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## Municipal waste market in Poland - analysis of the type of collected waste and liquid waste

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### ABSTRACT

The subject of the following study is the municipal waste market in Poland. The theoretical part of the study provides an overview of the definition of waste, as well as listing its types. In the empirical part, an analysis of the type of municipal waste and liquid waste was carried out.

**Keywords:** municipal waste, waste management, rainfall market in Poland, liquid waste

### 1. INTRODUCTION

Waste management is one of the particularly important areas of environmental protection. Its activities are related to the prevention of waste generation, reduction of its quantity, disposal and processing as well as storage. Waste is an integral part of the economic and living activities of man, but their management is a big problem and challenge. It is therefore necessary to limit damage to the environment arising during the waste flow process. The need for proper waste management is mainly due to the need to save natural resources. Waste management, and in particular municipal waste, is of interest not only to central authorities, but above all to local governments. In management of both public and private institutions one can distinguish processes related to environmental management. Their purpose is to organize waste flows in the most efficient way.

Climate change and depleting natural resources, as well as the desire to secure a space where negative environmental factors affect human life as little as possible have become a global challenge, the main assumption of which is to reduce waste and manage it effectively on a global scale. This applies to all countries, regardless of their level of development. They often have to undergo a transformation of the waste management process and transform the conventional waste management scheme into a system that takes into account the use of new technologies [1].

Waste management is a big problem and challenge of modern economies, both on a global and local scale. Therefore, it is necessary to minimize environmental damage during waste flow. Appropriate waste management assumes saving natural resources, minimizing the amount of waste as well as reducing the space intended for their disposal and storage. The waste management system is an important element of the country's environmental policy. A systematic approach to its operation is necessary to increase the efficiency of operations, which is why waste management companies are increasingly using specialized IT systems that support their activities.

The commune's own tasks involve the implementation of projects related to satisfying the current needs of residents. Their catalog is wide, and one of them is conducting municipal waste management. Therefore, the commune is responsible for municipal waste management and it should provide conditions for its proper management. Waste management is defined as "all projects, activities or procedures related to the avoidance and reduction of waste generation, its disposal and utilization as well as recovery of secondary raw materials and their subsequent reuse. Waste management consists in the collection, transport, recovery and disposal of waste, supervision of these activities and their disposal. Municipalities can adopt different models of waste collection organization solutions that result from their specificity [2].

In recent years, the problem of municipal waste is one of the most frequently discussed environmental issues. This issue is a great challenge for both local authorities and consumers themselves. The consumer plays a particularly important role in the waste management system: on the one hand, his purchasing decisions and subsequent decisions regarding the handling of post-consumer residues are important for the quantity and quality composition of generated waste, on the other hand the consumer is the recipient of services, and therefore his satisfaction is important from the level of services and prices offered on the market. Waste, regardless of its type, is a serious problem of both ecological and economic nature. The main place of municipal waste generation are inhabited areas, for which a particularly important aspect is the development of a proper waste management system, which consists of [3]:

- collection by type,
- removal,
- transport from the place of origin to the place of disposal,
- neutralization

In Poland, until recently, the most common method of waste disposal was landfilling, which contradicts the principle of disposing of as little of it as possible to landfills. In economically developed countries, most of the waste is transferred for reuse. Restrictive compliance with laws and regulations enables a significant increase in the amount of waste sent for recycling and creation of legal and economic foundations for the development of the waste collection and management system. Currently, the overarching goal of the state's policy in the field of waste management is to prevent its generation at source, therefore, year by year, due to

appropriate legal regulations, the amount of waste, not only industrial, deposited in landfills or landfills is reduced. These wastes are beginning to be used again in technological processes, as well as more widely used in road construction and in the production of building and other materials.

Municipal waste is the commune's own tasks, and its obligations in this respect are governed by the Act of 13 September 1996 on maintaining cleanliness and order in communes, which has been amended several times. The effect of frequent changes in the Act is the constantly expanding catalog of tasks of local authorities related primarily to waste management. The commune is responsible for organizing and covering all residents of the commune with a municipal waste collection system that will ensure the collection of all types of waste (biodegradable, paper, glass, plastic, hazardous waste, bulky, demolition). To this end, the municipality must regularly analyze the current state of waste management, the needs of residents in this area, the amount of waste generated, the state of infrastructure, and the costs of operating the system.

