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INNOVATIVE TECHNOLOGIES IN MANAGEMENT MUNICIPAL SOLID WASTE IN THE REPUBLIC OF BELARUS

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Abstract

The article is devoted to the problems of solid municipal waste management in the Republic of Belarus. The importance of finding innovative approaches to waste management due to the growing environmental, economic and social problems in society with an increase in the volume of generated waste is justified. The damage caused by the accumulation of municipal solid waste from the socio-economic system was systematized.

The article considers trends in waste management in the world, analyses the experience of using innovative solutions in the field of solid municipal waste management in the context of administrative-economic, organizational-technical and information-educational tools. Priority directions for the development of innovative technologies in the field of solid municipal waste management in the Republic of Belarus have been identified.

Keywords: municipal solid waste, waste management, sustainable development, ecological consciousness.

ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В УПРАВЛЕНИИ ТВЕРДЫМИ КОММУНАЛЬНЫМИ ОТХОДАМИ В РЕСПУБЛИКЕ БЕЛАРУСЬ

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Реферат

Статья посвящена проблемам управления твердыми коммунальными отходами в Республике Беларусь. Обоснована важность поиска инновационных подходов к управлению отходами ввиду нарастания экологических, экономических и социальных проблем в обществе с ростом объемов формируемых отходов. Систематизирован ущерб, наносимый накоплением твердых коммунальных отходов социально-экономическим системам.

В статье рассмотрены тренды обращения с отходами в мире, выполнен анализ опыта использования инновационных решений в сфере управления твердыми коммунальными отходами в разрезе административно-экономических, организационно-технических и информационно-образовательных инструментов. Определены приоритетные направления развития инновационных технологий в сфере обращения с твердыми коммунальными отходами в Республике Беларусь.

Ключевые слова: твердые коммунальные отходы, управление отходами, устойчивое развитие, экологическое сознание.

Introduction

In 2015, the world community reaffirmed its commitment to sustainable development by adopting the 2030 Agenda (Agenda 2030). With the signing of the document, the United Nations member States had undertaken to ensure sustained and sustained economic growth, social integration and environmental protection for the benefit of partnership and peace. In order to specify the goals of Agenda 2030, document [1] was developed, which includes 17 Sustainable Development Goals (SDGs). Each country planned to achieve the goals set for the world community and set priorities and targets based on its own level of development.

The Republic of Belarus, despite some differences in terminology, also adhered to the principles of sustainable development. The socio-economic development policy and forecast documents under development included quantitative indicators and qualitative characteristics of the environmental component, but that was not reflected in the title.

Since the programme documents do not define socio-economic development, we will consider it as a process of managed change in various areas of life, aimed at achieving sustainable economic growth, a high degree of employment and, on this basis, raising the standard of living of the population with the least damage to natural resources. Such an understanding of socio-economic development in relation to Belarus was made possible by the study of the goals of socio-economic development stated in the legislative documents and the prevailing ideas about development as "a characteristic of qualitative changes in objects, the emergence of new forms of being, innovations and innovations associated with the transformation of their internal and external ties" [2].

Belarus until 2030, according to which one of the development priorities is the green transition to inclusive and sustainable growth based on the requirements of the Responsible Consumption and Production TsUR-12. We can say that in Belarus Agenda 2030 is embedded in the system of state planning and forecasting documents and the "green economy" is one of the priorities of the country's development. This goal has many sub-goals, the most relevant is a significant reduction in the volume of waste by taking measures to prevent its generation, reduction, recycling and reuse by 2030.

These objectives require the participation of various stakeholders, including producers, consumers, researchers, scientists, the media, development cooperation institutions and others. Such participation in Belarus was realized through the creation of a partnership group under the Sustainable Development Council, consisting of representatives of the above groups [3]. In this article we will consider the results Belarus has achieved on this path; priority goals of development and possibilities of using innovative technologies in the field of solid municipal waste management (MSW) in the Republic of Belarus.

