Strategic Actions for Packaging Waste Management and Reduction

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Abstract. Following the growing trend of packaging waste quantities, it has become more and more actual the issue of the impact of this waste flow over environment and human health, as a consequence of inappropriate disposal methods and technologies. For this purpose, waste hierarchy must be applied, focusing on waste prevention, prepare for reuse, recycling and recovery, while waste landfilling should be the last available option of management, which corresponds to the highest level of loss and denaturation of resources. The food packaging is not only useful for food protection, but it is key element to attract consumers and to impact their consumption behavior. Food packaging should grow the value of the product that is packed, but also must meet certain requirements for recycling when packaging becomes waste. This is the reason why proper and efficient management of packaging waste is important for environment and human health. The problems generated by the packaging waste have determined governments to take measures for policy improvement, focusing also on other options of management, such as reduction of unnecessary packaging, promotion of packaging reuse and use of alternative packaging materials, in addition to growing the recycling efficiency and gradual ban of single use packaging. This paper presents strategic actions for packaging waste management and reduction, as measures to reduce negative impact of waste on environment and human health, in the context of circular economy. Therefore, reduction of packaging waste inputs to the environment must be tackled as a global multidisciplinary approach priority.

1. Introduction

The increase of life quality is our common goal and it represents the concept, which stands for the progress of the modern humanity [1]. Waste generation is the key element of the modern social lifestyle and one of the main problems for environment and human health [2]. Nowadays linear
economy, based on these of resources for manufacturing of goods and their disposal when they become waste (take-make-dispose economy), has become the main factor for climate change and ecosystems degradation [3]. The concept of circular economy has appeared as an instrument to prevent and reduce the human activities that bring prejudices to environment (promote industrial circularity, waste minimization, reduction of raw materials and energy consumption) [4]. Packaging for food and beverages represent a relevant fraction of municipal solid waste, with a critical management [5]. The appearance of packaging must considered not only during manufacturing, but also for their use and disposal, knowing that food packaging protects the food against degradation and contamination and contain details, which encourages the consumption of the product [6]. Plastic packaging is used very much in food industry because they are hygienic, light, cheap and have a long life on the shelf [7]. However, plastic waste has become lately a great environmental problem [8]. Thus, many national and European policies are focusing on raising the recycling degree, although it is difficult to collect all plastic waste for recycling and not all plastic materials can be recycled [9]. In Europe, the average recycling rate of plastic packaging is nearly 40%, compared to 80% for cardboard packaging and 75-80% for metal and glass packaging [10]. In the last years, experts have warned on massive oceans pollution with plastic waste and on marine species threatened because of plastic waste presence in the oceans [10]. At global level, estimations were done and it is appreciated that nearly 8 mill. tonnes of plastic waste enter the seas and oceans each year, the main source being the coastal countries (China, Indonesia, Vietnam, Malaysia, Bangladesh, Nigeria) [11].

All these issues have determined the governments to take measures for improvement of environmental policies by focusing also on other management options beside recycling [12]. The New Action Plan for Circular Economy proposes to prepare the European economy for an ecologic future, to improve competitiveness, to protect the environment and to offer new rights to the consumers [13]. It is focused on circular economy, with the objective to use own resources as much as possible.

The purpose of this paper is to present actions to reach the status of a recycling society, as it is mentioned in the National Strategy for Waste Management [14] offering practical recommendations to stakeholders. Strategic actions for packaging waste management and reduction presents information on the following issues: packaging and packaging waste; legal framework for packaging waste management, at national and European levels; main endpoints of European policy on packaging waste management; strategic priorities; examples of good practices in packaging waste management, framed within the objectives of actual policy of prevention and impact reduction.

2. Experimental

2.1. Material

Packaging and packaging waste addressed in the present paper are plastic packaging, paper/cardboard packaging, metal packaging, glass packaging and multi-layer packaging (composites).

2.2. Legal framework

European Union introduced first measures on packaging waste management as early as 1980s [15], setting rules on production, trading, use, recycling and reuse, but also for disposal of containers for liquids aimed for human consumption. Subsequently, in order to answer the requirements on environmental protection, some Member States have introduced their own measures in the field [16]. Therefore, it has appeared the need of the legal harmonization at European level, adopting in 1994 as a
consequence of the Directive 94/62/EC on packaging and packaging waste. This directive aims to offer a high degree of environmental protection and to ensure the internal European market for packaging. In 2004, the Directive was amended, setting criteria to make the term packaging clear and to increase the targets for recycling and recovery of packaging waste. The directive was reviewed in 2015 and determined by the adoption of the Directive (EU) 2015/720 on the consumption of single use plastic bags [17]. In 2018, the directive was amended by Directive (EU) 2018/852 [18].

