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WASTE MANAGEMENT AS AN ELEMENT OF REVERSE LOGISTICS IN THE CIRCULAR ECONOMY

Irina Solomatina
Lithuania Business College

Abstract
This article examines waste management and recycling as an element of reverse logistics in a circular economy. The concept of circular economy can be found very often in scientific and social environment. The aim of the article is to analyze the trends of waste management and recycling as a reverse logistics element in the conditions of circular economy in Europe and Lithuania. To achieve the goal were done: an analysis of theoretical sources to reveal the essence and connections of reverse logistics and circular economy, analysis of LR and EU legislation, development strategies of the environmental protection and waste management sector, analysis of EUROSTAT statistical data, monitoring, situation assessment and questionnaire survey. The main goals of the circular economy model are less raw materials, less waste, less emissions, managing such elements as raw materials, sustainable design, production, distribution, consumption, reuse, repair, collection, waste management, and residual waste. Direct logistics processes and reverse logistics play really important role in this concept. Logistics examines the movement of material, financial and information flows from the source of raw materials to the end user, reverse logistics examines the same flows, only in the opposite direction. Reuse, repair, collection, waste management are on responsibility of reverse logistics. For this reason, waste management in the terms of a circular economy cannot be seen only as the responsibility of the government and the end user (the resident sorting the waste). All participants in the supply chain, who were interested in bringing the material flow to the end user, and who created added value in the supply chain, according to the "polluter pays" principle, should take responsibility for the waste generated in the country, waste management and sorting, recycling. Because, for example, prevention of waste generation is a priority, and the cheapest solution is to avoid waste management and recycling. Thus, all participants in the supply chain must be interested and cooperate in the implementation of the circular economy. The general trends in the collection of the main sorted waste in Europe and Lithuania are not unambiguous, since waste management is regulated by different local laws of the countries. A general increase in the amount of sorted and collected waste is recorded, but not all countries demonstrate an increase, this may be related to the elements of the circular economy that have already been implemented, public awareness, declining consumerism, the economic situation in the country and other factors that lead to a generally more responsible approach to ecological aspects. EU newcomer countries are characterized by large increase in waste collection, regardless of waste types. Consumer opinion is quite favorable to the implementation of circular economy principles, but the main idea is that most of the responsibility for waste collection and management must be transferred to commercial participants in the supply chain.
KEY WORDS: reverse logistics, circular economy, waste management, supply chain

Introduction

Modern society accepts quite favorably the changes that taking place in the last few years in the environmental protection and waste management sector. It is necessary to examine waste management from point of view of the reverse logistics, because this activity belongs to reverse logistics, as and collection, repair, utilization, recycling, etc. In principle, society is the end user of production, but giving full responsibility to the end-user for post-consumer waste is a wrong approach.

The relevance of the article is certainly understandable, the circular economy is already an inseparable part of business and public life today. Solutions are already being integrated and implemented. Reverse logistics plays a very important role in the circular economy, because the main elements are precisely the limits of responsibility of reverse logistics, including waste management.

The problem of the article is formulated from the position that the essential role of the end-user as a participant in the supply chain in the primary sorting of waste is insufficient for the consistent implementation of the circular economy.

The subject of this article is waste management and recycling as an element of reverse logistics.

The purpose of the article is to investigate the trends of waste management and recycling as a reverse logistics element in the conditions of the circular economy in Europe and Lithuania.

Tasks to achieve the goal:

- To present the theoretical aspects of waste management and recycling as a reverse logistics element in circular economy terms.
- To carry out an analysis of the current situation of waste management and recycling as an element of reverse logistics in the terms of a circular economy in Europe and Lithuania (observation, statistical analysis, questionnaire survey)
- Anticipate unused opportunities for reducing, collecting and sorting municipal waste in Lithuania to implement the principles of circular economy.

To analyze waste management as an element of reverse logistics in the circular economy, to determine the current situation, trends, perspectives and applicability, the following research methods were used:

- analysis of relevant literature sources, the latest scientific insights and legal acts,
- monitoring the current situation in the country and identifying trends
- overview of waste management practices and strategies

• analysis of statistical information on waste collection in the EU and in the country

• assessment of the public's attitude towards waste sorting in circular economy conditions by means of a questionnaire survey.

Theoretical framework

Essential assumptions of reverse logistics

In general, reverse logistics is the process of planning, realizing and controlling material flow that is suitable for reuse and recycling. The goal of reverse logistics is repair, recycling, redelivery or disposal. So far, society has not paid enough attention to reverse logistics. Reverse logistics is often viewed in a fragmentary ecological aspect, although reverse logistics can help companies reduce losses and increase revenues. The modern world is seriously concerned about the problems of nature protection, they are really very important. Companies must plan their supply chains, both direct and reverse, by assessing ecological requirements both in the purchase of raw materials and in production, and in the distribution of products to consumers.

There is more than one definition of the term "logistics", and there is no single definition of "reverse logistics".

The table shows the evolution of reverse logistics definitions.

Table 1. Evolution of the definition of reverse logistics

Year	Authors	Definition of reverse logistics
1993	R.J.Kopicki, M.J.Berg, L.L.Legg, V.Dasappa, C.Maggioni	Reverse logistics is a process by which companies can become greener by recycling, reusing and reducing number of raw materials used. In a narrow sense, reverse logistics can be understood as the reverse distribution of materials to channel members (Kopicki et al. from Carter, Ellram, 1993)
2004	J. Blackburn, D.Guide, G.Souza, L.Van Wassenhove	Reverse logistics is the transportation of products to the point of inspection, sorting and disposal (Blackburn et al. 2004)
2010	B.Beškovnik, L. Jakomin	Reverse logistics consists of reverse distribution and includes the transportation of used products and the movement of waste (Beškovnik, Jakomin, 2010)
2013	Council of Supply Chain Management Professionals	Reverse logistics is a specialized segment of logistics focused on product movement and resource management after sales and delivery to the customer. Includes product return for repair and/or credit (Council of Supply Chain Management Professionals, 2013).
2017	Supply Chain Management Association	Reverse logistics – the entire supply chain for the reverse flow of products and materials - return, repair, rework and/or recycling (APIS, 2017)
2018	Y.Wang, S.Peng, KAssogba, Y.Liu, H.Wang, M.Xu, Y.Wang	Reverse logistics - the reverse flow of unused and unusable products from customers to the point of origin for disposal or recycling. In general, reverse logistics is used to recycle used products when a company is concerned about environmental issues, or to collect goods from customers for a new distribution cycle. (Wang Y. et al., 2018)
2024	Anon, S.Y.; Amin, S.H.; Baki, F	Reverse logistics is an essential type of supply chain that can reduce a lot of waste generated from the disposition of products. Sustainable growth and reverse logistics help achieve efficient remanufacturing processes and play pivotal roles in having closed-loop supply chains, stimulating the recovery and recycling of products and reducing harmful wastes. (Anon, S.Y.; Amin, S.H.; Baki, F., 2024)

The concept of reverse logistics has been around for about three decades, and during that time it has developed very intensively. First, it is not reverse logistics, but the return of products. According to Starostka-Patryk and Nitkiewicz (2014), who studied the development of reverse logistics, some authors used the term "reverse distribution" instead of "reverse logistics", but with an equivalent meaning. According to authors Blackburn et al. (2004) reverse logistics includes only the transportation process. However, definition of reverse logistics has become more common in the last decade. Reverse logistics is understood as a strategy that involves a series of operations after products have completed their traditional life cycle. Logistics is called "reverse" because the informational, material and financial flows of the product are opposite to the traditional flow of the supply chain - that is, from the customer to the place of origin or processing (Banguera, et al. 2017; Beškovnik et. al., 2010). Beškovnik and Jakomin (2010) state that the entire process of reverse logistics can be divided into four main stages: collection, inspection, selection and sorting stage, processing and finally, redistribution.

