The Importance of the Deposit-Return System of Packaging in the Circular Economy System: Slovak Innovation Experience for Ukraine

Iryna Reshetnikova [1,*], **Vanda Lieskovska** [2], **Olha Polous** [1], **Viliam Murin** [2]

[1] National Aviation University, Ukraine
[2] University of Economics in Bratislava with seat in Kosice, Slovakia
[*] Corresponding author: Iryna Reshetnikova, reshet2002@gmail.com

Type of manuscript: Research paper

Cite as: Reshetnikova, I., Lieskovska, V., Polous, O. & Murin, V. (2025). The importance of the deposit-return system of packaging in the circular economy system: Slovak experience for Ukraine. *Marketing and Management of Innovations*, *16*(1), 1–14. https://doi.org/10.21272/mmi.2025.1-01

Received: 19 August 2024
Revised: 21 December 2024
Accepted: 10 March 2025

Publisher & Founder: Sumy State University

Abstract: The purpose of this study is to generalize the existing theoretical approaches to the organization of the RPS deposit system and analyse the successful experience of their implementation in Slovakia with the aim of spreading them in Ukrainian realities. For decades, the management of food and beverage packaging waste has been a significant concern, closely tied to the circular economy and sustainable development. Effective waste collection systems are crucial for these goals, and they have garnered support from both global governments and leading companies. In Ukraine, the issue has become particularly pressing due to ongoing military conflict, with a large portion of the country both occupied and overwhelmed by waste. The lack of modern waste processing facilities exacerbates this problem, which Ukraine must address as it seeks EU membership. The European Union has long established legislation, such as Directive 94/62/EU, to regulate packaging waste, encouraging preventive measures and the reuse of packaging. Successful models from EU countries, such as Slovakia's deposit system for bottles and cans, offer practical solutions that could be adapted to Ukraine's context. The study employed methods of analysis, synthesis, and content analysis to explore DRS models across Europe and used panel regression analysis in R software to examine factors influencing municipal waste recycling in Slovakia. The research tested two hypotheses: one linking the volume of municipal waste processing to population income levels in Slovakia and another suggesting that the Slovak deposit return system (DRS) model could be optimal for Ukraine because of similarities in consumer behavior and market conditions. The results confirm that higher income levels are associated with lower municipal waste production, reflecting the influence of lifestyle and consumer behavior. In Slovakia, material incentives and the cost of deposit packaging are crucial motivators for waste collection, especially given the relatively lower incomes than those of other European countries. The research highlights that collecting used beverage packaging is crucial for managing household waste and supporting a circular economy. Deposit return systems (DRSs) have proven effective in many EU countries and are gaining popularity. The Slovak DRS model, involving the widespread use of vending machines in retail stores and balanced incentives across the beverage supply chain, is effective and could serve as a model for Ukraine, as it aligns its systems with EU standards.

Keywords: circular economy; cooperation; deposit-refund systems; extended producer responsibility; municipal waste; retail; returnable packaging.

Funding: This contribution is part of the solution to the grant project of the Ministry of Education of the Slovak Republic VEGA no. 1/0450/24 entitled Adaptation of the Slovak retail industry and the consumer to a dynamically changing environment.

1. Introduction. The problems associated with the processing and use of food and beverage packaging waste have remained relevant in recent decades. Waste collection in supply chains is an effective mechanism for ensuring the functioning of the circular economy in society, which ultimately affects the success of compliance with the principles of sustainable development. These ideas are supported by the governments of the world's leading countries and the European Union, and the world's leading companies are trying to join the principles of the circular economy and orient their business models and product design accordingly.

The problem of waste collection and processing became particularly relevant in Ukraine during military operations. According to the experts, "approximately 18% of Ukraine is currently occupied by the aggressor's troops, but almost 7% of the territory of our country is occupied by garbage". In addition, there are practically no modern waste processing plants in the country, which makes it possible to generate secondary raw materials and reduce the volume of waste disposal (Konsort.com.ua). At the same time, Ukraine's status as a candidate for EU membership requires it to bring this problem into line with European requirements. Attention has increasingly focused on environmental packaging legislation in EU Member States, with an emphasis on limiting the generation of packaging waste. As early as 1994, the European Parliament and the Council of the European Union adopted Directive 94/62/EU of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste. This was in response to a request from member countries to establish a system to guarantee the return of used packaging and packaging waste. This guide is updated regularly to take into account social, economic and environmental changes, as well as new scientific advice and evidence. EU legislation does not claim to address all aspects of these problems, but Directive 94/62/EU in Article 4 calls for preventive measures and supports the reuse of packaging. The specific form of implementation was left to the discretion of Member States. Several EU member states have adopted specific government measures to support reusable packaging, which mainly target manufacturers, wholesalers and retailers.

EU rules on packaging and packaging waste apply to both packaging design and the handling of packaging waste. Their goal is to solve the problem of growing amounts of packaging waste that cause environmental problems. Therefore, gradually, the countries of the European Union are implementing beverage packaging collection systems one by one, ensuring the implementation of one of the key processes of the circular economy. In European countries, there are various models of plastic collection systems and mechanisms for encouraging market relations. One of these mechanisms involves the introduction of a deposit system for glass, plastic and aluminium cans. The positive experience of the operation of such a system in Slovakia, which has achieved high efficiency, can be useful and interesting for Ukraine because of the similarity of culture, consumer behaviour and the economic level of society.

Moreover, it is worth noting that previous academic works have underscored the importance of transitioning from a linear economy to a circular economy, with particular attention given to sustainable packaging solutions. Previous studies have identified the efficient collection and processing of beverage packaging as a central mechanism for supporting circular economy principles. Researchers have extensively examined Deposit-Refund Systems (DRSs), revealing their effectiveness in multiple European contexts and highlighting the importance of adapting these systems to cultural and economic conditions. Comparative analyses indicate that balancing the interests of manufacturers, retailers, consumers, and policymakers is vital for maximizing the benefits of circular models. Furthermore, practical insights drawn from the experiences of EU Member States, including Slovakia, provide valuable guidance for countries such as Ukraine, as they seek to align with European waste management and sustainability standards, which makes the chosen research topic relevant.

2. Literature Review. The concept of the circular economy (CE), which replaced the linear economy, gained popularity during the last decade in connection with the spread of ideas of sustainable development and protection of the environment from excessive solid waste pollution. However, the increase in publications on this topic indicates that it has become an independent branch of scientific research. The vast majority of scientists consider the CE in connection with the concept of the sustainable development of society.

In particular, Geissdoerfer et al. (2017) and Nazir & Capocchi (2024) focused their attention on the study of similarities and differences between the concepts of the CE and sustainable development. A systematic review of the literature on these issues by Nazir & Capocchi (2024) included 145 articles and 20 reports from leading organizations. They also note that many practitioners and organizations apply CE principles in the manufacturing and service sectors for sustainable development, leading to better use of resources and services, as evidenced by financial and nonfinancial reporting.

The essence of the concept of the CE has been explored in works (Kirchherr et al., 2017), which cite 114 definitions of the circular economy, which are classified according to 17 dimensions, indicating that the

circular economy is most often depicted as a combination of reduction, reuse and recycling activities; thus, very often, it is not emphasized that the CE needs systemic change. The main goal of the circular economy is economic prosperity, followed by environmental quality; however, its impact on social justice and future generations is under researched.