It is the commune's responsibility to choose (by tender) the enterprise or enterprises that, at its request, will collect waste from residents, plan a system of fees that will cover the costs of organizing services, as well as the development of the necessary infrastructure. In addition to administrative and legal instruments, consisting of a whole system of administrative decisions and other obligations imposed on entities involved in waste management, also important are economic instruments, which include various types of fees and subsidies for co-financing projects in the field of ordering or improving waste management [4].

The municipal waste processing market in Poland is facing the need to open to new technologies in the field of recovery and recycling of raw materials. The experience of previous years indicates that administrative restrictions in this area may constitute an obstacle to the growth of innovation in the economy and the implementation of obligations arising from Poland's membership in the European Union [5].

## **2. MUNICIPAL WASTE - CHARACTERISTICS AND TYPES**

Waste management covers a whole range of activities related to waste management, from their production to management through recovery of secondary raw materials to environmentally and human safe disposal. The issue of waste management due to their quantity, diverse composition and properties is highly complex and at the same time complicated. This is mainly due to two aspects closely related. The first concerns the increase in the mass of waste along with the increasing population, economic development, as well as the increase in the well-being of society. The second one is associated with the nuisance and threat of waste, especially dangerous for the environment, and thus for humans. Therefore, it is necessary to strive to establish detailed and precise legal and organizational rules for dealing with various types of waste, which should also translate into the practical application of these provisions [6].

The organization of municipal waste collection within the commune should ensure achieving appropriate levels of recycling, preparation for re-use and recovery by other methods, and gradual reduction of the mass of biodegradable waste going to landfills. The measure of waste management effectiveness can be the relation between the mass of waste subjected to the recovery process, because only in this way can its mass be reduced and used as a secondary raw material to the mass of waste subject to storage, which is considered the least effective method

of waste management. In this situation, it is even difficult to talk about their utilization, because it consists only of placing them in one place and lying on them for many years, and if it is implemented improperly, i.e. without appropriate safeguards, this waste is a threat to the environment and man [7].

In addition, the Constitution also introduces the principle of sustainable development that is superior to establishing environmental conditions. A process integrating political, economic and social activities while maintaining natural balance and durability of basic natural processes, in order to guarantee the possibility of satisfying the basic needs of individual communities or citizens of both the modern generation and future generations. Combining environmental, economic and social elements in sectoral policies is a necessary systemic requirement of the Polish state. Balancing economic development and social cohesion (including counteracting stratification, marginalization, discrimination) with rational management of environmental resources [8].

Municipal waste management is one of the commune's own tasks. This term covers a series of activities and activities aimed at the most safe handling of the municipal waste generated for the environment and the health and life of people and animals. They include, among others [9]:

- collection,
- transport,
- disposal,
- waste treatment.

Municipalities are required to provide residents with the possibility of selective collection of municipal waste covering at least the following waste fractions: paper, metal, plastic, glass, multi-material packaging and biodegradable waste. For other waste generated in households, such as: expired medicines, waste batteries, accumulators, electronic and electric equipment as well as tires, furniture and other bulky waste, construction and demolition waste, as well as other specified in the ordinances of the minister competent for environmental issues, municipalities must establish at least one stationary point for selective municipal waste collection .

Waste is classified by including it in the appropriate group, subgroup and type of waste, taking into account [10]:

- source of their generation,
- properties causing the waste to be hazardous waste, waste components for which exceeding the concentration limits of hazardous substances may cause that the waste is hazardous waste.

It is forbidden to change the classification of hazardous waste into non-hazardous waste by diluting or mixing it with each other, or with other waste, substances or materials, leading to a lowering of the initial concentration of hazardous substances to a level lower than the level specified for hazardous waste. Hazardous waste is waste indicated in the waste catalog. The waste holder may change the classification of hazardous waste into non-hazardous waste if it proves that it does not have properties that make the waste hazardous, and in the case of waste with infectious properties, also that they do not meet the conditions for recognizing waste as having infectious properties.

