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Assessment of Sustainable Waste Management: A Case Study in Lithuania

Renata Činčikaitė

Faculty of Business Management, Vilnius Gediminas Technical University, Sauletekio al. 11, LT-10223 Vilnius, Lithuania; renata.cincikaite@vilniustech.lt

Abstract: Sustainable waste management is a very important issue that has received increasing attention in recent years due to its significant impact on the environment and human health. As the population and urbanization increase, more and more waste is generated, leading to problems such as pollution, resource depletion, climate change, etc. Therefore, it is necessary to develop effective waste management strategies that are sustainable and do not harm the environment. The EU is making progress in sustainable waste management within the wider context of a circular economy, but challenges remain, particularly in reducing material consumption and effectively managing specific waste streams. The EU's approach involves setting clear targets, monitoring progress in a comprehensive framework, and supporting Member States in achieving these targets. In 2019, Lithuanian companies invested about 40% more in environmental protection than in 2018. Notably, 15% of them are invested in waste management. An inhabitant throws out an average of 278 kilograms of mixed municipal waste per year. According to the global waste index in 2022, Lithuania ranked 16th (up from 23rd place), Latvia 37th (down from 35th place), and Estonia 32nd (down from 30th place). The purpose of this article is to identify the factors that determine sustainable waste management in cities and to predict the changes that will occur. Research methods: synthesis and comparison of concepts and methods in scientific literature, secondary data analysis, statistical data processing, and expert interview methods. Research results: It has been determined which factors and how they determine sustainable waste management in the country. The experts evaluated the alternatives—waste prevention, reuse, recycling, and optimization of landfills—according to the following criteria: economic, social, environmental protection, and technology. The most important criterion was determined to be the environmental protection criterion.

Keywords: sustainable waste management; expert interview methods; urbanization

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1. Introduction

In the field of sustainable waste management, various studies are carried out. Proposals are made such as integrated sustainable management, where the main focus is on food waste [1], various waste-to-energy (WTE) technologies [2], the use of agricultural waste biomass as composite absorbents for sustainable wastewater treatment [3], the provision of a classification of technologies that help address the challenges associated with sustainable resource use [4], policies, advice, and solutions related to the sustainable management of medical waste using green technologies [5], a framework to enable the integration and sustainability of MSW in light of recent barriers and CSFs needed to implement S-ISWM in municipalities in developing countries [6], an analysis of the relationship between the circular economy and renewable energy and the importance of efficiency in achieving

sustainable development in the application of the circular economy [7], and the implementation of the Internet of Things in the waste management system in order to eliminate gaps in waste use [8]. In addition, governments and organizations have begun to implement national strategies and plans to address the problem of waste management, such as the Palestine MTG National Waste Management Strategy [9] and the Australian County Council Environmental Sustainability Strategy 2018–2022 in Australia [10]. A mathematical toolkit is presented for the preliminary analysis of the financial and environmental sustainability of a WEEE waste treatment facility with resource recovery based on the principles of a circular economy [11]. An IWMP decision support tool has been introduced to inform and influence higher-level decision-making policy instruments on waste-related issues [12].

The waste sector, especially waste disposed of in landfills, contributes significantly to Lithuania's greenhouse gas emissions. The multifaceted problems posed by waste include environmental degradation, public health crises, and social and economic consequences [13]. The degradation of the environment remains one of the biggest consequences of improper waste management. Landfills, where most waste is often stored, not only visually spoil the environment, but also contribute to soil and water pollution. Toxic substances leached from waste, such as heavy metals and chemical pollutants, can degrade soil quality and contaminate groundwater resources, disrupting the delicate balance of ecosystems. Furthermore, the decomposition of organic waste in landfills produces methane, a powerful greenhouse gas that contributes significantly to global climate change [14]. The consequences of waste are not limited to environmental degradation, but pose a huge threat to public health [15]. The social and economic impact of waste is also very relevant. In many non-developing regions, the informal waste management sector plays an important role in waste management. People working in this sector often face dangerous working conditions, social exclusion, and economic exploitation. Inefficient waste management also leads to lost opportunities for recycling and resource utilization, further increasing the burden on natural resources [16].