Korhonen et al. (2018), investigating the essence of CE, noted that the model of linear flow of resources in the economy, which dominated general development, caused serious damage to the environment. In contrast, the circular economy approach, which is focused on practical policy and business, emphasizes product, component and material reuse; remanufacturing; refurbishing, repairing, cascading and retrofitting; and the use of solar, wind, biomass and waste energy in the entire product value chain. Murray et al. (2017) believe that the concept of a circular economy should be considered from a broad perspective: as an economic model where planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being. Webster (2021) also noted the global nature of the consequences of implementing circular economy ideas. The vast majority of scientists believe that the circular economy is an effective mechanism for achieving the sustainable development of society.

Research (Lewandowski, 2016; Blomsma & Brennan, 2017; Korhonen et al., 2018; Bocken et al., 2016) has focused on the analysis of specific concepts and business models of the CE. In particular, the Ellen MacArthur Foundation (EMF, 2019) provides a visualization of the effect of the circular economy in the form of a butterfly model.

The basic process of the circular economy is the establishment of a system of collection and processing and the reuse of solid household waste throughout the entire value chain of the product and its consumption. In this context, it is important to find a balance of interests between all the subjects of the logistics chain, which includes manufacturers, distributors, retailers, consumers, waste collectors, and their processors (Batista et al., 2019; Berardi & de Brito, 2021; Skrypko et al., 2021).

Velenturf et al. (2019) call for the integration of economic, social and environmental motives in the management of business support for the transition to a circular economy. (Reshetnikova et al., 2021) noted that the effect of the integration of the CE with business processes extends beyond purely economic evaluation.

Among the factors motivating the application of CE principles in business processes, in addition to economic factors, many scientists name reputational and social responsibility factors. In particular, this aspect was studied previously (Aguilera-Caracuel & Guerrero-Villegas, 2018; Ali et al., 2020; Buglewicz, 2017; Gazzola et al., 2023; Liczmanska-Kopcewicz et al., 2019). Attention is also given to the moral aspect of the CE (Gregson et al., 2015).

Returnable packaging systems (RPSs), which are related to the production and consumption of food products and use reusable containers, are also of interest to scientists and practitioners. In particular, the role of formal and informal collection schemes has been studied (Alemu, 2017; Barford, 2020; Barford & Ahmad, 2021; Gall et al., 2020). Deposit-refund systems (DRSs) are considered one of the most effective collection methods for beverage packaging. Their varieties are considered by (Zhou et al., 2020). The results of the analysis of the European DRS models of ten countries, namely, Croatia, Denmark, Estonia, Finland, Germany, Iceland, Lithuania, the Netherlands, Norway and Sweden, as well as the costs of their operation are given by Calabrese et al. (2021). The use of the DRS in the context of the distribution of responsibility between the producer and the consumer has been investigated (Ramasubramanian et al., 2023).

The role of retail in the functioning of DRSs was analysed previously (Raible et al., 2024). They compare the costs of a DRS organization with its benefits; explore the factors that influence the motivation of retailers and consumers to implement a collection system for plastic, glass and aluminium bottles; and emphasize the need to combine their interests to improve the effectiveness of DRSs. Jarossova & Gubiniova (2022) analysed the Slovak experience on the basis of the results of the year of DRS application. The leading retail chains operating in the country were selected as the objects of the study.

The analysis of literary sources devoted to the topic of the paper shows that, despite numerous publications on the conceptual problems of CE and the interest shown by business associations and politicians, the unresolved issues of balancing the interests of the participants of the logistics chain in RPS and the optimization of DRS schemes while taking into account the peculiarities of the environments of specific countries encourage further research. Such studies become especially relevant in anticipation of Ukraine's accession to the European Union, where on the one hand, there are quite high requirements regarding the

multiple uses of packaging materials, and on the other hand, many years of experience in the effective functioning of the RPS system in various countries have already accumulated.

3. Methodology and research methods. The research used primary and secondary methods. The observation method was used as the primary research method. The purpose of the observation was to identify problems of consumers and retailers with the return of glass, plastic bottles, and aluminium cans to deposit return machines. Vending machines are located in Lidl, Billa, Kaufland, Tesco, and Fresh (Slovakia) store chains. Observations were carried out from January to March 2024 in supermarkets where food products are sold and in which machines are installed to return deposits to consumers when glass, plastic bottles and aluminium cans are returned.

The sources of secondary research were scientific articles indexed in the Scopus and Web of Science Core Collection databases; reviews and reports of specialized organizations related to the problems of the circular economy and the functioning of the deposit return system; Eurostat data; and information from companies' websites. Methods of analysis and synthesis were applied to summarize the theoretical aspects of the CE and DRS. The study also uses content analysis to study DRS models in European countries, which involves obtaining structured information from unstructured texts. To identify the factors influencing the volume of municipal waste recycling, the panel regression method was used. The analysis was carried out in R software via the plm package for panel regression via the Hausman test. The primary data used to obtain the dependence data were statistical data from the Statistical Office of the Slovak Republic. Panel regression simultaneously accounts for both cross-sectional and time series variations, allows control for unobserved regional heterogeneity, and captures dynamic relationships between municipal waste volumes and income levels over time, which makes it an ideal method for conducting research in this case.

The following assumptions are proposed as research hypotheses:

- There is a dependence between the volume of municipal waste processing and the level of income of the population (in the conditions of the Slovak market).
- The Slovak BRP mechanism, which is based on the leading role of retail in the logistics chain of product creation and distribution, is optimal for the Ukrainian market environment on the basis of the cultural, economic and behavioural similarities of Ukrainian and Slovak consumers.

Therefore, the purpose of this study is to investigate the relationship between municipal waste processing volumes and population income in Slovakia and to assess the applicability and effectiveness of the Slovak beverage return packaging (BRP) mechanism for the Ukrainian market, taking into account the cultural, economic, and behavioural similarities of consumers in both countries.

4. Results. An analysis of scientific sources regarding the functioning of returnable packaging systems (RPSs) reveals that scientists distinguish between formal and informal packaging collection schemes. Informal schemes operate in countries with a low standard of living and underdeveloped economies, mainly in Africa, Asia, and Indochina (Barford & Ahmad, 2021). They were investigated previously (Wilson et al., 2006; Sembiring & Nitivattananon, 2010; Velis, 2017; Gall et al., 2020), which emphasized the need to integrate separate garbage collectors and used packaging materials into state waste management systems. In countries with a higher economic level, which also includes European countries, more formalized and established solid waste collection schemes are characteristic. The level of formalization, the specific mechanisms of RPS organization, the effectiveness of RPS functioning and compliance with the interests of society depend on many factors. (Gonzalez-Moreno et al., 2024) pay attention to the influence of cultural factors, the state of the regulatory framework in society and the level of entrepreneurship. Gregson et al. (2015) address the moral aspect of the operation of an RPS, as informal schemes are often associated with shadow business. Instead, (Beswick-Parsons et al., 2023) noted that while the success of reuse initiatives is often attributed to increased levels of environmental awareness, understanding national variations in reuse levels requires greater attention to commercial factors, regulatory factors and enforcement systems, in which they arise.