An object or substance arising as a result of a manufacturing process whose primary purpose is not their production may be considered a non-waste by-product if the following conditions are cumulatively met [11]:

- further use of the object or substance is certain,
- the object or substance may be used directly without further processing other than normal industrial practice
- the object or substance is produced as an integral part of the production process,
- a given substance or object meets all relevant requirements, including legal requirements, in the scope of the product, environmental protection and human life and health, for a specific use of these substances or objects and such use will not lead to general negative impacts on the environment, human life or health.

Waste is generated wherever there is any activity. Waste is a nuisance element released into the environment. The biggest threats are most often associated with improper waste management in all phases of its implementation, i.e. collection, storage and processing, including disposal. Most municipal waste is generated in residential areas. The amount and morphological composition of municipal waste depends on many factors, including [12]:

- the nature of housing estates,
- type and scope of economic activity in a given area,
- type of farm in the countryside (domestic, agricultural),
- wealth of residents,
- traditions and customs of the population,
- season.

Municipal waste includes waste generated in households, excluding end-of-life vehicles, as well as waste that does not contain hazardous waste from other waste producers, which due to its nature or composition is similar to waste generated in households. Waste can be classified according to: their source (places of origin), material composition, nuisance, environmental threat and suitability for further use. Collecting outside the place of manufacture is prohibited [13]:

- residues from municipal waste sorting, if they are intended for storage,
- municipal sewage sludge,
- infectious medical waste,
- infectious veterinary waste,
- unsorted (mixed) municipal waste,
- bio-waste constituting municipal waste.

Waste storage is carried out in accordance with the requirements of environmental protection and the safety of human life and health, in particular in a manner that takes into account the chemical and physical properties of the waste, including physical state, and the hazards that this waste may cause. Waste storage takes place in the area to which the holder of the waste has a legal title. Waste storage is carried out only as part of the generation, collection or processing of waste. Waste may be stored if the need for storage results from technological

or organizational processes and does not exceed the deadlines justified by the use of these processes, but no longer than by [14]:

- year - for the storage of hazardous waste, combustible waste, unsorted (mixed) municipal waste and waste from the treatment of municipal waste;
- 3 years - for the storage of other waste.

As part of waste collection, the maximum total mass of all types of waste that can be stored at the same time may not exceed half of the maximum total mass of all types of waste that can be stored during the year specified in the waste collection permit or waste processing permit or a waste production permit involving waste collection or treatment. Waste for storage can only be stored for the purpose of collecting the appropriate amount of this waste for transport to the landfill, but no longer than for a year. Waste storage periods are counted together for all subsequent owners of this waste. The waste holder is obliged to obtain a permit for waste collection or a waste processing permit, a waste production permit taking into account the collection or processing of waste or an integrated permit taking into account the collection or processing of waste, conducting waste storage, with the exception of the initial storage of waste by its producer or managing the landfill is obliged to operate a video storage location control system. The recording of the visual image of the waste storage or storage control system is kept for one month from the date of recording.

The waste holder obliged to obtain a permit for waste collection or a waste processing permit, a waste production permit taking into account the collection or processing of waste or an integrated permit taking into account the collection or processing of waste, storage of waste or managing a waste landfill provides a captured image or a copy thereof at the request of the authorized body to control waste management activities.

The waste producer is obliged to manage the waste it produces.

A waste producer or other waste holder may subcontract the waste management obligation only to entities that have:

- waste collection permit or waste processing permit,
- concession for underground waste storage, integrated permit, decision approving the mining waste management program, permit to operate a mining waste disposal facility,
- entry in the register of regulated activities in the field of collecting municipal waste from property owners,
- entry in the register.

The waste holder who transferred the waste to the waste transporter shall not be released from liability for collecting or processing waste, until the next waste holder who takes a decision who has a decision or has an entry in the register takes over. A natural person and an organizational unit other than entrepreneurs may recover only those types of waste, using such recovery methods and in such quantities that they can safely use for their own needs. The waste holder may transfer certain types of waste to a natural person or an organizational unit other than entrepreneurs, for use for own needs by means of acceptable recovery methods, in accordance with specific requirements.

