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TOWARDS A CIRCULAR ECONOMY: AN ANALYSIS OF KAZAKHSTANI CASE

A circular economy is an economic system in which resources are used, reused, and regenerated in a closed loop, rather than the traditional linear model of extraction, use, and disposal. The topic is particularly urgent for emerging countries as it can help address many of the economic, environmental, and social challenges these countries face. This article aims to analyze the current state of circular economy development in Kazakhstan and its progress in implementing circularity principles over the years. The research was conducted in two stages: (1) a statistical analysis based on secondary data, which identifies patterns and trends in waste recycling; (2) a regression model for evaluating the impact of management costs on the level of recycling and reuse of waste in Kazakhstan. The data was collected for the period from 2015 to 2021. The results show that solid waste recycling has increased more than 11 times, while the municipal waste generation rate per capita slightly decreased. The regression analysis demonstrates that increasing management costs does not have the desired effect on the reuse and recycling of waste, backing the previous research results about the importance of other factors like environmental consciousness and state regulation. Despite the general positive changes, the progress of Kazakhstan in implementing a circular economy is still in its early stages. The article can provide valuable insights to policymakers and researchers in Kazakhstan on ways of assessing the waste management system and promoting a circular economy in the country.

Key words: circular economy, waste management, regression analysis, environmental consciousness.

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Циркулярлы экономика жолында: Қазақстан кейсіне талдау

Циркулярлы экономика – бұл өндірудің, пайдаланудың және кәдеге жаратудың дәстүрлі сызықтық үлгісіне қарағанда, ресурстарды жабық циклде пайдаланатын, қайта пайдаланатын және қалпына келтіретін экономикалық жүйе. Зерттеу тақырыбы әсіресе дамушы елдер үшін өзекті болып табылады, себебі ол осы елдердегі бірқатар көптеген экономикалық, экологиялық және әлеуметтік мәселелерді шешуге көмектеседі. Бұл мақалада Қазақстандағы циркулярлық экономиканың дамуының қазіргі жағдайы және өткен жылдардағы циркулярлық қағидаларын қолдану нәтижелері талданған. Зерттеу екі кезеңде жүргізілді: (1) қалдықтарды қайта өңдеудің ағымдағы жағдайы мен тенденцияларын анықтайтын екінші ретті деректерге негізделген статистикалық талдау; (2) Қазақстандағы қалдықтарды қайта өңдеу және қайта пайдалану деңгейіне басқару шығындарының әсерін бағалаудың регрессиялық үлгісі. Мәліметтер 2015 жылдан 2021 жылға дейінгі кезеңде жинақталған. Талдау нәтижелері көрсеткендей, аталған кезеңде қатты тұрмыстық қалдықтарды қайта өңдеу 11 еседен астам өсіп, ал жан басына шаққандағы коммуналдық қалдықтардың түзілу деңгейі аздап төмендеген. Регрессиялық талдау басқару шығындарының ұлғаюы қалдықтарды қайта пайдалануға және қайта өңдеуге елеулі әсер етпейтінін көрсетеді, бұл экологиялық сана және мемлекеттік реттеу сияқты басқа факторлардың маңыздылығы туралы алдыңғы зерттеулердің нәтижелерін растайды. Жалпы оң өзгерістерге қарамастан, Қазақстанның циркулярлы экономиканы жүзеге асырудағы ілгерілеуі әлі де бастапқы сатысында. Мақала Қазақстандағы саясаткерлер мен зерттеушілерге қалдықтарды басқару жүйесін бағалау және елдегі циркулярлы экономиканы дамыту жолдары туралы құнды түсініктер бере алады.

Түйін сөздер: циркулярлы экономика, қалдықтарды басқару, регрессиялық талдау экологиялық сана.

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На пути к циркулярной экономике: анализ казахстанского кейса

Циркулярная экономика – это экономическая система, в которой ресурсы повторно используются и регенерируются в замкнутом цикле, в отличии от традиционной линейной модели извлечения, использования и утилизации ресурсов. Тема исследования особенно актуальна для развивающихся стран, поскольку она может помочь решить многие экономические, экологические и социальные проблемы, с которыми сталкиваются эти страны. Статья посвящена анализу текущего состояния развития циркулярной экономики в Казахстане и ее прогресса в реализации принципов замкнутого цикла за предыдущие годы. Исследование проводилось в два этапа: (1) статистический анализ на основе вторичных данных, выявляющий закономерности и тенденции переработки отходов; (2) регрессионная модель для оценки влияния управленческих затрат на уровень переработки и повторного использования отходов в Казахстане. Данные были собраны за период с 2015 по 2021 год. Результаты показывают, что переработка твердых бытовых отходов увеличилась более чем в 11 раз, при одновременном снижении уровня образования бытовых отходов на душу населения. Регрессионный анализ показывает, что увеличение затрат на управление не оказывает желаемого влияния на повторное использование и переработку отходов, подтверждая результаты предыдущих исследований о важности и других факторов, таких как экологическое сознание и государственное регулирование. Несмотря на общие позитивные изменения, прогресс Казахстана во внедрении циркулярной экономики все еще находится на начальной стадии. Статья представляет ценность для политиков и исследователей в Казахстане, заинтересованных в способах оценки системы управления отходами и продвижения экономики замкнутого цикла в стране.

Ключевые слова: циркулярная экономика, управление отходами, регрессионный анализ, экологическое сознание.