Considering the aspiration to efficiently use natural resources and ensure their conservation for future generations, the term "green logistics" is often encountered. However, researchers do not consider reverse logistics to be the same as "green logistics". It is believed that reverse logistics is the starting point of development of "green logistics". Reverse logistics includes the movement of the returned product from the consumer to the producer, product sorting, recycling and disposal, while "green logistics" environmental issues such as pollution and environmental problems caused by inappropriate logistics processes and the use of old, environmentally unfriendly transport technologies (Beškovnik et. al 2010). Reverse logistics is used to solve various tasks - container returns, repairs, processing, utilization, etc. The price of material flow, sales volume, distribution channels are very important. Reverse logistics also provides economic benefits in terms of less raw material procurement, inventory control and landfill by setting strategic locations for collection centers, reprocessing centers, remanufacturing and transportation (Fernando, et al., 2022). Reverse logistics is a strategy that focuses on the appropriate use of resources to mitigate environmental effects, regulate processes, and generate commitment on the part of companies as to the use and final disposal of the products they manufacture or market.

Reverse logistics contributes to increased demand for products and services since they can be developed with lower cost and impact on the environment. (Salas-Navarro et al., 2024). Reverse logistics is necessary for the solution of many business tasks:

• refunded products for processing (seasonal, defective, cancelled, surplus, etc.),

• for ecological initiatives,

• for repair, recycling,

• outdated waste disposal,
• for the disposal of hazardous and electronic waste.

Of course, return rates vary greatly depending on the type of production. Reverse logistics is an essential type of supply chain that can reduce a lot of waste generated from the disposition of products. Sustainable growth and reverse logistics help achieve efficient remanufacturing processes and play pivotal roles in having closed-loop supply chains, stimulating the recovery and recycling of products and reducing harmful wastes. (Anon, et al., 2024). Ecology is another term that was introduced due to changing priorities. Ecology envisages the minimization of ecological consequences in the operation of logistic systems. For example, reducing energy consumption and minimizing the use of raw materials. In today's world, ecological aspects influence many decisions in logistics. A lot of produce can't just be thrown away, forcing companies to collect their unrealized, expired products. There are limited waste disposals.

The essential principles of the circular economy and the importance of waste management

The circular economy theory delineates a conceptual framework for global economic systems that prioritize developmental and restorative objectives (Feiferytė, Navickas, 2016; Yamoah et al., 2022). According to the report of the EU Parliament, about 2.2 billion tons of waste is generated annually in the European Union. The EU is currently updating waste management legislation to encourage member countries to move towards a more sustainable model known as the circular economy. In 2020 March, the European Commission unveiled a new Circular Economy Action Plan, which includes proposals for more sustainable product design, waste reduction and citizen empowerment (such as the "consumer right to product repair"). Special attention is paid to resource-intensive sectors related to electronics, plastics, textiles and construction. In contrast to the "take-make-throw" model established in society, the circular economy aims to reduce waste and resource use as much as possible through advanced product design, product reuse and repair, recycling, sustainable consumption and innovative business models that, for example, as an alternative to purchasing a product offers the service of renting, lending or sharing it. The main goals of the circular economy model are less raw materials, less waste, less waste, managing such elements as raw materials, sustainable design, production, distribution, consumption, reuse, repair, collection, waste management, residual waste. Reverse logistics plays a very important role in this concept. The success of designing for a circular economy is contingent upon the incorporation of diverse closed-loop system design methodologies (Seetharaman et al., 2022; Tan et al., 2022). Reusing and recycling products would slow down the use of natural resources, reduce the destruction of landscapes and habitats, and help limit the loss of biodiversity. Developing more efficient and sustainable products would help reduce energy and resource consumption, as it is estimated that more than 80% of a product's environmental impact is determined at the design stage. A shift to more reliable products that can be reused, refurbished and repaired would reduce waste. Packaging is also a growing problem and on average each European is responsible for nearly 180 kg of packaging waste per year. The aim is to combat the problem of excess packaging and improve its design to encourage reuse and recycling. The recycling of bio-waste from households is an essential factor in achieving the recycling quotas for municipal waste laid down by the EU. A major problem is posed by impurities in the bio-waste collected, such as plastics, metals and glass (Adam, et al., 2024).

As the world population grows, so does the demand for raw materials. However, the supply of basic raw materials is limited, and some EU countries are dependent on resources supplied by other countries. The extraction and use of raw materials has a significant impact on the environment. This increases energy consumption and CO2 emissions, and smarter use could reduce these numbers. Total value of trade in raw materials (imports and exports) between the EU and the rest of the world since 2002 has grown almost threefold, and exports are growing faster than imports. Despite this, the EU still imports more than it exports. For this reason, in 2021 the trade deficit amounted to 35.5 billion euros. Processing raw materials also reduces supply-side risks such as price volatility, availability and import dependency. This is especially true for key raw materials needed to produce technologies that are critical to meeting climate goals, such as batteries and electric motors (European Parliament, 2024).

Today, cities or municipalities consume close to two-third of the global energy, account for about 80 percent of the global greenhouse gas (GHG) emissions and produce more than 50 percent of the global waste. The rapid growth of the urban population has led to several environmental problems and challenges such as pollution, resource scarcity, and limiting aging infrastructure. Urban areas are often acknowledged as growth engines and are recognized as productive places for experimenting with alternative modes of service provision and public governance. (Heshmati, et al., 2021)

Repurposing materials and products for circular use would also stimulate innovation in various sectors of the economy. In 2021 The European Parliament approved the new circular economy action plan and called for the establishment of mandatory 2030 purposes of use and consumption of materials. In 2022 March the Commission has announced the first package of measures to accelerate the transition to a circular economy. The proposals include the promotion of sustainable products, a review of the Construction Products Regulation and a strategy for sustainable textiles (European Parliament).

The path of industrialization has been material and energy intensive. Profit maximization, fierce competition in the market, and a policy of a ‘race to the bottom’ combined with limited knowledge about environmental consequences have led to unsustainable development of production, distribution, and consumption. To solve this problem, sustainable development strategies, policies, and standards are being developing at the regional, national, and international levels. Their target is reducing the level of emissions to the 1990 level by 2030. Given the rapid population increases, biased fossil energy-based technology development, and a dominant focus on increased productivity, these goals are seen as coming

late and merely cosmetic aimed at only partially greening the market economy. (Heshmati, et al., 2021)

In 2022 November EU Commission has proposed new EU-wide packaging rules. They include suggestions for improving packaging design, such as clear labeling to encourage re-use and recycling. The rules also call for a shift to biodegradable and compostable plastics (European Parliament).

EU Circular Economy Action Plan

In keeping with the goal of the Green Deal by 2050 to neutralize climate impacts in 2022 March, the European Commission presented the first package, which also includes a circular economy action plan, which aims to accelerate the transition to a circular economy. In 2022 November, the European Commission published a second package, including a proposal for new EU-wide packaging rules and a proposal for EU carbon emissions certification. The third package was delivered in 2023 March, including a proposal to regulate corporate environmental claims and guarantee the right to repair. In 2023 July, the Commission proposed a revision of the Waste Directive to promote the sustainable management of textile and food waste, in 2022 October, during the plenary session, MEPs approved the revision of the regulations on persistent organic pollutants (POPs) (European Parliament).

