the atmosphere and possible contamination of freshwater sources and agricultural soils;
- 7) affects the economy through the loss of valuable materials.

As noted by A. Kosieradzka-Federczyk (2013), it is necessary to strive for increasingly better technologies and reuse of waste materials. This should be

supported by the optimization of waste collection and segregation systems, as well as by reducing recycling costs and creating markets for secondary raw materials. A. Pires and G. Martinho (2019) believe that waste management principles should be modified, as the current guidelines within the European Union only measure recycling, incineration and landfilling of waste, omitting the measurement of the implementation of the waste hierarchy principle.

For this purpose, they introduced a waste hierarchy index (WHI) to measure the waste hierarchy in the context of a circular economy, in relation to municipal waste. When developing the WHI, recycling and preparation for reuse, as defined by Eurostat, were considered positive factors contributing to a circular economy, while incineration and landfilling of waste were considered negative factors. According to the authors, the WHI is a direct and concise indicator that provides a comprehensive perspective of waste management and makes waste management statistics more realistic.

2. Calculation of Waste Disposal Fees – Literature Review

Among the great variety of services offered by local authorities, that of municipal solid waste (MSW) collection and disposal is one of the most widely studied, due to the complexity of its provision, the significant cost involved and increasing environmental concerns in this respect (Bel *et al.*, 2010; Jacobsen *et al.*, 2013).

Studies show that development of an appropriate system of waste-management financing is not easy, because such systems are expected to: cover the costs of recycling and utilization; influence such behavior of people, that would cause reduction of the amount of waste in general, particularly, the behavior considered as hazardous; not overburden the household and business budgets; not cause disturbances in economic processes, for example, by adversely affecting the competitiveness of enterprises; be as simple as possible, so that the voters are able to understand the system.

These postulates are difficult to meet, because they are largely adversative. The researchers dealing with the role of cost accounting in solid-waste management systems indicate the local nature of the conditions in which the fees for waste management are calculated (Huang *et al.*, 2011, Jacobsen *et al.*, 2012,).

Authors of many studies emphasize that the solutions adopted and used in one country or region do not have to work in others. Some research findings even point to the fact that certain solutions in the area of solid-waste management, including cost accounting, can be used under strict conditions only, determined by such national and regional factors as, for example: regulations, peoples' habits, environmental awareness, officials' qualifications (Bebbington, 2001).

In recent years, many studies have been carried out to analyse the costs of the Ministry of the Internal Affairs management, in different countries, and various methods and

tools for measuring the financial results of collection, transportation and disposal processes have been proposed (Pires *et al.*, 2011).

These methods include various tools used in managerial accounting (Mendes *et al.*, 2013). In the United States, the early experience of adopting the Full Cost Accounting (FCA) method dates back to the eighties. Given the benefits this method offers, the US Environmental Protection Agency has been promoting the use of FCA since the mid-1990s, to support local authorities in the development of the Ministerial programs, assurance of effective cost reporting for citizens, and adoption of a pay-as-you-throw system. Following this, other countries have also begun constructing their versions of the FCA system (Karagiannidis *et al.*, 2008).

3. Research Methodology

In Poland, a waste management model has been functioning, which assumes that municipalities play the main role in it. They are responsible for the organization and maintenance of the waste collection and treatment system.

In principle, this system is to be financed by the fees collected from the waste producers - both enterprises and households.

The obligation to impose compulsory waste-management fees on citizens and collect these fees has been assigned to local-government authorities - both the executive and the legislative ones. Since these authorities operate under conditions of fierce electoral competition, a dilemma arises - how to construct the level of waste-management fees to win voter acceptance and, at the same time, obtain an appropriate level of cost coverage. The main purpose of the research was to identify the manner in which selected municipalities apply municipal waste-management calculations.

Additional objectives entailed: establishment of a relationship between the cost accounting of waste-management fees applied and such municipality attributes as: the wealth of the municipality, calculated as the budgetary income per capita; the number of inhabitants; the number of the people in the municipal local government who deal with waste management; establishment of the share of municipal waste-management fees in the budget structure; analysis of the relationship between the level of waste segregation obtained and the amount of the fee for segregated and unsorted waste, in the municipalities under examination.