Introduction

In the era of global challenges, the traditional linear "take-make-waste" approach is giving way to a new development strategy – a circular economy. If a linear economy uses resources indefinitely to produce products that will be discarded after use, a circular economy, in contrast, follows the "reduce, reuse and recycle" model, encouraging the reuse of products and raw materials, and preventing the waste release into the environment as much as possible (Preston, 2012). Many scientists consider CE a paradigm associated with sustainable development (Geissdoerfer et al., 2017). Even though the CE initially focused on the problems of waste recycling, scientists began to consider rethinking the strategic goals of production and consumption at multi-levels (Kirchherr et al., 2017) and assessing the effectiveness of progress in achieving circularity through indicators.

Several developed countries have begun active consolidated work on the transition to circularity: laws are adopted, government programs are developed, roadmaps are approved, and platforms are being created at the international level. Implementing a circular economy in emerging countries can help to promote sustainable economic growth and development, reduce poverty and inequality, and conserve natural resources. However, the scientific component of the circular economy concept in the world and Kazakhstan remains largely unexplored. Additionally, there is a lack of research dedicated to evaluating the implementation of a circular economy in Kazakhstan based on statistical data analysis.

This paper aims to analyze the current state of circular economy development in Kazakhstan and its progress in implementing circularity principles over the years.

The paper is structured as follows: (1) literature review, highlighting the main theoretical background of the topic; (2) methodology and data section, explaining the stages and methods of the study; (3) results and discussion, indicating the main findings; (4) and conclusion.

Literature review

The circular economy concept originated in the 1960s. Pierce and Boulding (1966) are believed to be the first scientists to introduce this concept into the scientific world. Since then, the concept of a circular economy has only gained significance with each passing decade. For example, the Brundtland report (1987), which was published in 1987, dis-

cussed the negative aspects of human consumer attitudes towards nature. Further, in 1990, scientists Pearce and Turner (1990) published their work, where the term "circular economy" was first introduced. In this work, they described the relationship between the economy and the environment, in which the traditional economic paradigm based on the profit-cost principle is inefficient, and that this paradigm should be changed to a new one that takes into account reasonable consumption and the idea of intergenerational utility.

The concept of a circular economy is currently at the peak of its popularity, as global problems are only getting worse from year to year (due to climate change, pollution, atmospheric emissions, population increase, etc.) (EU Commission, 2021). That is why many countries are implementing the principles of the circular economy in government strategies, major international projects, legislation, and other significant documents that are aimed at the efficient use of resources with minimal environmental damage. It is worth noting that one of the key elements of the introduction of a circular economy is the strengthening of waste recycling.

According to Ellen MacArthur (2013), the circular economy includes the following principles (Figure 1):

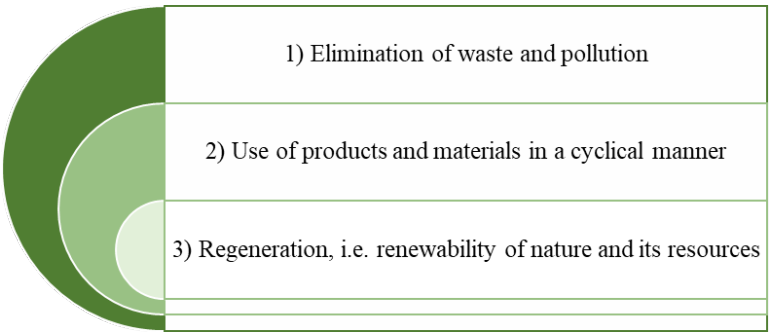

Figure 1 – Principles of the CE
Note: Compiled by the authors based on the source of the EMAF 2013.

It is also worth noting the study of M. Azizuddin, A. Shamsuzzoha and S. Piy, in their work they defined the circular economy as "a method of managing cyclicality, efficiency and optimization of resources that advocates the use of waste as a resource to create value" (Azizuddin et al., 2021).

EU Parliament (2015) in their report "Circular economy: definition, importance and benefits", described the concept of circular economy as a model of production and consumption, which uses sharing, leasing, reusing, repairing, refurbishing, and recycling. Due to this, the life cycle of products and materials can be extended as long as possible. The main goal of the concept is to reduce the amount of waste to a minimum. Thus, the "circular" economy is one of the best alternatives to the "linear" economy, which works only on the principle of "take-make-waste" (EMAF, 2013).

As A.F. Constant, O. Nottmeyer and K.F. Zimmerman (Constant et al., 2013) discussed, the transition to a circular economy opens up prospects for eradicating poverty. Also, the circular economy model is one of the most environmentally friendly and acceptable for sustainable development (Andersen, 2007).

However, as Potting et al. (2017) mentioned in their work, there are significant difficulties in determining the performance indicators of a circular economy. With the advent of the CE concept, scientists often face difficulties in measuring the performance of CE indicators (Calzolari et al., 2022). To solve this problem, the OECD, in their Inventory of Circular Economy report, gave 474 indicators by which it is possible to measure the performance of the circular economy.

For instance, in France, annual assessments are made of indicators such as internal consumption of materials, resource productivity, the amount of waste sent to landfill, the use of recycled raw materials, etc. (Ministry of the environment, energy and marine affairs of France, 2017). Also, the European Commission (2018) published a report entitled "Measuring progress towards circular economy in the European Union – Key indicators", which identified 10 key indicators. As a result, they

were able to evaluate the effectiveness of actions to move towards a circular economy (EC, 2018).

