WASTE SORTING IN LITHUANIA: IS INNOVATION NEEDED?

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Abstract. The article analyses the waste sorting situation in Lithuania, focusing on the issue of municipal waste sorting. The theoretical aspects of waste sorting suggest that waste sorting is a problematic area of sustainable development that constantly requires innovation to re-evaluate the waste sorting hierarchy. After the analysis of scientific literature, assessment of Lithuanian waste sorting infrastructure, analysis of municipal waste management statistics, it was established that changes and innovations are necessary to improve the situation of municipal waste management in Lithuania. The results of the empirical study showed that innovations must be implemented not only in order to upgrade the waste sorting infrastructure, but also by raising the awareness of the entire population, a responsible approach to waste sorting.

Keywords: waste sorting, waste sorting infrastructure, sustainable development.

Introduction

Humankind's productive and daily activities are accompanied by waste. The growing size of consumption and production is also related to the growing amount of waste. Dupre (2016) argues that waste sorting is one of the most important issues for ecologically sustainable development. Every year, on average, one inhabitant of the planet "produces" more than 400 kilograms of waste, of which only about 45 kg is recycled on average. Vijayalakshmi (2021) argues that the waste sorting system constantly requires innovation. The need for innovation is perceived both as raising people's awareness and as the development and application of new technologies to solve the problem of waste sorting. Temitope et al. (2020) analysing the COVID-19 global pandemic, notes that the number of medical wastes (disposable clothing, syringes, masks, etc.) has risen sharply worldwide. At the same time, the number of disposable containers and food packs increased in the treatment of COVID-19 patients. And the number of disposable masks used by the population has increased. Thus, the period of the global pandemic is due not only to the consequences of the spread of the dangerous virus, but also to the sharp increase in the amount of medical waste.

So, the problem of waste sorting is relevant all over the world. It is an integral part of sustainable development. The resulting waste is a perceived, huge problem of waste sorting in the global context due to the economic activities of enterprises and the principles of consumption and sorting by the population. In solving this problem, there are a lot of scientific discussions about the implementation of the principles of the circular economy in the activities of companies. Great attention is also paid to population responsibility and a harmonized approach to waste sorting. Good waste sorting infrastructure is essential to achieve a sustainable approach of sorting waste. The aim of this study is to perform an analysis of waste sorting problems in Lithuania. Objectives of the research: 1. to discuss the waste sorting infrastructure operating in Lithuania; 2. To analyse the legal bases of waste sorting in Lithuania; 3. To study the need for innovations in the field of waste sorting in Lithuania.

Methodology: Analysis, synthesis, generalization of scientific literature. Statistical data analysis Semi-structured interview.

Theoretical aspects of waste sorting

Presently, the implementation of the principles of sustainable development and the problems of climate change have received increasing attention all over the world. One of the major causes of climate change is the footprint of human life. Not only sustainable, responsible use of natural resources, but also waste management is considered a problem area.

According to Wilson (2007), waste management problems began as early as the 16th century, when people began to move to live in cities. In general, the massive "green" protests by NGOs in the second half of the twentieth century were linked to environmental issues. According to Garrick (2004), one of the most important issues was the problem of industrial waste utilization. The issue of waste collection, sorting and recycling remains extremely important these days (Jagdeep et al. (2014)). The authors argue that, from a global perspective, current waste and resource management lacks a holistic approach covering the entire chain of product design, raw material extraction, production, consumption, recycling and waste management. As stated in the European Commission's (2020) report "Proper waste management is part of the essential services to our society. Each person produces nearly half a tonne of municipal waste per year in the EU on average, which means that every week more than 20 kg of municipal waste is generated per household. Total annual waste generation in the EU amounts to 5 tonnes per capita. Preventing distortions in waste management, including separate

collection and recycling of waste, is crucial for the health and safety of our citizens, for the environment and for the economy."

