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PROBLEMS OF WASTE ACCUMULATION AND WAYS TO SOLVE THEM

The article highlights the problem of waste accumulation and ways to solve it. It is well-known that waste management plays a fundamental role, especially in developed and developing countries. The purpose of the article is to determine the problems of waste accumulation and ways to solve them. Soil, air and water pollution poses a risk to sustainable development worldwide. Waste disposal problems are exacerbated by changes in the structure of consumption, industrial development and urbanization. The main problem is the slow innovative development, the reasons for which are the predominance of raw materials in exports, low level of investments, outdated technologies, corruption, etc. Many developing countries are faced with the problem of improving waste management. An appropriate waste management policy reduces the negative impact of waste on the environment. It was established that there is a constant increase in the cost of collection process, utilization and removal of waste. Proposed measures and basic methods of waste management aimed at achieving environmentally safe waste management. Ways of implementing the closed loop model can be measures such as focusing on the sphere of services, encouraging capital investments, spreading the culture of circularity, training specialists, developing markets for secondary raw materials, adopting and implementing the circular economy indicator system, etc.

Key words: *waste, environment, circular economy, recycling, income level of the economy, solid household waste*

5 figures, 1 table, 13 references

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ПРОБЛЕМИ НАКОПИЧЕННЯ ВІДХОДІВ ТА ШЛЯХИ ЇХ ВИРІШЕННЯ

У статті висвітлено проблему накопичення відходів та шляхи її вирішення. Загальновідомо, що управління відходами відіграє фундаментальну роль, особливо в розвинених країнах і країнах, що розвиваються. Метою статті є визначення проблем накопичення відходів та шляхів їх вирішення. Забруднення ґрунту, повітря та води становить загрозу для сталого розвитку в усьому світі. Проблеми утилізації відходів загострюються змінами в структурі споживання, розвитком промисловості та урбанізацією. Основною проблемою є повільний інноваційний розвиток, причинами якого є переважання сировини в експорті, низький рівень інвестицій, застарілі технології, корупція тощо. Багато країн, що розвиваються, стикаються з проблемою вдосконалення управління відходами. Відповідна політика поводження з відходами зменшує негативний

вплив відходів на навколишнє середовище. Встановлено, що відбувається постійне зростання вартості процесу збору, утилізації та вивезення відходів. Запропоновані заходи та основні методи управління відходами, спрямовані на досягнення екологічно безпечного поводження з відходами. Шляхами реалізації моделі замкнутого циклу можуть бути такі заходи, як зосередження уваги на сфері послуг, заохочення капітальних інвестицій, поширення культури циркулярності, навчання спеціалістів, розвиток ринків вторинної сировини, прийняття та впровадження системи індикаторів циркулярної економіки тощо.

***Ключові слова**: відходи, навколишнє середовище, циркулярна економіка, переробка, рівень доходу економіки, тверді побутові відходи*

5 рисунків, 1 таблиця, 13 посилань

Statement of the problem. In modern world conditions with problems of excess waste and shortage of resources, interest in extracting raw materials from waste has been renewed. The concept of combining linear production lines into a closed loop is promoted by the circular economy or closed loop economy [1].

The circular economy is an economic system of closed cycles in which raw materials, components and products lose their value as little as possible, renewable energy sources are used, and systemic thinking is the basis [2]. As a result of increased consumption and accumulation of waste that is either harmful to the environment or difficult to recycle in a reasonable amount of time, there is a gradual transition to a circular economy model.

Ukraine faced serious obstacles on transition to a circular economy. The main problem is the slow innovative development, the reasons for which are the predominance of raw materials in exports, low level of investments, outdated technologies, corruption, etc. Ways of implementing the closed loop model can be measures such as focusing on the sphere of services, encouraging capital investments, spreading the culture of circularity, training specialists, developing markets for secondary raw materials, adopting and implementing the circular economy indicator system, etc.

Waste management plays a fundamental role in the creation of a closed-loop economy model, especially in developed and developing countries.The larger the population and the more developed economic activity, the greater the amount of waste due to the traditional linear economic model.

Also, waste generation increases with urbanization. High-income countries are more urbanized and generate more waste per capita and overall than less developed economies.