Results and discussion

Among the goals of sustainable development, waste management occupies a special place, since MSW causes significant economic, social and environmental damage to socio-economic systems, the main types of which are identified by us and are given in Table 1.

Table 1 – Damage to MSW socio-economic systems

Type of damage	Components
Economic	a) extraction from the turnover of land allocated for the arrangement of landfills: – reduction of land for possible economic use or human habitation; – construction costs of landfills; – costs of land restoration after use as landfills;
	b) extraction of resources from the turnover: – reduction of material resources due to their unsustainable use; – high waste delivery costs due to the remote location of landfills from settlements
Social	– increasing morbidity and mortality of the population; – reducing life expectancy; – reduction of the working population; – increased costs of temporary disability sheets; of full or partial disability payments
Ecological	– costs of environmental monitoring
	– costs of rehabilitation activities

Note: compiled by the author on the basis of [4, 5, 6, 7]

According to Agenda 2030, the governments of the countries that signed this document committed themselves to take measures to reduce all types of damage caused by MSW. The Republic of Belarus has also significantly increased its attention in recent years to problems in the area of responsible consumption and production. As a result, there is an increase in the collection of WTO resources (from 2010 to 2020 from 328.4 thousand tons to 1018.7 thousand tons (or 210%). As a result, the share of processed municipal solid waste in the total amount of its generation is increasing. In the period from 2016 to 2020 alone, their share increased from 15.8 to 25 % (Figure 1).

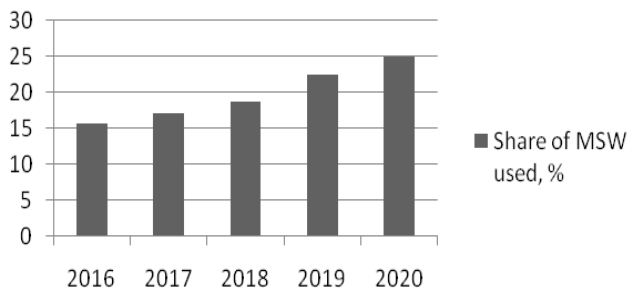


Figure 1 – Dynamics of the share of MSW used for 2016-2020 years, %

Note: proprietary development based on [8]

However, one cannot fail to note the negative dynamics of indicators related to waste generation. So, Figure 2 shows that if until 2019 there was a barely noticeable trend towards a decrease in the total volume of MSW formed, then in 2020 there was a rather sharp jump from 3784 thousand tons to 4070.4 thousand tons or by 7.56 %.

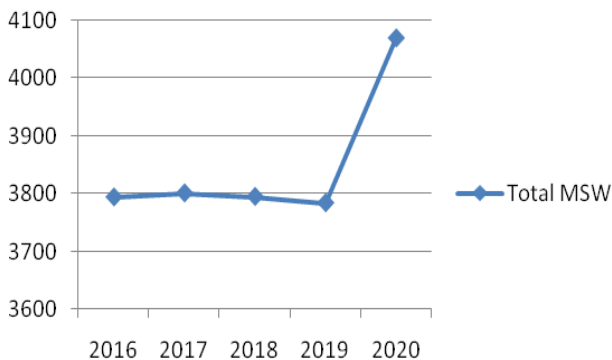


Figure 2 – Dynamics of municipal solid waste generation in 2016-2020 years

Note: proprietary development based on [9]

A negative trend is also noted in the dynamics of MSW per capita: if from 2016 to 2019 stabilization is observed at the level of 402 kg/person. (which corresponds to the European average), in 2020 there was a jump to the level of 433.9 kg or 8% (Figure 3).

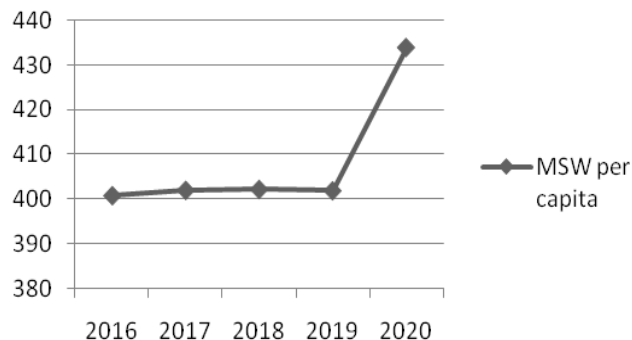


Figure 3 – Dynamics of MSW formation per capita for 2016-2020, kg/person.