Ebikapade & Baird (2016) state that waste sorting always needs innovations and modernization. According to the Commission, in order to analyse the issue of waste sorting, it is important to define that it is still regarded as waste. What are the types of waste, how is the waste generated? Organization for Economic Cooperation and Development (OECD) definition of waste: "Waste refers to materials that are not prime products (i.e., products produced for the market) and for which the generator has no further use for his/her own purpose of production, transformation or consumption, and which he/she discards, intends to discard or is required to discard". In the European Union, "waste" means any substance or object which the holder discards or intends or is required to discard. This Directive also addresses the waste prevention hierarchy, which identifies key priority areas in order. It is noted that this hierarchy must also be reflected in waste prevention and management legislation.
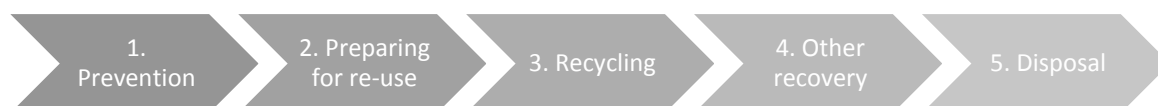
| 1. Prevention | 2. Preparing for re-use | 3. Recycling | 4. Other recovery | 5. Disposal |

Fig. 1. Waste hierarchy: as a priority order in waste prevention and management legislation and policy
(Source: DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008)

It can be said that the definition of waste, as well as waste sorting, is given special attention, which is reflected in legislation, laws, directives, as well as in scientific work. Dupre (2016) says that a waste sorting system operates only when the population is active in that system. Torkashvand et al. (2021) claim that waste sorting is related to a holistic approach to nature, waste and sorting in general. Analysing the various scientific sources, the directives, it has been observed that, for the sake of clarity, waste is divided into types, as well as the so-called waste "generators", which are the places where waste is generated.

Table 1. Sources and Types of Solid Wastes

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastics, textiles, leather, yard waste, wood, glass, metals, ashes, special waste (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous waste.).
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping waste, packaging, food waste, construction and demolition materials, hazardous waste, ashes, special waste.
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food waste, glass, metals, special waste, hazardous waste.
Institutional	Schools, hospitals, prisons, government centres.	Same as commercial.
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	Street sweepings; landscape and tree trimmings; general waste from parks, beaches, and other recreational areas; sludge.
Process (manufacturing, etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process waste, scrap materials, off-specification products, slay, tailings.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	Spoiled food waste, agricultural waste, hazardous waste (e.g., pesticides).

(Source: What A Waste: Solid Waste Management in Asia. Hoornweg, Daniel with Laura Thomas. 1999)

Such typology of waste makes it possible to understand not only the conditions and types of waste generation, but also the fact that waste remains in all areas of human activity. Starting with municipal waste in households, and combining all active human activities on land: commercial, industrial, etc. Thus, in terms of waste sorting and specifying the analysed area, it is useful to analyse not all waste generation sources, generators, but to delve into a specific area. In this article, it was

chosen to analyse municipal waste generated by households. The amount of municipal waste is increasing worldwide. In 2025, the amount of municipal waste in the world's cities is expected to increase.
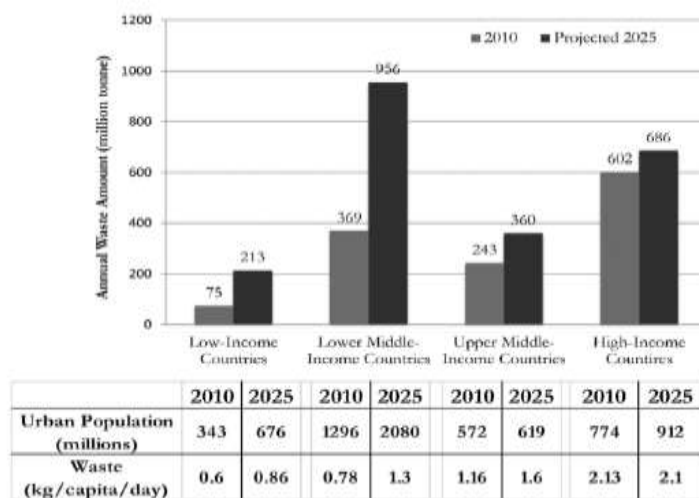