Therefore, on the basis of the generalization of the theoretical aspects of RPS construction outlined in the works of the abovementioned scientists, the following factors were identified that determine the scheme of its construction and the effectiveness of its operation: economic, ecological, political (stability in society and political attitudes), legal (level of the regulatory framework and business transparency), level of entrepreneurship, level of social consciousness and responsibility in society, level of cohesion of society and its individual communities.

With respect to the organization and effectiveness of RPS systems, it is important to note the problem of the distribution of responsibility between individual participants of the entire logistics chain, starting from the creation of product design and ending with its consumption and waste processing. Extended producer

responsibility (EPR) initiatives have shown success in enhancing the independent collection of plastic waste, but the existing recycling industry framework poses challenges for achieving optimal recyclability levels. To address this issue, various legislative strategies, including nonprofit EPR, door-to-door collection systems, and deposit refund schemes (DRSs), have been implemented in some countries, such as the UK and Germany. Plastic waste management responsibility is shared between consumers and producers in Europe, with consumers generating 40% of plastic waste and producers being responsible for the remaining 60% (Ramasubramanian et al., 2023).

Recently, external pressure on participants in the supply chain of the plastic packaging sector has increased due to adoption by the European Commission of stricter requirements for the functioning of the single European market. In April 2024, the EU Parliament approved new rules for reducing, reusing and recycling packaging (New EU rules for reducing, reusing and recycling packaging):

– All EU countries must achieve a 5% reduction in packaging waste by 2030 compared with 2018, then a 10% reduction by 2035 and a 15% reduction by 2040;

– ban on certain single-use plastics. From 1 January 2030, certain types of single-use plastic packaging, including plastic bags used for unprocessed fresh fruit and vegetables or packaging for food and drinks consumed in cafes and restaurants, were banned;

– recyclable packaging. Under the new rules, almost all packaging will have to be recyclable. All plastic packaging must contain a minimum percentage of recycled content from plastic waste. EU countries will have to take measures to achieve concrete recycling targets for packaging waste;

– collection systems for recycling. By 2029, 90% of single-use plastic and metal beverage packaging will have to be collected separately, ensuring efficient recycling processes.

In connection with this, individual countries and territorial communities take on additional obligations to collect plastic waste and recycle it (Ellen MacArthur Foundation, 2024). Subjects include polymer manufacturers, plastic processors, brand owners (that is, a company that markets a product using plastic packaging), retailers, consumers, waste collectors, sorters and waste processors (Stumpf et al., 2023).

The next study will focus on deposit refund schemes since they are the most widespread in the countries of the European Union. Deposit-refund systems (DRSs) are among the most effective methods for collecting one-way beverage packaging. However, analyses of their operating modes and related cost burdens for each actor are still evolving (Calabrese et al., 2021). In their research, the mentioned scientists analysed the organizational models of DRS in ten European countries, in which it was already functioning at that time, namely, Croatia (HR), Denmark (DK), Estonia (EE), Finland (FI), Germany (DE), Iceland (IS), Lithuania (LT), the Netherlands (NL), Norway (NO) and Sweden (SE). For this, three basic blocks of analysis were chosen: process participants (processes) – DRS operators, manufacturers, retailers and customers – monetary and material flows between them (mode of operation), as well as costs and revenues for each (cost burden) of the sub- objects. The best result was achieved in Germany, where 98% of single-sided plastic packaging was returned to the appropriate collection points. The case of Germany shows how historically determined elements of supply systems, particularly the cooperative wholesale model and bottle pool management, are aligned with the commercial interests of regional beverage producers. This created a level of reproduction through vested interests and mutual role expectations between SMEs and reuse infrastructures, representing a level of "organizational capital" (Beswick-Parsons et al., 2023).

The success of DRS depends on the interaction of chain participants, their motivation and the involvement of each of them in the process. All stakeholders, from manufacturers to end-of-life deployment, must work together towards a shared objective of creating a waste-free circular economy that benefits everyone. (Ramasubramanian et al., 2023). Berardi & de Brito (2021) noted that many studies recognize the importance of partnerships in the transition to the CE, but less attention has been given to those supply chain factors that strengthen or weaken the possibility of collaboration. Therefore, it is important to understand the motivation behind the participation of each member of the DRS chain to build a control system.

The effectiveness of DRS in the production of beverages has already been proven, and DRS has attracted increasing support in European countries every year. At the end of 2023, 14 European countries (DE, DK, EE, FI, HR, IS, LT, LV, MT, NL, NO, RO, SE, and SK) had a deposit system in place for beverage packaging, mostly targeting single-use containers. This makes the total number of people living with a deposit system 164 million in the EU and EFTA countries. Ireland, Luxembourg, and Poland will be launched in the near future. Portugal and Austria - in the development phase (ACR Deposit Refund Systems EU Report).

Indicators of packaging waste generation and its return in the specified countries are shown in Table 1. Each country has its own incentive tools that encourage participants in the logistics chain and determine the

success of DRS operation. They can be grouped into administrative and legal, economic and reputational. European directives serve as the basis for the development of national legal acts.

Table 1. Generation and return of packaging waste in European countries using DRS.

Country	Packaging waste generation, kg/person, 2021	The level of recycling of packaging waste, %, 2021	Year of DRS implementation	Return of beverage packaging through DRS, %, 2022	Deposit value of the packaging unit, EUR
Sweden	156.83	59.6	1984	87	0.08-0.16
Iceland	147.77	49.8	1989	84	0.13
Finland	158.74	72.5	1996	96	0.10-0.40
Norway	175.75	56.9	1999	92	0.26
Denmark	181.40	64.6	2002	92	0.13-0.26
Germany	236.69	67.9	2003	94	0.25
Netherland	171.52	76.8	2005	90	0.15-0.25
Estonia	149.96	70.4	2005	88 (2021)	0.10
Croatia	73.84	50.8	2006	80 (2021)	0.07
Lithuania	152.26	60.7	2016	91	0.10
Latvia	153.90	61.0	2022	77	0.10
Slovakia	105.4	73.9	2022	71	0.15
Malta	150.43	38.4	2022	-	0.10
Romania	127.21	38.3	2023	-	0.11

Sources: Developed by the authors based on ACR Deposit Refund Systems EU Report, 2023.

The specific economic mechanism of DRS for each country depends on the peculiarities of the national business environment (Table 2). In most cases, the primary responsibility lies with the producer for financing and organizing used beverage packaging in the system. However, the strong role of partnership with retail in shaping the appropriate behaviour of consumers should be noted, encouraging and motivating them to return used packaging to containers.

Table 2. The conceptual framework was developed by Calebrese et al. (2020) as an example of a comparative analysis of deposit systems.