Eva Mihaliková et.al (2022) showed a positive relationship between environmental protection costs and waste recycling. Banacu et al. (2019) put the same statement in their work. The authors have identified the relationship between various economic indicators and environmental taxes on household waste recycling, finding that the indicators have a direct and significant impact on household waste recycling.

In the Republic of Kazakhstan, several works have been written on the topic of waste management, among which it is worth mentioning V. Inglezakis et.al (2017), who in their work investigated waste management in the cities of Astana and Almaty. It is also worth noting the work of N. E. Dabyltayeva, G. Rakhymzhan (2019), who, in their work entitled "Waste disposal in Kazakhstan as a strategic direction of implementation of the "green" economy development program", argued that effective waste management is an important process for transition to sustainable development. For instance, the works of such authors as D.E. Ausharipova, L.B. Kulumbetova (2020), and also A. Tleppaev together with S. Zeinolla (2021) were devoted to the circular economy concept. In their work, academics substantiated the importance of the transition to a circular economy.

The literature review indicates that the study of the circular economy in Kazakhstan is still in its early stages, and there is a lack of empirical research examining the relationships between different factors in the context of this topic.

Legal framework

The legal framework on waste management in Kazakhstan is complex and has undergone significant changes in recent years. While there are several laws and regulations that address waste management in the country, there are still some gaps and challenges that need to be addressed. Here is an analysis of the legal framework on waste management in Kazakhstan:

Environmental Code: The Environmental Code of Kazakhstan is the primary legislation that regulates waste management in the country. It establishes the framework for waste management practices, including the collection, transport, storage, treatment, and disposal of waste. The Code also requires waste generators to minimize waste generation and promote waste reuse and recycling. However, there are some gaps in the Code, such as the lack of clear guidelines on hazardous waste management and the lack of a specific regulatory agency for waste management.

Waste Management Law: The Waste Management Law of Kazakhstan was adopted in 2021 and provides additional guidance on waste management practices. It defines the responsibilities of waste generators, transporters, and disposal operators, as well as the regulatory requirements for waste management facilities. However, some experts have criticized the law for being too general and not providing enough specifics on waste management practices.

In addition to the Environmental Code and the Waste Management Law, there are several other regulations that address waste management in Kazakhstan. These include regulations such as:

- The Law of the Republic of Kazakhstan "On Environmental Protection" (1997). This law is the main legal act regulating environmental protection in Kazakhstan. It establishes the basic rules for environmental protection, as well as the rights and obligations of legal entities and individuals in this area.

- The Law of the Republic of Kazakhstan "On Radiation Safety and Protection of the Population from Ionizing Radiation" (1998). This law regulates radiation safety in Kazakhstan and establishes rules for the protection of the population from ionizing radiation, as well as for the handling of radioactive waste.

- Government Decree of the Republic of Kazakhstan "On Waste Recycling" (2015). This regulation establishes procedures for waste recycling and defines requirements for waste processing organizations.

- The Water Code of the Republic of Kazakhstan (2003). This Code regulates the use and protection of water resources, including measures to prevent water pollution.

- Government Decree of the Republic of Kazakhstan "On Approval of the Rules for Hazardous Waste Management" (2015) – This decree sets out requirements for the management of hazardous waste in Kazakhstan, including the storage, transportation, and disposal of such waste.

However, there are still some gaps in the regulations, such as the lack of a clear mechanism for enforcing waste management regulations and the need for more specific guidelines on waste segregation and disposal. One of the main challenges facing the legal framework on waste management in Kazakhstan is the lack of effective enforcement mechanisms. While there are penalties for violating waste management regulations, enforcement is

often weak due to the lack of resources and technical capacity of regulatory agencies.

It should be noted that Kazakhstan's environmental laws and regulations have been developed to align with international standards and best practices. Nevertheless, the implementation and enforcement of these laws remains a challenge. Some of the key issues include a lack of sufficient funding for environmental protection and waste management programs, a shortage of skilled personnel, and inadequate infrastructure for waste management. Additionally, there is a need for greater public awareness and education on environmental issues in order to promote a culture of environmental responsibility and sustainability.

Methodology and Data

The study was carried out in 2 stages:

Stage 1: statistical analysis of the current situation in the development of indicators of the circular economy in Kazakhstan as a whole and by regions since 2015.

Stage 2: hypothesis testing based on data regression analysis.

Hypothesis: the volume of current costs for waste management has a statistically significant and positive effect on the level of recycling and reuse of waste in Kazakhstan.

All data for both statistical and regression analysis were collected from the official website of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. The data are annual, and based on the availability of data for analysis, the period from 2015 to 2021 was chosen.

The dependent variable was the level of recycling and reuse of waste in Kazakhstan, both in absolute terms (thousand tons per year), and the share of recycling and reuse of waste in the total volume of waste generation (in percent).

Waste is understood as the totality of all types of waste:

- solid household waste;
- municipal waste;
- industrial waste;
- hazardous waste.

The indicators presented in Table 1 were selected as independent variables.

Table 1 – Dependent and independent regression variables

Notation	Variable
y1	dependent variable, the share of reuse and recycling of the waste in the total volume of waste generation, %
y2	dependent variable, the volume of reuse and recycling of waste, thousand tons
x1	the volume of current costs for waste management, mln tenge
x2	investments in waste management, mln tenge
x3	generation of all types of waste, thousand tons
x4	the intensity of waste generation per capita, kg
x5	population, million people
x6	GDP at constant 2005 prices, million tenge
Note: Compiled by the authors	

To avoid endogeneity, the dependent variables in the model are taken with a lag of 1 year in order to eliminate the effects of possible simultaneity. Including explanatory variables in the model measured over the same time period as waste recycling and reuse may introduce endogeneity into the model, as waste reuse and recycling is not a fast process. And the inclusion of regressors with a lag avoids this problem.

