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EFFICIENT WASTE MANAGEMENT: ECONOMIC ASPECTS

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Abstract

At present, waste reduction or elimination has become a serious environmental concern for most countries and a priority for companies. Waste is not only an environmental problem but also an economic loss. A prerequisite for flourishing economic activity is the efficient management of waste and other resources. The recovery of waste resources has become an industrial reality due to technological innovations in the era of raw materials shortage. Sustainable materials management goes further than ecological waste management and focuses on the efficient use of available materials. The article aims to research the waste management process, shed light on the place of waste management in promoting the circular economy, and outline positive experiences in this area by highlighting the potential benefits and economic costs of applying these practices. That could serve as an incentive to accelerate efficient waste management processes in the Republic of Moldova. Waste management benefits the environment but also increases the number of companies and jobs. The presented article discusses waste management issues and shows some current issues related to them. The paper the authors wrote within the frame of the state project 20.80009.0807.22. - Developing a mechanism for the circular economy creation in the Republic of Moldova.

Keywords: *circular economy, waste disposal, developing countries, economic transition, sustainable development.*

1 INTRODUCTION

With the development of technology, consumption habits and product diversity have also changed. Mankind, which earlier produced only to satisfy its own needs, has switched to mass production whose scope exceeds the essential human needs. Mass production gave rise to the concept of the linear economy. The linear economy covers the processes of obtaining raw materials, their transformation into final goods, their consumption, and their transformation into waste. A linear economy is an approach to neoclassical economics that aims to support economic growth (Ozsoy, 2018). Until the 1970s, the views of economists, not pessimistic like Malthus, but optimistic like Smith, dominated economic policies, so natural resources were used excessively (Zweig, 1979). The fact is that the linear economy approach is growth-oriented. So it has caused many environmental problems in the coming periods. Environmental issues that we can see in global warming, climate change, etc., generate a series of challenges. In addition, the

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excessive use of limited natural resources can cause many problems in the future. For these reasons, the linear economy approach has begun to be questioned.

The amount of waste strongly depends on the living standard and economic growth. The studies in the field show that the volume of waste generated from our daily activity increases with consumption, which in turn increases with economic growth.

In economic theory, economic growth is a category that describes quantitative changes. This is a process of increasing national wealth over time and refers to the measurable sphere of the economy. Because the productive capacity of an economy is difficult to measure, GDP growth is most often used to measure economic growth. The shortcomings of this approach to economic growth became much more visible when it was necessary to move from a linear to a circular economy model, so new indicators are needed now to reflect quantitative aspects of population well-being.

2 WASTE PREVENTION IN THE WASTE MANAGEMENT HIERARCHY

Waste management is a significant area of activities undertaken to protect the natural environment. The waste affects the condition and functioning of the basic components of the environment, such as water, soil, Earth's surface, and the atmosphere. It is impossible to obtain a high-quality environment for human living without adequate and rational management in this regard.

According to the principles of sustainable development, the European Union has developed a waste management hierarchy to ensure a balance between the economy and the environment. The waste management hierarchy set out in the so-called Waste Framework Directive 2008/98/EC of 19 November 2008 consists of five action blocks, with priority given to those at the top of the list. Those from the end of the list are taken into account only as a last resort when there is no other option (Figure 1).

The recommended actions according to the adopted management hierarchy are (Directive 2008/98/EC):

- prevention;
- preparing for reuse;
- recycling;
- rother recovery, e.g., energy recovery; and
- disposal.

Fig. 1 Waste management hierarchy
Source: (EC, 2015)

Each EU Member State has been obliged to implement the provisions of the Framework Directive in its legal system. Even in the Republic of Moldova, which is not yet an EU member state but has aspirations to become one, this hierarchy is provided by the legislation in that area (Law of the Republic of Moldova, 2016).