The largest category of waste is food and organic waste, as well as waste from paper and cardboard, plastic and glass. The composition of waste also varies significantly depending on the level of income. Thus, the percentage of organic substances in waste decreases with increasing income.

An appropriate waste management policy reduces the negative impact of waste on the environment. So, the Organization for Economic Co-operation and Development (OECD) recommends using the following tools: economic, extended producer responsibility (EPR), regulatory tools, green public procurement, public information and awareness raising, monitoring and reporting, and facilitating the implementation of legislative acts.

Analysis of recent research and publications. In different countries, there are many approaches to implementing the concept of waste disposal. In the developed countries, garbage is recycled and reused. This returns waste to the state of raw materials (goods) and brings funds to enterprises engaged in processing. Michael Heit, Julian Stengel, Jens Ludwig and Frank Schulzman wrote that due to the development of countries, needs were increasing, and therefore the accumulation of residues, and only the reuse of materials could reduce the burden on the environment [3]. The concept of complete waste disposal means a multi-stage process of sorting and recycling waste, which minimizes the amount of residues during disposal, maximizes

economic efficiency and minimizes the impact on the environment (environmental legislation is observed). As Nadim Kopty, Didar Erjen and Turgut Oney point out, the consumer pays for waste disposal. The cost can be paid separately (for example, to utilities) or included in the price of the product. Paul Iseli and Eron Lowen in their works emphasize that a very important factor in the development of the waste processing industry is pricing and tariffs for waste removal and sorting [4]. In many countries, citizens pay a certain amount of money for the collection and disposal of garbage, which is included in the payment for communal services. Another approach is that waste disposal is handled by manufacturing companies, but the cost of recycling is also transferred to the consumer and reflected in the price of the product.

Roleders, Oriekhova and Zaharieva [5] emphasized that three levels of transition processes to a circular economy could be divided: the efficient use of materials; product life extension; smart production and use of products. Extended producer responsibility (EPR), a model in which packaging companies are responsible for the final life of materials, is extremely important for the circular economy policies to promote sustainable material management, recycling and reduction in the environmental impact. Manufacturers can influence change by making products and packaging more durable so that materials can be reused, recycled or reintegrated into the new product design [6].

In a series of works Pasichnyi et al. [7,8]. investigated both public expenditures' structure (e. g., R&D-related spending) and demographic impact on public welfare and proved that the circular economies' model application could boost economic growth.

The aim of the article is to determine the problems of waste accumulation and ways to solve them.

Research methodology. The methodological basis of the research is the fundamental provisions of the closed cycle economy's model. The main scientific method was the method of causal, logical and functional connections and dependencies. The theoretical basis of the work was the research of domestic and foreign scientists. Data from the World Bank Global Picture of Solid Waste Management, The Global Waste Index and others served as a factual and statistical basis.

Results of the research. Raw materials are becoming increasingly scarce, energy - more expensive and, at the same time, the amount of waste is increasing. In addition, soil, air and water pollution poses a risk to sustainable development worldwide. Currently, less than 10% of consumed raw materials are processed. Waste disposal problems are exacerbated by changes in the structure of consumption, industrial development and urbanization. Many developing countries are faced with the problem of improving waste management.

Ιt is important at the moment to prevent waste from entering uncontrolled landfills and illegal garbage dumps, open burning, as this leads to the release of greenhouse gases that destroy the ozone layer and harm the climate. In addition, it is necessary to stop the flow of waste into waterways, because it causes significant damage to flora and fauna and enters into the human food chain [9]. The concept of "waste" refers to any substance or object that is formed as a result of production activities or after use, and is no longer useful to its producer or owner, who seeks to get rid of it by obligation or desire [10]. Undoubtedly, today waste is an ecological, social and medical problem.Classification of waste is carried out according to several criteria depending on their aggregate state (solid, liquid, gaseous), their origin (industrial, communal, rural or urban), chemical composition (organic and inorganic) or classification with mixed criteria and more specific (plastic waste, food waste, etc.) [10].