Archetype of framework	Description	Member States (EU)
Archetype An operator-closing mode	The DRS operator collects the empty containers brought back by the consumer to the retailers and transports them to the sorting/recycling centre. Operator is responsible for their recycling. Various financial arrangements are possible, but producers bear the cost burden.	EE, DK, FI, HR, LT, NO, SE
Archetype B retailer-closing mode	Retailers are responsible for the transport of the empty containers and their recycling. Different cost/revenue distribution to Archetype A, mainly retailers bearing the costs	DE
Archetype C producer-closing mode	Producers keep the materials, instead of the operator (A) or retailers (B). They need to organize the process of collection from the return points. Unlike A and B, the costs burden is split between the retailers and producers.	NL
Archetype D consumer-closing mode	Consumer returns the empty beverage containers directly to the DRS operator; retailers are not involved.	IS

Source: Developed by the authors on the basis of Calebrese et al. (2021).

The mechanism of action of the DRS network in Slovakia corresponds to archetype A. When the system was introduced in January 2022, Slovakia undertook to increase the current collection of beverage containers from 60% to 90% in 2025, but already a year after the implementation, the figure was more than 70% (Table 1), and in 2023, the design indicator was reached ahead of schedule. That is, it is 6 years earlier than the deadline set by the Single-Use Plastics Directive (SUPD). The experience of Slovakia is of direct interest to Ukraine in terms of joining the European Union, as this country is close to us in terms of income, culture, level of social awareness and responsibility. Therefore, let us analyse it in more detail.

In this context, the National Council of the Slovak Republic approved Act No. 302/2019 Coll. on backup of disposable packaging for drinks and on amendments to some laws (Law no. 302/2019 Coll., on prepayment of disposable packaging for drinks and on amendments and additions to certain laws, of the National Council of the Slovak Republic). The goal was to ensure an increase in the rate of collection of waste from disposable beverage packaging and, at the same time, to reduce the amount of packaging in nature as waste burdens the environment. On the basis of the adopted legislation, a deposit system for plastic bottles and cans was introduced in the Slovak Republic from 1 January 2022. Together with the law, its implementation regulation is also valid –a decree implementing some of the provisions of the law on depositing disposable packaging for drinks.

The reserve system was put into operation in Slovakia beginning on January 1, 2022. It applies to single-use plastic bottles and beverage cans with a volume of up to three litters. Each backed-up bottle or can be marked with the Z symbol located in the recycling arrows and must also contain the text "BACKED UP".

The administrator of the return system in Slovakia is a nonprofit organization created by a consortium of four entities: the Slovak Soft Drinks and Mineral Waters Association (Asociacia výrobcov nealkoholických napojov a mineralnych vôd na Slovensku – AVNM), the Slovak Beer and Malt Association (Slovenské združenie výrobcov piva a sladu – SZVPS), the Slovak Alliance of Modern Trade (Slovenska aliancia moderného obchode – SAMO), and the Association of Commerce of the Slovak Republic (Zväz obchodu SR – ZOSR). These companies represent soft drink and mineral water producers, beer producers, and representatives of the wholesale and retail trade. Together, their members deal with almost 80% of all returned packaging and represent more than 3000 commercial outlets. The deposit return system is funded by producer fees, material sales, and uncollected deposits (Deposit return system in Slovakia).

The mechanism of DRS system action in Slovakia is shown in Figure 1.

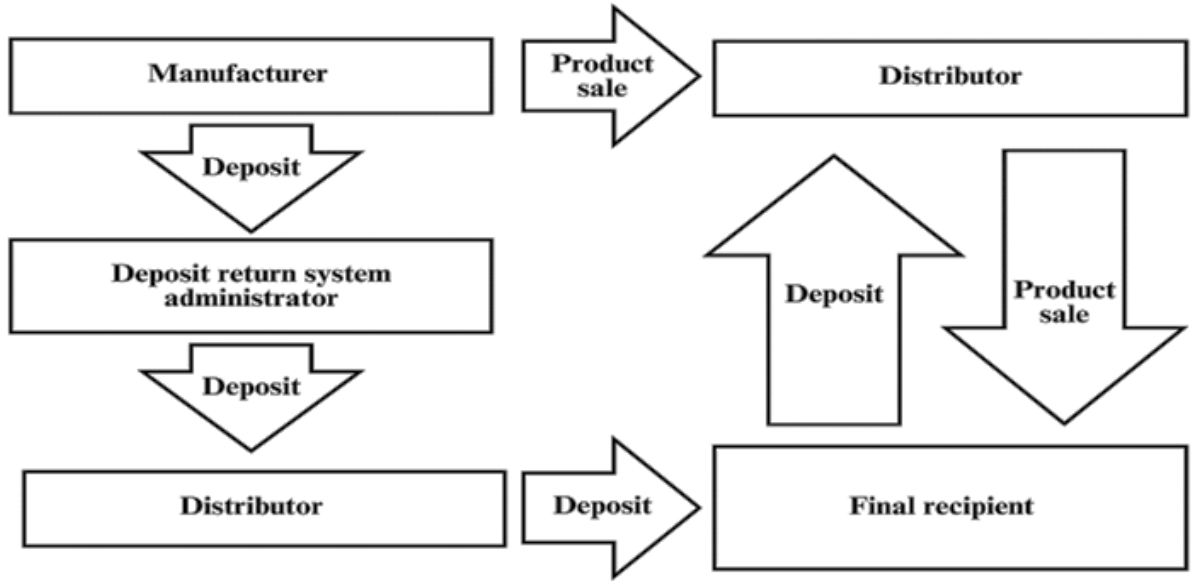

Figure 1. Scheme of the action of the backup beverage packaging system in Slovakia.
Sources: Sources: developed by the authors.

The deposit system works through a small surcharge (deposit) when a drink is purchased, which is fully refunded to the consumer when the container is returned at any point of sale. This mechanism not only boosts separate collection and recycling but also guarantees an effective local circular economy—as is the case in Slovakia—which "closes the loop" with a "bottle to bottle" and "can to recycle". The beverage packaging collected in Slovakia feeds into the production of identical packaging, reducing the dependence on virgin PET or aluminium, and is not "downgraded" into a secondary raw material to produce yarn, car spare parts or other objects that no longer have a recycling circuit (Closing the Resource Loop: Lessons to be Learned from the Slovakian deposit return system).

A total of 307 beverage producers and 284 registered beverage distributors are actively involved in backup. There are 4,256 registered product EAN barcodes, of which 2,103 are national EAN codes and 2,153 are international EAN codes. As of June 30, 2023, 3,147 collection points were involved in the backup of beverage

packaging in Slovakia. All stores with sales areas of more than 300 square meters became compulsorily involved. Their number is approximately one thousand, one hundred and sixty and represents a share of 37%. Almost two thousand stores, 63%, voluntarily joined the backup system.

Almost three-quarters of the shops use automated packaging collection in the form of deposit machines. The remaining 26% of establishments use manual collection of beverage packaging (the success of the Slovak deposit system inspires abroad). This broad involvement of retail entities became a decisive factor in the success of the Slovak DRS. Table 3 shows data on the collection of packaging through the DRS by region of Slovakia. Statistical data for the last five years indicate an increase in the volume of municipal waste in Slovakia; at the same time, the introduction of a deposit system for the return of beverage packaging in 2022 had a positive effect on the mentioned dynamics and contributed to a decrease in the trend. This can be seen in Figure 2.

Table 3. Backup in individual regions of Slovakia (as of June 30, 2023).