Note: proprietary development based on [9]

The growth rate is even higher for MSW per unit of GDP expressed in international dollars. If for the period from 2016 to 2019 there was a downward trend (for this period there was a decrease of 7.8%), then as a result of a jump in 2020, the volume of MSW per unit of GDP increased by 8.65% and exceeded the level of 2016 (Figure 4).

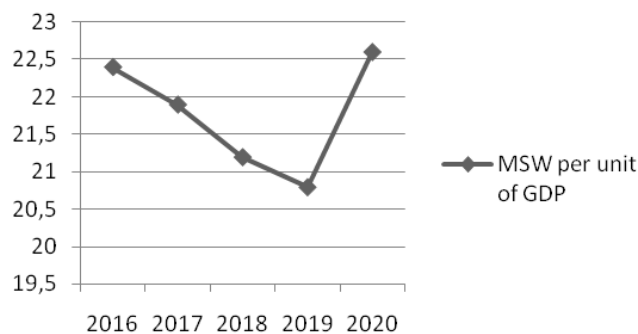


Figure 4 – Dynamics of MSW formation per unit of GDP for 2016-2020 years, kg/thousand international dollars.

Note: proprietary development based on [9]

The statistics we have provided show that efforts to increase waste use do not even offset the growth in waste generation. It is also important to analyse not only the proportion of secondary waste used, but also which waste management approaches are used in general. In world practice, considerable experience has been gained in the field of waste management. So, at the level of the European Union, there is a general waste management policy, the tools of which are taxes on primary raw materials, the principles of eco-design of products, requirements for the recycling of vehicles and much more. The experience of foreign countries shows that waste prevention and reuse are priority approaches, since the division of waste into useful components used as secondary raw materials in enterprises allows not only to benefit financially from garbage, but also to clean the environment.

The methods of use of the generated municipal waste can be conditionally divided into the following three groups:

1. Processing (recycling) – the return of individual MSW components to commercial circulation by separating them from the total mass and transferring them to use as raw materials for production of products.
2. Composting – use of the organic part of MSW after its biological treatment (decomposition of organic substances) with the help of various microorganisms;
3. Incineration - use of mixed MSW or calorific fractions separated from them to obtain thermal and/or electrical energy.

Unused MSW shall be buried in specially equipped places (in the field) taking into account environmental protection requirements.

The use of existing approaches to MSW management in Belarus as of 2020 is presented in Figure 5.

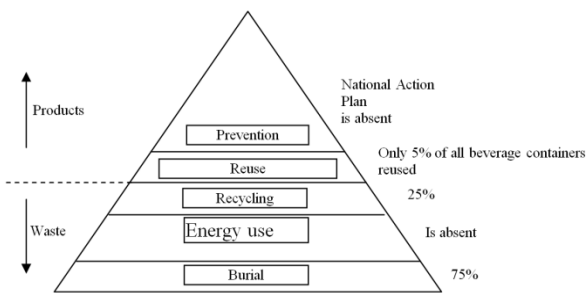


Figure 5 – MSW management approaches and their use in the Republic of Belarus

Note: proprietary development based on [10]

As we see, the main approach in Belarus is burial, there is no energy use, as well as the National Action Plan to prevent the formation of MSW, which cannot be evaluated positively.

The use of these groups of methods varies considerably among countries, due to both the general level of socio-economic development and a number of other factors, and the characteristics of different countries.

Quantitative data on the use of secondary material resources (BMP) collection, composting and MSW combustion in the countries of the European Union and the Republic of Belarus as of 2017 are presented in Figure 6.