According to a 2018 World Bank report, the world generates 2.01 billion tons of solid waste annually, at least 33% of which is not subject to environmentally sound management. In the world, the waste generated per person per day averages 0.74 kg, but varies widely – from 0.11 to 4.54 kg. High-income countries account for about 34% of global waste, middle- and lower-income countries account for 32% and 29%, respectively, and low-income countries for only 5%.

In numerical terms, the volume of waste in high-income countries was 683 million tons, in upper-middle and lower-middle-income countries – 655 million tons and 586 million tons, respectively, and in low-income countries – only 93 million tons, compared to others (Fig. 1):

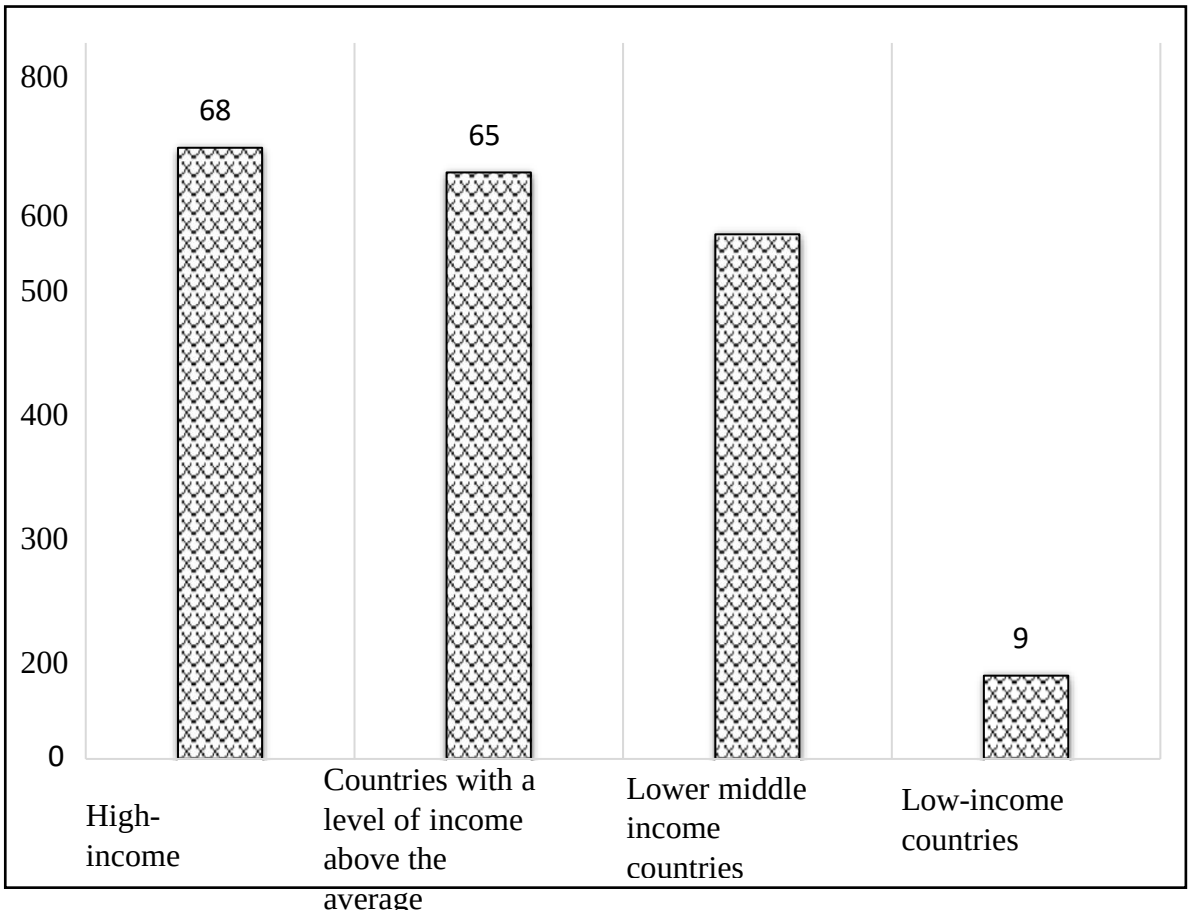

Figure 1. Volume of generated waste depending on the country's income level in 2019, (million tons)

Note. Built by the author based on World Bank Global Picture of Solid Waste Management 2020

However, in low-income countries, per capita waste generation decreases as incomes rise. The slower growth of waste generation at higher income levels is due to a decrease in the marginal demand for consumption, and therefore to a decrease in waste [11].