2.3. Strategic priorities

Strategic principles on which the paper is based are the same with strategic principles of waste management activities provided in the National Strategy for Waste Management: principle of raw materials protection, principle of preliminary measures, prevention principle, polluter pays principle, substitution principle, principle of proximity, subsidiarity principle, principle of integration. Waste management is based on the 4Rs hierarchy: reduction, reuse, recycling, recovery [14].

3. Results and Discussions

3.1. Packaging and packaging waste

For packaging, two types of materials have been defined: permanent and non-permanent. Permanent materials may be reused and/or recycled repeatedly (e.g. metal, glass) and their properties are not modified during the use. Non-permanent materials modify their properties during the use and recycling process (limited recycling), e.g. thermoplastics, paper/cardboard, or they cannot be recycled.

EUROSTAT reports on packaging waste of 2017 show that 172.6 kg/capita were generated in EU: 41% paper/cardboard packaging waste, 19% plastic packaging waste, 18% glass packaging waste, 5% metal packaging waste, the rest being wood packaging waste and other materials [19].

3.1.1. Plastic packaging. Plastic is the most common material for food packaging and it comes in different forms: films, bottles, bags, boxes, trays etc. One of the properties of this material is durability. Most of the plastic waste is not biodegradable, remaining in the environment for a long time [20]. Global production of plastic rose from 2 mill. tonnes in 1950, to over 400 mill. tonnes in 2015, overtaking any other type of material. Half of the whole plastic quantity was manufactured in the last 13 years, meant to become waste in the next period [20]. Thus, there is an urgent need to take efficient measures to prevent plastic waste. In 2017, 14.5 mill. tonnes of plastic waste were generated at European level, representing the second significant material after paper/cardboard [19]. Market demand for plastic packaging represents 40% of the total plastic products. In the same time, plastic packaging waste is 60% of the total plastic waste. Out of the total plastic packaging put on the market, around 65% are consumption packaging. In Europe, according to available data, 42% of plastic waste is collected for recycling [20].

3.1.2. Paper/cardboard packaging. From 2007 to 2017, paper and cardboard were the main packaging materials in EU – 31.2 mill. tonnes in 2017, representing 41% of the total packaging waste generated [19]. Paper and cardboard are mainly used for packing dry food or as secondary packaging. In Europe, cellulose fibers are recycled 3.5 times, but technically, they may be recycled 7 times [21].

3.1.3. Metal packaging. Metal packaging for food is tins, cans, containers, lids, protection layers. Cans for drinks are made also from aluminum, but the main metal is steel for main food packaging.
Metal packaging waste represented in 2017 only 5% of the total packaging waste generated in EU (3.9 mill. tonnes) [19]. Metal is a permanent recyclable material, being a great advantage. The average recycling rate at global level for aluminum cans is around 70%.

3.1.4. Glass packaging. Glass has been used as food packaging as early as its discovery. It is an inorganic permanent material, which may be recycled without properties modification. It also has protective properties, as it is an inert material. In 2017, 18% of the packaging waste quantity generated in EU was represented by glass packing waste – around 14 mill. tonnes [19]. Recycling of glass bottles in Europe reached an average of 74% in 2014 (some Member States have recycling rates of 90%). Glass packaging recycling saves resources, energy and reduces carbon emissions [22].

3.1.5. Multi-layers packaging (composites). Multi-layers packaging is widely used for food and beverages. They may be manufactured from different materials (cardboard, aluminum, plastic) or made of more layers of the same material (plastic). Generated quantities are reported according to the main material prevailing in weight. Taking into account the basic functions and safety of the packaging, the concept of reduction and reuse of packaging must be revised. As an example, Zero Waste shops offer products without packaging, the consumer brings own reusable packaging when buys products. Packaging reuse in case of glass packaging may be used at a large scale. In circular economy, sustainable food packaging must combine all these efforts, involving all stakeholders: manufacturers, recyclers, decision factors, consumers.

3.2. European legislation and policy

3.2.1. Directive (EU) 2015/720 [15]. This directive foresees that Member States take sustainable measures for the reduction of the consumption of plastic bags and entails the following objectives:

- Until 2019 – reduction of single use plastic bags consumption up to 90 pieces/capita per year.
- Until 2025 – reduction of consumption up to 40 pieces/capita per year.

It has to be mentioned that, in 2010, the average consumption of plastic bags at EU-27 level was 198 pieces/capita per year; in Romania, the consumption was 252 pieces/capita per year [23].