Region	Collected pieces	Share, %	Population	Per person, pieces
Bratislavský (BA)	202537311.00	15.44	677024	299.16
Nitriansky (NR)	188357626.00	14.36	671508	280.50
Košický (KE)	173669064.00	13.24	802092	216.52
Trnavský (TN)	164870554.00	12.57	565324	291.64
Prešovský (PO)	153886818.00	11.73	827028	186.07
Žilinský (ZA)	153528618.00	11.70	691136	222.14
Banskobystrický (BB)	145497722.00	11.09	634102	229.45
Trenčiansky (TT)	129451477.00	9.87	582567	222.21
Total	**1311799190,00**	**100%**	**5450781**	**240.66**

Sources: Sources: developed by the authors.

The first of the research hypotheses was the existence of a dependence between the volume of municipal waste and the level of income of the population (in the conditions of the Slovak market). To confirm or refute this hypothesis, the panel regression method and information on the volume of municipal waste by region of Slovakia and the income level of residents of these regions were used in the study.

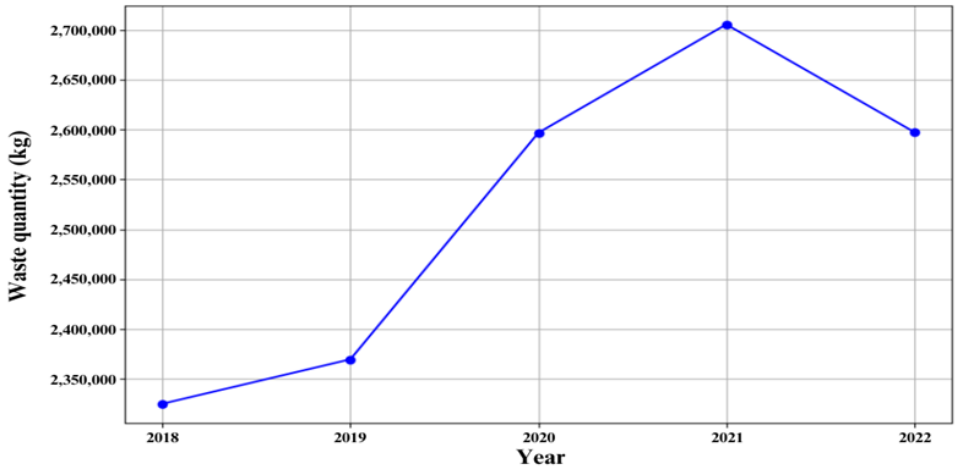

Figure 2. Total volume of municipal waste in Slovakia (2018–2022).
Source: Developed by the authors on the basis of data from the Statistical Office of the Slovak Republic.

Panel regression is a statistical method suitable for analysing panel data. Panel data consist of observations for multiple units (e.g., regions) across different time periods (e.g., years). This method allows for the analysis of temporal changes while controlling for unobserved heterogeneity between units.

This approach allows us to analyse in detail the relationships between variables in panel data, control for unobserved heterogeneity, and correctly interpret statistically significant differences between units (regions). The use of pooling, fixed effects, and random effects models, along with tests such as the pool test and Hausman test, ensures robust data analysis and helps identify the most suitable model for the given data.

Initially, a pooling model was estimated, assuming homogeneity across regions. A fixed effects model was subsequently applied to control for unobserved heterogeneity by accounting for region-specific characteristics

that remained constant over time. To assess the suitability of the fixed effects model over the pooling model, the pool test was employed. Following this, a random effects model was estimated, which assumes that individual effects are random rather than fixed. The Hausman test was used to determine the appropriateness of the fixed effects model compared with the random effects model. The analysis was conducted via R software, specifically the *plm* package for panel regression.

The panel regression formula, defined for the observed data, is as follows:

$$RecycShare_{i,t} = \beta_0 + \beta_1 Wage + \beta_2 Year_{i,t} + \beta_3 DummyRec_{i,t} + u_{i,t} \quad (1)$$

where RecycShare – the share of recycling (material recovery) from the total municipal waste; *Wage* – the average nominal wage in the given region; DummyRec – the variable for the introduction of the deposit system in 2022; i – the region; t denotes the time; and u_(i,t) – a normally distributed random variable, where (u_(i,t),u_(j,t)) may be nonzero and cov(u_(i,t),u_(j,t))=0 in general.

On the basis of the results of the Hausman test, the random effects model was consistently selected as more appropriate than the fixed effects model. The analysis initially considered data for all regions combined. Thereafter, a systematic exclusion of each region, one at a time, was performed to assess the robustness of the results. The exclusion of the Bratislava region (BA) was found to exert the most significant influence on the outcomes. These findings are reported for the final random effects model, which was preceded by regression analyses using both the pooling and fixed effects models (Table 4).

Table 4. Panel Regression Random Effects Model of Changes in Recycling Share from Total Municipal Waste for Regions from 2018--2022.

	Intercept	**Wage**	**Time**	**DummyRec**	**Haus-Chisq**	**p value**
all regions	-1238.6	-0.013217**	0.63062	0.47743	0.59563	0.8974
-BA	1113.3	0.006195	0.54334	0.56101	1.6941	0.6382
-KE	-971.84	-0.013520**	0.49861	0.59655	0.22074	0.9742
-PO	-1403.4	-0.015463	0.71353	0.56054	1.0568	0.7875
-TT	-1979*	-0.013557**	0.99739*	0.019106	0.066721	0.9955
-TN	-1199.5	-0.013358**	0.61141	0.43551	0.32773	0.9547
-NR	-1410.3	-0.014887**	0.71667	0.44384	0.4542	0.9288
-ZA	-1136.9	-0.012961***	0.57989	0.4844	0.21785	0.9747
-BB	-1109.9	-0.012705**	0.56655	0.28297	0.51869	0.9148
* results after excluding DummyRec						
all regions	-1392.9 .	-0.012928**	0.70689 .	-	0.79921	0.6706
-BA	1082.1	0.0076749	-0.52858	-	1.9245	0.382
-KE	-1171.2	-0.012303**	0.59717	-	0.4576	0.7955
-PO	-1578.8 .	-0.015086**	0.80021 .	-	1.2176	0.544
-TT	-1982.8**	-0.013527**	0.99926**	-	0.05544	0.9727
-TN	-1341.8	-0.013108**	0.68173 .	-	0.46987	0.7906
-NR	-1560.4*	-0.014669**	0.79089*	-	0.59749	0.7417
-ZA	-1315.4*	-0.012833**	0.66824*	-	0.37887	0.8274
-BB	-1199.8	-0.012521*	0.61099	-	0.55776	0.7566

*Note: *** p<0.01, ** p<0.05, * p<0.1.*
Sources: Developed by the authors.

Recycling increases over time but decreases with rising wages. The negative sign could have several explanations. One important factor is that higher wages in a region are associated with lower recycling rates. This may be attributed to the tendency of low-income groups to regard recycling as an additional source of income. These low-income groups are most prevalent in regions with the highest recycling rates. The variable DummyRec, which accounts for the introduction of the deposit system in Slovakia in 2022, was not statistically significant for the recycling share in individual regions according to the results of the random effects panel regression model (Figure 3).