Waste prevention, the first in the waste management hierarchy and the most fundamental, tried to be implemented both at the level of a person and a business entity but is the most complicated to implement. The study of the specialized literature allowed us to identify the main factors that influence the adoption of a preventive strategy at different levels:

- individual attitude towards the environment.
- regulation,
- collaboration with stakeholders,
- certification of environmental management systems,
- company characteristics.

We can analyze an *individual's attitude* regarding involvement in the waste prevention process in terms of *Planned Behavior Theory* (Ajzen,1991). By this theory, the individual's intention depends on three factors:

- *attitude towards the environment.* People with ecological attitudes toward the environment will adopt an ecological behavior, such as waste reduction and recycling. They will

influence by their behavior and the activities of the organizations in which they work or interact (Stern, 2000).

- *subjective norm.* It refers to the social pressure that the individual feels in the sense of engaging in that behavior. These pressures may come from stakeholders such as customers, suppliers, shareholders, employees, and municipalities… They may affect the behavior of managers because they have significant power over the company stakeholders and can act against companies that do not comply with their environmental requirements (Ozsoy, 2018).
- *perceived behavioral control.* It refers to the perception of ease or difficulty in performing that behavior, a perception based on previous experiences and anticipation of possible obstacles (the intention to perform a behavior increases when perceived behavioral control is high (Cordano & Frieze, 2000).

The regulation is a component of state policy in environmental protection and it includes various environmental taxes, technological standards, various permits, etc., which forces companies to reallocate their resources to reduce pollution and get involved in the prevention process. Thus, from a business perspective, regulations impose additional costs, which affect their competitiveness. They have to invest in new technologies and innovations to minimize environmental taxes. For example, it has been shown that firm and well-designed regulations can favor innovation. Such legislation improves ecological performance but also partially or fully covers imposed costs. Pollution is often a waste of resources, and reducing pollution would improve productivity. (Porter, & Van Der Linde, 1995).

The research on the relationship between environmental regulations (often measured by pollution costs) and innovation (generally measured by research and/or the number of patents) shows a positive but sometimes weak or non-existent relationship between these two variables (Ambec et al., 2013). However, the studies show that regulatory pressures lead companies to adopt a preventive strategy.

The collaboration with stakeholders is identified as a separate factor influencing various companies to get involved in adopting environmental innovations. It includes collaborations with customers and suppliers. The last one plays a key role in making companies` decisions in favor of the environment in the opinion of several researchers. It is emphasized that companies that make environmental innovations are more efficient in terms of resources and energy if they work more closely with stakeholders (Rennings, 2000). Stakeholder participation in companies' environmental decisions increases the quality of these decisions (Reed, 2008). Thus, the companies that work more closely with stakeholders are encouraged to adopt a preventive strategy.

The certification of environmental management systems. Companies that adopt an environmental management system can apply for certification through international accreditations. ISO 14001 has become a standard in environmental management systems around the world. Many empirical studies try to measure the impact of adopting an environmental management system on the environmental performance of companies, but the results are not conclusive. Several authors note the positive impact of accreditation on the environmental performance of companies (Arimura, Hibiki, & Katayama, 2008), while others do not find any significant impact (Barla, 2007). However, the impact on the environment we can only observe in the long term, and obtaining accreditation transforms the company and encourages it to aim to implement more environmental actions (EEA, 2021). For example, the accreditations require companies to keep environmental accounts, write an environmental policy and designate a person explicitly responsible for this strategy. This leads to a transformation of knowledge and relationships between actors. The effects on environmental innovations can be significant, as they solve the problem of lack of information about the possibilities and ways of innovation in a specific company (Horbach, Rammer, & Rennings, 2012). Thus, the companies that obtain environmental accreditations can be encouraged to adopt a preventive strategy.

The companies' characteristics are identified in the literature as a significant factor in the decision to adopt the waste prevention strategy, important being the internal structural characteristics of the company, such as size, group membership, or

sector of activity. The large companies with more available resources would have fewer constraints to adopting an environmental innovation compared to small companies. At the same time, belonging to a group can encourage the adoption of a preventive strategy. Indeed, the company can benefit from the financing of the parent company, which allows it to overcome the financial difficulties of implementing such a strategy (Galliano & Nadel, 2013).

