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MANAGEMENT OF PACKAGING WASTE FROM E-COMMERCE IN THE CONTEXT OF THE CIRCULAR ECONOMY

BY

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Abstract. Sustainability in e-commerce is a new but significant issue in the context of European Union's transition to a circular economy due to the rapidly growing e-commerce market. In Romania, over 500,000 single-use plastic or cardboard packaging materials are used daily for online shipments. The packaging sector is one of the major consumers of virgin raw materials. The increased use of packaging, combined with low rates of reuse and recycling, hinders the development of a circular economy. In recent years, the packaging industry has grown faster than the national gross income of various countries, leading to increased CO₂ emissions and other pollutants, as well as overexploitation of natural resources, loss of biodiversity, and pollution.

To minimize the negative impact, efforts are currently underway to develop and implement more sustainable practices in the online commerce industry, including the use of recyclable packaging, optimizing transportation, and promoting ecological practices. Consumers can also play a crucial role by carefully choosing products and merchants with environmental concerns and by adopting more responsible purchasing practices.

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In this context the main objective of this study is to analyse the management of packaging waste generated by e-commerce within the framework of circular economy. The most important practices and trends at international and national level are discussed and recommendations regarding the management of packaging waste resulted from electronic commerce in Romania are provided.

Keywords: e-commerce, circular economy, packaging waste, sustainability.

1. Introduction

Marketed products, especially those traded electronically, need packaging to be protected and easily transported from where they are manufactured/marketed to where they are used or consumed. The prevention of barriers to the internal market for packaging is essential for the functioning of the internal market for products. Unclear rules and vague requirements create uncertainty and additional costs for economic operators. Recent Eurostat data highlights packaging waste's significant role in the EU's environmental challenges. As of 2021, the EU generated 188.7 kg of packaging waste per person, a substantial increase from previous years. This waste comprised 40.3% paper and cardboard, 19.0% plastic, 18.5% glass, 17.1% wood, and 4.9% metal (Eurostat, 2024).

Packaging is a key environmental concern. The packaging sector is one of the main users of virgin raw materials. The increased use of packaging, combined with low rates of reuse and recycling, hinders the development of a low-carbon circular economy. In recent years, the packaging industry has been growing faster than gross national income, leading to increased CO₂ and other emissions, as well as overexploitation of natural resources, loss of biodiversity and pollution. Eurostat data and market data reports indicate an increased use of packaging design features that may inhibit widespread recycling (Ecoteca, 2022).

The legislative provisions aimed at the management of packaging waste result from: Directive (EU) 2018/852 of the European Parliament and of the Council of May 30, 2018 amending Directive 94/62/EC on packaging and packaging waste. Furthermore, Article 4 of the Waste Hierarchy Directive 2008/98/EC, in which Member States shall adopt measures to encourage an increase in the share of reusable packaging placed on the market and systems for the reuse of packaging in an environmentally sound manner and in accordance with the Treaty provisions, without compromising food hygiene or consumer safety.

In order to respond to the legislative requirements imposed by the European Commission and move closer to the circular economy model, the Romanian authorities have decided to implement environmental principles to regulate the waste and packaging waste management system, namely "pay for what you throw", "extended producer responsibility" and "landfill tax".

At the Romanian level, the most important legal act regulating packaging is Law no. 249/2015 on the management of packaging and packaging waste with subsequent amendments, the minimum values are presented in Table no. 1. These targets are valid until 2025, after 2025 and 2030 new and even more ambitious targets have already been formulated.

Table 1

Minimum target values for recovery and recycling** of packaging waste respectively*

No.	Objective	Percentage (%)
1.	Global objective of valorisation	65
2.	Global recycling objective	60
3.	Paper - cardboard recycling objective	70
4.	Plastics recycling objective	45
5.	Recycling glass objective	65
6.	Recycling steel objective***	70
7.	Aluminium recycling objective	30
8.	Wood recycling objective	50

* Includes the amount of packaging waste recycled and incinerated in incineration plants with energy recovery

** Includes the amount of wood packaging that is repaired for reuse

*** From 1.01.2025.

Romania's latest report to Eurostat includes data for 2021, since 2022 there has been no reporting on packaging waste recycling rates. Given the data for 2021, the packaging waste recycling rate is 38.3%, the lowest in compared to the other reporting member states (Eurostat, 2024).