The new rules will further reduce the amount of hazardous chemicals in waste and manufacturing processes by introducing stricter limits, removing pollutants from the recycling chain and banning certain chemicals. A circular economy has major benefits in four areas: environmental benefits, economic benefits, resource benefits, and social aspects. (Heshmati, et al., 2021)

To create an EU market for sustainable, climate-neutral and resource-saving products, the Commission proposes to extend the application of the Eco-design Directive to non-energy-related products and to create a digital product passport containing important information throughout the product's life cycle. It also supports improving the durability of products and the principle of "consumers' right to repair". Extended producer responsibility (EPR) is commonly implemented as a strategy in waste management. The core of the concept itself is a waste reverse logistics (WRL), which dictates how the collection, inspection and processing of end-of-life products are performed. Existing studies of EPR mainly focused on single products instead of using broader perspective on national level. Its contribution towards circular economy through slowing and closing the loops also has not been widely discussed. (Mayanti, et al. 2024)

The Parliament adopted the directive in 2024 April. The new rules should make it easier and cheaper to repair products than to buy new ones. In 2024 January, approved a temporary deal with the Council to update EU consumer rules that would stop "eco-manipulation" and provide consumers with more information about the durability of products. In 2024 March, the Parliament also adopted a position on the system for verifying companies' environmental claims. For a circular economy to be realized, sustainability must be integrated into all stages of the producer-consumer chain, from design to production and consumption (European Parliament, 2024).

The European Commission's plan aims to focus more on resource-intensive sectors with high circularity potential and calls for concrete action in areas such as plastics; textiles; electronic waste; food, water and nutrients; packaging; batteries and vehicles; buildings and construction.

The EP supports the European strategy on the role of plastics in the circular economy, which aims to phase out the use of microplastics. Textile production uses a lot of raw materials and water, but less than 1% of clothing worldwide is recycled. In 2022 March EU sustainable and circular textile economy strategy presented by the Commission aims to ensure that by 2030 Textile products placed on the EU market would be durable and suitable for recycling, made from as many recycled fibers as possible and without hazardous substances. The amount of electrical and electronic waste is growing the fastest in the EU, but less than 40% of it is recycled. The governments as actors can impose and enforce official order in the form of specific instruments or regulations that affect multiple actors. They can mandate producers to arrange a free-of-charge collection system which will affect the producers that have to bear the economic responsibility of collection and the subsequent treatment; hence, added fee is included at the point of sale (advanced disposal fee). This set of regulations from the government will be translated into strategies by the producers to meet extended producer responsibility requirements and advocate for consumers to participate accordingly (Mayanti, et al. 2024)

In the EU, 10% of all available food is wasted every year. MEPs call for by 2030 to halve this number under the Farm-to-Fork strategy. The amount of packaging waste in Europe is growing. One person in the EU in 2021 generated an average of 189 kg of packaging waste. In 2024 April, the EP approved an agreement reached with the Council on EU rules on packaging and packaging waste to reduce and improve the situation. MEPs have approved new rules requiring that batteries and accumulators supplied to the EU market should be sustainable, efficient and safe throughout their life cycle, and that their production should meet human rights and social standards. The construction sector accounts for more than 35% of all waste in the EU. The Commission has announced a review of the Construction Products Regulation to update from 2011 applicable rules. MEPs aim to extend the service life of buildings, reduce the carbon footprint of materials and set minimum requirements for resource and energy efficiency. In 2024 March, the Parliament approved the updated rules for the energy efficiency of buildings, which aim at to create a climate-neutral building sector.

It can be inferred that the shifting global scenario is

exerting an impact on the inclination toward transitioning

to a circular economy via cohesive and comprehensive

policy interventions (Chioatto et al., 2022; Awan et al. 2022).

Measures to reduce food waste

Food waste is one of the main obstacles to the implementation of the circular economy. It is estimated that around 10% of the food available to EU consumers is wasted, but there are more than 37 million in the EU people who cannot afford quality food every other day. Reducing food waste and food loss are two of the EU's main goals to achieve by 2050 create a circular economy.

Standardized portions and overestimated number of guests are among the causes of food waste in restaurants and catering establishments. According to a study by the European Commission, food waste is also caused by date marking on food, such as "Best before". A better understanding of labels can help reduce food waste by up to 10%. Reducing food waste is essential to managing climate change. It accounts for around 16% of all greenhouse gas emissions from the EU food system. According to the UN's Food and Agriculture Organization (FAO), the production and transport of food, which is then wasted, accounts for 8% of the world's greenhouse gases. Households and businesses could save money by reducing food waste (European Parliament, 2024).

EU legislation on reducing food waste.

The goals of the Farm-to-Fork strategy include clearer date labeling and curbing their misuse in to reduce food waste. As part of this strategy, the Commission will also investigate food losses throughout the food supply chain. Donating food is another way to reduce unnecessary food waste. EU food donation guidelines were adopted in 2017 to facilitate the recovery and redistribution of safe, edible food to those in need. In 2019 EU methodology was adopted to measure food waste at each stage of the food supply chain. A common methodology facilitates the monitoring and reporting of food waste across the EU (European Parliament, 2024).

Sustainable waste management.

2.1 billion tons of waste are generated annually in the EU. The amount of waste and its management methods vary widely in EU countries, but there is a noticeable shift towards more waste recycling and less disposal in landfills. Waste management practices vary across EU countries. The EU wants to promote waste prevention and reuse of products. If this is not possible, priority is given to recycling (including composting) and then using the waste to generate energy. The most harmful option for the environment and human health is to simply dispose of the waste, for example in landfills, although this is also one of the cheapest options. Even though the amount of waste per capita has increased, waste management has also improved, with more recycling and composting, and fewer landfills. 60% of municipal waste collected and processed by municipalities, according to EU goals, must be reused or recycled by 2030. According to the Landfill Directive, EU countries also have until 2035 reduce the amount of municipal waste disposed of in landfills to 10% or less of the total municipal waste generated (European Parliament, 2024).

Export of waste outside the EU

Part of EU waste is also exported. In 2022 export of EU waste to non-EU countries amounted to 32.1 million tons. This indicator increased by 3% compared to 2021.

Most of the waste exported outside the EU (55%) consists of metal (iron and steel) waste, which is mostly exported to Turkey. The EU also exported a large amount of paper waste (15%), with India being the main destination. In 2022 39% of EU waste went to Turkey (12.4 million tons), followed by India (3.5 million tons), United Kingdom (2 million tons), Switzerland (1.6 million tons) and Norway (1 .6 million tons). The EU wants to fight illegal exports and ensure that waste is managed in an environmentally friendly way in destination countries. In February 2024, the Parliament approved stricter rules for transporting waste to third countries. The rules will ban the export of plastic waste to non-OECD countries and introduce stricter conditions for exports to OECD countries. Export of waste to another EU country will be possible only in exceptional circumstances (European Parliament, 2024).

Packaging waste

Online shopping, takeout, food delivery only add packaging waste. Packaging comes in various formats (bottles, containers, cans, boxes, bags), is made of various materials (paper, cardboard, plastic, glass, wood, metal) and is used in all stages of production - from raw materials to processed goods. Manufacturers, transporters, supermarkets, restaurants, households - they all need packaging and use it to protect and transport goods. In general, packaging is products used to store, protect, handle, deliver or present goods. Logistics and marketing packages should be distinguished. They perform sufficiently different functions, but both logistic and marketing packaging are waste that must be properly sorted and disposed of, packaging is not related to the use or functionality of the product. Packaging comes at an environmental cost. In 2021 each EU resident generated an average of 189 kg of packaging waste. This amount has increased by more than 20% in ten years. 1 figure presents the dynamics of packaging waste in the EU in 2012 – 2021.

