Economic aspects of organic waste disposal in the Republic of Kazakhstan

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Abstract. The study examines the impact of municipal solid waste on the environment and the volume of its formation in the Republic of Kazakhstan. It has been established, that the main component of solid household waste is food (organic) waste, the disposal and processing of which is becoming a relevant and important direction for the development of the waste management industry in Kazakhstan. The purpose of the study was to identify, through a study of potential areas of application of organic waste, the most effective ways of using it, both from the point of view of environmental safety and from the point of view of economic efficiency. The main environmental problem is not only the increase of the amount of waste, but also the absence of its high-tech disposal and processing. In Kazakhstan, a significant part of organic waste as part of municipal solid waste continues to get to landfills, so the landfill is the most common method of waste disposal in the country. Today, there are various technologies for utilization and processing of the organic (food) fraction of municipal solid waste, including biogas production, combustion with energy recovery, composting and others. However, in order to establish a waste collection and recycling system in Kazakhstan, first of all, it is necessary to consider waste as a valuable secondary raw material. At the same time, separating food waste from the rest of the garbage will keep it dry and clean and increase the efficiency of sorting. It was found that recycling organic waste is effective not only from an environmental safety point of view, but also from an economic efficiency point of view.

1 Introduction

The impact of municipal solid waste (MSW) on the environment and the volume of its formation in the Republic of Kazakhstan are among the urgent environmental issues that require the development of integrated approaches and measures to solve problems of their management.

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Currently, separate collection of municipal solid waste at the source of waste has not been established in Kazakhstan on a systemic level, so it is difficult to conduct a comprehensive economic assessment of waste separation systems at the source, separate waste removal, recycling and sale of recovered materials throughout the country. One of the main problems of the state is to increase the efficiency and reliability of the range of services for the collection, transportation, disposal, processing and disposal of solid household waste, increasing the share of its processing, as well as ensuring safe waste disposal.

The main component of municipal solid waste is food waste, the sustainable management of which has become a global challenge [1].

At present, the country does not have the practices and capacity to process the most widespread organic (food) fraction of municipal solid waste, which causes great damage to the environment. When organic waste gets to the landfill as part of municipal solid waste, it affects climate change and releases landfill gas, including flammable methane, which leads to fires and explosions at landfills. Thus, the disposal and processing of the organic (food) fraction of municipal solid waste is becoming a relevant and important direction for the development of the waste management industry in Kazakhstan.

The purpose of the study is to identify the most effective ways of using it not only from the point of view of environmental safety, but also from the point of view of economic efficiency, based on a study of potential areas of application of organic waste.

Research hypothesis: recycling of organic waste is effective not only from the point of view of environmental safety, but also from the point of view of economic efficiency.

2 Material and research methods

To achieve this goal, theoretical research methods were used in the work: analysis - to reveal the theoretical provisions of the concept and identify topics of discussion, synthesis - to determine key points and the sequence of changes and additions, as well as generalization - to formulate conclusions. The information base of the study consists of official data from the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan [9], data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan [10], which ensures their accessibility and comparability.

3 Results and discussion

Environmental protection has been the most pressing problem for Kazakhstan, and the disposal of production and consumption waste is one of the most difficult. The reasons for the annual increase of waste which are growing exponentially are the growth of the economy and ongoing urbanization in Kazakhstan. In the coming years we should expect an increase in the volume of solid waste generated due to an increase in the range of food and non-food products, the range and types of packaging for them, and an increase in the standard of living of the population.

Previously, the main attention in solving environmental problems was paid to the treatment of household and industrial wastewater, which caused catastrophic damage to the environment and the quality of life of the population [2]. Currently, one of the significant tasks to improve the ecosystem is the disposal of solid household waste.

The basis of the regulatory framework governing the management of municipal solid waste in Kazakhstan is the Environmental Code, which regulates economic incentives for activities aimed at environmental protection [3].

The document includes tools to support “green” technologies aimed at producing non-toxic products in a closed cycle “production - recycling - new production” and reducing waste through innovation in technology and consumption patterns.