In order to secure its position as the leader of the circular economy in Europe, Lithuania has planned until 2024 to reach the EU average in the index of the use of secondary raw materials, and by 2030—to reduce the amount of waste disposed of in landfills to 5 percent and to have the first sewerless municipality. The ultimate goal is to make the entire Lithuanian economy a circular economy by 2050 [17]. The target is ambitious, but the generation of waste at the primary source is still growing. Therefore, the question arises as to what factors lead to the generation of waste and its growth. To solve this question, our research focuses on the primary dimensions: indicators of waste generation and management, conducting a systematic analysis of statistical data to assess trends in this phenomenon, and an expert survey to determine what influences sustainable waste management. The next section provides a summary of relevant literature on sustainable waste management. The third part presents the methodological base in which methods are used: descriptive statistics and analytic hierarchy process (AHP). The fourth chapter discusses the results and provides perspectives for future research.

2. Literature Review

Sustainable waste management is often defined by researchers as the implementation of practices and strategies that aim to minimize the environmental, social, and economic impacts of waste generation, collection, treatment, and disposal. Sustainable waste management aims to promote the efficient use of resources, reduce pollution, conserve natural resources, and improve public health and well-being (see Table 1).

Table 1. The concept of sustainable waste management.

Author	The Concept of Sustainable Waste Management
Nabavi-Pelesaraei Kaab et al., 2019 [18]	Waste management follows an ideal hierarchy with prevention as the most acceptable method, followed by the 3Ps (reuse, recycling, and recovery), and landfill as the least acceptable option.
Ribić et al., 2017 [19]	Substantial improvement of the current waste management system, especially taking into account the obligations set out in various directives of the European Union.
Wiah et al., 2022 [20]	Defined as the ability of a plastic waste management system to remain closed, ensuring a continuous flow of both direct and reverse products and waste.
Ming Hung Wong 2022 [1]	Waste management in order to protect the environment and human health, emphasizing the efficiency of resource use.
Wilson et al., 2013 [21], Memon 2020, [22]	A process that includes the physical components of waste collection, disposal, recycling, and management, such as financial sustainability and proactive policies.
Cucchiella et al., 2017 [23]	Environmental, economic, and social impact assessment of possible waste management options.
E. Pongrácz 2004 [24]	Waste management is a response to the very fact of waste generation, including its accumulation, transportation, use, and disposal, including the control of these processes and assessment of the impact of disposed waste.
Podgaiskytė 2011 [25]	It is not only the disposal of already generated waste, but also the management of limited natural resources.

Although these authors have different views on sustainable waste management, they share the common opinion that sustainable waste management is not only waste disposal but also an inseparable connection with wider resource management, environmental sustainability, and a circular economy. It focuses on reducing waste generation, maximizing resource utilization, and ensuring that waste management processes are integrated into a sustainable cycle of material use and reuse [18]. International organizations (OECD and UNEP) provide a complete list of materials and products that are considered waste. Sustainable waste management in this article will be considered as a process that ensures environmentally friendly, economically viable, and socially acceptable ways.

To achieve sustainable waste management, it is necessary to promote the conscious behavior of residents, factories, and companies. The following pollution prevention models are distinguished: the requirement to take back one's own production; deposit schemes; subsidizing the early stages of production; and advance fees for waste management [26,27]. When it comes to sustainable waste management, it is necessary to know what categories waste is divided into. Waste is divided into several categories according to its origin, composition, and possibilities for reuse or recycling: municipal solid waste (MSW). This waste, commonly called garbage, includes items thrown away by society every day, such as household waste, packaging, food scraps, and yard waste [28,29]. Industrial waste: waste resulting from industrial activities including manufacturing, mining, and agriculture. They can be dangerous or non-dangerous [18]. Hazardous waste: waste that has properties that make it hazardous or may be hazardous to human health or the environment [14].