Table 2 presents descriptive statistics.

Table 2 – Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
y1	6	29,492	12,835	8,325	48,09
y2	6	271023,1	131231,2	29961,9	419587,8
x1	6	55328,73	8902,841	42104,86	66280,73
x2	6	9528,763	2826,001	6209,542	14130,75
x3	6	1003211	133830,1	872496,5	1242505
x4	6	55370,86	8318,429	48305,04	70827,03
x5	6	18,153	0,452	17,543	18,756
x6	6	13826266,07	755723,6	12919190,1	14794066,7
Note: Compiled by the authors					

Results and Discussion

Analysis of current trends and patterns

According to the results of statistical analysis, the following data was revealed for the period between 2015-2021 years. (Figure 2)

According to the definition of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, municipal solid waste includes municipal waste in solid form. As can be seen in Figure 2, the total volume of generated MSW in the Republic of Kazakhstan has a positive trend. For example, if in 2015 the total volume of MSW generated on the territory of the Republic was 5 467.3 thousand tons, then at the end of 2021 this figure dropped to 4 214.1 thousand tons. The situation is the same MW – if in 2015 the total volume of generated MW reached 3 235.5 thousand tons, then on the next year this mark dropped to 2 813.6. However, starting from 2017, the total volume of generated MW kept above 3 415.0 thousand tons, and in 2021 it reached 4 006.5 thousand tons.

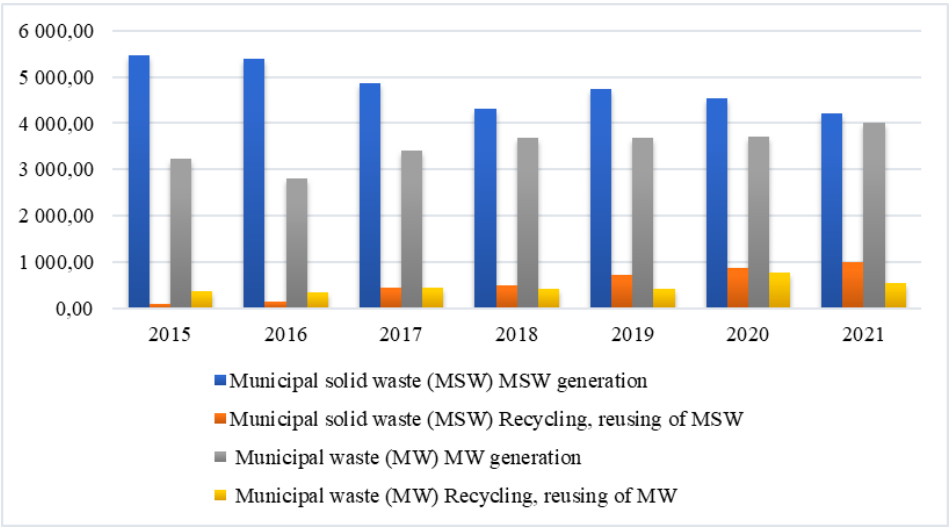

Figure 2 – Generation of municipal solid waste, municipal waste and the level of their processing
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

As for the recycling, reusing of MSW, statistical data shows that compared with 2015, in 2021 the share of MSW processing increased from 1.8% to 21.1%. The share of recycling and reusing of MW also has a positive trend – this figure in 2021 reached 13.6%. There is also a decrease in the intensity of MSW and MW formation per capita for 6 years (per kg.):

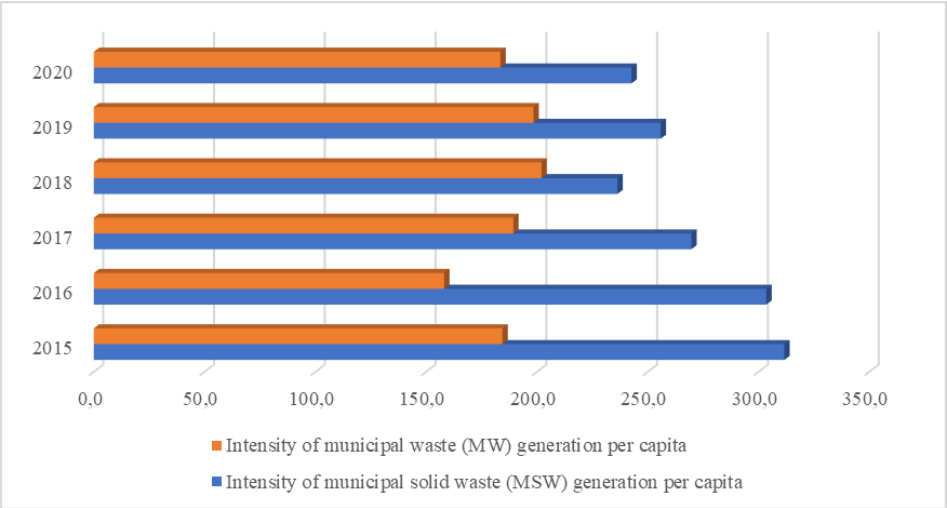

Figure 3 – Waste generation intensity for the period between 2015-2020
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

Figure 3 shows that the intensity of municipal solid waste generation tends to decrease every year, which is a positive indicator. As for municipal waste, if in 2015 the intensity of municipal waste generation was 184 kg per capita, then in 2020 this mark shows 183 kg per capita, which shows a more or less stable result.