Fig. 2. Municipal waste growth forecast
(Source: Singh, J., Laurenti, R., Sinha, R., & Frostell, B. (2014))

Figure 2 shows that the amount of municipal waste will increase in all countries of the world, regardless of the level of economic development of the countries. Still, the highest growth in municipal waste is projected in lower-middle-income countries. Gößling-Reisemann (2011) states that not only the amount of municipal waste is growing, but also the composition of some municipal waste is changing, making its sorting a challenge. In addition, the recycling of complex waste streams poses technological challenges and reduces their potential utility. Serret and Ferrara (2008), Jacoba et al. (2021), point out that a number of key factors are important in analysing the sorting of municipal waste. Above all, the awareness and responsibility of the population and households are important. Another important factor is the waste sorting conditions or infrastructure. Jacoba et al. 18 (2021) distinguish three possible actions of households related to waste:

- On – site: Composting, re-use, burning, burial.
- Off – site: Landfill, public receptacles, waste collection facilities, drop-off centres, donate, burn, litter or dump on uncontrolled dumps;

- Curb – side: Mixed waste and/or separated recyclables for collection by municipal trucks and/or other recyclables collectors.

Each of the listed ways of managing the waste sorting process is related to the general waste sorting infrastructure as well as to the awareness of the population and waste sorting habits.

Summarizing the theoretical aspects of waste sorting, it can be stated that waste sorting is broadly related to the goals of sustainable development. In the narrow sense, waste sorting is related to waste types, generation sites, waste sorting infrastructure in one or another society. Sorting of municipal waste is related both to the existing infrastructure, the tax burden on the population, and to the sorting habits and awareness of the population.

Waste sorting infrastructure in Lithuania: an analysis of situation and legal aspects

In 2016, the EU generated 2.5 billion tonnes of waste. 8.5 percent of all waste is municipal waste. (The latest available data on municipal waste in the EU and Lithuania are from 2019

Table 2. Municipal waste sizes in Lithuania and the European Union

Region, Country	Municipal waste generation (kg. per capita)	Recycled and composted waste (2017, percent)	Waste disposed of in landfills (2017, percent)
EU (28 countries)	489	46	24
Lithuania	464	48	33

(Source: Eurostat 2020)

The data show that in 2018, Lithuania did not reach the EU average in terms of municipal waste generation. The share of recyclable and compostable waste and the percentage of waste disposed of in landfills were higher than the EU average. Report (2018) states that in the period 2006-2017, Lithuania, like Slovenia, Latvia, Estonia and Finland, has made the greatest progress in reducing the amount of waste disposed of in landfills. Analysing statistical data, waste management in Lithuania also includes municipal waste, taking into account that municipal waste falls into different waste categories.

Statistics also show that the amount of municipal waste increased throughout the European Union between 2013 and 2019.
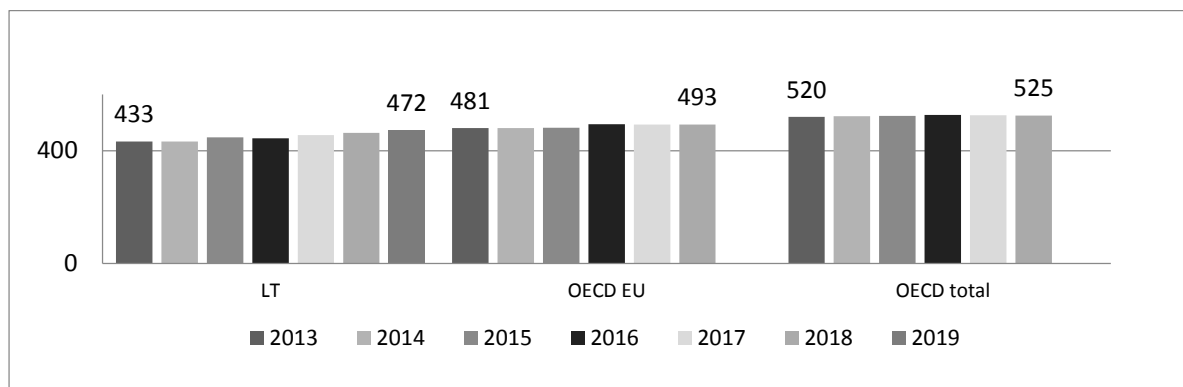

Fig. 3. Municipal waste generation (kg. Per capita) in 2013–2019
(Source: Eurostat 2020)

The statistics provided in *Figure 3* represents data prior to the pandemic period in 2020. It is likely that the overall growth dynamics of municipal waste associated with the pandemic period may be even higher, taking in mind increased consumption of disposable masks, disinfectants, and other measures to prevent COVID-19.