Waste is processed in installations or devices. Waste treatment installations and equipment shall only be operated if [15]:

- meet the requirements of environmental protection, including do not exceed the emission standards referred to in environmental protection regulations,
- residues resulting from waste treatment activities will be processed subject to certain requirements in the act.

The entity collecting municipal waste from property owners is obliged to transfer unsorted (mixed) municipal waste to a municipal installation providing processing. The producer of waste generated in the process of mechanical and biological processing of unsorted (mixed) municipal waste or residues from sorting of municipal waste, intended for storage, is obliged to transfer this waste to the municipal installation providing storage.

Waste management should be based on the principles of sustainable development. Creating sustainable development is associated with the ecological awareness of society, which is an important element of the feeling of threat to the nature surrounding humanity as well as belonging and social responsibility. In recent years, concern can be observed about the state of the natural environment, which is why a significant goal is to shape the appropriate attitude of society to the environment, as well as the need to solve many problems occurring in both the economic and social sphere. Sustainable development refers to many issues related to environmental protection as well as social issues. Industrialization and globalization make the concept of sustainable development increasingly important.

Sustainable development occurs in the economic and social area and affects the maintenance of balance in the natural environment. Its primary goal is to meet elementary social needs. The concept of sustainable development also assumes that human activities should as little as possible affect the natural environment, because they should be left in the best condition for future generations. In both Poland and European countries, the environmental aspect is becoming an important element in state management, which is why more and more international legal regulations are being created. Sustainable development is a concept that has evolved over the last years. It seeks to raise the standard of social life while reducing human impact on the environment and modifying social values. The goal and at the same time the effect of sustainable development is the quality of social life. European Union countries, including Poland, have adopted the fundamental principles of sustainable development in the process of improving the quality of socio-economic life [16].

### **3. ANALYSIS OF THE TYPE OF COLLECTED MUNICIPAL WASTE AND LIQUID WASTE**

A systematic increase in the amount of waste can be observed in Poland. In 2017, 11,968.7 thousand were collected in Poland tons of municipal waste (an increase of 2.7% compared to 2016). On average, 312 kg of municipal waste collected per one inhabitant of Poland. Compared to 2016, the amount of municipal waste generated per capita increased by 9 kg. Municipal waste collected in 2017 from households (9,971.2 thousand tonnes) constituted the majority (83.3%) of municipal waste generated. The amount of this waste increased by 4.3% compared to the previous year. In 2017, there was an increase in the amount of municipal waste generated by 2.7% compared to the previous year. The annual growth dynamics of the amount of municipal waste generated is 102.7%. The amount of municipal waste generated per capita increased by 9 kg compared to 2016.

**Table 1.** Municipal waste generated in 2016-2017.

[CSO, Signal report, Municipal infrastructure]

Specification	2016	2015 = 100	2017	2016 = 100
Total municipal waste in thous. ton	11,654.	107.3	11 968,7	102.7
Municipal waste collected or collected selectively in thous. tone	2,942.3	116.0	3 239,4	110.1
Municipal waste mixed in thous. tone	8,712.1	104.6	8 729,3	100.2

The total number of enterprises that received municipal waste from property owners in 2017 was 1,295 and decreased by 11.4% compared to the previous year. The number of enterprises that collected municipal waste from property owners decreased compared to 2016 by over 11% In 2017, there were 2,148 points of separate municipal waste collection in Poland, of which 791 (36.8%) were located in cities and 1,357 (63.2%) in rural areas.

**Table 2.** Municipal waste treatment in 2005, 2010, 2015–2017.

[CSO, Signal report, Municipal infrastructure]

Specification	2005	2010	2015	2016	2017
<b>Municipal waste directed to recovery processes (thousand t)</b>	685	1 965	4 845	6 172	6 771
from this to:					
material recycling	367	1 783	2 867	3 243	3 199
organic recycling (composting or fermentation)	318	181	661	814	848
thermal processing with energy recovery	–	–	1 318	2 114	2 724
<b>Municipal waste directed to disposal processes (thousand t)</b>	8 667	8 076	6 018	5 483	5 198
from this to:					
storage	8 623	8 037	5 897	5 331	5 000
thermal processing without energy recovery	44	39	121	152	198

From municipal waste collected or collected in 2017 6,770.9 thous. tons were designated for recovery (approx. 56.6% of the amount of municipal waste generated). About 3,198.7 thous. tons of municipal waste was designated for recycling (26.7% of the amount of municipal waste generated). About 848.0 thousand tons of municipal waste (7.1% of the amount of municipal waste generated) was sent to biological processing (composting or fermentation) processes. Almost 2,724.2 thousand tons of municipal waste (approx. 22.8% of municipal waste generated) was designated for thermal transformation with energy recovery.