The concept of "circular economy" can be defined as a production and consumption model in which waste is minimized and the life cycle of packaging is extended as far as possible through models such as collaborative economy, reuse and repair, refurbishment, reconditioning and recycling (Fig. 1).



Fig. 1 – Circular economy diagram (Source: European Research Service).

When packaging reaches the end of its life cycle, its materials are kept in the economy as long as possible to create value. In this way the "production - use - disposal" loop that characterizes the circular model is closed as effectively as possible. By comparison, the most common linear model on the market is based on the "use- production - consumption - waste" model (<https://www.europarl.europa.eu/topics/ro/article/20151201STO05603/economia-circulara-definitie-importanta-si-beneficii>).

The way value that is created distinguishes the linear from the circular model of the economy. The linear is consumption-oriented, with value tied to the volume of packaging placed on the market. By contrast, the circular model is data-driven, focusing on extending the life of a package, on restoration and regeneration and restoration processes. Value is not just created, but also amplified through cost reduction, risk limitation, reduced consumption of resources, and customer loyalty fostered by circular business models. The information derived from the recovery of packaging on customer behaviour, product usage, and more, is the fuel that powers this model (<https://dng6bz1fnhn09.cloudfront.net/media/2022/05/ghid-economie-circulara-220512.pdf>).

Waste management is one of the acute problems of contemporary society. Identifying solutions to optimize waste management is a constant concern for public authorities, citizens and actors that have an impact on the environment.

Reducing packaging waste should not only contribute to the reduction of packaging waste, not only producers and logistic carriers on sustainable packaging, but also consumers. Accessibility of packaging requires that packaging is easy to open, has legible labels and does not compromise safety or quality. With growing concerns about easy-to-open and functional packaging, labelling is a good tool to provide consumers with information about environmental sustainability (Ecoteca, 2022).

Over the last decade, e-commerce or on-line commerce has faced a significant market expansion among European Union countries, being accentuated by the COVID-19 pandemic (in 2019) and consumers' preferences for online shopping. However aside the increase turnover for the enterprises and customer satisfaction, one problem that arises is associated with increased single use packaging quantities for various products like food, beverages, e-commerce and household care products that turn into waste. With 2019 as reference year, Romania is a case in which the e-commerce has seen significant expansions of 7.2% in 2020 and 1.4% in 2021, as well as an increase of the packaging quantities of 6.3% (2020) and 17.5% (2021) (Gavrilescu *et al.*, 2024).

2. Analysis of international e-commerce trends and impacts

According to recent industry studies, India will rank first among 20 countries worldwide in terms of retail e-commerce growth between 2023 and 2027, with a compound annual growth rate (CAGR) of 14.1% (Fig. 2). The Indian e-commerce market is currently valued at US\$ 63.17 billion. Argentina and Brazil are also among the fastest growing e-commerce markets globally with a CAGR of over 13.6%. The global retail e-commerce CAGR was estimated at 11.16% over the same period (Statista Research Department, Nov 15, 2023).