3.2.2. Directive (EU)2018/852 [22]. This directive amends Directive (EU) 2015/720 and foresees the following measures: prevention of packaging waste generation and promote reuse, recycling and other forms of recovery for packaging waste, contributing to the transition to a circular economy. Directive (EU) 2018/852 has to be transposed into national legislations of Member States until July 5, 2020. Member States should encourage the grow of the reusable packaging put on the market, without compromising the food safety. It is necessary that Member States take measures to reach the recycling targets. In the context of circular economy, the recycling targets for municipal waste are 55% until 2025, 60% until 2030, 65% until 2035. The new recycling targets for packaging waste are presented in table 1.

| Table 1. Recycling targets for packaging waste. |
### 2025 2030

| Total packaging | 65% | 70% |
|-----------------|-----|-----|
| Plastic         | 50% | 55% |
| Wood            | 25% | 30% |
| Ferrous metal   | 70% | 80% |
| Aluminum        | 50% | 60% |
| Glass           | 70% | 75% |
| Paper/cardboard | 75% | 85% |

Essential requirements for packaging put on the market are referring to: limitation of weight and volume of packaging to a minimum, respecting safety level, hygiene and quality levels for consumers; reduction of hazardous substances and materials in materials and components of packaging; design of reusable and recoverable packaging. Member States must ensure systems for the return and/or collection of used packaging and/or packaging waste, and also for reuse or recovery, including recycling, of packaging and packaging waste collected. Until 2025, Member States must ensure the function of producer responsibility schemes for packaging.

Thus, hierarchy of waste must be applied (figure 1), with focus on waste prevention, prepare for reuse, recycling and recovery, while landfilling should be the last available option, corresponding to the highest level of loss and degradation of resources.

![Waste Hierarchy](image1.png)

**Figure 1.** Waste hierarchy [24].

![Circular Economy](image2.png)

**Figure 2.** Circular economy.

In the last 20 years, many Member States have improved their waste management, according to waste hierarchy. Therefore, if in 1995, in EU, 64% of municipal waste was landfilled, in 2000, the average of landfilled waste was 55%, and recycling rate was 25% [25]. In 2016, municipal waste landfilling has dropped to 24%, while recycling rate rose to 46%. However, due to big differences between them, some Member States still landfill over 50% of municipal waste, while others incinerate over 40%. Romania is part of the EU Member States in which the majority of collected municipal
waste a very small extent [26]. By the end of 2015, European Commission adopted a package of legislative proposals on waste, as part of the European Action Plan on Circular Economy [27]. European Parliament approved this plan in April 2018. Action plan includes measures for stimulation of the transition to circular economy (figure 2), for global competitively growth, for encouraging growing of the sustainable economy, for creation of new jobs. The legislative package adopted by EC in 2018, includes also the following key documents:

• European strategy for plastic materials in the context of circular economy [28]
• Directive proposal on environmental impact reduction of certain plastic products [29].

Plastic packaging are a priority for the European policy, representing 60% of plastic waste in EU [30]. The key to improvement of the recycling degree is the design of these products. Another objective is to maintain high standards for food safety, when recycled plastic is used for packaging in contact with food (e.g. packaging for drinks). Directive (EU) 2019/904 on environmental impact reduction of certain plastic products (Directive of single use plastics) introduces measures for prevention and reduction of the impact of certain plastics and promotes transition to circular economy [31]. The directive encourages prioritization of reusable products, which are sustainable and non-toxic. Member States must include provisions of the directive in own legislation until July 3, 2021. In March 2019, European Commission adopted a report on the implementation of the Action Plan for Circular Economy [32]. A key document elaborated as a consequence of this report was Circular Economy for Plastics. Due to the fact that all 54 actions of the plan were met or implemented, in March 2020, EC adopted a New Action Plan for Circular Economy [33], part of the new European agenda for sustainable development – European Green Deal [34]. This document proposes immediate actions to support Europe to become a sustainable society, with a competitive economy based on efficient use of resources and surpass the problems linked to environmental degradation and climate changes. The New Action Plan for Circular Economy aims to prepare the European economy for a green future, to improve competitiveness, to protect the environment and to offer new rights to the consumers.

3.3. Strategic actions for packaging waste management

For reaching the aim of the paper, three strategic objectives were laid down: grow of the recycling rate of packaging waste, development of sustainable packaging and decoupling of packaging waste quantities from economic growth. For the improvement of packaging circularity it is most important to ensure a good recycling of packaging waste and to secure that packaging do not go to landfill or in the environment.

3.4. Good practices in packaging waste management

Lately, a greater attention has been given to plastic waste due to the environmental problems associated with the consumption of plastic and waste generation, which obstructs the circularity of products:

• Many plastic products are single use products, have a short life cycle and cannot be reused
• Plastics are used in large quantities for packaging, but they have a short life
- Plastic products may contain hazardous substances in significant quantities; these substances may be found also in recycled plastic
- Recycling rate for plastics is low.