The concept of the Republic of Kazakhstan’s transition to a "green economy" is based on state policy regulating waste management [4]. By 2030, the share of waste recycling, according to the Concept, should be 40%, by 2050 - 50%.

This provision of the Concept is consistent with the Sustainable Development Goals adopted by Kazakhstan, including:

- SDG-12.3 - by 2030, Reduce food losses in food supply chains, including post-harvest losses, and cut the quantity of food wasted globally per person at the retail and consumer levels;
- SDG-12.5 - by 2030, significantly reduce the volume of waste by taking measures to prevent its formation, reduce it, recycle and reuse it [5].

In the Republic of Kazakhstan, practical steps to "green economy" introduction are outlined in the Action Plan for 2021-2030, developed to implement the Concept of Transition to a "Green Economy" [6]. In this document, the greatest interest from the point of view of organizing a waste management system is such an item in the action plan as the organization of separate waste collection in populated areas.

The efficient use of secondary resources is based on separate waste collection.

To stimulate the comprehensive utilization of municipal waste, the Environmental Code of the country has been supplemented with a requirement to separate solid domestic waste into two main categories: "dry" and "wet" [3].

The requirements for separate waste collection, considering technical, economic, and environmental feasibility, were approved on December 2, 2021 [7].

Initially, priority was given to collecting secondary resources that could be sorted and recycled, such as plastic, glass, and waste paper. The remaining waste, consisting primarily of food and hygiene products, was sent to the landfill without sorting [8].

In 2022, in the Republic of Kazakhstan, out of 207 cities and districts, separate collection at different stages was introduced in 133, and sorting in 103 settlements. On December 31, 2022, there were about 564 enterprises operated in the field of waste management in Kazakhstan [9].

Information on the introduction of separate collection and sorting of solid household waste is presented in Table 1.

Table 1. Introduction of separate collection and sorting of solid household waste in Kazakhstan, 2022 [10].

№	Region/Area	Number of settlements where separate collection of municipal solid waste (MSW) is implemented	Number of settlements where the sorting of municipal solid waste (MSW) is implemented
1	Abai Region	2	2
2	Akmola Region	10	7
3	Aktobe Region	9	7
4	Almaty Region	10	3
5	Atyrau region	6	5
6	East Kazakhstan Region	2	1
7	Jambyl Region	11	9
8	Jetisu region	4	1
9	West Kazakhstan Region	13	13
10	Karaganda Region	8	6
11	Kostanay Region	20	13
12	Kyzylorda region	8	8
13	Mangystau Region	4	4
14	Pavlodar Region	7	3
15	North Kazakhstan Region	7	1
16	Turkistan region	17	16
17	Ulytau region	1	1
18	Almaty city	1	1
19	Astana city	1	1
20	Shymkent city	1	1
	Kazakhstan	142	103

The main environmental problem is not only the increase of the amount of solid household waste, but it is the absence of its high-tech disposal and processing. There are an insufficient number of solid waste processing plants in the country. The most common waste disposal method in Kazakhstan is landfills.

Today in Kazakhstan, a certain share of food waste generated in private households and public catering establishments is separated and used for animal feed, as well as for making compost at home. However, a significant portion of organic waste as part of municipal solid waste continues to end up in landfills.

Landfills have a great impact on the environment and pose a great danger to humans. One of the reasons is the high contact of municipal solid waste with the environment. Also, in the depths of landfills, where oxygen does not penetrate well, gas is formed under the influence of anaerobic digestion - a mixture of carbon dioxide and methane, which can lead to an explosion. A toxic liquid called leachate appears in landfills; its release into water also poses a great danger [11].

In accordance with Article 348 of the Environmental Code of the Republic of Kazakhstan, a waste disposal site is defined as a location with the necessary facilities to permanently dispose of trash while adhering to building, environmental, and sanitary-epidemiological codes. [3].