Statistical data on industrial waste is available since 2015. As a rule, industrial waste is divided into hazardous and non-hazardous waste. The results of the statistical analysis showed the following results:

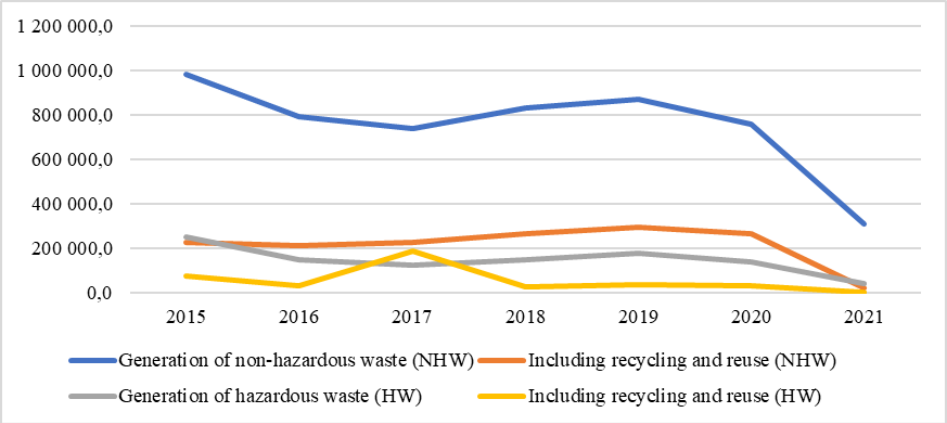

Figure 4 – Industrial waste and its processing
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

According to Figure 4, the generation of non-hazardous waste decreased by 31.5% in 2021 compared to 2015. However, if in 2015 the recycling and reusing of non-hazardous waste reached 227 114.4 thousand tons, then in 2021 this mark fell to 23 506.3 thousand tons. As for the generation of hazardous waste, compared to 2015, in 2021 the volume of HW generation decreased from 251 565.7 thousand tons to 42 090.0 thousand tons.

As for the share of processing and disposal of industrial waste in relation to the level of their generation, the results of the analysis can be seen in the diagram:

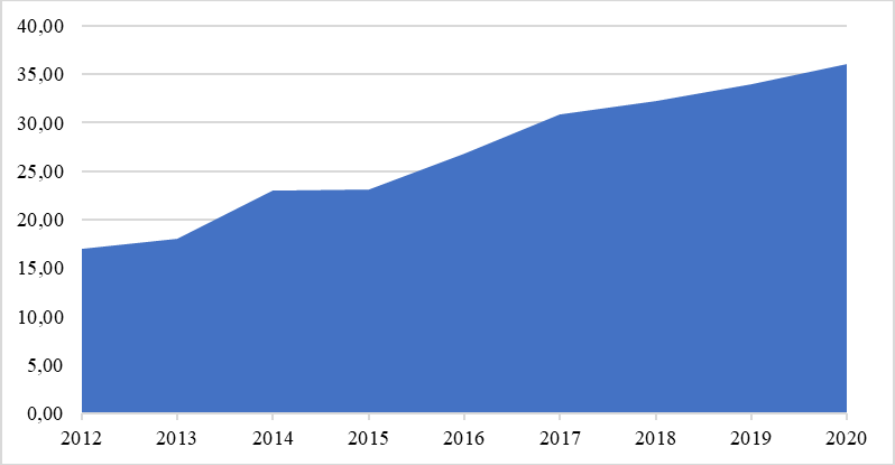

Figure 5 – The share of processing and disposal of industrial waste to their generation (%)
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

As it can be seen in Figure 5, the results of the analysis between 2012-2020 showed that there is a positive upward trend in the share of processing and disposal of industrial waste to their generation. For example, the share of processing and disposal of industrial waste to their formation in 2020 reached 36.06%.

According to the latest report of the Bureau of National Statistics, the number of enterprises and organizations for the collection and removal of municipal waste in the territory of the Republic of Kazakhstan shows the following figures:

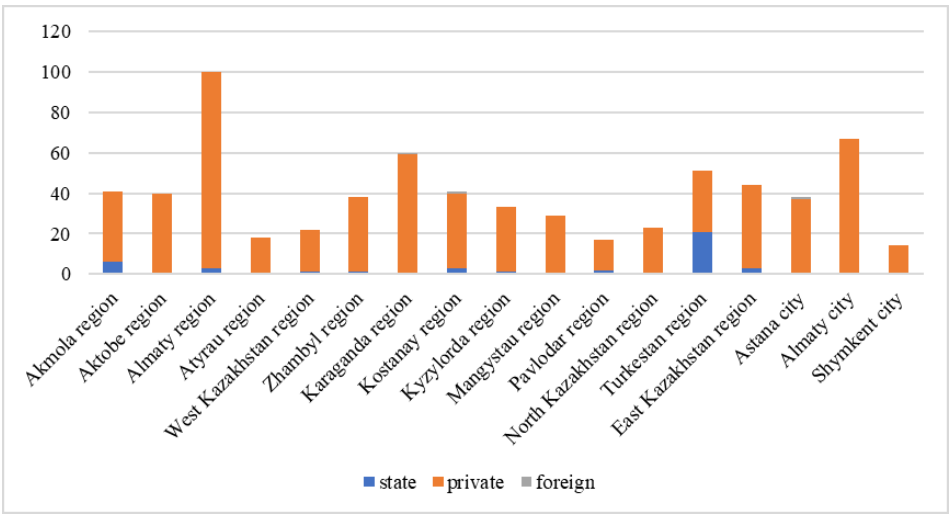

Figure 6 – Number of enterprises and organizations for the collection and removal of municipal waste
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

As Figure 6 shows, the largest number of enterprises for the collection and removal of municipal waste is located in the Almaty region and Almaty city. The smallest number of enterprises was in Shymkent city. Most of them are private enterprises.