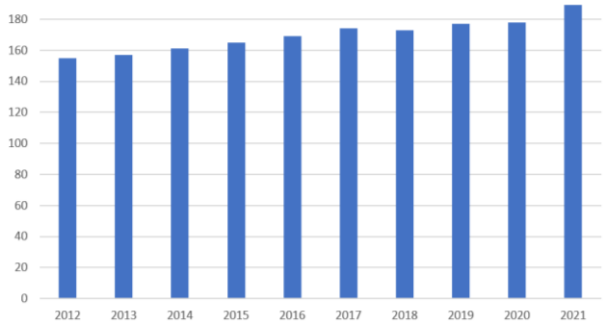

Fig. 1. Dynamics of packaging waste generated by each resident per year in the EU in 2012 – 2021, kg
Source: Eurostat database adapted by author

These numbers vary from country to country, from a minimum of 74 kg per person in Croatia to 246 kg per person in Ireland. On average, a Lithuanian resident generates 136.79 kg of packaging waste per year in 2021. In the EU, a total of 84.3 million tons packaging waste, i.e. 4.8 million tons more than a year ago. Paper and cardboard accounted for the majority (40.3%), followed by plastic (19%), glass (18.5%), wood (17.1%) and metal (4.9%). In 2021 about 64% of packaging waste was recycled and about 80% was used, i.e. the waste has been

processed in one way or another so that it can be useful in the future (this also includes recycling). Recommended a transition to bio-based, biodegradable, and recyclable plastics to mitigate packaging waste and enhance package design (Feiferytė and Navickas, 2016).

EU rules on packaging and packaging waste

EU regulations on packaging and packaging waste cover both packaging design and packaging waste management. They aim to harmonize national measures, prevent waste generation and increase reuse and recycling. In addition, they set the minimum requirements that packaging sold on the EU market must meet. These rules began to be applied in 1994, and in 2018 were changed. In order to achieve by 2050 move to a circular economy, in 2022 November, the Commission proposed a new revision of the rules. Parliament and the Council reached an agreement and MEPs approved it in 2024 April (European Parliament, 2024).

The aim of the rules is to reduce, reuse and recycle packaging and increase its safety and sustainability. A lot of attention is paid to plastic packaging, because it is particularly harmful to the environment.

The new rules:

• set packaging reduction targets (5% by 2030, 10% by 2035, 15% by 2040);

• from 2030 January will ban various types of plastic packaging, such as: very light plastic bags, plastic packaging for fresh fruits and vegetables, etc.

• from 2030 in January will ban persistent pollutants (also known as "permanent chemicals") used in fireproof or waterproof food packaging, which can affect health;

• promote re-usability and re-filling by setting specific reusable packaging targets for alcoholic and non-alcoholic beverages (at least 10% by 2030) and enabling consumers to bring their own food and beverage takeaway containers;

• require member states to promote the provision of tap water in restaurants, canteens, bars, cafes and catering establishments;

• will introduce stricter recycling criteria (European Parliament, 2024).

The role of food packaging is being developed in light of changing market conditions. (Lingaitienė, et al., 2023)

Consumers are willing to correctly dispose of the bioplastics, the availability of correct (and uniform) sorting instructions is crucial to reduce this confusion. One possible way of doing this could be for manufacturers to include a note on their product stating: ‘Biodegradability of this item does not imply a certain disposal route since this depends also on the existing waste treatment infrastructure and waste legislation. Please follow the waste sorting guidance in your region’. Additionally, having uniform sorting guidelines for a product throughout the country would also help in easing the confusion (Mhaddolkar, et al., 2024).

In general, a circular economy is considered as a development strategy which eases tensions between environmental concerns and economic development. Circular economy can also help consider pollution problems and resource scarcity and it enables green competitiveness (Heshmati, et al., 2021).

A cleaner and sustainable environment is becoming a topmost priority for both owners and stakeholders involved in businesses. It could be achieved by adopting better sustainable practices like reduction in waste through process of recycling, recovery and remanufacturing which helps to minimize both the cost and environmental losses (Dutta, et al., 2020)

Methodology

To analyze waste management as an element of reverse logistics in the conditions of circular economy, to determine the current situation, trends, perspectives and applicability, the following research methods were used:

• Monitoring the current situation in the country and identifying trends

• Overview of waste management practices and strategies

• Analysis of statistical information on waste collection in the EU and in the country

• Assessment of the public's attitude towards waste sorting in circular economy conditions with the questionnaire survey.

The monitoring of the current situation in the country and the identification of trends are carried out in accordance with the legal acts valid in the region, according to the publicly published information in the domain database of the ministry, according to the publicly available data of the institutions responsible for waste management in the country. Analysis of statistical information on waste collection (main types of waste, plastic, glass, paper and cardboard, directly related to end users) is performed according to Eurostat data, Lithuanian Statistics Department data, according to officially published and publicly available information.

The review of strategies is carried out according to the plans of the Ministry of Environment.

The assessment of public opinion is carried out with the help of a questionnaire survey, presenting 20 questionnaire and open questions to a random group of respondents (100 respondents/households), systematizing and summarizing the obtained data, clarifying the connections between variables.

Results

Monitoring the current situation in the country and identifying trends

It was decided to examine the current situation in the country according to the valid legislation and regulations, according to the activities and results carried out. Pursuant to the Law on Local Self-Government and Waste Management, the implementation of municipal waste management systems, the organization of the collection and processing of secondary raw materials, the installation and operation of landfills is an independent function of municipalities, and municipalities administer the provision of municipal waste management services. Municipal waste management service is a public service that includes municipal waste collection, transportation, use, disposal, organization of these activities, monitoring, and subsequent supervision of disposal sites. Pursuant to the Law on Waste Management, municipalities in Lithuania must ensure that the municipal waste management service is universal, of good quality,

accessible (affordable) and meets environmental, technical-economic and public health safety requirements. The capacity of waste collection facilities and the frequency of waste collection from waste collection facilities are determined in such a way as to meet the need for the collection of municipal waste generated by the waste holder, and can be determined individually, depending on whether the waste is sorted and composted at the place of its generation. The capacity of waste collection containers and the minimum frequency of waste collection (or emptying) are discussed in the contract between the waste manager and the municipality or administrator (hereinafter referred to as the contract). If there is no contract, the capacity of the collection facilities and the frequency of waste collection from the waste collection facilities shall be determined by the municipality in the waste management rules. Mixed municipal waste in Lithuania is collected in waste collection containers for mixed waste or by other means separately from other waste. The minimum collection of mixed municipal waste from waste collection facilities must be carried out at least once a month. Municipal waste management must be organized in such a way as to encourage the use and recycling of waste. Municipalities, applying various methods and measures of waste collection, must ensure that in the municipal waste management systems they manage, when individuals sort waste at the place of their generation, the following municipal waste is separately collected: hazardous waste; biodegradable waste (green waste and food/kitchen waste); secondary raw materials - paper and cardboard, glass, plastic, metal, including packaging waste; electrical and electronic equipment waste; used tires; bulky municipal waste (for example, furniture and others); construction and demolition waste; textile waste; mixed municipal waste (waste remaining after sorting).

Municipal waste and its management.

According to official sources, in Lithuania in 2022 a total waste was 6.8 million tons. 1.3 million tons was municipal waste generated in the household, i.e. average is about 475 kg per inhabitant of the country. Municipal waste is the type of waste that is generated in households. In 2022 of all generated municipal waste, was 718 thousand tons more than half was mixed municipal waste, i.e. the majority of which are not suitable for recycling or reuse. Municipal waste consists of waste that can be recycled and reused. These are secondary raw materials and packaging waste. Secondary raw materials are paper, glass, plastic and metal waste, which can be recycled into new products. Packaging waste is packaging made of various materials, intended for wrapping, protecting, transporting and presenting products to consumers. It should be remembered that there are logistic and marketing packages. About 15% of municipal waste in 2022 were removed to landfills, about 40% were recycled, and about 35% were burned for energy. The share of this waste disposed of in landfills would not exceed 5%, the share of waste prepared for reuse and recycled until 2035 would be at least 65%. For this, measures must be provided to encourage residents to reduce the generation of waste, to properly sort it, and after sorting, the remaining waste would be managed in accordance with the hierarchy (fig.2) of its management.