When analysing the issues of municipal waste sorting, it is useful to discuss not only the number of these wastes generated, but also the number of treated wastes. Taking into account that there are no official statistics covering only the amount of municipal waste by type of management in Lithuania, general statistics on treated waste by type of management in Lithuania are presented and analysed.

According to the method of disposal, municipal waste falls into all the listed categories such as landfill, recycling, treatment, etc.

In Figure 4 we can see quantities of treated waste according to management methods in thousands of tonnes in 2016 - 2018 in Lithuania.

Although the amount of treated waste increased in 2018, the amount of recycled waste decreased. The use of waste for energy has also decreased. Such a change is not statistically significant, but may also indicate the need for innovation in the waste management system.

In order to modernize waste management and sorting, from 2002 to 2005, regional waste management and sorting centres were established in 21 regions of Lithuania, which united waste management institutions operating in different municipalities in one region. Today, there are 10 regional waste management centres in Lithuania: Vilnius, Kaunas, Klaipėda, Šiauliai, Panevėžys, Alytus, Utena, Marijampolė, Tauragė and Telšiai regions. The establishment of regional waste management centres remains an important and innovative factor contributing to more sustainable waste sorting, recycling and reuse. The establishment of regional waste management centres has significantly improved waste management infrastructure. For example, the establishment of the Vilnius County Waste Management Centre allowed the establishment of one regional landfill and the closure of 126 non-compliant landfills in the region. In other regions, large and modernized landfills have also been set up, destroying small, non-compliant landfills. The functions of the organizer of the municipal waste management system were transferred to the regional waste management centres. However, according to the state waste management plan 2014–2020 and the project of State Waste Prevention and Management Plan 2021–2027 municipalities are responsible for the organization of municipal waste management systems, ensuring their functioning, the organization of the management of waste whose holder cannot be identified or does not exist, and the administration of the provision of municipal waste management services. The mentioned documents indicate that a part of the municipalities has delegated the organization of the municipal waste management system to companies established by several municipalities as a mandatory task. Other municipalities coordinate the municipal waste management system themselves. This basically