The business field is a classic control variable in environmental innovation studies in general (Galliano & Nadel, 2013) and pollution prevention in particular (Papagiannakis, & Lioukas, 2012). On the one hand, the regulations are different depending on the field. Some fields are subject to very strict regulations regarding waste management, such as the chemical field, and the companies working in these areas tend to develop new technologies to reduce pollution at the source.

The company's age can influence the adoption of a preventive strategy (Khanna, Delta, & Harrington, 2009). The old business may be more resistant to change. On the other hand, a young company can take advantage of the latest technological innovations from the outset, making it easier to adopt prevention.

The waste management hierarchy implementation must, above all, lead to stopping the constant trend of increasing the amount of waste that accompanies economic growth. Economic growth is the goal of every country. It proves greater economic activity of society, which usually creates a higher income for each citizen and improvement of its basic needs. In turn, the higher amount of waste generated indicates a waste of limited resources, excessive consumption, and a burden on the ecological and economic system, reducing the quality of individual components of the natural environment, thus adversely affecting the standard of living and health of people.

3 CIRCULAR ECONOMY AND WASTE MANAGEMENT

The circular economy is a system that aims to eliminate environmental problems caused by the linear economy and achieve environmentally friendly economic growth. The circular economy was developed inspired by the fact that every object in nature is the source of another phenomenon. For the first time, the concept was mentioned in Kenneth Boulding's book The Coming Spaceship Economy. However, the concept took its original form in the study of Pearce and Turner (1990) (Winas et al., 2017). It is a new paradigm, an economic cycle in which everything that enters a product or process from the design phase is designed to fall into two categories: either a biodegradable component or a component with 100% recycling potential.

The implications of such a definition are huge. However, at the level of humanity, we need enormous changes to succeed in reversing some of the trends identified by economists and sociologists. On the one hand, the circular economy appears as an economic system that aims to facilitate sustainable development by applying it at the micro and macro levels to prevent the depletion of material and energy resources (Prieto-Sandoval, Jaca, & Ormazabal, 2018). The circular economy can be defined as a system that reduces environmental damage by reducing waste generation, preventing excessive consumption of limited global resources, and targeting sustainable development.

The 3R concept describes the circular economy. It consists of the initials the Reduce, Reuse, and Recycle used in defining the essential principles of the circular economy:

- Reduce – refers to the reduction of waste generated by production and consumption activities. We can say that the biggest goal of the circular economy is to reduce the amount of waste. Here we found the first stage of waste management in the previously analyzed waste hierarchy.
- Reuse – refers to the use of waste whose life cycle can be prolonged by repair (especially electronic waste) or its subsequent use as parts in the manufacture of other products.
- Recycling – refers to the use of waste that has ended its economic life and can be used as raw materials in the production of another product.

In some studies, the concept of 3R has been expanded and transformed into 6R. In addition to those 3Rs, there are three more related to redesign, remanufacturing, and recovery (Jayal, et al., 2010).

One of the main goals of the circular economy is to keep waste generated as a result of production and consumption at the lowest level. For this reason, waste management in the circular economy is extremely important.

One of the biggest problems in the world is what to do with waste generated as a result of production and consumption. For example, in the EU, the total generation of waste from all economic activities is around 2.2 billion tons per year since 2004 (over 2.3 billion in 2018) or 5.0-5.2 tons per capita (except for 2008), with a citizen producing almost half a ton of municipal waste on average (EC, 2020).

We can use as an example European Union countries to establish a ratio between GDP and recycling in the context of the circular economy. They produce billions of tons of municipal waste and 1.67 billion tons of industrial waste annually. (OCDE, 2020) As can be seen from these figures, it is unlikely that the world will be able to cope with this level of waste. The concept of recycling is an important alternative for solving the waste problem.