The more detailed breakdown is presented in Annex 2. It shows that the East Kazakhstan region (14,109 tons) is the leader in sorting food waste, followed by the Kyzylorda region (10,068 tons). In terms of sorting waste cardboard and paper waste, the top three include the Karaganda region (57,582 tons), the Almaty region (27,571 tons), and the East Kazakhstan regions (16,379 tons). Karaganda region is the leader in sorting cullet, plastic waste, polyethylene and polyethylene-terephthalate packaging, as well as in non-ferrous and ferrous scrap. But the situation with the sorting of electronic and electrical equipment is much worse than other types of waste, because it is sorted only in 2 regions of the Republic of Kazakhstan – Mangystau region (32 tons), and North Kazakhstan region (12 tons). Tires are mostly sorted in the East Kazakhstan region (1566 tons). Sorting of trees and leaves is mostly in the Almaty region (25,325 tons). Clothing and textiles are sorted more often in the East Kazakhstan region (3,285 tons) and the Almaty region (2,137 tons). Well, in terms of sorting other waste, Astana is firmly in the lead with a mark of 292,551 tons for the year 2021.

According to the Bureau of National Statistics of the Republic of Kazakhstan, the total volume of disposed and buried waste in the Republic of Kazakhstan for 2021 amounted to 134,498 tons. The volume of waste sent to the construction activities of the landfill is 95,958 tons, the volume of waste sent for incineration (burning) with energy recovery is 6,470 tons, and the volume of waste sent for other types of disposal is 32,970 tons. Also, the presence of waste located in places of temporary storage of waste (sites, warehouses, storage facilities) amounted to 27,267 tons. Detailed information for the regions of the Republic of Kazakhstan can be seen in the following Figure 7:

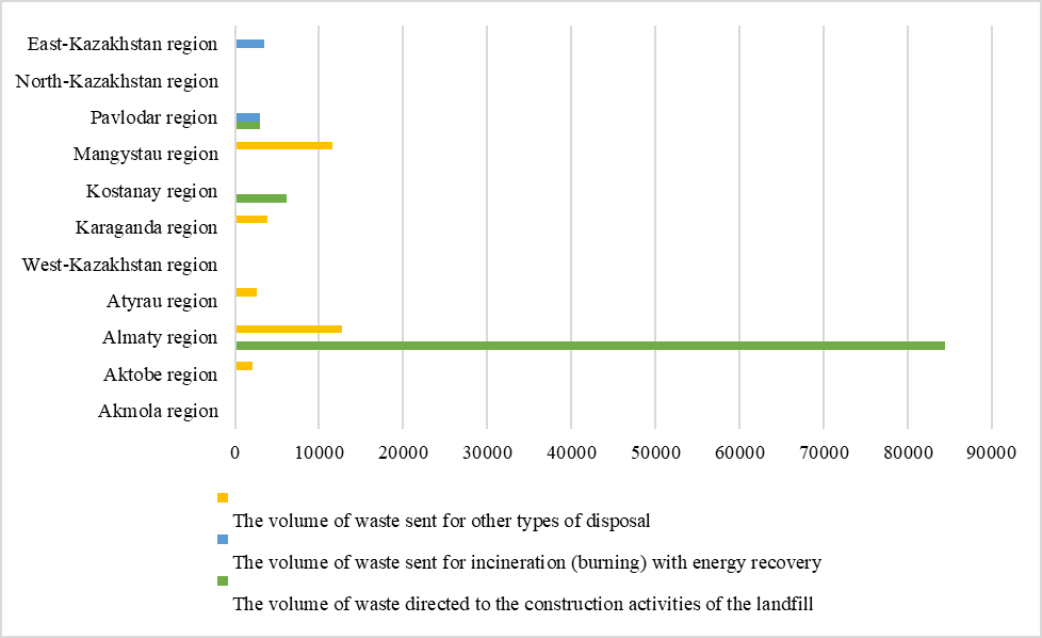

Figure 7 – Total volume of disposed waste
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

According to Figure 7, the largest volume of disposed waste falls on the Almaty region, in 2021 the volume of waste directed to the construction activities of the landfill amounted to 84,442 tons. Next on this point is Kostanay region, with a volume of 6,100 tons. The third place is occupied by Pavlodar region, which showed a result of 2,990 tons. As for the volume of waste sent for incineration with energy recovery, there are data for only two regions throughout the Republic of Kazakhstan – East Kazakhstan region (3,457 tons) and Pavlodar region (3,008 tons). The largest volume of waste directed

to other types of disposal falls on the Almaty and Mangystau regions. The presence of waste located at temporary waste storage sites (sites, warehouses, storage facilities) accounts for the most in the East Kazakhstan region with a result of 20,457 tons.