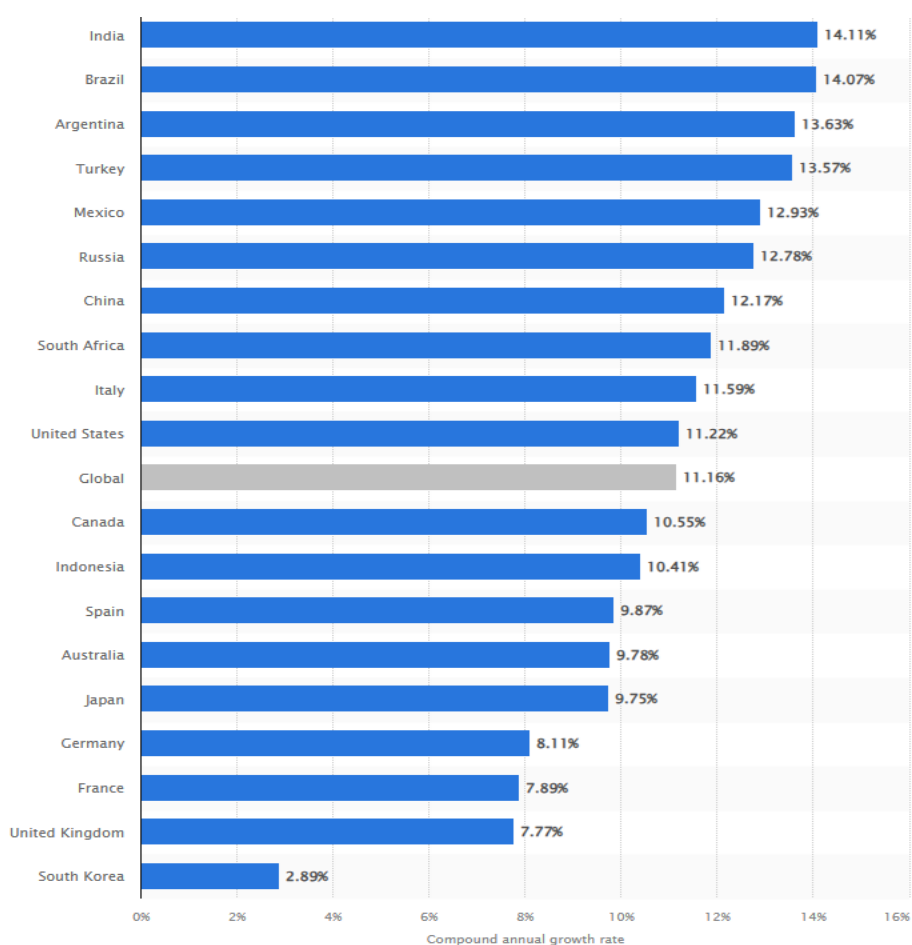


Fig. 2 – Compound annual growth rate of retail e-commerce sales (CAGR) from 2023 to 2027, by country, Statista Research Department, Nov 15, 2023.

According to the latest research, within e-commerce, there are a few key areas that have the highest environmental impacts in terms of greenhouse gas

emissions (GHG) (calculated as carbon footprint of all sectors). According to the study by the MIT Real Estate Innovation Lab, the processes with the highest impact are as follows:

- Packaging (45%): refers to the production, use and disposal of packaging. Plastic packaging often generates high GHG emissions;
 - Return rates (25%): this can come from the additional shipping and packaging required to return an online purchase;
 - Utility level emissions (15%): this includes things like energy consumption, water consumption, paper usage;
 - Transportation emissions (13%): this includes not only emissions associated with transportation. It also covers the use of fossil fuels during the transportation of materials for the production of products and moving items between warehouses.
 - Logistics (2%): this has to do with carbon emissions from product warehousing and general operations (MIT Real Estate Innovation Lab, 2023)
- E-commerce is skyrocketing, and its emissions are following suit. Amazon, which has pledged to be carbon neutral by 2040, saw an 18% increase in emissions in 2021. While e-commerce offers enormous benefits as it grows, unnecessary purchases and the production of poor quality products together lead to a significant negative impact on our environment (Yu *et al.*, 2022).

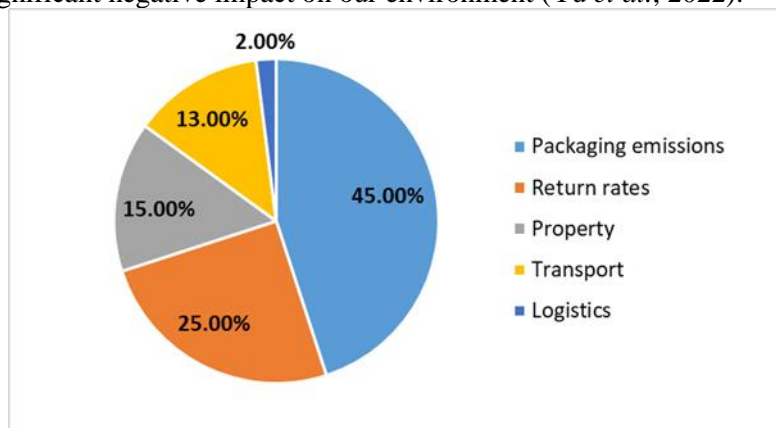


Fig. 3 – Distribution of e-commerce average greenhouse gas (GHG) emission worldwide as of 2020, by source, MIT Real Estate Innovation Lab, 2023, <https://realestateinnovationlab.mit.edu/>.