Medical waste: items such as syringes, dressings, and surgical instruments. They can be dangerous and require special disposal methods [9]. Electronic waste (e-waste): discarded electronic devices: computers, televisions, and mobile phones [15]. Recyclable waste: paper, glass, metal, and certain plastics (materials that can be recycled into new products) [21]. Construction and demolition waste: waste that is generated during the construction, renovation, or demolition of buildings and structures [28]. Organic waste: biodegradable waste from plants or animals, often used for composting [30]. It is necessary to emphasize that each type of waste requires special handling, processing, and disposal methods in order to reduce its impact on the environment and human health. Waste management is one of the main social and management challenges, especially in urban areas with increasing populations and garbage generation. In developing countries, most cities collect only 50–80% of the waste generated, spending 20–50% of their budgets, of which 80–95% is spent on waste collection and transportation [31–33]. In addition, many low-income countries collect as little as 10% of municipal waste, which poses public health and environmental risks, including increased diarrheal and acute respiratory infections among people, especially children, living near landfills [31,34]. Deterioration of the environment can lead to a public health crisis (e.g., contaminated water causes disease) [13,16]. Environmental degradation often occurs over a long period of time, and public health crises can have immediate and acute impacts. Solving environmental problems can involve policy changes, technological innovations, and global cooperation (e.g., reducing methane emissions from landfills) [15].

In 2021, Awasthi described and discussed several methods and concepts of sustainable waste management: first of all, he suggests rethinking open landfills and closed landfills. Traditional landfills and underground landfill methods are considered suboptimal due to their impact on the environment. It is worth noting also that innovative technologies such as microwave pyrolysis can be used to treat waste such as solar cells and agricultural waste, creating useful by-products and reducing emissions during combustion. [28]. A zero-waste concept, this focuses on redesigning the resource supply chain to ensure that all products and by-products are reused or recycled [20,28]. The researchers found that extending the life of a product can significantly reduce waste as fewer products are thrown away over time. It is suggested to apply resource-efficient systems [18,28].

The differences between sustainable waste management and traditional waste management were described as follows: Boakye 2023 and Oked 2022 distinguished the following main differences: approach to energy and resources: Sustainable waste management gives priority to renewable and sustainable energy sources, abandoning traditional fossil fuels. This approach contrasts with traditional waste management, which often relies on landfills and usually does not include waste energy recovery [2]; environmental impact and sustainability goals: Sustainable waste management is aligned with the Sustainable Development Goals of the United Nations and aims to reduce the negative impact of waste on the environment, including reducing greenhouse gas emissions and pollution. Traditional methods of waste management, such as landfilling or incineration without energy recovery, are of great environmental concern as they contribute to emissions and pollution [2]; waste management practices: sustainable waste management includes practices such as recycling, reuse, biorecovery, and the use of nonrecyclable waste for energy production. Traditional waste management often involves simple disposal methods such as landfills, with minimal emphasis on recycling and reuse. Sustainable waste management practices aim to minimize the negative effects of waste on health and reduce its impact on the environment [30]; however, the implementation of sustainable waste management practices varies widely across regions and countries [2,28,35]; sustainable waste management requires greater awareness and cultural change as it often involves more complex and integrated systems compared to traditional methods [2,28]. Thus, by developing and implementing sustainable

waste management strategies, it is possible to reduce the negative impact of waste on the environment and human health.

There are studies on methods used to analyze sustainable waste management, such as the application of the AHP method [36], as well as research aimed at identifying the best ways to collect plastic waste. Additionally, the application of multicriteria evaluation methods, like TOPSIS, is intended to assist decision-makers in the Portuguese waste management system [37]. After analyzing the scientific literature to determine which methods are used to justify decisions on waste management at various levels of society, the researchers distinguished the following methods: environmental impact assessment, strategic environmental assessment, life cycle assessment, cost and benefit analysis, and cost-effectiveness. Efficiency analysis, life cycle costing, risk assessment, material flow accounting, material flow analysis, and energy analysis [38] are all important considerations, but other researchers have concluded that the majority of research focuses on the broader application of life cycle assessment, multicriteria decision-making, cost-benefit analysis, risk assessments, and comparative analysis [39]. Therefore, in this article, the AHP method is applied to determine which criterion is more important for different sustainable waste management measures (such as waste prevention measures, waste reuse measures, waste recycling measures, and landfill optimization measures).

3. Methodology

The work uses secondary data analysis and expert surveys. The sample is made by snowball, otherwise known as the chain sampling method, which allows researchers to obtain detailed information about the object of the study. This method was chosen because it allows the informant to indicate to the researcher other experts worthy of inclusion in the study due to their qualifications in the relevant topic, who belong to a relatively limited group but with specific information that would be difficult for the researcher to access and about which the researcher has very little knowledge, or does not have it at all [40]. Fifteen experts were interviewed, and they were selected based on the experts' experience (at least 10 years) and information saturation. The information saturation effect allows the researcher to decide whether all the necessary data have been collected or whether additional data should be sought [41]. This makes it possible to determine that the existing number of experts is sufficient if all necessary information is received. Informants' positions, seniority, and other data are not disclosed and are encrypted for data protection, consensus, and compliance with work research ethics.