Early trends indicate a decline in recycling rates (share of material recovery from municipal waste) in two regions, Bratislava (BA) and Trnava (TT). The highest recycling rate is observed in the Žilina (ZA) region, whereas the lowest is in the Bratislava (BA) region. The Trnava (TT) region also has a low recycling rate. Economic prosperity is not compensated by the level of recycling (material recovery).

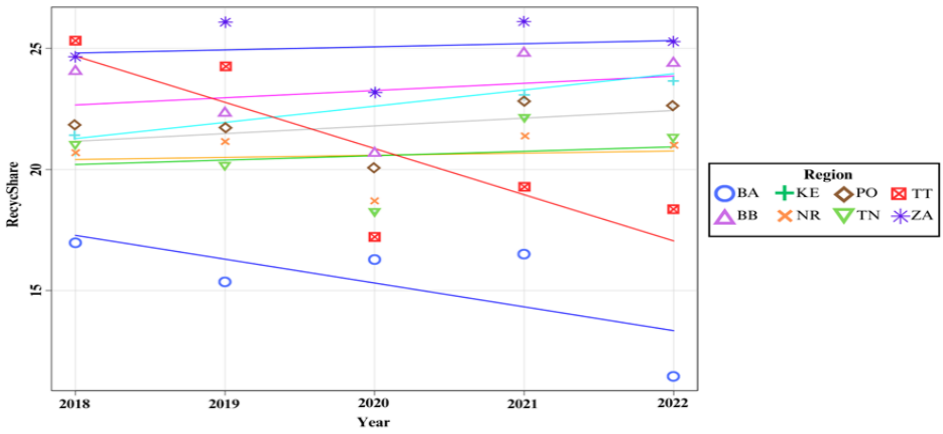

Figure 3. Changes in recycling share by region for the years 2018--2022.
Sources: Developed by the authors.

5. Discussion. The obtained results confirm the proposed hypothesis regarding the influence of the level of income on the volume of municipal waste in certain regions. The higher the income of the population is, the less communal waste they create during their life activities. This is explained by their lifestyle and consumer behaviour. As incomes decrease, municipal waste production increases. Therefore, material incentives play an important role in the motivation of consumers to collect household waste in the Slovak market. Moreover, the cost of collateral packaging is quite noticeable against the background of the small incomes of the population compared with other European countries.

The harmonization of the interests of DRS participants also helped to achieve significant success in collecting used beverage packaging (Closing the Resource Loop: Lessons to be Learned from the Slovakian deposit return system):

- Beverage producers are satisfied because they no longer see their branded containers littering and because they can buy back their material at controlled prices to meet (and exceed) the recycled content targets of the SUP directive for PET bottles equal to 25% by 2025 and 30% by 2030.
- The main Retail Organization SAMO and independent retailers are very satisfied with the handling fee they receive from the system administrator for each package they collect. Beverage retailers and large-scale retail trade brands are satisfied with the handling fee they receive from the DRS administrator to compensate for the costs they incur for the collection of beverage containers at their own sale points, which also covers the costs incurred for the purchase of the reverse vending machines. Even small retailers that might be exempt from having a return point want to participate voluntarily for the benefits that come with it, e.g., in terms of customer loyalty.
- In addition to benefiting from the positive effects for the local economy and employment, municipalities appreciate the considerable reduction in beverage containers, which are littered or disposed of in residual waste, and the cost savings this implies.

Thus, unlike some European countries, where the leading role in the collection of used beverage packaging belongs to territorial communities, which rely on the activity and social responsibility of their residents (Ortega Alvarado & Pettersen, 2024), in Slovakia, a centralized mechanism has been built, which relies on an extensive system of collection points for used packaging with so-called "Pfandomats" in retail chains throughout the country.

With respect to Ukraine's experience in organizing the collection of solid household waste and, in particular, beverage packaging, unfortunately, our country is at the beginning of this path, which it needs to go through to meet the requirements of EU members. In fact, plastic bottles are accepted at points of reception of secondary resources; they are very inexpensive, and therefore, their disposal is interesting only to homeless people. Companies processing plastic bottles accept them at a price of UAH 6,000 per ton; they are interested in batches of 100 kg or more, which is a large number of bottles.

Fandomats have not yet become part of reality, although several attempts have been made to introduce them in various areas. Therefore, in 2007, the first machine appeared in Kharkiv (which was installed by enthusiasts) and gave out symbolic prizes for containers: calendars, magnets or small toys for children. In addition, in Kharkiv in 2017, a fandomat was installed to exchange bottles for children's toys. In 2019, the Ministry of Regional Development, Construction and Housing and Communal Services of Ukraine offered

the integration of fandomats into the Ukrainian space. One fandomat was designed for 5,000 people. However, this project was not implemented. In 2020, a Yapomogabox machine, which was installed to exchange plastic bottles for food for homeless animals, appeared in Kyiv. It is known that, on the very first day of its work, it collected 68 kilograms of plastic, once again proving the willingness of people to join such initiatives (Fandomats - machines for accepting plastic bottles).

One of the problems for the formation of fandomats can be their rather high price. Fandomats are mostly produced in Germany, and their cost ranges from 4,800–7,000 euros. That is, according to some estimates, they will be able to pay off in approximately 5–6 years. Thus, it becomes clear that building a network of fandomats is possible only with state or municipal support. As an example, it is advisable to consider the Slovak experience of the DRS organization. The following arguments support such a conclusion:

– under the conditions of current martial law and after military recovery, most financial resources and administrative levers are concentrated at the state level. The role of territorial communities is often limited, both financially and administratively. Therefore, state institutions should take the leading role in the creation and organization of DRSs functioning in Ukraine;

– real incomes of the population remain at a low level due to inflation, so material incentives, such as those operating in Slovakia, will be successful. If the optimal cost of bottles is established, it will encourage consumers to collect and return them;

– retail in Ukraine, regardless of the negative consequences due to military actions, demonstrates stable growth rates, as it satisfies the primary needs of consumers. Despite the growth of internet trade, visiting stores is almost a daily habit of Ukrainians. This especially applies to the population with low incomes;

– a large number of stores of domestic chains, such as "ATB - Market" LLC Fozzy Group (Silpo, Fora), VolWestRetail (Nash Kray), Varus, and others, despite the losses caused by the war, continue to open new stores throughout the country, creating a powerful basis for creating, on their basis, an extensive network of fandomats similar to the Slovak system;

– The war imposed on Ukraine highlighted the high level of cohesion of Ukrainian society around social events and projects and the social responsibility of individual citizens. This is manifested, in particular, in constant donations for the benefit of the armed forces and the restoration of the affected areas. Therefore, such a socially responsible project, such as the collection and recycling of used bottles, will definitely find supporters among different strata of the population, who will support it not only for the sake of material reward but also for the purpose of preserving the environment.