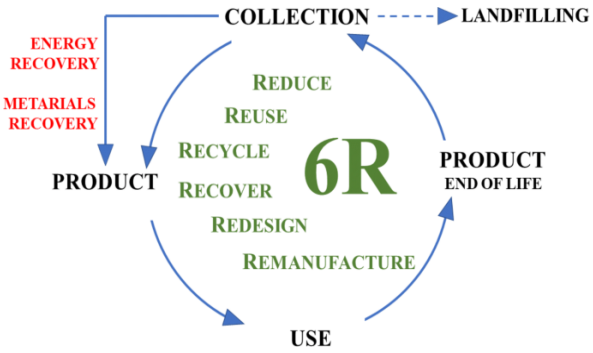

Fig. 2. The basic concept of circular economy
Source: (Nakajima et al., 2010)

For example, by recycling 1000 mobile phones, we can separate and include in the reproduction 250 mg of silver, 24 mg of gold, 9 mg of palladium, and 9 g of copper (Ciftlik et al., 2009). In short, recycling is one of the indispensable factors of the circular economy.

Recycling is a resource recovery practice. It involves the collection and use of waste. Materials of the used products can be reprocessed into new products. The recycling material can be collected separately from general waste using dedicated waste bins and collection vehicles, a procedure called side collection. In some communities, the owner of the waste must separate the materials into several different baskets (for example, paper, plastics, metals) before collection. In other communities, people place all waste in a single collection bin, and sorting performs in the central. The last method is known as, "single flow recycling" (Wilson, Velis, & Cheeseman, 2006).

The purpose of recycling is to use resources most efficiently so that the waste generated by the production process is transformed into input by reintroducing them into the economy and preventing them from causing environmental problems. In addition, recycling also saves energy. For example, only 5-10% of the energy required in the initial extraction process is required for aluminum recycling (Nakajima et al., 2010). Shortly, recycling is a method that contributes both to the support and development of the economy and to the protection of the environment.

Recycling first appeared to eliminate the shortage of raw materials during the Second World War. The recycling campaigns were launched in almost all countries involved in the war and continued in countries with limited natural resources after the war. For example, in Japan, 98 percent of metal and 72 percent of plastic bottles are recycled, while about 90 percent of the materials that make up electronic devices they recover to use in making new gadgets. Looking at the world in general, we can say that recycling is not widespread enough.

Of course, there are different opinions in academic circles regarding the circular economy system, for example, Allwood (2014) and Zink and Geyer (2017) are less convinced of the possibilities of successfully implementing the principles of the circular economy, the main arguments taking into account the following aspects:

- in the event of increasing world demand for raw materials, it will be very difficult in a circular economic system to meet this demand, as this demand can only be met by extracting new raw materials.
- continuous technological development may lead to a situation where an old technology product cannot be used as a raw material or component of a high-tech product.
- the complete recycling of some products in the current conditions of technology development is impossible, respectively the generation of waste is impossible to be eliminated.

- the use of fossil fuels for the energy supply of the circular economic system will also create waste and contradict the main idea of this system. Therefore, the circular economic system should use renewable energy sources.
- declining demand for raw materials in a circular economy may lead to a decline in economic growth. There is no certainty whether this situation will be accepted in today's world, where the perception of the economy focused on economic growth remains dominant.
- not all waste can be recycled, so a 1:1 conversion is excluded.
- the rebound effect, which is mainly observed in the energy market, can also occur in recycling, so even in the amount of the raw material recovered through recycling, even if it increases, more will always be needed.
- according to the principles of the circular economy, technologically obsolete mobile phones, electronic devices, and automobiles are to be used as spare parts or raw materials in the production of electronic devices and automobiles equipped with new technology. But, in real life, they are still widely exported from developed countries to developing countries.
- some recycled raw materials could hardly compete with their primary alternatives in terms of quality, price, and target markets.