The research was carried out in accordance with the principles of ethics: scientific objectivity, autonomy, the anonymity of all participants in the research is ensured, and no personal data and other data that could reveal the participants were collected.

In order to determine which criterion (see Table 2) is more important for different measures of sustainable waste management (such as waste prevention measures, waste reuse measures, waste recycling measures, and landfill optimization measures), the AHP method was chosen. This method is based on the comparison of two alternative elements, so even very complex problems can be solved in this way [42]. According to Šostar and Ristanović (2023), the AHP method is one of the most accurate road decision-making methods. The hierarchy of criteria established during the research allows us to understand how strongly individual factors of the lowest level influence the main goal. Meanwhile, criteria weights reflect the opinion of expert evaluators about the importance of criteria compared to other criteria. The method is applied by filling in the matrix of pairwise comparison of experts' indicators (T. Saaty's importance scale (see Table 3)).

Table 2. Criteria for expert survey.

Factors	Criteria	Code
Legal environment	National management	M1.1
	International management	M1.2
Economic environment	Infrastructure	M2.1
	Taxes	M2.2
	Recycling	M2.3
Social environment	Consciousness	M3.1
	Engaging communities	M3.2
	Habits	M3.3
Environmental protection	Conservation of resources	M4.1
Technologies	Waste management technologies	M5.1
	Waste collection systems	M5.2

Table 3. T. Saaty's importance scale and its description [43].

Level of Importance	Description
1	Indicators are equally important
3	One indicator is slightly more important than the other
5	One indicator is more important than another
7	One indicator is much more important than the other
9	One indicator is incomparably more important than the other
2, 4, 6, 8	Intermediate values

The weighting coefficients of the criteria are calculated as follows (see Equation (1)):

$$w_j = \frac{\sum_{j=1}^{n} x_{ij}}{n}; \quad (1)$$

here:

$\sum_{j=1}^{n} x_{ij}$ —the sum of the rows of a normalized matrix;

n—number of criteria;

w_j—criterion weight.

A consistency ratio (CR) is calculated, which allows the detection of computational and evaluation deficiencies (see Equation (2)).

$$CR = \frac{CI}{RI} \quad (2)$$

here:

n—number of indicators;

CI—sequential index;

RI—Value of T. Saaty's coefficients.

If $C.R. < 0.1$, then it is concluded that the matrix is aligned. The averages of the matched matrices are the final weighting factors.

4. Results

In 2024, the environmental protection rating of Lithuanian municipalities was published, the purpose of which is to determine which of the municipalities is the most involved/made the biggest breakthrough in getting involved in the green course [17]. This

assessment was carried out in several sections (waste and circularity, energy, construction, spatial planning, communication, climate change management and policy, environmental quality, prevention, and comfort, water quality, biodiversity, landscape, and environmental awareness). In the waste and circularity category, the contribution of municipalities in creating the most comfortable conditions for waste sorting and product reuse was evaluated. The study results showed that the municipality of Utena district showed leadership in this category, while the municipality of Panevežys improved its results by more than two points (2022—36.64, 2024—38.97). In the category of environmental awareness, it was evaluated how municipalities study residents' satisfaction with the quality of the environment, implement community involvement initiatives, and what funding they allocate to the environmental education of residents. In 2024, the Utena district municipality showed leadership in this category, which improved its results by more than 13 points compared to 2023 (2023—16.48, 2024—28.91).

The first figure (Figure 1) shows the percentage of municipal waste recycled compared to municipal waste generated. In 2022, it was more than 4 percent less than in 2018.