A total of 5,177.8 thousand were sent to disposal operations. tonnes, of which 4,999.7 thous. tonnes (41.8% of municipal waste generated) was designated for landfilling, and 198.1 thous. tonnes (1.7% of municipal waste generated) for disposal by thermal transformation without energy recovery. 56.6% of municipal waste was sent to recovery processes

At the end of 2017, 301 landfills receiving municipal waste operated. These landfills occupied a total area of 1,741.6 ha. In 2017, 21 landfills of this type were closed, covering an area of approximately 59.7 ha. In 2017, there were 267 landfills in Poland equipped with degassing installations and they constituted 88.7% of the total of active landfills where municipal waste was deposited. In 2017, as a result of neutralization through incineration of captured gas, about 96,997,000 was recovered. MJ of thermal energy and about 121,574 thousand kWh of electricity. Almost 89% of landfills receiving municipal waste were equipped with degassing installations. About 92.5% of the area on which municipal waste was stored in Poland in 2017 is the area of active controlled waste landfills. The remaining part is the surface of illegal dumps, i.e. places not intended for storing municipal waste. At the end of 2017, there were 1,661 illegal dumps in Poland, while 13,000 were closed during the year under review. such places. In 2017, 13 thousand were liquidated illegal dumps. During the liquidation of illegal dumps, approximately 42.8 thous. tons of municipal waste.

In the case of insufficiently developed areas in terms of sewage infrastructure, some inhabitants use home sewage disposal systems, which are sometimes a cheaper alternative to constructing a sewage network draining sewage to sewage treatment plants. These are drainless tanks and household sewage treatment plants. In 2017, there were 2,121 thousand in Poland. drainage tanks and almost 234,000 home sewage treatment plants. Of the total number of drainage tanks, almost 15% were located in cities, while 85% in rural areas. In the case of home sewage treatment plants, there were over 8% in cities, while in rural areas - 92%.

**Table 3.** Liquid waste collected in 2016-2017  
[CSO, Signal report, Municipal infrastructure]

Specyfification	2016	2015 = 100	2017	2016 = 100
Total liquid waste in hm <sup>3</sup>	23,1	100,8	23,7	102,3
Liquid waste from households in hm <sup>3</sup>	16,2	102,3	17,0	105,0
Liquid waste from other sources in hm <sup>3</sup>	6,9	97,5	6,7	95,8

Liquid impurities were collected from drainage tanks and delivered to sewage treatment plants or catchment stations. In 2017, approx. 23.7 hm<sup>3</sup> of liquid waste was collected. Of the

total amount of liquid waste discharged to sewage treatment plants or catchment stations in 2017, approximately 72% (17.0 hm<sup>3</sup>) came from households, while the remaining part was collected from public buildings and buildings of units conducting business activity. The amount of liquid waste collected from households increased by 5% compared to the previous year. The amount of liquid waste collected from households increased by 5% compared to the previous year

Liquid waste collected during emptying of drainage tanks located in urban areas accounted for 31%, while collected from rural areas - 69% of the total amount of liquid waste collected. In 2017, there were 2,301 catchment stations in Poland, of which approximately 67% were located in rural areas.