The benefits of the circular economy implementation in terms of efficient waste management outweigh the risks and costs.

3 WASTE MANAGEMENT BETWEEN REALITIES AND ECONOMIC PERSPECTIVES

Every time a product is thrown away and turned into waste, its treatment entails a series of side effects. They affect the environment and the economy and society in general. Waste management is a complex process that cannot ignore any of these effects. It is impossible to study and manage them individually without considering all complex factors: environmental, economic, and social. Poor, inadequate, incomplete, disorganized, and/or inefficient waste management has disastrous results in all the above areas.

Poor waste management pollutes the oceans, blocks rivers, causes floods, creates conditions for the multiplication of pathogens responsible for the transmission of infectious diseases, and contributes to increasing the population's health problems. The uncontrolled waste treatment ultimately affects economic growth through various channels, such as reluctance of investors, lack of tourism, and diminishing economic benefits in the affected areas (WB, 2021).

Improper waste management has the greatest impact on the population of economically weaker countries, which are also the most vulnerable. People in poor areas have a minor impact on government policies, and waste is often disposed of, formally or informally, in addition to their areas of residence (WB, 2021). Although waste management is crucial for the development of sustainable cities, it is also an expensive service. It is estimated that municipalities in low-income countries spend 20% of their budget on waste management. In more than 90% of cases, management involves methods such as incineration and free storage on open land. In middle-income countries, waste management absorbs 10% of municipal budgets, while in high-income countries only 4% (WB, 2021).

The implementation of the "polluter pays" principle, generally accepted by most countries, including the Republic of Moldova, can reduce the cost of management through savings caused by discouraging companies to pollute the environment. The latest views on the economic aspects of waste management refer to the circular economy associated with sustainable development, as it creates a model of economic feedback. The linear economic model that is established about consumption, presupposes the existence of an end to the use of products. Instead of that, the concept of the "circular economy" includes the reuse, repair, renewal, and recycling of existing materials and products, to protect natural resources and the economy of raw materials (MEMO, 2005).

At the same time, experience shows that waste management can create jobs and provide an opportunity for entrepreneurship. In Europe, recycling has had high growth rates since 2005, and an estimated turnover of over EUR 100 billion while providing about 1.2 to 1.5% of jobs. Also, in

the same period, it was shown that the most environmentally friendly ways of waste management gave the most encouraging results in terms of employment: at a time when waste storage provided 10 jobs, incineration provided 20-40 places, and recycling has created 240 new jobs (MEMO, 2005). Of course, the economic benefits of recycling are visible in the long run and are linked to all aspects of waste management: recycling means less use of raw materials, reduced transport costs, etc. However, the costs of waste management are high and remain an unresolved issue.

The European Union promoted the circular economy model in the context of good practice for businesses and individuals covering all stages of the product life, from its design that could ensure, by choosing its materials, its reuse in the future. At the same time, it brings a change of culture in consumption in general, but especially in the issue of waste, changes the way of receiving the same concept of discarded material and transforms it from a "problem, into a useful resource" (Hollins et al., 2017).