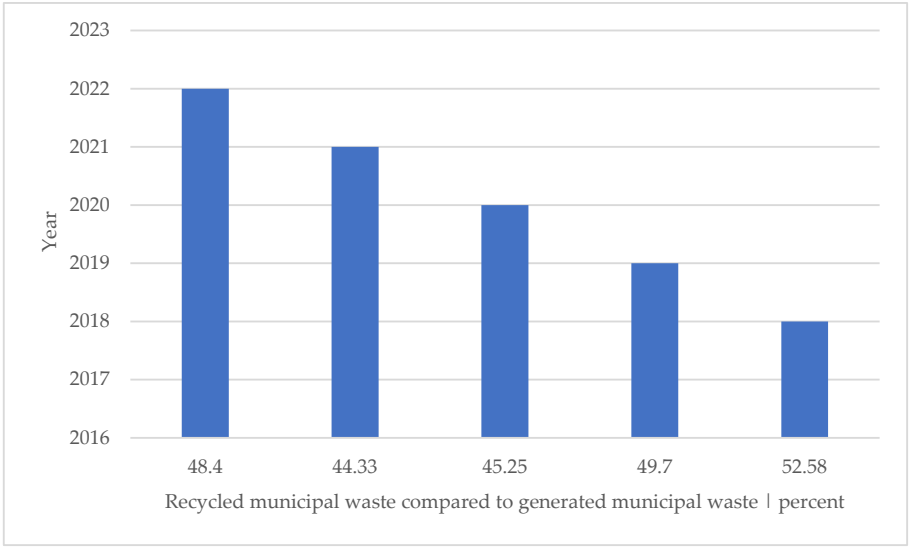

Figure 1. Recycled municipal waste compared to generated municipal waste | percent.

The interview consisted of 12 questions, which covered five topics: the country's legal environment, economic environment, social environment, environmental protection, and applied technologies. Expert opinions on sustainable waste management in the country differed slightly. All experts, when asked about their goals in waste management, identified the following essential goals: 1. to reduce environmental pollution; 2. to reduce the generation of waste; 3. to increase waste recycling; 4. to increase awareness of both residents and businesses; and 5 to sort, recycle, or reuse sorted waste. According to experts, recycling or reuse of waste contributes to the ecology of nature. Less waste ends up in landfills, energy is extracted, or it is simply reused. Waste sorting also provides a slight financial benefit, because, according to experts, you have to pay much less for sorted waste than for unsorted waste, and sometimes waste such as scrap metal or large-sized waste is even bought. However, experts note that many citizens, companies, and factories still avoid properly sorting or disposing of waste. There are also cases of illegal burying and the removal of waste in remote places. "It is a pity that not everyone understands the importance of sorting, I notice cases, and certainly not isolated ones, when construction waste is transported to the country's forests". "Of course, there is no way to change habits, and sorting is simply inconvenient and sometimes even illegal. The collection sites may

not be easily accessible to everyone, and additional funds need to be allocated for the management of certain wastes".

The regulation of waste management in Lithuania is regulated by both the European Union and national legislation. The experts singled out the following main documents: the Waste Management Law of the Republic of Lithuania, the EU Waste Directive (2008/98/EC), and the Law of the Republic of Lithuania on Packaging and Packaging Waste Management. Every municipality in the country prepares waste management plans and must ensure the proper functioning of the waste collection, sorting, and recycling system. There are also different ordinances for waste removal and waste management, depending on the category. However, as experts have noticed, there is a lack of regulatory instruments for promoting the responsibility of manufacturers (although the first steps are already being taken), re-processing and secondary use, and restrictions on landfills for waste disposal.

According to the data presented in the audit report of the State Audit Office, it was determined that national law does not ensure an effective infrastructure for waste management, does not adequately implement the compliance with the principles of zero waste when managing the generated waste streams (their separate types), and secondary waste sorting and recycling also remain problematic. In Lithuania, the focal point of the aforementioned problems continues to be the problematic solutions of legal regulation and practical implementation of municipal waste, especially textile waste.

All experts claim to see a major breakthrough in the development of waste management infrastructure: sorting containers, bulky waste sites, organic waste programs, re-sorting workshops, and their activities, and biodegradable waste collection sites. In addition to business taxes, experts unanimously agreed that residents have already gotten used to the deposit system, which has been operating in Lithuania since 2016. However, it suggests considering such taxes as landfill tax; waste disposal fee; subsidies for processed products; and the introduction of a pay-as-you-throw tax. Asked if they had suggestions for improving the waste infrastructure, the experts mentioned that it is necessary to reduce as much as possible the number of landfills in the country or to think about other forms (10 out of 15 experts), to tighten sorting responsibilities (14 out of 15 experts), and to raise awareness (15 out of 15 experts).