Waste generation also increases with urbanization. High-income countries are more urbanized and generate more waste per capita and overall. North America, with the highest level of urbanization at 82%, generates 2.21 kilograms of waste per capita per day, while Sub-Saharan Africa generates 0.46 kilograms per capita per day with an urbanization rate of 38%. For the same reason, the countries of Europe and Central Asia generate a large amount of waste (1.18 kg per day per capita), and the countries of East Asia and the Pacific region have a low rate (0.56 kg per day per capita).

An important step in the waste management system is thecollection. Indicators in this area vary significantly depending on the level of income. Thus, high-income countries collect 96% of waste. Above- and below-middle-income countries collect 82% and 51%, respectively. Low-income countries collect about 48% of waste in cities, but this share drops sharply to 26% outside urban areas, so the average figure is 39%. Across all regions, sub-Saharan Africa collects about 44% of waste, while Europe, Central Asia and North America collect at least 90% (Fig. 2):

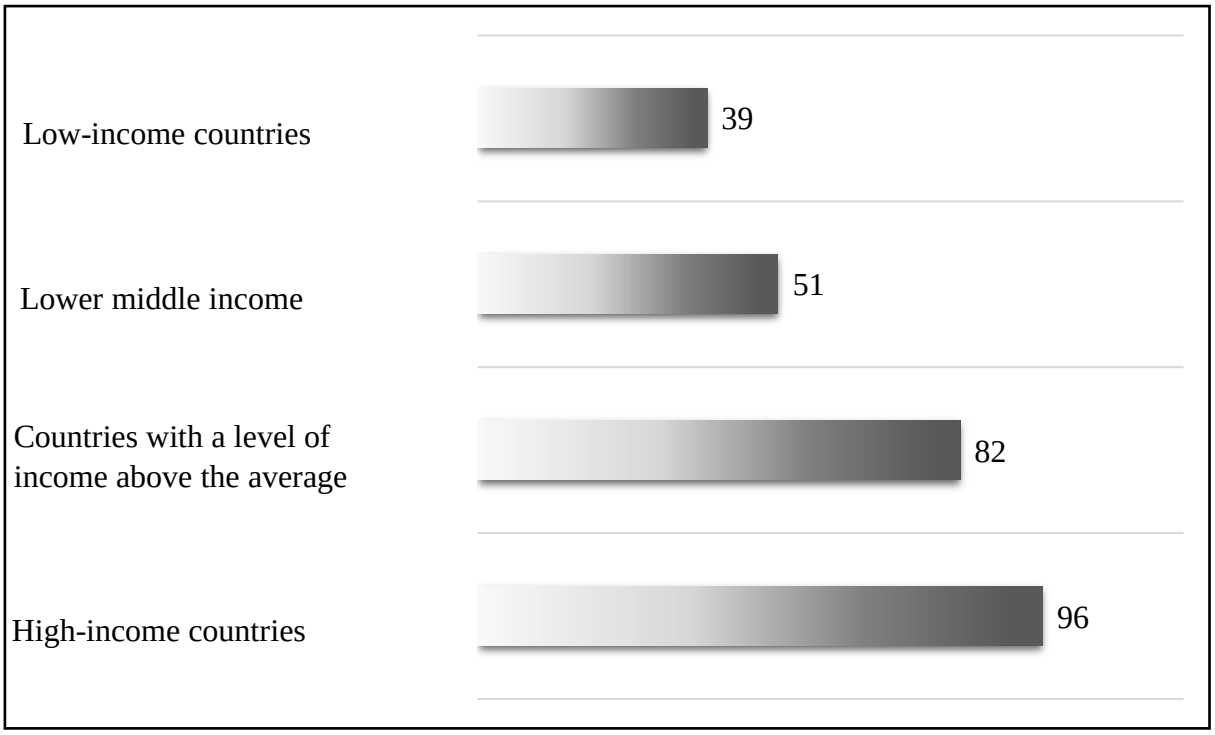

Figure 2. Indicator of waste collection depending on the income level of economies in 2019, (%)

Note. Built by the author based on World Bank Global Picture of Solid Waste Management 2020

In low-income countries, households often collect waste themselves, which is usually thrown away, incinerated or rarely composted. Improvement in waste collection services is an important step to reduce pollution and thereby improve people's health [11].