In total, 469 waste landfills were registered in the Republic of Kazakhstan in 2022, of which hazardous waste landfills - 65 units, non-hazardous waste landfills - 173 units, solid waste landfills - 231 units (table 2).

Table 2. Number of landfills registered in the state waste cadastre in Kazakhstan in 2022, in units [10].

№	Region/ Area	Hazardous waste landfills	Non-hazardous waste landfills	Solid waste landfills
1	Abai Region	0	0	0
2	Akmola Region	6	9	21
3	Aktobe Region	11	7	7
4	Almaty Region	0	5	3
5	Atyrau region	10	0	4
6	East Kazakhstan Region	2	7	5
7	Jambyl Region	1	20	13
8	Jetisu region	0	0	0
9	West Kazakhstan Region	1	2	30
10	Karaganda Region	1	40	31
11	Kostanay Region	2	29	60
12	Kyzylorda region	2	9	4
13	Mangystau Region	14	2	3
14	Pavlodar Region	7	19	27
15	North Kazakhstan Region	0	9	9
16	Turkistan region	4	11	12
17	Ulytau region	0	0	0
18	Almaty city	1	1	0
19	Astana city	0	1	1
20	Shymkent city	3	2	1
	Total:	65	173	231

In 2022, the number of solid waste landfills in the republic amounted to 3,012, of which 633 (21%) comply with environmental and sanitary standards.

The smallest share of landfills that meet environmental and sanitary-epidemiological standards is in the Abai region - 5 (2.9% of the total number of landfills), Pavlodar region - 5 (1.5%), West Kazakhstan region - 2 (1.36%) and North Kazakhstan regions - 16 testing grounds (3.5%).

Today, Kazakhstan is in second place in terms of total environmental pollution with organic substances among the countries of Central, Eastern Europe and Central Asia [12].

About 4.5-5.0 million tons of solid household waste are generated annually in Kazakhstan. According to official data, in 2022, 4.3 million tons of solid household waste were generated in the Republic of Kazakhstan. Of this, 1.1 million tons were municipal waste collected by 850 units of specialized enterprises and individual entrepreneurs responsible for waste collection and transportation.

The main share is household waste (65.6%), 20.2% is industrial waste (equal to household waste), 10.5% is street waste, 2.2% is market waste.

The share of processed and disposed municipal solid waste in Kazakhstan in 2022 was 25.4%. Information on processed and disposed municipal solid waste by region is presented in Table 3.

Table 3 Share of recycled and disposed solid waste, 2017-2022 [13].

№	Region/ Area	Share of recycled and disposed solid waste, %					
		2017	2018	2019	2020	2021	2022
1	Abai Region						1,6
2	Akmola Region	2,11	2,93	3,02	15	8,7	7,9
3	Aktobe Region	3,51	11,69	10	10	10,7	15
4	Almaty Region	24,77	27,55	23,28	17	17,6	17,1
5	Atyrau Region	44,33	1,69	10,44	20	21,6	27,5
6	East Kazakhstan Region	3,17	4,84	3,28	18	11,3	16
7	Jambyl Region	3,47	3,11	8,53	13	12,7	16,1
8	Jetisu region						17,8
9	West Kazakhstan Region	2,17	5,28	8,6	11	11,6	15,1
10	Karaganda Region	13,96	16,39	17,42	29	29	54,6
11	Kostanay Region	0,93	9,65	10,3	12	17,7	18,2
12	Kyzylorda region	8,13	7,42	10,78	18	19,7	24,5
13	Mangystau Region	6,49	1,42	33,8	35	28,3	32,1
14	Pavlodar Region	0,23	0,12	15	22	23,8	27,3
15	North Kazakhstan Region	3,59	7,59	10,78	13	15	18,3
16	Turkistan region	3,48	7,17	10,05	13	16	19
17	Ulytau region						0,1
18	Almaty city	10,01	5,7	10,95	10	14	18
19	Astana city	8,33	12,25	15,92	30	75	75,2
20	Shymkent city		18,28	22,77	25	27,2	30,3
	Kazakhstan	9,05	11,51	14,9	18,3	21,1	25,4

*Note New regions were formed (Abai, Ulytau and Jetisu), however, for 2017, 2018, 2019, 2020, 2021, the data for the regions is not divided in this table.