Currently, there are more than 60 recycling companies operating in Lithuania, and businesses create new products by processing one or another type of waste. Comparing 2020 with 2018, waste recycling increased in the glass sector in 2020. The biggest gap in recycling is observed in textiles and mixed waste. Experts note that one of the main factors determining the extent of waste recycling (of course, depending on the waste category) is awareness and developed habits. When talking about waste sorting and the benefits of sorting, all experts understand and describe it in the same way: waste management is the collection, transportation, processing, recycling, and disposal of waste. This activity is carried out in order to effectively manage waste and reduce its impact on the environment and health. Proper waste management reduces the risk of disease transmission through waste and ensures a cleaner and healthier living environment. Less impact on the environment: by separating secondary raw materials from general waste, the unit contributes to less use of landfills, fewer greenhouse gas emissions, and conservation of natural resources, reduces land use, and protects soil and water from pollution. Prevents pollution. "Proper disposal of hazardous waste, such as batteries, electronics, and medical supplies, protects the air, water, and soil from pollution by harmful substances". "Saves resources: recycling paper, plastic, glass and metals would reduce the need to extract and process raw materials, thus saving energy and natural resources". In addition, recycling and waste reduction efforts also reduce energy consumption and greenhouse gas emissions. Cost savings: efficient waste management can reduce municipal waste management costs.

Economic benefit: money saved: efficient management of household waste can reduce the costs of waste collection, transport, and disposal, which means it is possible to save money and use it more purposefully, for example, by purchasing new equipment. f we managed and managed our waste more efficiently, we would save a significant amount in the budget. Income from secondary raw materials: The sale of secondary raw materials can generate income to offset some of the costs of waste management systems. Education and awareness: Participating in waste management initiatives raises awareness of environmental issues and promotes a sustainable lifestyle. "I sort waste both at home and here, I don't see any problem with it, and I encourage my colleagues". "Fundamentally fective waste management not only contributes to a cleaner and safer environment, but also promotes community responsibility and sustainability".

When experts were asked if they sort waste at home, 15 out of 15 answered that they do. However, four experts shared their experiences when they did not pay much attention to it before and did not realize the extent of the damage. Several mentioned that there is an excellent educational program already in preschool education about waste, its sorting, the benefits of sorting, and the harm of waste. The experts did not elaborate on the aspect of resource conservation. Several emphasized (2 out of 15) that it is necessary to tighten the control of environmental care in order to prevent illegal waste management in places not designated for that purpose.

Unfortunately, the sorting and recycling of municipal waste is insufficient in Lithuania, because either there is not sufficient capacity or the available equipment is not capable (requiring modernization), so innovations (e.g., automated sorting centers, digital deposit machines) are introduced into waste management technologies; waste collection systems unequivocally contribute to the cohesion of the country.

In the questionnaire, the experts were presented with four tables with identical sets of four criteria, which the experts evaluated according to four different alternatives: waste prevention, reuse, recycling, and optimization of landfills. Experts were asked to evaluate the importance/impact of the criterion when applying sustainable waste management measures as an alternative. In the study, weights and ranks were assigned to each of the criteria. The reliability of the weights was checked by calculating the consistency coefficient (see Table 4).

Table 4. Pairwise Comparison of Criteria.

	Waste Prevention Measures	**Waste Reuse Measures**	**Waste Recycling**	**Landfill Optimization**
Waste prevention measures	1	0.20	0.20	0.25
Waste reuse measures	5	1	4.00	5.00
Waste recycling	5	0.25	1	0.2
Landfill optimization	4	0.20	5.00	1

Where λ_{max} = 4.02, *RI* = 1.12, *CR* = 0.01 (<0.1). Similar calculations were used in Tables 5–8 and their values for *CR* are calculated in a similar way.

Table 5. Weights of waste prevention measures contributing to sustainable waste management criteria.

Criteria	Weight (Rank)
Economical	0.1523 (3)
Social	0.1632 (2)
Environmental protection	0.5427 (1)
Technologies	0.1418 (4)

Table 6. Waste reuse measures contributing to sustainable waste management criteria weights.

Criteria	Weight (Rank)
Economical	0.1688 (3)
Social	0.1257 (4)
Environmental protection	0.5027 (1)
Technologies	0.2028 (2)

Table 7. Weights of waste recycling measures contributing to sustainable waste management criteria.