According to the World Bank, in 2019, the largest category of waste in the world was food and organic waste, which accounted for 44% of global waste; next in terms of volume are waste from paper and cardboard, plastic and glass – 17%, 12% and 5%, respectively (Fig. 3).

The composition of waste varies significantly depending on the level of income. The percentage of organic substances in waste decreases with increasing income.

Consumer goods in high-income countries include more materials such as paper and plastic than in low-income countries [11].

According to the World Bank, 33% and 25% of all waste in the world is disposed of in illegal and official landfills, respectively. Only 13.5% of waste is processed and 5.5% is composted, and 11% is incinerated. National governments are recognizing the risks and costs of landfill disposal and sustainable methods of waste disposal [11].

Municipal solid waste is one of several waste streams managed by the authorities.

Other common waste streams are industrial waste (12.73 kg/day per capita), agricultural waste (3.35 kg/day per capita), construction waste (1.68 kg/day per capita), hazardous waste (0.32 kg/day per capita), medical waste (0.25 kg/day per capita) and electronic waste (0.02 kg/day per capita) (Fig. 4).

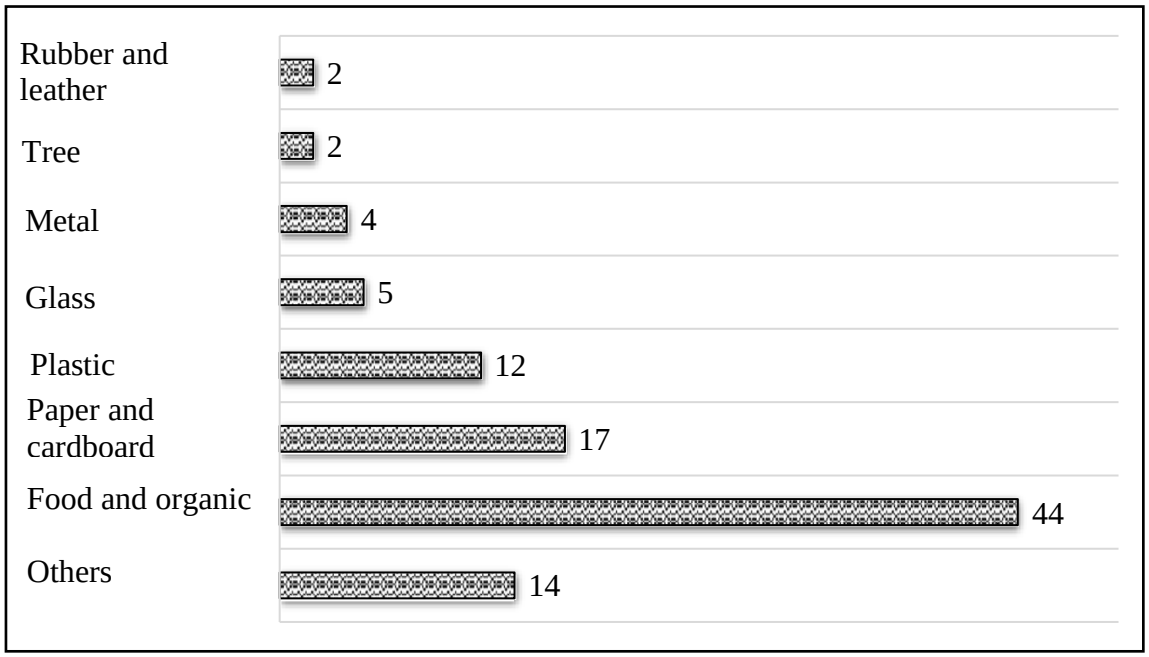

Figure 3. Share of waste by category in the world in 2019, (%)

Note. Built by the author based on World Bank Global Picture of Solid Waste Management 2020

For countries with available data on industrial waste generation, the trend shows that worldwide industrial waste generation is almost 18 times greater than municipal solid waste. The volume of industrial waste increases significantly with the rise in the country's income level [11].