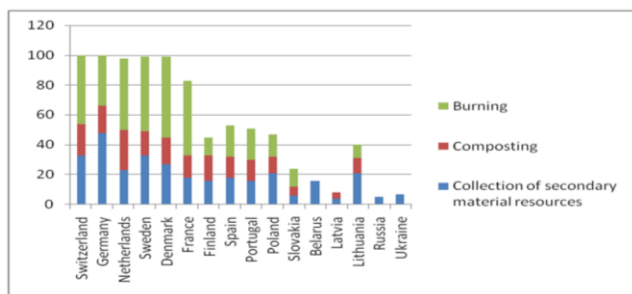


Figure 6 – Methods of MSW use in the countries of the European Union and the Republic of Belarus, %

Note: proprietary development based on [10]

As shown in Figure 6 in the EU countries at present, the priority approach to MSW management is to involve them in industrial processing and recycling. This approach initially began to be implemented forcibly in countries with a small area and a high population density. To implement the approach, the concept of "Wastetoenergy" ("waste - into energy") was developed, according to which waste is considered a source of renewable energy. As a result, emphasis was placed on thermal processing of MSW, primarily on combustion for energy production.

However, practice has shown that the construction of incinerators is not a solution to the MSW problem. First, incineration of unprepared, unsorted MSW is the most costly and environmentally unsafe option to solve the waste problem. When burning MSW, hazardous wastes (fly ash, a mixture of gases) are formed, which with atmospheric precipitation return to the surface of the earth, contaminating the soil and water. Direct energy utilization of MSW excludes their use as secondary material resources (BMP), which is not economically feasible.

Due to the impossibility of solving the problem of waste only by burning it, the so-called "compost" concept was developed. Its proponents assumed that up to 70% of MSW is a biodegradable fraction, therefore they can be fermented to produce a product for agricultural use, provided that it does not contain heavy metals and other contaminants, including mechanical ones; compost improves soil structure, moisture content, reduces erosion. However, the use of such a method has a number of limitations, special requirements for the temperature and humidity of landfills, and on its basis it is also impossible to completely solve the problem of waste disposal.

As a result, the concept of integrated MSW processing was widespread, in which the justification for the use of combination technological solutions was given, based on sorting. According to the concept, it is

impossible to use one particular method or technology to process the entire generated mass of MSW, otherwise this leads to a deterioration in economic indicators, an increase in costs, an increase in the negative impact of technology on the environment, which ultimately does not solve the problem of waste. That is, for a long time, waste was managed in relation to waste generated after the sale of various goods. However, the possibilities of waste management are much wider and it is necessary to use innovative technologies and solutions in this area based on a combination of administrative-economic, organizational-technical and information-educational tools.

Administrative and economic instruments include measures related to improving legislation in the field of waste management, the formation of a system of incentives for the population for environmentally responsible behavior (financial incentives, a system of fines and restrictions, the development of business incentives (financial, tax incentives).

By organizational and technical we will mean tools aimed at introducing new technologies and improving infrastructure at all stages of the waste management life cycle: prevention, collection, transportation, sorting and disposal and recycling of MSW. These include the introduction of resource-saving technologies, information systems for managing the waste management system, the organization of training of qualified personnel for the field of MSW circulation management, the expansion of the use of secondary raw materials and the introduction of innovative technologies for their processing and recycling. As practice has shown, the use of public-private partnerships is also effective [11].

Information and educational tools are understood as a set of measures aimed at the formation of guidelines for environmental responsibility of the population, popularization of behaviors, education of environmental culture, and the development of environmental marketing. It is necessary to form a conscious attitude among the population to waste collection, to hold conversations with children, starting from kindergarten and school, to form a careful attitude to nature at an early age.

The above-mentioned tools affect the efficiency of waste management at various stages of the waste management life cycle: prevention, collection, transportation, sorting, processing and disposal (Table 2).