In 2021, the volume of environmental protection costs amounted to 416 955 575 000 tenge. This indicator is 8.6% more compared to 2020, and 0.8% less than was allocated in 2019. The dynamics of costs can be seen in the following Figure 8:

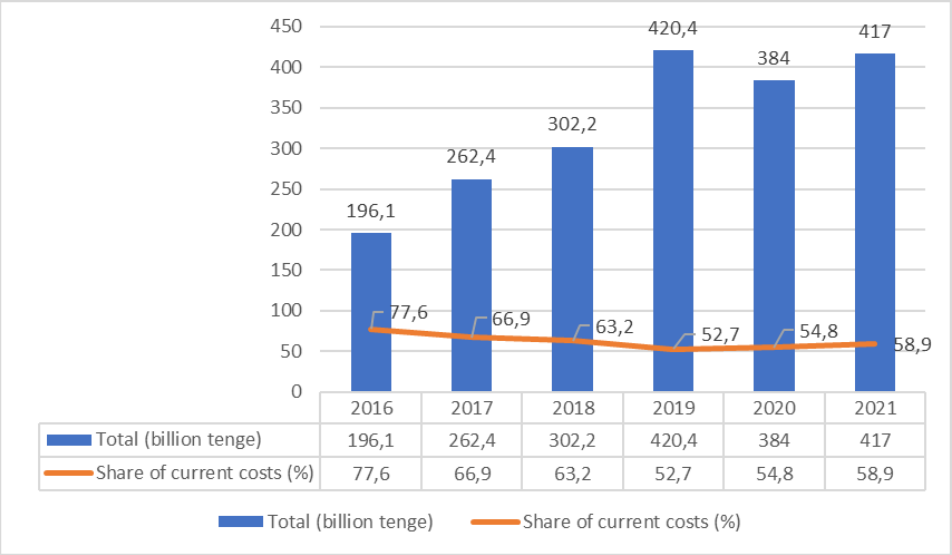

Figure 8 – Dynamics of environmental protection costs
Note: Compiled by the authors based on the source of the Bureau of National Statistics in the Republic of Kazakhstan

Based on Figure 8, there is a positive trend since 2016, and the highest peak in environmental spending in 2019. Then in 2020 there is a slight decrease, and in 2021 the costs amounted to approximately 417 billion tenge, which is 8% more than last year. However, the share of current spending on environmental protection has been decreasing from year to year. In 2021, there is an increase in the share from 54.8% to 58.9%.

According to the reports of the Bureau of National Statistics of the Republic of Kazakhstan, approximately 90% of the costs of environmental protection fell on the industry. Namely: mining and quarrying (129.3 billion tenge), followed by the supply of electricity, gas, steam, hot water and air conditioning (121.9 billion tenge), also manufacturing industry (107.8 billion tenge), and for the water supply along with the collection, treatment and disposal of waste was spent only 17 billion tenge. It is worth noting that less than 1 billion tenge was spent on education, information and communications altogether – only 700 million tenge. Also, according to the report of the Bureau of National Statistics of the Republic of Kazakhstan, the main source of financing for environmental protection costs is the own funds of enterprises: 317.7 billion tenge for 2021. In the previous year, the amount of financing was 281.5 billion tenge. It is also worth noting that funding from the republican budget for 2021 amounted to 6.7 billion tenge (in 2020 – 4.6 billion tenge), and about 16.2 billion tenge was financed from local budgets (in 2020 – 12.6 billion tenge). billion tenge).

Summing up, the analysis of statistical data for the Republic of Kazakhstan showed that municipal solid waste tends to decrease from year to year. There is also a positive result on their processing and recycling. As for municipal waste, its volume is growing. Therefore, it is worth paying attention to its generation and processing. Also, private organizations for waste processing prevail in the Republic of Kazakhstan, which is a common situation among many countries. Over the past three years, more than 1 trillion tenge have been allocated for environmental protection in the country. However, environmental issues still remain an acute and urgent problem for most regions in the Republic of Kazakhstan.

Regression analysis

Before building the regression model, a multicollinearity test was performed between the explanatory variables to avoid specification errors. The results of the correlation matrix are presented in Table 3.

As can be seen in Table 3, variables x5 (population) and x6 (GDP) are closely related to the main variable of interest x1 – the volume of current costs for waste management. Therefore, these two variables were excluded from the model. There is also a very close relationship between the variables x3 (generation of all types of waste) and x4 (intensity of waste generation per capita). In this regard, in the further stages of the study, the variables x3 and x4 will not be considered within the same model.

Table 3 – Correlation matrix of independent variables

	x1	x2	x3	x4	x5	x6
x1	1					
x2	0,157	1				
x3	0,067	0,532	1			
x4	-0,072	0,462	**0,988**	1		
x5	**0,794**	-0,197	-0,507	-0,625	1	
x6	**0,903**	-0,203	-0,315	-0,445	**0,937**	1
Note: Compiled by the authors						

During the model evaluation, two specifications were selected. One of them among the independent variables contains the generation of all types of waste, and the other – the intensity of waste generation per capita. The dependent variable in both specifications is the volume of reuse and recycling of the waste in thousands of tons, that is, not in percentage terms, but in absolute terms. When using the share of reuse and recycling of the waste in total waste generation, neither the general equation of the model nor the coefficients of the variables showed statistical significance.

Both model specifications are shown in Table 4 (Equations I and II). For each of them, the Fisher test confirms the quality and statistical significance of the general equation of the model. Regression analysis was carried out using the STATA statistical software package.