The world volume of agricultural waste is four and a half times greater than solid household waste. Agricultural waste is often treated separately from other waste streams because it is mainly organic and can serve as a useful source for future agricultural activities [11].

Hazardous, medical and e-waste are usually only a fraction of solid waste. Such waste is usually processed in specialized facilities, including chemical processing plants, incinerators and dismantling centers.

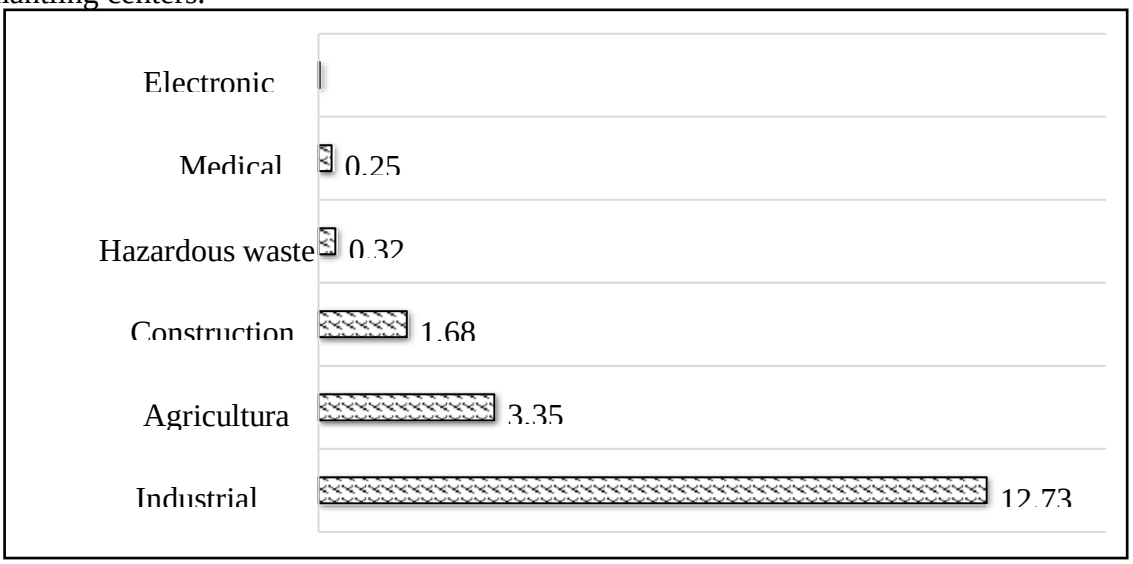

Figure 4. Share of waste from economic activity in 2019, (kg/day/day)

Note. Built by the author based on World Bank Global Picture of Solid Waste Management 2020

The generation of e-waste is linked to economic development, with high-income countries generating five times more e-waste than low-income countries. The increase in the amount of e-waste, its pollution of the environment and the possibility of its recycling should become a subject of consideration for rapidly developing countries (Sensonseo Global Waste Index, 2019). Slovak company Sensoneo, which offers smart waste management services, has developed The Global Waste Index, which ranks 36 countries that are part of the OECD according to the efficiency of their waste management per capita using such indicators as waste generation, recycling, incineration, official and illegal landfills [12]. Thus, as of 2019, countries such as the USA (5), Denmark (4.72), New Zealand (4.17), Canada (3.96), Switzerland (3.96) generated the largest amount of waste (Fig. 5):