Due to the creation of infrastructure for the separate collection, processing, and disposal of solid waste, the share of processing and disposal of solid household waste in the country increased from 9.05% in 2017 to 25.4% in 2022.

The increase in waste generation is inextricably linked with the increase in the welfare of society, i.e. there is a relationship between the dynamics of gross domestic product per capita and specific waste generation. Intensive urbanization, population growth, and unsustainable production and consumption patterns all lead to the generation of significant amounts of waste. And if we take into account the fact that in our country household waste is practically not recycled, but is accumulated in landfills and its quantity is increasing every day, then the ecological state of the country is one of the urgent and serious problems [14].

Since January 1, 2021, the disposal of food waste in landfills has been prohibited in Kazakhstan [3]. This measure should lead to a reduction in waste disposal at landfills.

The largest share of thrown away garbage is organic (food) waste. 60% of municipal solid waste is the organic fraction [15].

As part of the upcoming goals for the transition to a sustainable society and the active implementation of a circular economy, one of the EU goals is to reduce the amount of municipal solid waste and initiate the separation of its organic fraction, i.e. biological waste. Therefore, the question of how to manage bio-waste better at the municipal level is of great importance, and previous studies have shown the strong influence of local factors on the most sustainable treatment option [16].

Organic waste treatment has traditionally been based on schemes involving a single bioprocess such as composting or anaerobic digestion, and in some cases a combination of these two processes [17].

Today, there are various technologies for utilization and processing of the organic (food) fraction of municipal solid waste, including: biogas production, combustion with energy recovery, composting and others. Energy consumption (both industrial and household consumption) was the most significant generator of greenhouse gas emissions [18]. International experience and Kazakh practice show that waste must be sorted at the moment of generation, “at the source”. This allows you to increase the volume of waste sent for processing, as well as improve the quality of the raw materials obtained from them [19-21].

In order to establish a waste collection and recycling system in Kazakhstan, first of all, it is necessary to treat waste as a valuable secondary raw material. The waste management sector requires systemic changes aimed at reducing the negative impact on the environment and increasing the efficiency of resource use. But in practice, there really is a problem of low culture of separate waste collection among the country's population.

It is also important that the solid waste processing industry in the country is at the initial stage of development, and its efficiency is extremely low.

The existing problem with solid waste must be solved, taking into account the experience of other states in this area, with strict adherence to environmental safety issues, and also taking into account that waste is essentially a cheap secondary resource. There are not enough waste recycling enterprises throughout the country, and the existing ones are not operating at full capacity due to poor interaction between local authorities, public utilities and, accordingly, the institutions themselves. More often, a significant part of the waste is simply dumped in natural landfills, because the capacity of official landfills is insufficient for the exponentially growing volumes of garbage.

The environmental and economic feasibility and the need for repeated reuse of natural resources by involving part of the production and consumption waste into economic circulation as secondary raw materials has been proven by many years of practice in many countries of the world [22].

4 Conclusions

In a world with limited resources, waste or residues, including organic waste, should be considered as sources of recyclable materials. Currently, the “value” of organic waste is obtained in the form of only a few products, such as biogas, compost and nutrients in the liquid phase of digestate.

They have relatively low economic value, often supported by incentives for renewable energy production provided by environmental and energy policies adopted in some countries [23].

When food waste ends up in trash cans along with other waste, it contaminates it, reduces the quality of recyclables, and often makes sorting impossible. As a result, double economic benefits are missed, both from processing food waste and from recycling materials. The introduction of a simplified dual system would help to recycle most waste, since separating food waste from other waste would keep it dry and clean and increase sorting efficiency. This will also help to improve the culture of waste separation among the population and, in the future, organize complete separate waste collection.

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