Fig. 2. Hierarchy of waste management
Source: European Parliament, 2024

The container system is primarily used to collect municipal waste from residents. Residents of apartment buildings throw mixed waste into mixed waste containers and sorted secondary raw materials and packaging waste into paper, plastic-metal and glass, and residents can also bring them to waste collection sites. In some municipalities, used clothes that are still suitable for use are collected in special closed containers. Containers for mixed waste are issued to residents of individual houses. At their request, containers can also be issued for green waste, glass, general containers for paper, plastic and metals.

Separately collected recyclable waste is additionally sorted before recycling, separating those parts that cannot be recycled. This waste is burned in power plants or disposed of in landfills. In most cases, waste suitable for recycling is only prepared (shredded, pressed) and then exported abroad according to EU practice. Such waste includes metal waste and textiles. Part of the waste is processed in Lithuania. Colored bottle glass shards are used as raw material. They are processed by the “Kauno stiklas” company. Paper waste is processed by the “Grigeo” company. Used electrical and electronic equipment is disassembled, shredded and separated into recyclable components. The most difficult situation is in the field of plastic waste recycling. Business representatives are usually only interested in recycling clean plastic production waste. Of the separately collected municipal plastic waste, only polyethylene film and PET bottles are recycled after additional sorting. A large part of food packaging made of polypropylene and polystyrene remains unrecycled. This is a big problem, and it's not just the end users who need to be concerned with solving it. Now the largest plastic waste processor in Lithuania is the company “Plasta”. Waste that is not suitable for disposal in the household waste container can be delivered free of charge to bulky waste collection sites. They can carry hazardous waste, dismantled furniture, wood, household appliances, electronics, construction, textiles, batteries and accumulators, metal, glass, paper, plastic, daylight lamps, mercury-containing waste, as well as tires (but only 4 pcs. per year).

Construction, repair and demolition waste, i.e. concrete, bricks, ceramic and stone mass tiles, ceramics, double-glazed windows, reinforced glass, mirrors, crystal, laminate, linoleum, plasterboard, glass wool, stone wool, carpets, mattresses, soft furniture parts cannot be thrown or left near household or other sorting containers. They must be brought to the waste collection sites or delivered to the waste handlers handling such waste after payment.

Waste electrical and electronic equipment, i.e. all devices that require an electrical network, batteries or electromagnetic fields to operate, as well as those devices that are designed to create, transmit, measure those currents and fields - must be taken to waste collection sites or electronic equipment distributors (electronic stores), if that waste have the same purpose as products sold by distributors. To remove bulky equipment, residents can call electrical and electronic equipment handlers to remove this waste from their homes. Small electronic waste can be disposed of in designated bins in many supermarkets and large stores.

Old portable batteries and accumulators can be taken to waste collection sites (bulky waste collection sites), battery collection buckets located at distribution points of such products, shopping centers, offices, educational institutions, as well as organizations. Scrap metal i.e. non-ferrous metal waste (aluminum, copper scrap, lead, brass), scrap metal from cars (batteries, starters, generators, gearboxes, aluminum turbine parts), copper wires and cables, car cables, ferrous metal must be delivered to waste collection sites or to official waste managers. Medical waste, i.e. human and animal health care and related research waste - can be collected, transported and processed by companies licensed for such activities. It is forbidden to throw medicines and medical waste into municipal waste containers. Citizens can return unused (expired) medicines that are no longer needed at any pharmacy throughout the country for free.

Mixed municipal waste is sent to mechanical-biological treatment facilities. Mixed municipal waste from households, i.e. those not sorted by residents are sent to mechanical-biological treatment facilities for secondary sorting. Those wastes that can be used as raw materials are mechanically separated, all others are diverted to cogeneration power plants as fuel to obtain energy, and non-burnable waste to landfills. The Ministry of the Environment informs that waste that cannot be used as secondary raw materials or to obtain energy is disposed of in landfills. The Ministry also emphasizes that disposal of waste in landfills is the lowest priority waste management method, therefore only those wastes that can no longer be processed or otherwise used must be disposed of. For a long time, the only waste management method in Lithuania was its disposal in landfills, and before the changes in the waste system began in 2000. more than 900 landfills operated in the country. Since 2007 11 regional modern non-hazardous waste landfills with gas collection and filtrate treatment systems have been put into operation in Lithuania. In 2009, the old district and municipal landfills were closed and recultivated. The amount of waste disposed of in landfills is decreasing. The State Audit Office informs that due to the mechanical and mechanical-biological treatment and new incineration facilities that started operating in the regions, the disposal of municipal waste in landfills from 2014 to 2021 decreased more than 3.5 times (from 58.85 to 15.36%). In turn, the ministry announces that by 2035 in Lithuania, no more than 5% of all generated waste can be disposed of in landfills. It is also emphasized that currently the development of landfills is not encouraged and supported with state funds. In the state audit report "Municipal Waste Management" prepared by the State Audit Office, it is emphasized that the municipal waste collection system in Lithuania needs to be improved.

Despite the fact that the share of the population sorting municipal waste increased from 40 % (2016) to 60 % (2021), and awareness in the field of waste management in 2015 – 2021 fluctuated around 74 % – 80 % during the period, due to poor waste sorting, the share of secondary raw materials included in the composition of mixed municipal waste did not change and is about 33 %. Without ensuring proper waste sorting at the place of their generation, the goals set for municipal waste recycling will not be achieved. Attention is also drawn to the fact that the mixed municipal waste collected in municipalities is not weighed or its quantity is not otherwise recorded at the time of collection, so that residents are assigned the actual amounts of waste to be managed, therefore it is not ensured that the fee for the management of this waste will encourage proper sorting of waste and thus reduce the amount of mixed municipal waste amount of waste. It is also emphasized that due to improper waste sorting, 33% of the waste in mixed municipal waste consists of packaging, the handling of which must be paid for by manufacturers or importers, in accordance with the requirements of legal acts. Therefore, the costs of handling packaging that ends up in mixed municipal waste are actually paid by the residents. It is also emphasized that the municipal waste management system would be more efficient if the residents were given the conditions and motivated to sort waste properly, and it would also be ensured that the collected waste was processed and organized in accordance with the hierarchy of their management.

Analysis of statistical information on waste collection in the EU and in the country

To comprehensively assess the dynamics, trends, dependencies, achievements, and effectiveness of waste collection in Europe in general and in the country under consideration, statistical data analysis is also carried out in the study, and reports are submitted according to EUROSTAT. Some data tables are very massive and are not presented due to the limited scope of the article, but the data are described. Waste collection data are provided in EUROSTAT for the period 2004-2020, the resource does not provide more recent data. The following types of waste were chosen for the study - paper and cardboard, glass and plastic, these are the wastes that are generated in households, if they are collected properly, they can be efficiently recycled, these wastes mainly make up packaging.

Paper and cardboard waste.

Analyzing the trends of paper and cardboard waste collection in Europe, the following important data have been collected. Total amount of paper and cardboard collected in Europe in 2004 - 2020 remained almost unchanged, i.e. the change was just 2%. Also, if the entire time interval is examined, clear downward trends are identified. 3 figure shows the total amount of paper and cardboard waste collected in European countries in 2004 – 2020.