Plastic demand is high because the plastic materials have useful properties. For example, plastic demand in EU-28 in 2017 was 52 mill. tonnes, higher than 2010 (46 mill. tonnes). The global plastic production in 2017 was 348 mill. tonnes, with 13 mill. tonnes more than in 2016 [35].

3.4.1. Prevention of packaging waste. According to Waste Framework Directive [36], prevention of waste is a priority, representing the first option in management hierarchy. European Commission reaffirms the strategic importance of waste prevention in the context of circular economy and highlights the focus on prevention of plastic waste through: implementation of regulation instruments, implementation of voluntary agreements and implementation of information measures. A good example for prevention of packaging waste is Italy, through the initiative Eco-Point for selling bulk commodities [37]. As early as 2005, supermarkets in Italy have created selling points in shops for bulk dry products, un-packed, where consumers serve themselves using dispensers. They proposed a new way of shopping, answering to legal requirements and also to higher public concernment for environmental issues. This initiative helps reduction of packaging and packaging waste quantities and products have a lower price. It is estimated that this system prevents the use of 1 mill. packaging per year.

3.4.2. Reuse of packaging waste. Good practices consist of extracting of reusable products from waste flow and introduce them in reuse systems, usually through second-hand shops, repair shops, flea markets or charity markets. The next figures (Figures 3-6) show examples of good practices in packaging reuse.

![Figure 3. Packaging reuse at consumer.](image1)

![Figure 4. Packaging reuse at shop.](image2)
Some packaging may be reused by the consumer, others may be returned to the shop or producer, being again used for packing. Reuse is placed on top of waste hierarchy, as a waste prevention measure, avoiding the environmental problems related to generation and management of waste, as Waste Framework Directive requires. In the literature, it is specified that, if 20% of single use plastic packaging be replaced with reusable packaging, a 10 billion $ opportunity is created for consumers, representing a crucial element in elimination of plastic pollution [38]. Thus, new models need to be created for consumption, production and distribution, to stop packaging waste at source.

3.5. Collection of packaging waste

The main objective of a collection strategy is to implement collection of waste separated at source, as correct as possible, in time and on a budget, in order to ease subsequent sorting and treatment, aiming to maximize waste recycling [39]. These objectives may be realized through: frequent separate collection of food waste from population (weekly or more frequent, according to climate and season), mixed waste collection (every 2 weeks), recyclables collection from population (paper/cardboard, aluminum, plastic, glass), separated, by type or mixed and sorted afterwards in a sorting station; glass and paper/cardboard are collected separated and public centers for waste (amenity sites) are beneficial; they should be placed in convenient places for population, and accept all fractions of waste that were not collected door-to-door or in street containers, including hazardous waste and bio-waste.

An example of good practice related to collection of different waste fractions is the Swedish system Optibag [40] which consists in 6 bags of different colors for the following fractions: green bag - organic waste; orange bag – plastic packaging; gray bag – metal packaging; yellow bag – paper/cardboard packaging; blue bag – papers, journals; white bag – combustibles. The bags may be collected by a single collection vehicle and transported to a sorting facility using optic separation, being sorted for recycling or incineration.

3.6. Packaging waste recycling

Steel is a unique packaging material: resistant, yielding, durable and offers safety for the packaging of many products. Steel may be recycled and used permanently without being worn-out. Steel recycling avoids greenhouse gases emissions and eutrophication; it also helps saving energy and natural resources like ore, coal, and limestone. Where recyclables separate collection is not well organized,
steel packaging waste is collected together with the residual waste and usually go to the incineration plant. Due to its magnetic properties, steel may be extracted from residues and may be reintroduced in the fabrication process.

3.7. Packaging waste treatment

In many European countries, packaging waste is collected together, in order to ease the task of consumers to separate them at source and to reduce collection costs. For a high level of recycling of such mixed packaging, the best solution is material recovery facility. There are many technologies used for sorting and good segregation for high rate of recycling.

The main objective of a waste collection strategy is to implement collection of waste separated at source as correct as possible, in time and at low costs, in order to ease sorting and treatment and maximize waste recycling [39]. In order to avoid the negative impact on environment, packaging waste fate must be controlled. The 2019 Environmental Implementation Review shows that waste management remains a key challenge for Romania, despite formal progress thanks to adoption of the national waste management plan in December 2017. Additional measures have to be adopted and fully implemented, while awareness of the circular economy needs to increase.

4. Conclusions

Efficient management of packaging waste comes from the need to identify objectives and action policies, which Romania has to follow in waste management, in order to reach the status of a recycling society. This paper offers useful information for a recycling society by encouraging waste prevention and reuse for a higher resources efficiency and the presented actions show a close link to circular economy, an inevitable alternative for future society, capable to face challenges.

A general conclusion of the studies presented in the paper is that food packaging has to grow the value of the packed product but also to meet the requirements for efficient recycling of packaging waste.

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