6. Conclusions. Research has shown that the problem of collecting used beverage packaging occupies one of the central places in the system of processing household waste and establishing the functioning of the country's circular economy. Despite the numerous theoretical achievements and experiences of leading companies, each country has gone its own way in building a packaging waste processing system and achieving the principles of a circular economy. The DSR has proven effective in almost half of the EU countries and continues to gain its supporters. Every year, the number of participants who prefer the collateral system of selling drinks and returning their packaging is increasing. Studies have shown that for consumers with relatively low incomes, the cost factor of collateral packaging is quite important. With an increase in income, the material incentive for consumers to return containers decreases. This proves the hypothesis put forward at the beginning of the study and actualizes the problem of using ethical incentives in relation to the share of consumers with high incomes.

The Slovak experience of the DRS organization has proven its effectiveness. It is based on the widespread involvement of retail stores throughout the country through the installation of fandom machines, as well as the creation of a balanced system of incentives for all participants in the beverage production chain and their distribution, consumption and return of packaging. This experience can serve as a guide and a good example for building a similar system in Ukraine, whose status as a candidate country for the EU obliges it to reform many spheres of society and economy in accordance with the requirements of the single European market. The study proved that this is facilitated by the extensive system of retail enterprises in Ukraine, the tendency to centralize the management of similar socially significant projects, the high level of social responsibility of Ukrainians and the low level of income of the population.

Directions for further research may be to determine the readiness of retail enterprises and the expectations of Ukrainian consumers for the implementation of such a system and possible incentives for their encouragement.

Author Contributions: conceptualization, I. R. and V. L.; methodology, I. R.; software, V. M.; validation, V. L.; formal analysis, V. L.; investigation, I. R.; resources, V. L.; data curation, V. M. and V. L.;

writing-original draft preparation, O. P.; writing-review and editing, O. P.; visualization, V. M.; supervision, V. L.; project administration, I. R.; funding acquisition, V. L.

Conflicts of interest: The authors declare that they have no conflicts of interest.

Data availability statement: Not applicable.

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

References

1. ACR Deposit Refund Systems EU Report (2023). [Link]
2. Aguilera-Caracuel, J., & Guerrero-Villegas, J. (2018). How corporate social responsibility helps MNEs to improve their reputation. The moderating effects of geographical diversification and operating in developing regions. *Corporate Social Responsibility and Environmental Management, 25(4),* 355–372. [Google Scholar] [CrossRef]
3. Alemu, K.T. (2017). Formal and informal actors in Addis Ababa's solid waste management system. *IDS bulletin, 48(2),* 53–70. [Google Scholar] [CrossRef]
4. Ali, H.Y., Danish, R.Q., & Asrar-ul-Haq, M. (2020). How corporate social responsibility boosts firm financial performance: The mediating role of corporate image and customer satisfaction. *Corporate Social Responsibility and Environmental Management, 27(1),* 166–177. [Google Scholar] [CrossRef]
5. Barford, A. (2020). Informal work in a circular economy: waste collection, insecurity and COVID-19. *Proceedings of the IS4CE2020 Conference*.[CrossRef]
6. Barford, A., & Ahmad, S.R. (2021). A Call for a Socially Restorative Circular Economy: Waste Pickers in the Recycled Plastics Supply Chain. *Circular Economy and Sustainability, 1,* 761–782. [Google Scholar] [CrossRef]
7. Batista, L., Bourlakis, M., Smart, P., & Maull, R. (2019). Business Models in the Circular Economy and the Enabling Role of Circular Supply Chains. *Operations Management and Sustainability*, Palgrave Macmillan, Cham, 105–134. [Google Scholar] [CrossRef]
8. Berardi, P.C., & de Brito, R.P. (2021). Supply chain collaboration for a circular economy-From transition to continuous improvement. *Journal of Cleaner Production, 328,* Article 129511. [Google Scholar] [CrossRef]
9. Beswick-Parsons, R., Jackson, P., & Evans, D.M. (2023). Understanding national variations in reusable packaging: Commercial drivers, regulatory factors, and provisioning systems. *Geoforum, 145,* Article 103844. [Google Scholar] [CrossRef]
10. Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology, 21(3),* 603–614. [Google Scholar] [CrossRef]
11. Bocken, N. M., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of industrial and production engineering, 33(5),* 308–320. [Google Scholar] [CrossRef]
12. Buglewicz, K. (2017). *Społeczna odpowiedzialność biznesu. nowa wartość konkurencyjna*. Warszawa. Wydawnictwo: Polskie Wydawnictwo Ekonomiczne. [Link]
13. Costa, R., Levialdi Ghiron, N., Menichini, T., Miscoli, V., & Tiburzi, L. (2021). Operating modes and cost burdens for the European deposit-refund systems: A systematic approach for their analysis and design. *Journal of Cleaner Production, 288,* Article 125600. [Google Scholar] [CrossRef]
14. Closing the Resource Loop: Lessons to be Learned from the Slovakian deposit return system (2024). [Link]
15. Deposit return system in Slovakia. [Link]
16. Ellen MacArthur Foundation (EMF) (2024). Aiming for 100% circularity: Amsterdam. [Link]
17. Fandomats - machines for accepting plastic bottles. [Link]
18. Gall, M., Wiener, M., Chagas de Oliveira, C., Lang, R.W., & Hansen, E.G. (2020). Building a circular plastics economy with informal waste pickers: Recyclate quality, business model, and societal impacts. *Resources, Conservation and Recycling, 156,* Article 104685. [Google Scholar] [CrossRef]
19. Gazzola, P., Paterson, A., Amelio, S., Grechi, D., & Cristina, S. (2023). The role of individual social responsibility and corporate social responsibility in the tax fraud war: A comparison between the priorities of Italian and Romanian consumers. *Corporate Social Responsibility and Environmental Management, 30 (5),* 2265–2277. [Google Scholar] [CrossRef]
20. Geissdoerfer, M., Savaget, P., Bocken, N.M., & Hultink, E.J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of cleaner production, 143,* 757–768. [Google Scholar] [CrossRef]
21. Gonzalez-Moreno, A., Triguero, A., Díaz-García, C., & Saez-Martínez, F.J. (2024). Circular economy and entrepreneurship in Europe: An analysis of the impact of cultural factors, regulatory framework and rate of entrepreneurship. *Environmental Technology & Innovation, 35,* Article 103656. [Google Scholar] [CrossRef]
22. Gregson, N., Crang, M., Fuller, S., & Holmes, H. (2015). Interrogating the circular economy: the moral economy of resource recovery in the EU. Economy and Society, 44(2), 218–243. [Google Scholar] [CrossRef]
23. Jarossova, M. & Gubiniova, K. (2022). Beverage Container Deposit Return System in Slovakia: Insights after One Year of Its Introduction. *Engineering Sciences and Technologies, 1(38),* 75–89. [Google Scholar] [CrossRef]

24. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, conservation and recycling, 127,* 221–232. [Google Scholar] [CrossRef]
25. Konsort.com.ua. [Link]
26. Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: the concept and its limitations. *Ecological economics, 143,* 37–46. [Google Scholar] [CrossRef]
27. Law no. 302/2019 Coll., on prepayment of disposable packaging for drinks and on amendments and additions to certain laws, of the National Council of the Slovak Republic. [Link]
28. Lewandowski, M. (2016). Designing the business models for circular economy - towards the conceptual framework. *Sustainability, 8(1),* Article 43. [Google Scholar] [CrossRef]
29. Liczmanska-Kopcewicz, K., Mizera, K., & Pypłacz, P. (2019). Corporate social responsibility and sustainable development for creating value for FMCG sector enterprises. *Sustainability, 11(20),* Article 5808. [Google Scholar] [CrossRef]
30. Murray, A., Skene, K. & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics, 140,* 369–380. [Google Scholar] [CrossRef]
31. Nazir, S., & Capocchi, A. (2024). Systematic Literature Review of Circular Economy and Sustainable Development. *Sustainability Reporting Practices and the Circular Economy*. Palgrave Macmillan, Cham., 15–81. [Google Scholar] [CrossRef]
32. New EU rules for reducing, reusing and recycling packaging (2024). [Link]
33. Ortega Alvarado, I.A., & Pettersen, I.N. (2024). The role given to citizens in shaping a circular city. *Urban Geography, 45(4),* 611–630. [Google Scholar] [CrossRef]
34. Raible, I.M., Holweg, C., Reiner, G., & Teller, C. (2024). Returnable packaging systems and store operations: Processes, costs, and benefits. *Journal of Industrial Ecology, 28(3),* 1–16. [Google Scholar] [CrossRef]
35. Ramasubramanian, B., Tan, J., Chellappan, V. & Ramakrishna, S. (2023). Recent Advances in Extended Producer Responsibility Initiatives for Plastic Waste Management in Germany and UK. *Materials Circular Economy, 5,* 6. [Google Scholar] [CrossRef]
36. Reshetnikova, I., Apalkova, V., Lytovchenko, I., & Wiktor, J.W. (2021). An evaluation of the economic and green market utility in a circular economy. *International Conference on Sustainable, Circular Management and Environmental Engineering, 255,* Article 01038. [Google Scholar] [CrossRef]
37. Sandtner tax center (2022). [Link]
38. Sembiring, E., & Nitivattananon, V. (2010). Sustainable solid waste management toward an inclusive society: Integration of the informal sector. *Resources, Conservation and Recycling, 54 (11),* 802–809. [Google Scholar] [CrossRef]
39. Skrypko, T., Popadynets, N., Yakhno, T., Shulla, R., Vlasenko, T., Irtyshcheva, I., & Boiko, Y. (2021). Optimizing the polymer waste supply chains based on circular economy. *Uncertain Supply Chain Management, 9(2),* 343–350. [Google Scholar] [CrossRef]
40. Stumpf, L., Schöggl, J. P., & Baumgartner, R.J. (2023). Circular plastics packaging–Prioritizing resources and capabilities along the supply chain. *Technological Forecasting and Social Change, 188,* Article 122261. [Google Scholar] [CrossRef]
41. The success of the Slovak deposit system inspires abroad (2024). [Link]
42. Velenturf, A.P.M., Jensen, P.D., Purnell, P., Jopson, J., & Ebner, N.A. (2019). A Call to Integrate Economic, Social and Environmental Motives into Guidance for Business Support for the Transition to a Circular Economy. *Administrative Sciences, 9(4),* Article 92. [Google Scholar] [CrossRef]
43. Velis, C. (2017). Waste pickers in Global South: informal recycling sector in a circular economy era. *Waste Management & Research: The Journal for a Sustainable Circular Economy, 35(4),* 329–331. [Google Scholar] [CrossRef]
44. minzp.sk (2023). We are well on our way to meeting the goals set for 2023 in the backup of beverage packaging [Link]
45. Webster, K. (2021). A circular economy is about the economy. *Circular Economy and Sustainability, 1,* 115–126. [Google Scholar] [CrossRef]
46. Wilson, D., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International, 30(4),* 797–808. [Google Scholar] [CrossRef]
47. Zhou, G., Gu, Y., Wu, Y., Gong, Y., Mu, X., Han, H., & Chang, T. (2020). A systematic review of the deposit-refund system for beverage packaging: Operating mode, key parameter and development trend. *Journal of Cleaner Production, 251,* Article 119660. [Google Scholar] [CrossRef]

Ірина Решетнікова, Національний авіаційний університет, Україна
Ванда Ліесковска, Братиславський економічний університет, Словаччина
Ольга Полоус, Національний авіаційний університет, Україна
Вільям Мурін, Братиславський економічний університет, Словаччина

Важливість системи депозит-повернення упаковки в системі циркулярної економіки: словацький інноваційний досвід для України

Метою даного дослідження є узагальнення існуючих теоретичних підходів до організації системи депозит-повернення упаковки та аналіз успішного досвіду її впровадження у Словаччині з метою її поширення в українських реаліях. Протягом десятиліть управління відходами від упакування харчових продуктів і напоїв було серйозною проблемою, що тісно пов'язана із циркулярною економікою та сталим розвитком. Ефективні системи збору відходів мають вирішальне значення для досягнення цілей сталого розвитку, і вони підтримуються як світовими урядами, так і провідними компаніями. В Україні дане питання стало особливо актуальним через триваючий військовий конфлікт під час якого значна частина країни окупована та завалена відходами. Відсутність сучасних сміттєпереробних потужностей загострює дану проблему, яку Україна має вирішити, прагнучи вступити до ЄС. Європейський Союз вже давно розробив законодавство, таке як Директива 94/62/ЄС, що регулює відходи упаковки, заохочуючи профілактичні заходи та повторне використання упаковки. Успішні моделі країн ЄС, як, наприклад, система депозит-повернення упаковки у вигляді пляшок і банок Словаччини, пропонують практичні вирішення вище зазначених питань, які можна адаптувати до контексту України. У дослідженні використовувалися методи аналізу, синтезу та контент-аналізу для вивчення моделей систем депозит-повернення упаковки по всій Європі та було використано панельний регресійний аналіз у програмному забезпеченні R задля вивчення факторів, що впливають на переробку побутових відходів у Словаччині. Дослідження тестувало дві гіпотези: одна пов'язувала обсяг переробки побутових відходів з рівнем доходів населення в Словаччині, а інша припускала, що словацька модель системи депозит-повернення упаковки може бути оптимальною для України через подібність поведінки споживачів та ринкових умов. Отримані результати підтверджують, що вищий рівень доходу пов'язаний із меншим утворенням побутових відходів, що відображає вплив способу життя та поведінки споживачів на досліджувані процеси. У Словаччині матеріальні стимули та депозитна вартість упаковки є вирішальними мотиваторами збирання відходів, особливо з огляду на відносно нижчі доходи населення порівняно з іншими європейськими країнами. Дослідження підкреслює, що збір використаної упаковки від напоїв має вирішальне значення для управління побутовими відходами та підтримки функціонування циркулярної економіки. Система депозит-повернення упаковки довела свою ефективність у багатьох країнах ЄС і набуває популярності. Словацька модель системи депозит-повернення упаковки, що передбачає широке використання спеціалізованих автоматів у роздрібних магазинах і збалансовані стимули за всім ланцюгом постачання напоїв, є ефективною та може слугувати потенційною моделлю для України, оскільки вона узгоджує своє фукнціонування зі стандартами ЄС.

Ключові слова: циркулярна економіка; кооперація; система депозит-повернення упаковки; розширена відповідальність виробника; побутові відходи; роздрібна торгівля; повернення тари.