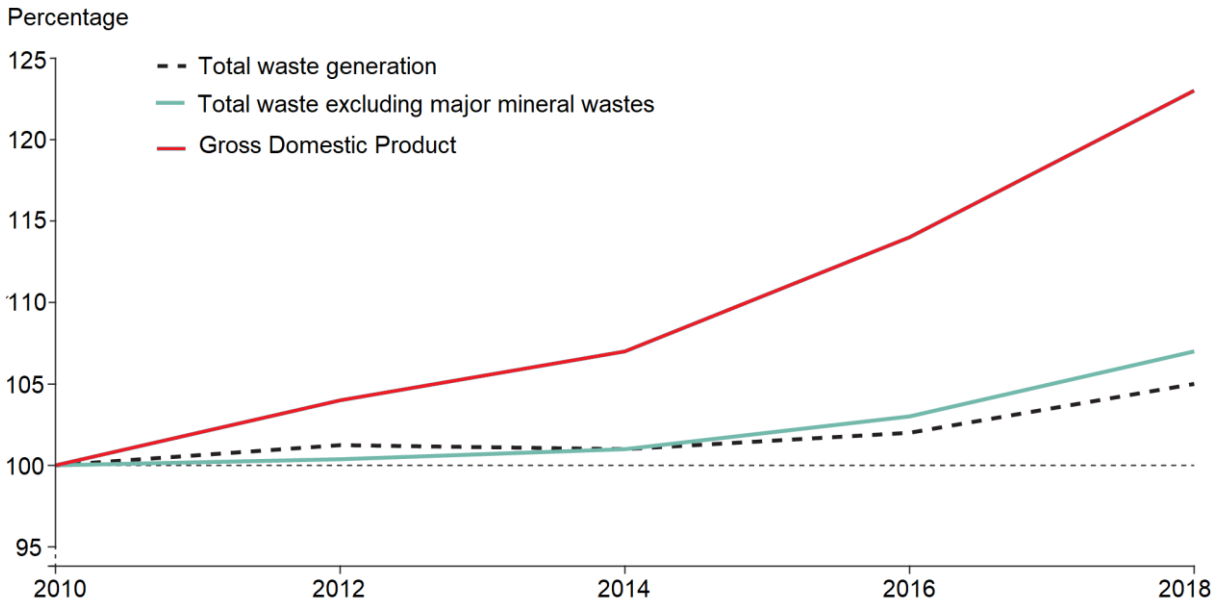

Fig. 3 Waste generation and decoupling, EU-27

Source: (EEA, 2021)

The latest data show that from 2010 to 2018, total waste generation has increased by 5% (114 million tons) in the EU-27, which endangers the policy goal of reducing waste generation. These developments are considered to be mainly due to economic growth. A positive is the fact that the amount of waste generated has increased to a lesser extent than the economy. It indicates the relative decoupling of waste generation from economic growth. Changes in waste management have also contributed to these results. Almost one-half of the increase can be explained by secondary waste, from operations such as waste sorting (EEA, 2021).

What is now required in EU policies is to identify the parameters in waste management with those of the circular economy, as the development of the circular economy requires high-quality secondary raw materials, which can re-enter the production process. In this regard, the field of waste management should be linked directly to the creation of new business models that aim not only at the prevention described in the previous chapter (non-waste generation) but also at the conversion of waste into resources.

In any case, the increased demand for products and the low availability of resources, make the transition to a circular economy somewhat inevitable. The proposed objectives of the EU circular economy package will be easier to achieve for countries with more advanced waste management procedures.

The factors preventing the establishment of the circular economy model are lack of modern infrastructure, high dependence on landfills with

low or non-existent recycling rates, administrative and institutional deficiencies, lack of political will and domestic legislation, and lack of attention to waste management outside urban centers (neglect of good practices) and insufficient segregation of municipal waste at source.

4 CONCLUSIONS

The issues presented in the article allow us to draw the following conclusions. By implementing the provisions of the Waste Framework Directive, the EU has proposed specific directions of conduct in waste management, which must contribute to more efficient use of natural resources and improve the quality of life of society.

The first benefits of this behavior are already visible and demonstrate, albeit with slow steps, the existence of several economic, social and environmental benefits. However, in the EU countries and the Republic of Moldova, although measures to improve waste management are being taken, changes in their implementation are slow.

The main causes that would be valid for our country would be:

- the lack of a coordinated system of separate waste collection that demotivates citizens to do so, irrational behavior at the level of municipalities that minimize costs for waste management,
- lack of motivation to carry out a reliable and selective waste collection.

To streamline this process, in addition to a legal and regulatory framework that would specify the tasks and obligations of waste management institutions, it is necessary to specify:

- the financial or other contributions borne by the government;
- starting conditions and evaluation procedures; and
- the existence of adequately trained staff, both financial and technical.

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