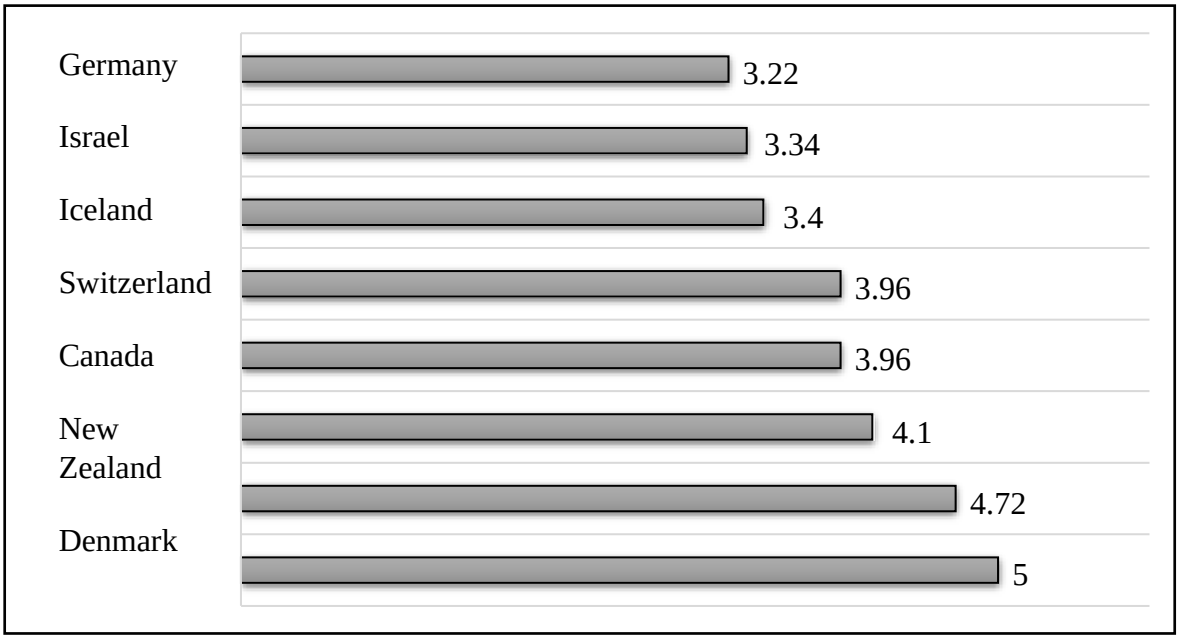

Figure 5. Ranking of OECD countries by volume of waste generation in 2019, (items)

Note. Built by the author based on The Global Waste Index 2019 [12]

The rating of countries for waste processing is led by Iceland with an index of 6.67, and by waste incineration – Denmark (1.67), which is shown in the table below.

Table 1. Ranking of OECD countries by recycling and waste incineration

Country	Recycling, (items)	Country	Combustion, (items)
Iceland	6,67	Denmark	1,67
Germany	5,51	Switzerland	1,36
USA	5,10	Japan	1,11
Australia	4,29	Netherlands	0,99
Switzerland	4,11	Finland	0,96

Note. Compiled by the author based on The Global Waste Index 2019 [12]

As a result, the final value of the Global Waste Index is the maximum value for South Korea (100), 93.09 for Sweden, 92.48 for Japan, 89.14 for Switzerland and 87.43 for the Netherlands.

The OECD, in its report "Environmental Performance Reviews", examines a number of policy instruments that are being implemented for the management of waste and materials. Thus,

the following policies can be ways of developing waste management:

1. Regulatory tools

- linking regulatory instruments with economic instruments and raising awareness to create strong policy measures (landfill ban in the Netherlands);
- standardization of goods and services aimed at recycling and circular economy (EU directive on end-of-life vehicles);
- capacity-building measures where necessary to ensure the performance of key bodies (household waste management reforms in Poland).

2.Economic instruments

- full reimbursement of waste management costs for implementation of the polluter pays principle (Netherlands, Norway);
- ongoing pricing improvements for household waste management services to improve cost recovery and avoid perverse incentives (Colombia);
- use of income received from the provision of household waste management services to build the capacity of municipalities to perform their waste management functions (Poland);
- differentiation of disposal taxes depending on environmental damage associated with different types of waste processing (Norway);
- the use of a fee for non-ecological products deters the use of environmentally harmful products (Hungary).