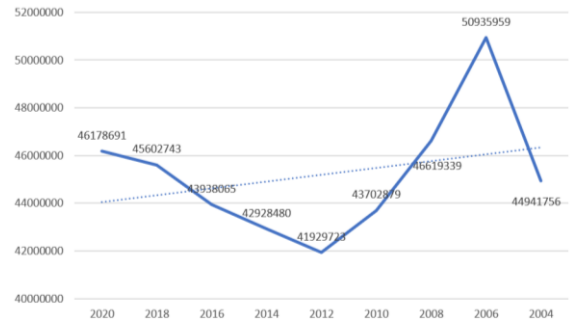

Fig. 3. Total amounts of paper and cardboard waste collected in European countries in 2004 - 2020, tons
Source: Eurostat database adapted by author, 2024

The countries where the largest amounts of paper and cardboard waste were collected in 2020 are Germany, France, Italy Spain, Belgium, these countries together collected 59% of the total amount of paper and cardboard waste collected in Europe. It is important to mention that changes in waste collection data need to be evaluated together with changes in the population in the country, political decisions made during the examined period, etc. In the analyzed dataset, countries that are not members of the EU, joined the EU in 2004 or later, in those countries the increases in the amount of waste collection during the considered period are the largest. For example, the amount of paper and cardboard waste collected in Slovakia increased by as much as 391% between 2004 and 2020. i.e. from 76080 to 373980 tons, in Bulgaria 353%, in Poland 315%, in Turkey 252%, in the Czech Republic 183%, in Lithuania 173%, in Iceland 169% and in Croatia 125%. Other countries also stand out with increases in their paper and cardboard waste management indicators, i.e. Malta 63%, Slovenia 49%, Portugal 38%, Italy 34%, Greece 28%, Belgium 26%, Austria 12%, Spain 2.6%. Romania's data did not change overall during the considered period, i.e. 0.49 %, but the year 2006 was marked by a large increase and a clear downward trend (fig. 4).

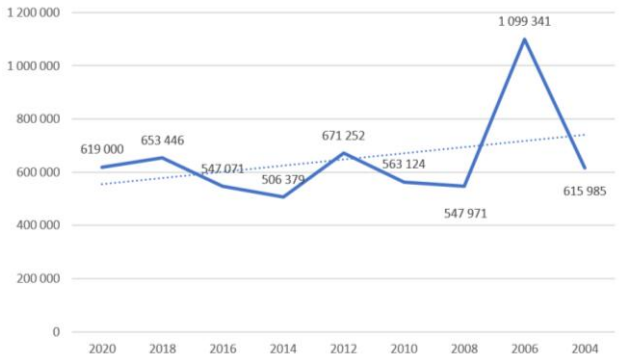

Fig. 4. Paper and cardboard waste collected in Romania in 2024-2020, tons
Source: Eurostat database adapted by author, 2024

Countries such as Serbia, North Macedonia, Bosnia and Herzegovina, Montenegro, and Liechtenstein are difficult to assess objectively, since Eurostat data are not available since 2004 and later, in 2008-2012.

Figure 5 shows the countries where the amount of collected paper and cardboard waste decreased from 2004 to 2020.

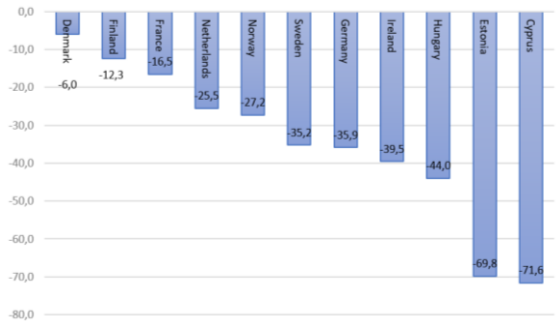

Fig. 5. Countries and the decrease in the amount of collected paper and cardboard waste 2004-2020, %
Source: Eurostat database adapted by author, 2024

As mentioned, the amount of paper and cardboard waste collected in Lithuania in 2004-2020 increased by 173%, i.e. from 74862 tons to 204991 tons. The diagram 6 presents the dynamics of paper and cardboard waste collection in Lithuania. A rhythmic growth dynamic is discernible.

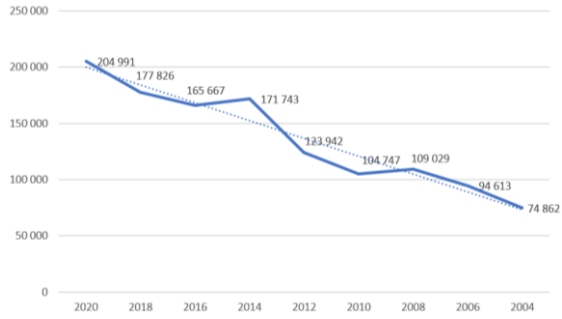

Fig. 6. Paper and cardboard waste collected in Lithuania in 2004-2020, tons
Source: Eurostat database adapted by author, 2024

Glass waste

Analyzing the trends of glass waste collection in Europe, the following important data are generally available.

Total amount increase of glass waste collected in Europe during 2004 – 2020 was 40%, i.e. from 12786476 tons to 18012473 tons. The dynamics of the increase are presented in 7 figure, clear increasing trends are visible.

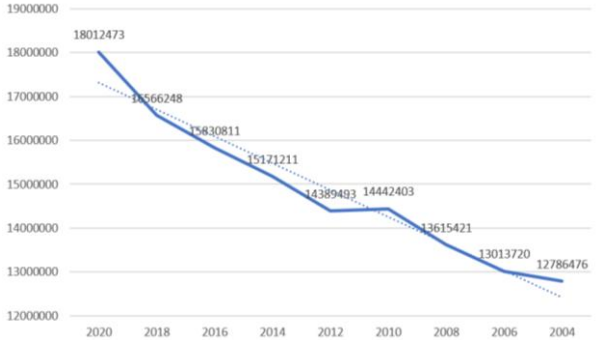

Fig. 7. Total amount of glass waste collected in Europe during 2004 – 2020, tons
Source: Eurostat database adapted by author, 2024

The countries where the largest amount of glass waste was collected in 2020 are Germany, Italy, France,

Belgium, Poland, these countries together collected 40% of the total amount of glass waste collected in Europe. The largest increases in the amount of glass waste collection during the considered period were achieved by Bulgaria 2307%, Malta 1874%, Slovakia 687%, Croatia 272%, Poland 254%, Belgium 206%, Latvia 160%, Italy 120%. Other countries also stand out with increases in their glass waste collection rates, where the percentage of increase is in the range of 100-0 %. These countries and indicators are shown in figure 8.

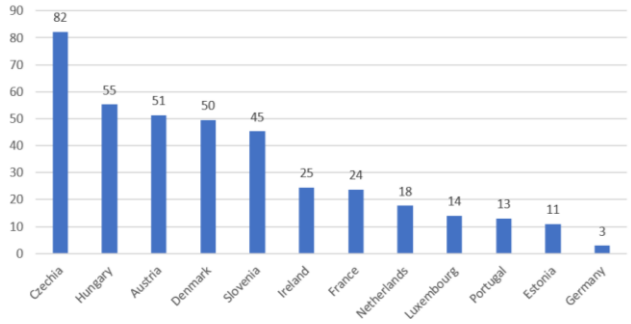

Fig. 8. Countries and percentage of increase in glass waste collection in 2004-2020
Source: Eurostat database adapted by author, 2024

The following figure 9 presents the dynamics of glass waste collection in Portugal in the years 2004-2020, as the increase in glass waste collection in this country in 2008 stands out among other countries in the entire analyzed data array. In general, according to the data, a decreasing trend can be seen.