shows that the existing waste management and sorting infrastructure in Lithuania is different. Therefore, in order to harmonize and develop regional waste management systems, regional waste prevention and management plans are prepared, which, according to the peculiarities of their municipality, are detailed in municipal waste prevention and management plans and municipal waste management rules.
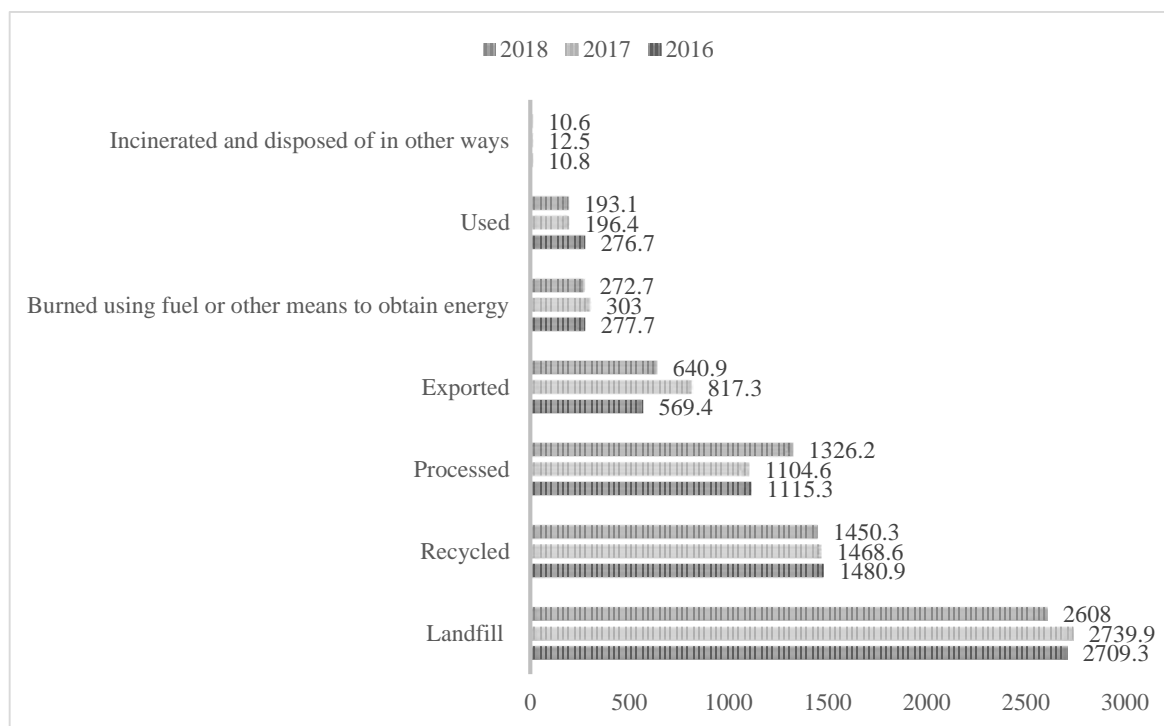

Fig. 4. Amount of waste managed by management methods in 2016–2018. (Thousands of tonnes)

(Source: Lithuanian environment, agriculture and energy (2020))

The activities of regional waste management centres are not limited to the activities of landfills. These centres administer bulky waste collection sites as well as green waste composting sites.

Regional waste management centres also provide public information and education on waste sorting. It also promotes a sharing economy by creating places on bulky sites where inoperable or obsolete items can be delivered free of charge and which other people can pick up and continue to use free of charge. For example, in Šiauliai, this initiative is known as the "Yard of Things". Similar initiatives are being implemented in other regional waste management centres. An analysis of the official information provided on the websites of the regional waste management centres has shown that the information provided varies widely. There is a lack of a more unified information system. Not all centres provide waste collection statistics, and it is also noticeable that not all centres provide information on waste collection rates, as well as descriptions of waste quantities received from residents or legal entities per year, waste declaration.

To sum up, it can be stated that Lithuania has a modern, upgraded waste sorting infrastructure. However, the municipal waste management system is not clear. Some municipalities have outsourced municipal waste collection to regional landfills. Other municipalities employ municipal waste collection companies on the basis of public tenders. Municipal waste taxes also differ in various Lithuanian municipalities. Determining whether such a different way of collecting municipal waste is appropriate is difficult. An analysis of the information provided by the regional waste management centres shows that it is very different from that provided to stakeholders. It is difficult to compare the statistics provided, as not all regional waste management centres provide such information. The same applies to the information provided by municipalities concerning municipal waste management.

Analysing waste sorting issues related to waste management infrastructure, it was observed that there are still significant differences in municipal waste management between urban and rural areas. For example, textile collection containers are mostly accessible to urban residents, but more difficult to access to rural residents. Analysing the collection of textile waste in Kėdainiai district, it can be seen that textile containers cover the entire territory of the city. However, in the case of rural areas, only textile containers are indicated in some areas of rural settlements designated on the principle of elderships.

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In other words, in order to dispose of textile waste, a resident has to travel more than 5-9 kilometres to the container. The situation is similar in other rural areas of Lithuania. Such a textile waste collection system should be modernized in order to facilitate the sorting of waste by the population.

The legal framework for waste sorting is further analysed, focusing on the legal regulation of municipal waste sorting. The legal regulation of waste sorting in Lithuania is closely related to the directives of the European Union. National waste management plans are prepared and approved on the basis of EU directives (Directive 2008/98 / EC of the European Parliament and of the Council, Directive 94/62 / EC, Directive 2006/66 / EC, etc.).