3. Tools of extended producer responsibility

- mechanisms of intermediary services for coordination of EPR;
- RBB certification to ensure compliance with environmental standards (Norway);
- advance payment for the disposal of small waste streams for which the removal program would be too expensive (Korea);
- consultations with interested parties during the development of schemes and their ongoing operation to ensure the involvement of industry and relevant authorities (Netherlands);
- landfill taxes for transformational changes in waste management.

4.Green public procurement

- use of eco-labeling for public procurement (Korea);
- government assistance in reducing waste (Norway);
- using procurement as a tool for the circular economy: supporting secondary goods and "circular procurement" (Netherlands);
- monitoring of green public procurement in order to hold procurement agencies accountable (Czech Republic).

5. Informing the public and raising awareness

- inclusion of waste reduction and recycling in environmental education programs (Colombia);
- encouraging and supporting the activities of non-governmental organizations to raise public awareness, for example, organizing clean-up events (Estonia, Colombia).

6. Monitoring and reporting

- comprehensive monitoring and reporting on waste generation and processing to support policy development and review (Norway);
- implementation of modern information systems for tracking industrial and other waste (Korea);
- elimination of information gaps to improve understanding of international flows of materials for the production of goods (Japan, the Netherlands).

7. Facilitating the implementation of legislative acts

- coordination mechanisms between executive authorities (Israel, Poland);
- promotion of compliance with the aim of ensuring awareness among polluters and waste management entities (Norway);
- specialized units for investigating and prosecuting violations of waste management

(Colombia, Norway) [13].

Conclusions. Waste management plays a fundamental role, especially in developed and developing countries. The larger the population and the more developed economic activity, the greater the amount of waste due to the traditional linear economic model appears. An appropriate waste management policy reduces the negative impact of waste on the environment. Ways of developing waste management can be such policies as: regulatory tools, economic instruments, tools of extended producer responsibility, green public procurement, informing the public and raising awareness, monitoring and reporting, facilitating the implementation of legislative acts.

REFERENCES

1. Organisation for Economic Cooperation and Development, OECD (2022). Retrieved from: http:// www.oecd.org/.
2. Indicator 8.4.1: Material Footprint, material footprint per capita, and material footprint per GDP (2022). Retrieved from: https://unstats.un.org.
3. Michael Hiete, Julian Stengel, Jens Ludwig and Frank Schultmann (2011). Matching construction and demolition waste supply to recycling demand: a regional management chain model, Building research and information, Vol. 39. № 4, 333–351.
4. Isely P., Lowen A. (2007). Price and substitution in residential solid waste. Contemporary Economic Policy, Vol. 25, №. 3, 433–443.
5. Roleders V., Oriekhova T., Zaharieva G. (2022). Circular Economy as a Model of Achieving Sustainable Development. Problemy Ekorozwoju – Problems of Sustainable Development, 17(2), 178-185. doi: 10.35784/pe.2022.2.19.
6. Roleders V., Oriekhova T., Sysoieva I. (2022). Trends in a Global Circular Economy. Management Theory and Studies for Rural Business and Infrastructure Development, Vol. 44 No.2, 176-184. doi: https://doi.org/10.15544/mts.2022.18.
7. Pasichnyi M., Kaneva T., Ruban M., Nepytaliuk A. (2019). The impact of fiscal decentralization on economic development. Investment Management and Financial Innovations, 16(3), 29–39.
8. Pasichnyi M., Nepytaliuk A. (2021). The Contributions of Demographic Factors to Economic Growth. Problemy Ekorozwoju – Problems of Sustainable Development, 16(1), 219–229.
9. Waste Management: the Base for Circular Economy (2020). Retrieved from: https://www.ennomotive.com/waste-management/.
10. The World Bank (2018). What a Waste 2.0 A Global Snapshot of Solid Waste Management to 2050, Washington, 295.
11. OECD (2019). Policy instruments for waste and materials management, Waste Management and the Circular Economy in Selected OECD Countries: Evidence from Environmental Performance Reviews, OECD Publishing, Paris, https://doi.org/10.1787/d8216b41-en.
12. Sensonseo Global Waste Index (2019). The biggest waste producers worldwide, https://sensoneo.com.
13. Environmental Performance Reviews (2017). OECD, Paris, 16.