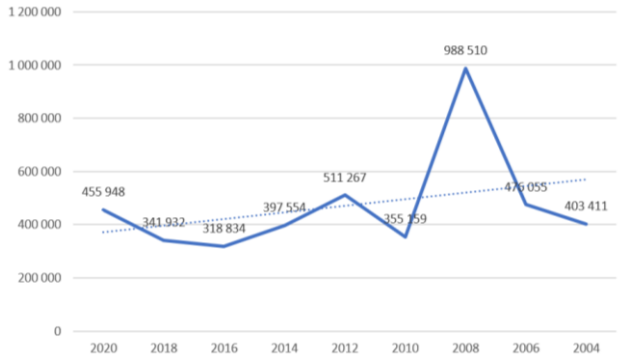

Fig. 9. Dynamics of glass waste collection in Portugal in 2004-2020, tons
Source: Eurostat database adapted by author, 2024

The figure 10 shows the countries where the amount of collected glass waste decreased between 2004 and 2020.

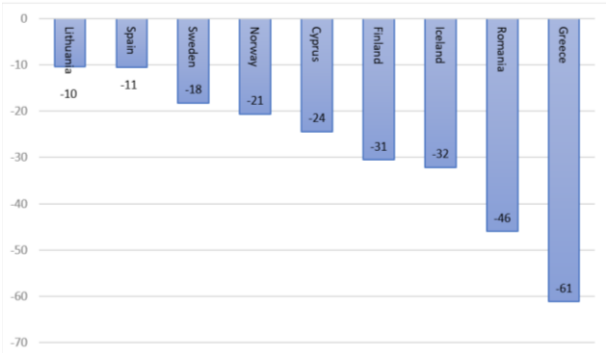

Fig. 10. Countries and percentage of glass waste reduction in 2004-2020, tons
Source: Eurostat database adapted by author, 2024

Countries such as Lithuania (-10%), Spain (-11%), Sweden (-18%), Norway (-21%), Cyprus (-24%), Finland (-31%) Iceland (-32%), Romania (-46%) and Greece (-61%) demonstrate a decrease in the amount of glass waste collection.

As mentioned, the amount of glass waste collected in Lithuania decreased by 10% between 2004 and 2020, i.e. from 105142 tons to 94129 tons. The diagram 11 presents the dynamics of glass waste collection in Lithuania. The chart also shows a general downward trend.

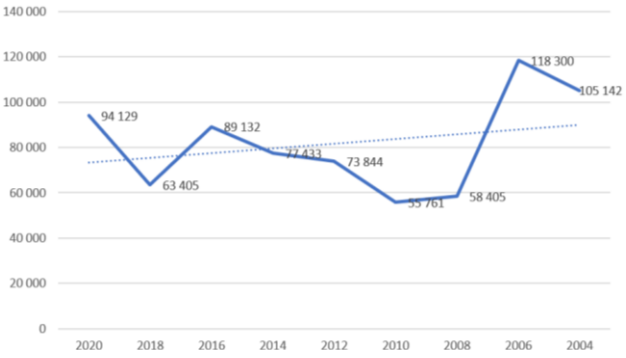

Fig. 11. The dynamics of glass waste collected in Lithuania 2004- 2020, tons
Source: Eurostat database adapted by author, 2024

Plastic waste.

It is emphasized that the summarized table of plastic collection in Europe in 2004-2020 is not presented in this article due to its large volume. Analyzing the trends of plastic waste collection in Europe, the following important data are generally available. Total plastic collected in Europe increased by 105% between 2004 and 2020.

Figure 12 shows the total amount of plastic waste collected in European countries in 2004 - 2020. A clear upward trend is visible, the collected quantities only increased every year.

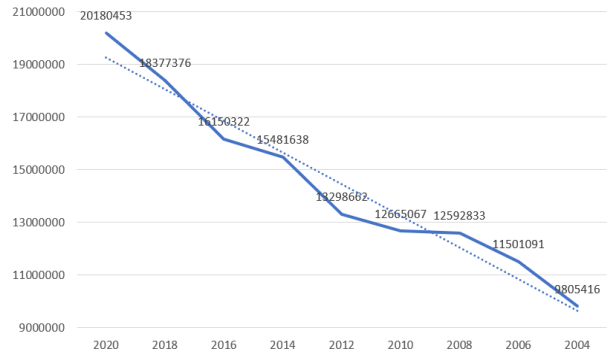

Fig. 12. The total amount of plastic waste collected in European countries in 2004 – 2020, tons
Source: Eurostat database adapted by author, 2024

The countries where the largest amount of plastic waste was collected in 2020 are Italy, Germany, France, Poland, Belgium, these countries together collected 67% of the total amount of plastic waste collected in Europe. It is important to mention that changes in waste collection data need to be evaluated together with changes in the population in the country, political decisions made during the examined period, etc. In the analyzed dataset, countries that are not members of the EU, joined the EU in 2004 or later, in those countries the increases in the amount of waste collection during the considered period are the largest. For example, the amount of waste collected in Poland increased by 1044% between 2004 and 2020. i.e. from 195685 to 2238779 tons, in Bulgaria 730%, in Lithuania 524%. Other countries also stand out with increases in their plastic waste management indicators, i.e. Slovakia 369%, Norway 350% Turkey 270%, Italy 247%, Czech Republic 229%, Germany 172%, Denmark 158%, Sweden 109% Iceland 102%

Countries such as Serbia, North Macedonia, Bosnia and Herzegovina, Montenegro, and Liechtenstein are difficult to assess objectively, since Eurostat data are not available since 2004. and later, in 2008-2012.

The figure 13 shows the countries where the amount of collected plastic waste increased to 100% between 2004 and 2020.

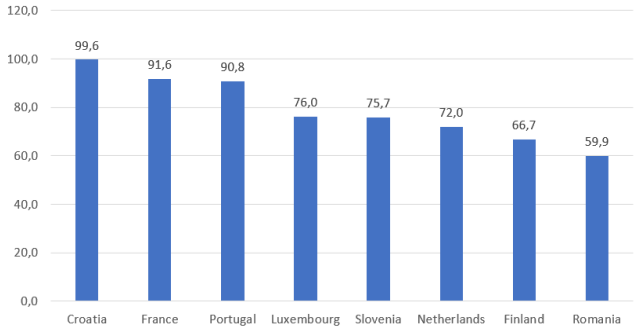

Fig. 13. Countries where the amount of collected plastic waste increased to 100% in 2004-2020.
Source: Eurostat database adapted by author, 2024

The decrease in the amount of plastic waste collection is demonstrated by countries such as Belgium (-25%), Spain (-27%), Austria (-32%), Ireland (-36%), Estonia (-41%), Greece (-51%) , Cyprus (-77%).

As mentioned, the amount of plastic waste collected in Lithuania in 2004-2020 increased by as much as 524%, i.e. from 17687 tons to 110399 tons. The diagram 14 presents the dynamics of plastic waste collection in Lithuania. Clear upward trends are visible, and the increase is recorded every year throughout the entire considered period.

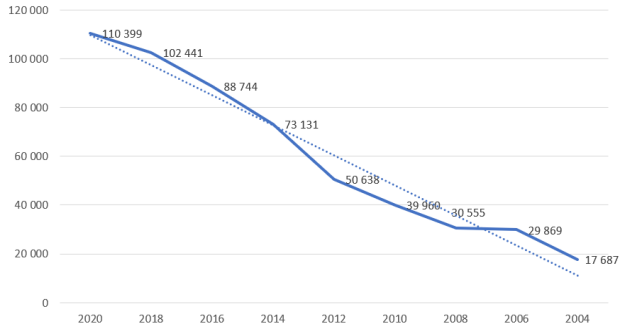

Fig. 14. Dynamics of plastic waste collection in Lithuania in 2004-2020, tons
Source: Eurostat database adapted by author, 2024

Evaluation of the public's attitude towards waste sorting in the conditions of a circular economy by the questionnaire survey

In general, it can be stated that society has a sufficiently favorable view of the principles of the circular economy and realizes its responsibility in the implementation of changes. The majority of respondents belongs to the age group of 35-45 years, women who raise children, have higher education, work, are socially active, have average and higher incomes, i.e. a part of society that is often responsible for household maintenance, takes care of food and other household supplies, makes basic purchases for the family, and is also responsible for waste management in the family.