Criteria	Weight (Rank)
Economical	0.1997 (3)
Social	0.1240 (4)
Environmental protection	0.3512 (1)
Technologies	0.3251 (2)

Table 8. Landfill optimization measures contributing to sustainable waste management criteria weights.

Criteria	Weight (Rank)
Economical	0.2802 (2)
Social	0.2253 (3)
Environmental protection	0.3520 (1)
Technologies	0.1425 (4)

When experts assess the importance of the criteria for the application of waste prevention measures, environmental protection (impact on the environment) is chosen as the most important criterion (0.5427). Experts rated technology as the least significant criterion (technologies used, modernity). After calculating the reliability coefficient of the results, it was found that the reliability coefficient = 0.0538. Since 0.0538 < 0.1, the presented evaluations can be considered reliable.

When experts assess the importance of the criteria for the application of the waste reuse measure, environmental protection (impact on the environment) stands out as the most important criterion (0.5027). Experts rated social (impact on health, well-being) as the least significant criterion (0.1257). After calculating the reliability coefficient of the results, it was determined that the reliability coefficient = 0.0327. Since 0.0327 < 0.1, the presented evaluations can be considered reliable.

When experts assess the importance of the criteria for the application of the waste reuse measure, environmental protection (impact on the environment) stands out as the most important criterion (0.5027). Experts rated social (impact on health, well-being) as the least significant criterion (0.1257). After calculating the reliability coefficient of the results,

it was determined that the reliability coefficient = 0.0327. Since 0.0327 < 0.1, the presented assessments can be considered reliable.

When experts assess the importance of the criteria for the application of the landfill optimization tool, environmental protection (impact on the environment) is selected as the most important criterion (0.3520). Experts rated technology (the modernity of technologies used) as the least significant criterion (0.1425). After calculating the reliability coefficient of the results, it was found that the reliability coefficient = 0.0753. Since 0.0753 < 0.1, the estimates presented can be considered reliable.

When experts evaluate the importance of the criteria for the optimization of landfills, environmental protection (impact on the environment) is the most important criterion (0.3520). Experts rated technology (0.1425) as the least significant criterion. After calculating the reliability coefficient of the results, it was determined that the reliability coefficient = 0.0841; since 0.0841 < 0.1, the presented evaluations can be considered reliable.

In today's world, the issue of sustainability and nature conservation has grown dramatically and become a necessity. Limitations in resources, climate warming, and the scale of urbanization have forced us to look at the changing world differently. In the world, there are many indexes evaluating waste management, such as countries in the Global Waste Index 2022, where the best three positions are shared by the following countries: South Korea, Denmark, and Germany. The 2024 Environmental Performance Index (EPI) lists the leading countries as Luxembourg, Austria, and Switzerland. Lithuania ranks 16th in waste management, 141st in waste generated per capita, 44th in controlled solid waste, and 18th in waste recovery rate. However, a complex systemic approach is missing. Further areas of this research could be the creation of a complex sustainable waste management model (for a separate waste category) and the creation of an evaluation instrument for cities/countries/regions in terms of waste management.

5. Conclusions

After analyzing the scientific literature, sustainable waste management can be defined as waste management in environmentally friendly, economically viable, and socially acceptable ways. Sustainable waste management is ensured by awareness among individuals, the development of habits, and, of course, all political, legal, and management measures. Sustainable oil management ensures less environmental pollution and improves personal health. However, there are still many gaps in Lithuania, both political and economic, which must be corrected to achieve the goal. Although the current shifts towards coherence are visible, legal regulation is expanded, educational programs are applied, infrastructure is expanded, innovations are introduced, and more and more waste is processed every year. Sustainable waste management is a fundamental area of environmental protection that aims to ensure that waste is managed in a way that has minimal impact on the environment, conserves natural resources, and reduces adverse effects on human health. To achieve sustainable waste management results, it is necessary to combine legal, economic, social, and environmental environments. Only by combining these environments can a sustainable waste management system be created that reduces environmental impact and contributes to circular economy goals. Sustainable waste management has great potential for development in both technological, social, and economic aspects. Investments in innovation, infrastructure, and education are necessary to ensure that Lithuania can further strengthen its waste management system and contribute to the circular economy goals. A modernized and efficient waste management system can not only reduce environmental pollution but also create new business opportunities and contribute to more sustainable economic development.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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