Waste sorting is also legally regulated by the Law of the Republic of Lithuania on Waste Management No. VIII-787, which was adopted in 1998, is constantly supplemented and updated. This Law and its amendments define the basic principles of waste sorting. As already mentioned, state waste prevention and management plans are also being prepared and implemented. There is currently no valid state waste prevention and management plan, therefore the draft State Waste Prevention and Management Plan for 2021–2027, covering the draft plan covering 2021-2027, is being discussed.

This project declares that the plan fully complies with the separate EU directives on waste sorting issues, procedures and regulation. In the analysed draft of the State Waste Prevention and Management Plan for 2021-2027, based on the 2008 November 19 Directive 2008/98 / EC of the European Parliament and of the Council on waste and repealing certain Directives (Text with EEA relevance) is based on the order of priority of waste prevention and management discussed in the theoretical part. In particular, these are prevention (sustainable design, economical use of raw materials, production, durability, repair, refurbishment), prevention against littering, measures to prevent food waste. Preparation for use is redefined as such preparation in which, in particular, certain components of the product which are unfit for further use or processing are separated. Processing and production of secondary raw materials are carried out by separating parts of the product that are not suitable for further use. Another use that is perceived as the use of waste, for example, to extract energy by incinerating waste. In all cases, it is necessary to separate waste suitable for other uses before any other use of the waste. The last priority is disposal. Disposal takes place only in order to minimize the amount of waste by sorting, recycling and separating the components of the product that are suitable for further use.

It is also stated that the disposal of green and biodegradable waste is prohibited. The aim is to set higher taxes for construction, oil and other waste disposed of in landfills. According to the EU Directive of 2008 November 19 Directive 2008/98 / EC of the European Parliament and of the Council on waste and repealing certain Directives.

As it was decided to focus on municipal waste sorting issues when analysing the problems of waste sorting in Lithuania in order to discuss whether innovations are needed in this field, the State Waste Prevention and Management Plan 2021–2027 problematic issues of municipal waste management are further analysed.

It is stated that not all municipalities provide the necessary conditions for the sorting of municipal waste. Analysing the waste sorting infrastructure, the problem of differences in sorting conditions in municipalities was also seen. This reaffirms the premise that innovations and new solutions are necessary to enable equal sorting of municipal waste in all Lithuanian municipalities.

This project of Waste Prevention and Management Plan 2021-2027 states that "there is no common and clear mechanism for evaluating the performance of municipal tasks, there is no accurate and reliable accounting of municipal waste generation and management, therefore unreasonable strategic decisions on waste management methods can be made". As mentioned in this article, when collecting statistics, significant differences were observed in the waste sorting data provided by individual municipalities. Another major problem related to the sorting of municipal waste is related to the education and upbringing of the population. Although the function of educating the population is specified by all Regional Waste Sorting Centres in their statutes, the project of National Waste Prevention and Management Plan for 2021–2027 states that "education of the population is insufficient, which would promote their ecological awareness. There is a lack of systematic unified concentrated information on the sorting, collection, infrastructure, services of bulky (furniture), electronics, batteries, construction, hazardous, textile waste, tires, food and green waste, end-of-life vehicles;

There is a lack of information on sorting secondary raw materials and ensuring the collection of correct waste in sorting containers, especially in collective containers. Therefore, the assessment of waste sorting infrastructure in Lithuania, review of legal documents related to municipal waste management and sorting infrastructure significantly improves the situation of waste collection, recycling and reuse.

However, the existing different municipal waste collection and management actions in municipalities, the different conditions for the population to sort waste, show that new solutions are

needed to enable more efficient waste sorting. It is also important that the sorting of municipal waste depends not only on the incentives of the municipality, but also on the awareness of the population, the available knowledge that enables the formation of the necessary municipal waste sorting habits.

Research results

In order to determine what innovations are important and necessary in Lithuania, a pilot semi-structured interview was conducted, interviewing 6 senior or middle managers working in the field of waste sorting for at least three years. After interviewing 6 respondents, sample saturation was achieved as the answers to the questions began to recur.