**Table 4.** Sewer infrastructure in 2017-2018  
[CSO, Signal report, Municipal infrastructure]

Specyfification	2017	2016 = 100	2018	2017 = 100
Sewage network in thous. km	156,8	101,8	160,7	102,5
Sewage system in km per 100 km <sup>2</sup>	50,1	101,6	51,4	102,6
Connections to residential buildings in thous. pcs.	3 307,2	102,5	3 367,3	101,8
Waste water from households discharged via a sewage network during the year in hm <sup>3</sup>	954,4	101,7	969,5	101,6

In Poland, the length of the sewage network is still increasing and the number of connections to residential buildings is increasing. In 2018, the sewage network in Poland reached a length of 160.7 thousand. km, while the number of connections to residential buildings - 3.4 million. In relation to the previous year, the length of the sewage network built or rebuilt increased by approx. 3.9 thous. km, i.e. by 2.5%, with a simultaneous increase in the number of connections by over 60 thousand pcs, i.e. by 1.8%.

59.0% of the sewage network and 45.4% of all sewage connections to residential buildings were located in rural areas. In comparison with the previous year, the length of the network in rural areas increased by 2.8 thous. km (by 3%), and the number of connections by almost 31 thousand pcs (by 2.1%). In the same period, 1.1 thousand were built in cities km of network (increase by 1.7%) and over 29 thousand installed number of connections (increase by 1.6%).

At the end of 2018, the percentage of residential buildings connected to the sewage system amounted to 50.6% and compared to 2017 was higher by 1.1 percentage point. In cities, 74.6% of residential buildings were connected to the sewage network, while in rural areas 36.2%.

The amount of wastewater discharged from households by the sewage network in 2018 amounted to 969.5 hm<sup>3</sup> (in cities - 845.5 hm<sup>3</sup>, and in rural areas - 124.0 hm<sup>3</sup>) and increased compared to 2017 by 15 hm<sup>3</sup> (14.6 hm<sup>3</sup> and 0.4 hm<sup>3</sup>, respectively).

#### **4. CONCLUSIONS**

The basis for all activities related to the design of waste management solutions is the determination of their quantity, as well as composition and properties. A significant impact on the quality and volume of waste generated in a given area has a standard of living of the inhabitants, their level of education, eating habits or wealth. In cities, the problem of waste can be particularly bothersome due to the large amounts of waste, which is why authorities should encourage the local community to take measures to reduce the negative impact of waste on the environment. The main principles of municipal waste management include limiting their quantity, ensuring reuse, and in cases where this is not possible - disposal.

The organization of the collection system has a significant impact on the process of waste flow in cities. Waste management is an important issue in the activities of all local government units. It requires financial outlays and the involvement of the local community in the implementation of the most important assumptions. It should be properly implemented and planned because then it ensures adequate living comfort for the residents. There are many classifications of waste, and one of the basic is their division into municipal and industrial waste. Industrial waste is a by-product of business operations, while municipal waste is created in Scientific Notebooks of Czestochowa University of Technology Management in households and is not related to the industrial activity of man. It is important that industrial waste is reused much more than municipal waste, therefore, especially in municipalities, their market potential should be exploited [17].

Poland's accession to the European Union in 2004 resulted in the need to adapt Polish law to applicable EU law, including in the field of waste management and environmental protection. Poland has undertaken to take measures to organize waste management, and in particular to reduce the amount deposited in municipal waste landfills and to reduce the share of biodegradable waste in them. It also committed to significantly increase the recovery and recycling of other waste fractions [18].

A difficult task of communes, but very significant for the proper functioning of the municipal waste management system in the commune, is the objective and reliable development of the costs of this system and the amount of fees collected from waste producers. The legislator has made the local government responsible not only for organizing the collection of municipal waste from property owners, but also for most aspects of waste management, including organizational and investment processes. At the same time, the legislator has designed a number of regulations that give competences to other public authorities, having a significant impact on the planning and implementation of the waste management system.

When choosing the method of calculating fees, the Commune Council should take into account such factors as: the nature of the development of the commune area, the ratio of the number of inhabitants to the cubic capacity (area) of residential premises, type of economic activity, water supply system for the population [19]. In rural areas, municipalities are forced to take into account the specificity of their activities regarding the use of water for production purposes on the farm.

The use of the amount of water used in a given property as an indicator for fees for waste management will be impossible if the municipality is not 100% equipped with a water supply system or when on the farms significant amounts of water are used for agricultural production, e.g. livestock farming, use of water for sprayers watering gardens. In this situation, the amount of municipal waste generated is most often inversely proportional to water consumption [20].

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