The use of plastic packaging has increased significantly due to the pandemic and a new hyper-hygienic lifestyle. In addition, panic shopping and stock-outs due to changes in consumer behaviour have increased the requirement for plastic-based packaging materials (Jribi *et al.*, 2020). This new e-commerce shopping trend is estimated to result in 1012.6 billion demand for plastic packaging by 2021, which is 103.4 billion more than that produced in 2019

(Parashar and Hait, 2021). As the COVID-19 pandemic has increased plastic pollution, people should be aware of the consequences of plastic pollution and should limit their use of plastic until it is eliminated. Based on recent data and hypothetical calculations, an enormous amount of plastic has been generated globally due to the COVID-19 pandemic.

The latest study by packaging distributor manufacturer INATECH Packaging shows that on the Romanian market, the most in-demand product types are e-commerce packaging, with a 24% growth in 2023 compared to 2022. In 2023, INATECH entered the waste plastic recycling and processing segment for the production of recycled granule raw material required for product protection as part of the group-wide sustainability strategy. INATECH Packaging serves the markets of Bulgaria, Hungary, Republic of Moldova, Germany and Austria, with the export segment accounting for 10% of the business (<https://logisticpost.ro/articole/inatech-packaging-piata-de-ambalaje-crestere-lenta-in-2023-pe-fondul-reducerii-consumului.html>).

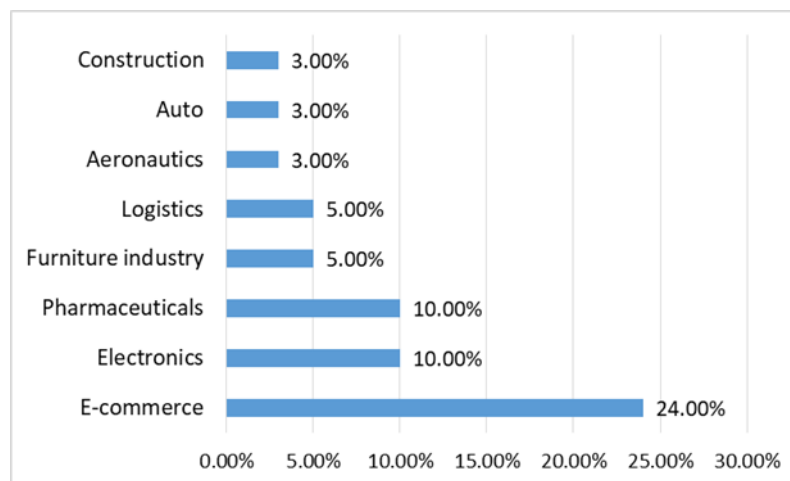


Fig. 4 – Packaging demand infographic by industry 2023 vs 2022, according to INATECH Packaging, 2023.

3. E-commerce packaging waste in the circular economy context case studies

3.1. Closing the loop for e-commerce packaging waste in India

This study aims to create a closed-loop logistics model for e-commerce deliveries that emphasizes the use of sustainable, reusable packaging made from recycled PET. This model involves establishing a comprehensive and integrated system for e-commerce logistics and comparing the CO₂ emissions (kg CO₂ eq.)

across all life stages: raw materials extraction, manufacturing, disposal, and transportation of conventional cardboard packaging versus reusable PET packaging through a Life Cycle Assessment (LCA).

This approach not only promotes the recycling of PET bottles but also presents an opportunity for Extended Producer Responsibility (EPR) for e-commerce companies. Government support, through dedicated funding for circular economy and waste management initiatives in India, could significantly aid in implementation. To facilitate rapid adoption, e-commerce companies could incentivize participation with subscription or deposit-based models (Raut and Chandel, 2023).

3.2. Disposable packaging versus reusable packaging in e-commerce: Comparing carbon footprints and identifying profitability points in Germany

In Germany, e-commerce generated over 68 billion euros in revenue in 2018, with more than two billion shipments delivered. Notably, up to 30 per cent of the carbon footprint from online retail is attributed to shipping packaging. Studies comparing single-use and reusable packaging systems outside the e-commerce sector indicate that reusable systems are environmentally beneficial if a sufficient number of reuse cycles is achieved. The break-even point varies; for instance, the reusable shipping bag reaches this point in just a few cycles, whereas the reusable polypropylene (PP) box requires significantly more cycles.

Achieving a high return rate for reusable packaging requires a thorough analysis of incentive systems and their impacts, as well as exploring other stimulating strategies. Potential legal measures and instruments supporting reusable systems must also be examined (Zimmermann and Bliklen, 2020).