Given that two out of 6 respondents did not consent to the use of their personal data, the data of all informants are encrypted. Respondents were asked questions covering the assessment of waste sorting infrastructure and the need for innovation in the field of municipal waste collection and sorting.

Table 3. Respondents' codes and characteristics

Respondent code	Position	Experience
I1	Top Manager	6 years
I2	Middle chain manager	4 years
I3	Middle chain manager	7 years
I4	Middle chain manager	4 years
I5	Middle chain manager	11 years
I6	Top Manager	8 years

(Source: Compiled by the authors according to the research data)

The description and analysis of the research results are presented taking into account the categories identified during the research and the subcategories that emerged during the analysis.

The first category identified is the assessment of waste sorting infrastructure. All respondents stated during the survey that Lithuania has a good, modern waste sorting infrastructure. However, like any other infrastructure, it must be constantly maintained, upgraded and modernized.

Table 4. Assessment of waste sorting infrastructure

Subcategory	Proof statements
The need for modernization	**I4** [*invest more in a systematic waste sorting algorithm, which would combine the latest technological solutions with a clear waste collection mechanism covering the whole of Lithuania.*] **I5** [*… modernize together with the structure of waste taxes*], **I6** [*… modernize and implement innovations, depending on the era. Other waste and other waste sizes during the pandemic.*]
Support for a common infrastructure system	**I2** [*… missing system. Each municipality acts as it is more convenient for the municipality. Taxes for residents vary from municipality to municipality. And the prices of adding asbestos slate. And this is where the "desire" of the population not to add that slate arises.*] **I3** [*… the infrastructure is good, there is no system. Each municipality has its own system, which becomes a challenge for the population and not only for them.*]; **I6** [*… legislation is needed to create a unified framework to support existing infrastructure*].

(Source: Compiled by the authors according to the research data)

To conclude, all respondents rate the existing waste collection and sorting infrastructure as good. The important work of regional waste management centres is emphasized. It is also emphasized that the developed infrastructure complies with the EU requirements. However, there is a need to modernize existing infrastructure. Modernization should be linked to both the tax system and the single mechanism for collecting municipal waste from the population. Therefore, the study highlighted the need to maintain and develop a common framework for existing infrastructure. A common system would make it possible to harmonize waste collection in the various municipalities I3 [*… regional waste management centres in carrying out all the functions for which they were set up.*].

The aim of the study was to determine how the municipal waste sorting habits of the Lithuanian population are assessed. (Distinguished category: sorting habits of the Lithuanian population). The obtained data show that although all respondents state that the sorting habits of the population are improving, these skills can be assessed as insufficient for sorting municipal waste.

Table 5. Assessment of population sorting habits

Subcategory	Proof statements
Dependence of age and municipal waste sorting practice	**I1** [... *also the older generation tends not to sort. Young people are more educated, sort more responsibly.*]; **I3** [*There is a growing belief among the elderly that sorting is not worthwhile because everything still ends up in the same landfill for garbage collection.*]; I6 [*Elderly rural people are less likely to sort. Sometimes they do not sort because they do not have special sorting containers. Or have containers, but still throw everything in mixed waste containers.*]
Lack of information on proper sorting of municipal waste	**I2** [*Household waste is poorly sorted, plastic containers are often full of glass and other waste.*]; **I3** [*... part of the population considers that sorting is not worthwhile, as one vehicle comes to collect waste.*]; **I5** [*the problem remains too little interest in product labelling. As a result, waste is often sorted incorrectly. For example, ceramic waste, light bulbs, varnishes, paints, glass containers with residues of materials are thrown into glass containers. Diapers, packaging containing more plastic than paper are thrown into paper containers.*].
The difference between rural and urban areas	**I1** [*We receive complaints that garbage containers are removed too infrequently in rural areas and garden areas. If the containers are full, immediately dispose of the rubbish without sorting it.*]; **I3** [*... less graded in rural areas*]; **I4** [*...mini landfills forming near the containers in rural areas ...*]

(Source: Compiled by the authors according to the research data)

In summary, it can be stated that different sorting habits related to age are identified as problem areas. Older people, according to respondents, tend to sort less than younger people. There is also a lack of knowledge about the correct sorting of municipal waste. Respondents indicated that the labelling of packaging was often disregarded, with the result that some waste was not placed in a container for the collection of this waste. Sorting differences between rural and urban residents are also visible. It is pointed out that in rural type settlements, garden communities waste is sorted less than in cities. Such a distribution of the obtained data shows that in order to ensure proper sorting of municipal waste, education and information on waste prevention. It is likely that information on waste sorting in order to change the habits of the population should be provided according to the age groups of the population, place of residence.