Thus, the following research questions can be formulated:

- *RQ1: How do selected municipalities apply calculations for municipal waste management?*
- *RQ2: What are the relationships between the cost calculation of waste management fees and selected municipal attributes (number of inhabitants, budget revenues)?*

A qualitative approach based on the methodology characteristic of a case study with the following features was used to obtain the answers (Yin, 2014):

- number of cases: 3
- selection of cases: city of Gdańsk, Sopot, Gdynia
- selection data for analysis: internal and external reports related to the waste management.

4. Results

In the empirical part, the research object was three neighboring municipalities – Gdańsk, Sopot and Gdynia, located in northern Poland on the Bay of Gdańsk. Due to the proximity of the municipalities and the fact that they form a conurbation called the Tri-City, they were selected for analyses related to the municipal waste management system.

Table 3. Demographic data of the cities included in the Tricity for 2022

City	Population [persons] Area [km ²] Population density [persons/km ²]	Population [persons] Area [km ²] Population density [persons/km ²]	Population [persons] Area [km ²] Population density [persons/km ²]
Gdańsk	464 254	262	1772
Gdynia	246 306	135	1823
Sopot	36 533	17	2114
Tri-City	747 093	414	1805

Source: Own study based on Area and population in territorial cross-section in 2022, GUS.

Table 3 presents data for the Tri-City illustrating the number of inhabitants, area and population density. Gdańsk, in this comparison, occupies the largest area and is the most populated city, and is therefore also the seat of the authorities of the Pomeranian Voivodeship. Sopot has the highest population density, while Gdynia is almost twice smaller than Gdańsk. In total, the Tri-City conurbation is inhabited by 747 thousand inhabitants, and the area is 414 km².

After presenting data on the area and population in individual Tri-City cities, it is necessary to familiarize oneself with data on waste collected in their area. Each city has a separate operator dealing with municipal waste management and has developed a different way of organizing and managing the waste management system.

Table 4. *Municipal waste collected in 2022 [in t]*

Territorial unit Total From households From other sources (municipal services, trade, small business, offices and institutions)	Territorial unit Total From households From other sources (municipal services, trade, small business, offices and institutions)	Territorial unit Total From households From other sources (municipal services, trade, small business, offices and institutions)	Territorial unit Total From households From other sources (municipal services, trade, small business, offices and institutions)
Gdańsk	189 325	139 409	49 916
Gdynia	92 940	75 883	17 057
Sopot	16 769	11 287	5 482
Tri-City	299 034	226 580	72 454

Source: Own study based on data from the Local Data Bank
(<https://bdl.stat.gov.pl/BDL/dane/podgrup/tablica>)

The data in Table 4 illustrate the amount of municipal waste collected in the cities that are part of the Tri-City in 2022. The total amount of waste collected is 299,034 t, where 226,580 t is waste from households, and the remaining part - 72,454 t - waste from other sources such as: municipal services, trade, small business, offices or institutions. Waste collected in Gdańsk constitutes 63% of waste collected in the entire Tri-City. The least total waste was generated in Sopot and the share of waste from other sources in total waste is the highest among the cities mentioned and amounts to 31%.

However, the main factor that motivates residents to segregate is the increasing fee paid to the commune for the lack of segregation. Currently, the fee for the lack of segregation can be a maximum of twice as high as the fee for segregation. In the future, this fee will be four times higher. The Gdańsk City Council has adopted a method for determining the fee for municipal waste management for individual owners, communities and cooperatives, according to which this fee is the product of the area of the residential premises and the fee rate, which is respectively:

- PLN 0.44/m² in the case of segregated waste in the part of the surface not exceeding 110 m²,
- PLN 0.88/m² in the case of unsegregated waste in the part of the surface not exceeding 110 m²
- PLN 0.05/m² in the case of segregated waste in the part of the surface exceeding 110 m²,
- PLN 0.10/m² in the case of unsegregated waste in the part of the surface exceeding 110 m².

The resolution of the Gdynia City Council specifies the fee rate for municipal waste management and it depends on the square footage of the household. If waste is collected selectively, the fee rates are as follows:

- 1) PLN 16 per household occupying a residential premises with an area not exceeding 45 m²,
- 2) PLN 26 per household occupying a residential premises with an area exceeding 45 m², but not exceeding 60 m²,
- 3) PLN 30 per household occupying a residential premises with an area exceeding 60 m², but not exceeding 80 m²,
- 4) PLN 37 per household occupying a residential premises with an area exceeding 80 m².