3.3. Analysis of e-commerce packaging in Romania

E-commerce has grown significantly in Romania over the past decade, particularly during the pandemic. According to data analysed by Clean Recycle, about 10,000 online platforms in Romania sell various products. However, only some of these platforms meet the legal requirement to recycle and recover 60% of the packaging waste they generate. In 2021, e-commerce sales in Romania reached €6.2 billion, and by the end of 2022, they had exceeded €6.8 billion, marking a 10% increase according to industry data. About 38% of Romanians purchased products from e-commerce sites in the past year, generating tens of thousands of tons of packaging waste annually (Report Clean Recycle, 2023, <https://www.cleanrecycle.ro/articole.html>).

Clean Recycle is among the top five players in Romania's packaging waste responsibility transfer (OIREP) market, handling the mandatory reporting,

collection, and recovery of packaging waste for producers and importers. The company manages a portfolio of over 700 companies across Romania, spanning sectors such as FMCG and retail, agribusiness, automotive, distribution, industrial production, and pharmaceuticals. Sameday, one of the leading courier services in Romania, announced that starting in April 2023, it will use 100% recycled plastic bags for deliveries and actively promote responsible packaging consumption (Report Clean Recycle, 2022).

In terms of packaging, **FAN Courier** is constantly looking for increasingly sustainable alternatives. It has already introduced recycled cardboard envelopes and has also tested recycled plastic packaging alternatives. The plan for the first half of next year is to phase as many recycled plastic envelopes as possible into the system, thereby reducing the environmental impact. The company has also been testing biodegradable packaging, but this has not proved strong enough for delivery. However, FAN Courier remains committed to continue its efforts to identify and introduce packaging with the lowest environmental impact (Sustainability Journal, 2023).

R-CREATE is the start-up that launches the first packaging-as-a service in Romania, an innovative circular economy product for packaging and online deliveries. In Romania, the start-up R-CREATE proposes the first returnable e-commerce packaging on the market. R-CREATE is a returnable packaging that is easy to access and use to deliver online orders to the home without creating additional waste. A first pilot test of the solution took place in Bucharest together with Sinapseria, a bicycle courier company. From May 20 to June 2, 2020, the start-up also ran another test with FAN Courier, Sinapseria and Cărturești. In the trial with Sinapseria, more than 1,200 single-use packages were saved by replacing them with R-Create returnable packaging. R-Create enables the control of packaging throughout the entire supply chain, including the step at the end of its lifecycle, through cradle-to-cradle partnerships - whereby used packaging is collected and sent to the manufacturing plant for recycling and use in the next production batch. This type of agreement allows minimizing negative environmental impacts: the service, becoming truly waste-free, and it is valuable for the factory because it involves a regular flow of inputs that become raw materials (Report GpeC, 2020).

As for the e-commerce segment, **eMAG** offers some examples of sustainable practices applied to packaging, storage, and delivery processes, as well as related services associated with orders. Plastic bags and cardboard boxes are 100% recycled and recyclable. Transfer of goods between showrooms is done in reusable plastic boxes, and parcels are stored/transported in metal boxes that are reused (Sustainability Report, Emag 2023).

In Romania, the recycling rates for cardboard and paper packaging waste were 70.07%, 68.06%, and 66%, while plastic packaging waste achieved recycling rates of 46.79%, 46.07%, and 42.32% for the years 2019, 2020, and 2021, respectively. Incineration rates for cardboard and paper were 3%, 3.82%,

and 3.63%, and for plastic waste, they were 9.24%, 10.79%, and 10.27% over the same period (Deloitte, 2022). The material composition was determined to be 87.61% cardboard shipping cartons, 9.95% paper envelopes, 1.57% plastic magazine covers, and 0.87% plastic carrier bags (Gavrilescu *et al.*, 2024).

4. Conclusions

This study proposed a comparative analysis of the situation of packaging waste from e-commerce at international level and in Romania, in the context of the circular economy.

E-commerce has become a popular choice among consumers for purchasing goods for various reasons, including home delivery, both out of convenience and easy product search, but also in the context of the COVID-19 pandemic, the rapid global expansion of e-commerce business increasing dramatically in the last 10 years.