The study also aimed to identify which innovations would help to improve the collection and management of municipal waste (the third category of the study is the need for innovation in the field of municipal waste management and sorting). Analysing the obtained research data, it was found that the respondents believe that the most important innovation is the education of the population, as well as the expansion of the network of some sorting containers and the solution of municipal waste collection taxation issues.

It can be stated that the essential areas that require change and innovation, according to the respondents, are the constant providing of information and training of the population. The analysis of the documents also showed that special attention must be paid to educating and informing the population in order to improve the situation related to waste sorting. It is also important to develop and continuously assess the issues of municipal waste collection infrastructure in order to ensure that municipal waste is properly sorted and collected. Innovation is needed in the area of municipal waste taxation as well.

Conclusions

Theoretical, statistical data, analysis of legal acts and qualitative research data showed that the quantity of municipal waste in Lithuania has a tendency to grow. Although Lithuania has made significant progress in the area of municipal waste collection and sorting, this is not enough. Continuous monitoring and surveillance of the situation is necessary.

The research of waste sorting infrastructure in Lithuania revealed that this infrastructure has been upgraded and meets the standards set by the EU. However, the development of the infrastructure itself to this day also requires innovation and change. Municipal waste collection procedures differ in different Lithuanian municipalities. Not all regional waste collection centres perform municipal waste collection functions. There are significant differences in waste taxes between municipalities.

Table 6. The need for innovation in municipal waste sorting

Subcategory	Proof statements
Information and education of the population	**I1** [*... maybe the wrong word is innovation in this case, but I think the most important thing now is to keep the population informed and trained, to be trained and re-taught how to sort properly ...*]; **I3** [*... only education how to sort ... the most important thing is to teach.*]; **I4** [*... advertising everywhere and constantly about the importance of sorting with specific, interesting facts and figures*]; **I5** [*... training and education from an early age.*].
Development of municipal waste infrastructure	**I1** [*... infrastructure development, more containers in villages and more frequent assembly*]; **I2** [*... it cannot be as it was in Vilnius that no one takes out the rubbish. It is necessary to address and plan how to ensure this*]; **I5** [*... increase fines for irresponsible sorting*]; **I6** [*... the municipal waste collection system needs to be changed. Even with the introduction of city-branded garbage bags, as is the case somewhere in Europe. Where you have to use the branded bags in order to have your waste collected. This encourages a more responsible sort*].
Improving the tax system for municipal waste collection	**I1** [*... is the rule that the polluter pays. Balance taxes so that the less you waste, the less you pay*]; **I2** [*increase taxes on unsorted waste ...*]; **I3** [*... I think we need to balance taxes with the education of the population.*]

(Source: Compiled by the authors according to the research data)

The analysis of the legal regulation of situation of waste sorting has shown that the legal requirements for waste sorting are formed and implemented in accordance with the relevant EU directives. Legal documents and waste management plans identify problematic areas of municipal waste collection, and aim to create an effective legal framework to address problematic areas.

In order to determine what innovations or changes are important in the field of waste sorting, it was chosen to analyse the necessary changes in the field of municipal waste sorting. A qualitative study found that more attention needs to be paid to raising public awareness of municipal waste sorting. It is important to develop appropriate municipal waste sorting habits, taking into account the place of residence and age of the population. It is also important to assess the entire waste sorting infrastructure by choosing an appropriate waste collection schedule, as well as the expansion of the container network (such as textile containers). It is important to regulate municipal waste collection fees.

Acknowledgements

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