Table 2 – Effectiveness of circulation management tools of MSW

Tools	Degree of impact at stages of MSW circulation life cycle				
	preventing	collection	transportation	sorting	disposal and processing
Administrative and economic	H	H	A	L	H
Organizational and technical	M	H	M	M	M
Information and education	H	H	M	A	L

Note: a) H – high, MC – medium, L – low, A – absent; b) proprietary development based on [12]

Belarus has recently adopted a number of legislative documents regulating economic relations in the field of MSW circulation [13-16]. It seems to us that it is extremely important to adopt a decree outlining measures for 2020-2023 to gradually reduce the use of polymer packaging. In addition to prohibiting measures, this document also provides for the introduction of incentive measures for the production of biodegradable packaging; and the use of new types of compensation for producers using eco-packaging in the production of products intended for sale in Belarus, produced using at least 30% of secondary resources.

From the point of view of developing the infrastructure of the waste management industry in Belarus, significant efforts are also being made: waste processing plants are being put into operation, the number of container sites for separate garbage collection is constantly increasing. In addition, Belarus pays great attention to the development of biodegradable materials: a biodegradable film made of polylactide, as well as a biodegradable packaging material - paper with various properties [17]. However, steps should be taken to encourage the development of other types of environmentally friendly packaging, since none of the existing biodegradable plastics is completely safe [18].

In our opinion, in addition to the actual growth in the volume of production and consumption waste, the problem of waste is acute, which is impossible or extremely difficult to process. Thus, in this area, States have two tasks: reducing the actual amount of waste generated, reducing

the proportion of non-decomposable waste and waste that cannot be recycled [19]. In our view, these problems require:

- firstly, the awareness of the need for separate garbage collection by the population. To this end, information and educational influence on the population forming environmental consciousness is used in world practice;
- secondly, the need to train the population in the correct sorting of waste. In addition to the issues of the availability of containers for separate garbage collection, in this direction there are problems of low public awareness of the possibility of recycling certain types of plastic. Improper collection of plastic waste leads either to the need for additional sorting, or to unsuitability for recycling. Studies in this area have shown that only about 25% of consumers are well versed in environmental signs. Most respondents know about environmental labeling and the need for its application by manufacturers, but do not know how to recognize and interpret it [20].
- In Belarus, the solution of problems in the sphere of MSW circulation, we believe, can significantly accelerate the use of information and educational tools by creating an environmental consciousness of the population, both collective and individual, the development of environmental marketing at all levels.

Collective ecological consciousness is understood by us as the commonality of views on the strategy of attitude to nature, due to the level of understanding of the natural environment as an integral part of man and humanity as a whole [19, 21]. The interpretation of the forms and content of the relationship between man and nature common to any social structure creates opportunities for following the common goals of organizing and implementing the impact on objects and phenomena of nature and the general adoption of all regulatory and legal regulations that determine such impact.

Individual ecological consciousness is considered by us as the result of individual concrete experience of interaction with nature, knowledge about nature and the external environment obtained in the process of learning, and models of ecological consciousness and ecological behavior imposed by society, formed on the basis of personal psychological characteristics [19, 22].

Currently, the world practice has already accumulated considerable experience in the system management of the formation of ecological consciousness of the population and business through the creation of unified information portals, the creation of environmental education centers, the development and implementation of mass information and education programs, street advertising that can be used in Belarus. In addition, we consider it important to develop understandable, easily memorable symbols to indicate information on the package about the possibility or impossibility of its processing.

Conclusion

On the basis of the above, it can be said that in recent years Belarus has taken significant steps to solve problems of waste management, primarily on the basis of organizational, technical and administrative-economic instruments. In order to achieve the intended goals of sustainable development in the sphere of MSW circulation management, in our opinion, it seems advisable to more actively use innovative information and educational tools of environmental marketing:

- Strengthening of motivation of producers to use of eco-friendly packing;
- Encouraging producers, in addition to the application of standardized symbols for ecological packaging, to post visible information to consumers about the possibility or impossibility of its disposal and processing;
- Purposeful activity on formation of ecological consciousness not only producers, but also society as a whole.

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