Circular economy offers ingenious solutions whereby efficiencies are increased and hence the products and services on offer are competitive with those realized in a traditional, linear economy, as are most in the market. In the online area, such solutions are sorely needed in view of the explosive growth and the collateral damage caused to the environment.

First, an overview of the state of packaging waste internationally has been provided to better understand the trends in the generation and management of packaging waste from e-commerce, and to propose suggestions for more efficient management of packaging waste in e-commerce.

One aspect of sustainable packaging is to consider the whole life cycle of the product. This means designing packaging that is not only environmentally friendly but also efficient in terms of transportation and storage and number of usage cycles. By optimizing the size and weight of the packaging, companies can reduce fuel consumption during transport, thus reducing their carbon footprint. By adopting sustainable packaging practices, online businesses can play a crucial role in reducing waste, conserving resources and protecting our planet for future generations. Sustainable packaging in online business plays a vital role in promoting environmental responsibility. Opting for eco-friendly alternatives demonstrates a commitment to sustainable practices and contributing to a greener future.

One of the significant challenges is to eliminate misconceptions about sustainable packaging, such as the belief that it is less efficient or more expensive. Customers and stakeholders have to be aware about the benefits and value of sustainable packaging, emphasizing its positive environmental impact and degree of innovation. Sustainability solutions in e-commerce packaging can be adopted by companies without compromising product quality and functionality. For example, the delivery of textile products (clothing) in reusable, textile-type packaging.

Recommendations for a more efficient management of packaging waste in e-commerce may include, without being limited to:

- **Usage of sustainable packaging:** Promoting and using biodegradable, recyclable or reusable packaging materials can reduce environmental impact.
- **Encourage recycling:** Provide information and facilities for customers to recycle packaging properly.
- **Optimising packaging size:** Using packaging that can be adjusted to the size and shape of products can reduce the amount of material needed and the amount of empty space in packaging.
- **Improving logistics:** Optimising delivery routes together with reducing the amount of packaging used can reduce costs and carbon emissions associated with transport.
- **Education and awareness:** Educating customers and employees about the impact of packaging waste and ways to reduce leads to changes in behaviour and greater involvement in recycling and responsible waste management.
- **Working with suppliers:** Working with suppliers to find more sustainable packaging and delivery solutions can improve the entire supply chain.
- **Packaging innovation:** Researching and implementing new packaging technologies and materials can lead to more efficient and environmentally friendly solutions.
- **Performance monitoring and reporting:** Tracking the amount of packaging waste generated and reporting on performance in terms of reduction, recycling and reuse can help identify further opportunities for improvement.

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MANAGEMENTUL DEȘEURILOR DE AMBALAJE DIN COMERȚUL ELECTRONIC ÎN CONTEXTUL ECONOMIEI CIRCULARE

(Rezumat)

Sustenabilitatea în comerțul electronic este o problemă nouă, dar semnificativă în contextul tranziției Uniunii Europene către o economie circulară, datorită creșterii

rapide a pieței comerțului electronic. În România, peste 500000 de ambalaje din plastic sau carton de unică folosință sunt utilizate zilnic pentru expedierile online. Sectorul ambalajelor este unul dintre principalii consumatori de materii prime virgine. Utilizarea crescută a ambalajelor, împreună cu ratele scăzute de reutilizare și reciclare, împiedică dezvoltarea unei economii circulare cu emisii reduse de carbon. În ultimii ani, industria ambalajelor a crescut mai rapid decât venitul brutale diverselor țări, ceea ce a condus la creșterea emisiilor de CO₂ și a altor poluanți, precum și la supraexploatarea resurselor naturale, pierderea biodiversității și poluare.

Pentru a minimiza impactul negativ, în prezent se depun eforturi pentru a dezvolta și implementa practici mai durabile în industria comerțului online, inclusiv utilizarea ambalajelor reciclabile, optimizarea transportului și promovarea practicilor ecologice. Consumatorii pot juca, de asemenea, un rol crucial prin alegerea cu atenție a produselor și a comercianților cu preocupări ecologice și prin adoptarea unor practici de achiziții mai responsabile.

În acest context, obiectivul principal al acestui studiu este de a analiza managementul deșeurilor de ambalaje generate de comerțul electronic în contextul economiei circulare. Cele mai importante practici și tendințe la nivel internațional și național sunt discutate, și sunt prezentate recomandări de îmbunătățire a managementului deșeurilor de ambalaje provenite din comerțul electronic din România.