During the research, the dependences between the income received and the benevolent involvement in the household waste sorting process become apparent. i.e. the higher-income part of society is more interested in sorting waste benevolently and free of charge.

Respondents (70%) consider fines for improper waste sorting to be an unfounded measure and deny the effectiveness of financial fines for improper disposal of stocks. Delivering waste to waste collection sites, according to 65% of respondents, can be a challenge, as well as the limited amount of waste per inhabitant, which can be delivered free of charge per year to waste collection sites, negatively affects the efficiency of such a scheme, according to 45% of respondents. The lower income segment of society tends to benefit financially from proper waste management. It can also become a source of small income by helping to sort waste.

The main reasons why there is no favorable attitude towards free waste sorting are as follows: lack of time, busyness, there is no organized waste sorting area in residential premises (home), waste sorting habits have not been formed, lack of information, it is physically inconvenient to reach the waste collection point (containers). Even 46% of the respondents claim that purchasing waste, even at minimal rates, is an untapped opportunity in waste management. Most of the

respondents confirm that the participants of the supply chain, first retail trade, must provide conditions and be interested in waste sorting, i.e. a greater variety of containers and packaging must be returned for recycling for a fee specifically at retail outlets, as is done with deposit plastic packaging that is suitable for beverages. It should be noted that not only plastic packages are used for drinks, but there are also other liquid products sold in small plastic containers. Respondents (78%) strongly support standardized deposit packaging in retail. Here, the responsibility of the manufacturer arises even before the product is placed on the market. Thus, it can be said that the regulation of production activities, indicating the standards for production packaging, has a sufficiently large contribution to the implementation of the circular economy. Respondents (64%) welcome the possibility to buy liquid and non-food products using their reusable containers. According to the respondents, the implementation of this measure is even delayed, it could have been implemented several years ago. The majority of those surveyed (82%) agree with the manufacturer regarding the tightening of measures to ensure product quality and durability. 94% of the respondents agree with the statement that the user must be fully enabled to carry out high-quality product repair. The interviewees emphasize that now, repairs and warranty service in retail are performed quite problematically (71%). 98% of respondents agree with the statement that repair should be more financially beneficial than purchasing a new product. According to the respondents, the textile waste collection system should also be improved (93%). Even 69% of respondents do not sort textile waste at all. This is a very undeniable sign. Solutions i.e. special containers for textiles and the possibility of delivery to retail clothing sellers at points of sale (for giving a corresponding discount on the next purchase) do not work. In this area, there is a clear lack of public information and promotion, according to 67% of respondents. The majority of respondents (86%) agree that end-user waste is not only the responsibility of end-users, but of the commercial intermediaries of the entire supply chain. The "polluter pays" principle must be directed at the intermediaries of the supply chain, not the end user, but the end user must be responsibly provided with favorable conditions, without coercive actions and restrictions. Waste management habits of society must be developed both in the family and in educational institutions, starting with preschool institutions. Here, decisions on solutions must be taken by education specialists, and a clear and consistent plan of actions and measures must be drawn up. All of them must reflect the importance of circular economy and waste sorting.

Conclusions

Waste management is important topic in the modern world, when resource conservation and ecological aspects become particularly important. The world's growing consumerism is becoming a negative phenomenon and must be managed in a way that conserves resources. The implementation of the circular economy aims at exactly such goals, i.e. less raw materials, less waste, less emissions by managing such elements as: raw materials, sustainable design, production, distribution, consumption, reuse, repair, collection, waste management, residual waste control. Reverse logistics plays a very important role in these aspirations, as reverse logistics is an entire supply chain dedicated to the reverse flow of products and materials - return, repair, rework and/or recycling. Waste management is also a reverse logistics task. Reverse logistics involves the movement of returned product from consumers to the manufacturer, product sorting, recycling and disposal. Often, reverse logistics is associated with the return of only low-quality material flow, but a truly unexploited opportunity in reverse logistics is the return of any product, whether it is a fragment of a product, whether it is parts, waste, etc. into the supply chain. Reuse, repair, collection, waste management are only the responsibility of reverse logistics. For this reason, waste management in circular economy conditions cannot be seen only as the responsibility of the government and the end-user (resident sorting waste). All participants of the supply chain, who were interested in bringing the material flow to the end-user and who created added value in the supply chain, according to the "polluter pays" principle, should take responsibility for waste generated in the country, waste management and sorting, recycling, as an extreme option. Because the prevention of waste generation is a priority, and the cheapest solution to avoid waste management and recycling. A shift to more reliable products that can be reused, refurbished and repaired would reduce waste. EU regulations on packaging and packaging waste cover both packaging design and packaging waste management. They aim to harmonize national measures, prevent waste generation and increase reuse and recycling. Food waste is one of the main obstacles to the implementation of the circular economy. In implementing the goals set by the EU circular economy regarding municipal waste management, Lithuania aims to have by 2030 the share of this waste disposed of in landfills would not exceed 5%, the share of waste prepared for reuse and recycled until 2035 would be at least 65%. For this, measures must be provided to encourage residents to reduce the generation of waste, to properly sort it, and after sorting, the remaining waste is managed in accordance with the hierarchy of its management, i.e. prevention, preparation for reuse, recycling, utilization (energy recovery), disposal. Certain conditions have been created for the society for the proper sorting of waste, but those measures are insufficient, as demonstrated by the household’s survey. Some measures are considered overdue, for some types of waste, e.g. favorable conditions for collection of textiles are not created, tools such as deposit packaging, which have proven to be excellent for plastic collection, are not used, proper waste sorting is encouraged by fines that do not materialize and do not cause internal motivation, waste weight restrictions are used, complex independent waste transportation, etc. In general, the topic of waste management is dynamic topic, new strategies, legal acts, rules are foreseen and approved in it, the monitoring of the situation should be continuous, assessing the public's reaction to the adopted changes.

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Nekilnojamojo turto objektų, kurių savininkas arba įgalioti asmenys privalo mokėti nustatytą rinkliavą arba sudaryti komunalinių atliekų tvarkymo paslaugos teikimo sutartį, rūšių sąrašas. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.443603/hcMrcSGQPH?positionInSearchResults=4&searchModelUUID=6a1cd897-f9c2-4ba2-aa3b-80d4bed34407

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Vietinės rinkliavos ar kitos įmokos už komunalinių atliekų surinkimą iš atliekų turėtojų ir atliekų tvarkymą dydžio nustatymo taisyklės. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.454394/ulQqAtMmvU?positionInSearchResults=0&searchModelUUID=6a1cd897-f9c2-4ba2-aa3b-80d4bed34407

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Irina Solomatina, Lithuania Business College, Associate Professor. Master degree "Organization of International Transportation" Vilnius Gediminas Technical University 2006. Field of scientific research: logistics, reverse logistics, modern logistics principles, global logistics, transport logistics, optimization of supply chain, sustainable logistic, sustainable mobility. Address: Turgaus St. 21, Klaipėda LT-91249, Lithuania, +37067237161. irina.solomatina@ltvk.lt, https://orcid.org/0009-0007-9991-242X