Residents who decide not to segregate waste will be charged a higher fee, which amounts to:

- 1) PLN 32 per household occupying a residential premises with an area not exceeding 45 m²,
- 2) PLN 52 per household occupying a residential premises with an area exceeding 45 m², but not exceeding 60 m²,
- 3) PLN 60 per household occupying a residential premises with an area exceeding 60 m², but not exceeding 80 m²,
- 4) PLN 74 per household occupying a residential premises with an area exceeding 80 m².

The resolution also specifies the rates for the disposal of containers with municipal waste collected on properties where no residents live, but municipal waste is generated. In Sopot, the City Council passed a resolution on the waste management fee, which depends on the amount of water used. The resolution adopted lower rates for property owners who collect waste selectively, the amount of the fee is:

- 1) PLN 14 per month – flat fee for each household on a given property,
 - 2) PLN 3.50 fee for 1 m³ of water used in the household, with the monthly water consumption per household reduced by 4 m³ each time,
 - 3) PLN 30 per month – flat fee for a household that is a large family.
- If waste in households is not collected selectively, the fees are as follows:
- a) PLN 21 per month – flat fee for each household on a given property,
 - b) PLN 5.25 fee for 1 m³ of water used in the household, with the monthly water consumption per household reduced by 4 m³ each time.

A large family is understood as a family residing in Sopot, including a foster family, consisting of parents or one parent supporting three or more children up to the age of 18 or 25 – in the case of continuing their education. Water consumption does not include the amount of water used irretrievably (including for watering green areas), the consumption of which is determined on the basis of an additional water meter.

Water consumption is calculated based on the average consumption based on settled readings for the last 12 months, accurate to one decimal place. Properties not connected to the water supply network provide average water consumption per

capita according to the regulation of the Minister of Infrastructure on determining average water consumption standards.

5. Conclusions

The main goal of implementing selective waste collection and recycling is to ensure that as little waste as possible ends up in landfills, while the waste that does end up there has no utility value and cannot be used as a raw material for another technological process. To this end, it is necessary to discipline residents to segregate waste "at source" to the greatest extent possible. This should be achieved primarily by increasing the ecological awareness of residents and, above all, creating an appropriate fee system that favors entities that segregate waste.

In order to reduce the amount of waste, society should use more ecological technologies, eco-designs or more ecologically efficient production and consumption systems. Waste prevention and recycling, focusing on material technology, can also reduce the impact of used resources on the environment by limiting the extraction of raw materials and their processing during production processes. (Statystyki dotyczące odpadów, 2015).

Based on the municipalities examined, it has been observed that municipalities use various methods to calculate the fees for municipal waste management and they apply various, different rates. The presented results derive from the unique and individual nature of each municipality. The multi-faceted diversity of municipalities prevents the creation of one, best municipal waste-management system. Selection of a system for a specific local unit should be optimized in accordance with the regional economic, ecological and social criteria.

A correctly calculated municipal waste-management fee must be bona fide and insightful. It should also cover the costs associated with this process and ensure self-balancing of the entire system. In this context, it is necessary to continue the research enabling formulation of the criteria shaping appropriate cost accounting since the analysis of the source data did not show any significant relationships between the examined attributes of the municipality and the method of calculating the costs of waste management adopted by it.

Thus, it was possible to obtain a clear answer to RQ2 – this requires more in-depth research. On the other hand, the verification of RQ1 leads to the following conclusions:

- 1) municipalities use different accounts to calculate the cost of waste-management fees;
- 2) only in one case, application of full cost accounting was found, the remaining calculations were of a statistical, simplified nature;

- 3) there is no single standard combining the cost accounting system with the attributes of a given municipality - the study did not provide an answer to the question of whether the municipality attributes defined affect the quality of the cost accounting of waste-management fees;
- 4) no direct relationship between the amount of the fee for waste management and the level of segregation and recycling achieved has been demonstrated;
- 5) large variety of fees for the fees in individual municipalities has been noted;
- 6) selected municipalities achieved very good recycling results, in some cases at the level of 90%;
- 7) over the years under examination, the amount of the source materials collected per capita increased.

It is worth paying attention to the microeconomic context of research on the calculation of waste management costs - application of cost accounting taking into account the possibility of calculating unit costs of waste acceptance services or recovered raw materials can be an important element of waste management facilities (Kowalak, 2024).

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