Table 4 – Results of the regression analysis, dependent variable – y2 (volume of reuse and recycling of waste)

Independent variable	Equation	
	I	II
x1 – the volume of current costs for waste management	-5,982 (3,668)	-3,959 (4,211)
x2 – investments in waste management	-57,32 (18,31)	-55,114 (19,876)
x3 – generation of all types of waste	1,047 (0,383)	
x4 – the intensity of waste generation per capita		16,075 (6,685)
Constant	97969,32 (343008,5)	125151,8 (376879,5)
Number of observations	6	6
R^2	0,88	0,85
Fisher test	F(3, 2) = 6,9 [0,042]	F(3, 2) = 6,5 [0,04]
Note – in parentheses are the standard errors of the regression coefficient. Compiled by the authors		

With a sufficiently high coefficient of determination and statistical significance of the general equation of the model, the coefficients of all variables did not show statistical significance even at the 10% level. Consequently, the hypothesis that the volume of current costs of waste management has a statistically significant and positive effect on the level of recycling and reuse of waste in Kazakhstan is refuted.

The volume of current waste management costs is not sufficiently correlated with the volume of reuse and recycling of the waste in Kazakhstan.

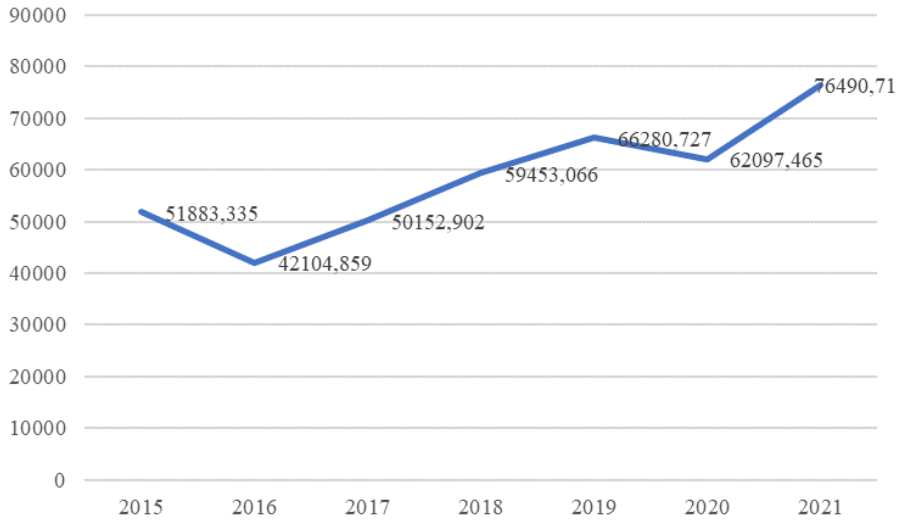

Figure 9 – The volume of current costs for waste management in Kazakhstan, million tenge

Annually, the volume of costs for waste management averages 30% of the total environmental costs and tends to grow (Figure 9), amounting to more than 75 billion tenge in 2021. The result of the regression analysis shows that simply increasing funding does not have the desired effect on the level of reuse and recycling of waste, since the waste generation volume grows even faster. Here it can be assumed that for the positive impact of funding allocated to waste management, first of all, it is necessary to reduce the generation of all types of waste by raising environmental consciousness and awareness of the population, both private and legal persons. A high correlation between waste generation and environmental awareness of the population was concluded in a previous study by the authors based on a questionnaire survey of the population (Zhidebekkyzy et al., 2022).

It is also worth noting the work of W. Huang et.al., (2014), who argued that despite the fact that financial investments have their own significance for sorting and reducing household waste, they alone cannot give a result. It should be targeted at relevant stakeholders in the context of broader considerations to create a common food waste recycling environment in China.

A. Constantinescu et al. in their work explored the relationship between eco-investment and e-waste. Thus, developed countries such as Sweden, Germany, France and the UK have a higher rate of collection and recycling of e-waste, while less developed countries have a very low rate of e-waste recycling (such as Romania and Cyprus). The authors also argue that increased environmental investment will boost the collection and recycling of e-waste.

Conclusion

Developing a circular economy in Kazakhstan can have many benefits for the country's economy and environment. Measuring progress towards circularity is extremely important and should be supported at the government's level.

This study attempted to analyze the current state of the development of the circular economy in Kazakhstan based on the data from 2015 to 2021. The results show that there has been progress in reducing the volume of municipal solid waste and increasing its processing and recycling rate. Despite the allocation of significant funding for environmental protection in recent years, the regression analysis did not confirm its substantial effect on the reuse and

recycling of waste. It highlights the need for continued efforts to address environmental challenges and ensure an effective waste management system in the country.

The legal framework on waste management in Kazakhstan is relatively comprehensive, but there are still some gaps and challenges that need to be addressed. Improving enforcement mechanisms, providing more specific guidance on waste management practices, and establishing a specific regulatory agency for waste management could help strengthen the legal framework and improve waste management practices in the territory of the Republic of Kazakhstan.

Overall, this study provides valuable insights into the state of circular economy development in Kazakhstan and the factors that influence the level of waste recycling and reuse in the country. These findings can be used to inform future policy and decision-making, and to support the continued growth and development of a sustainable and circular economy in Kazakhstan. The lack of data for some indicators of circularity and the absence of statistics for past years can be indicated as research limitations. Further research can be dedicated to the statistical analysis and comparison of panel data for different regions in the country.

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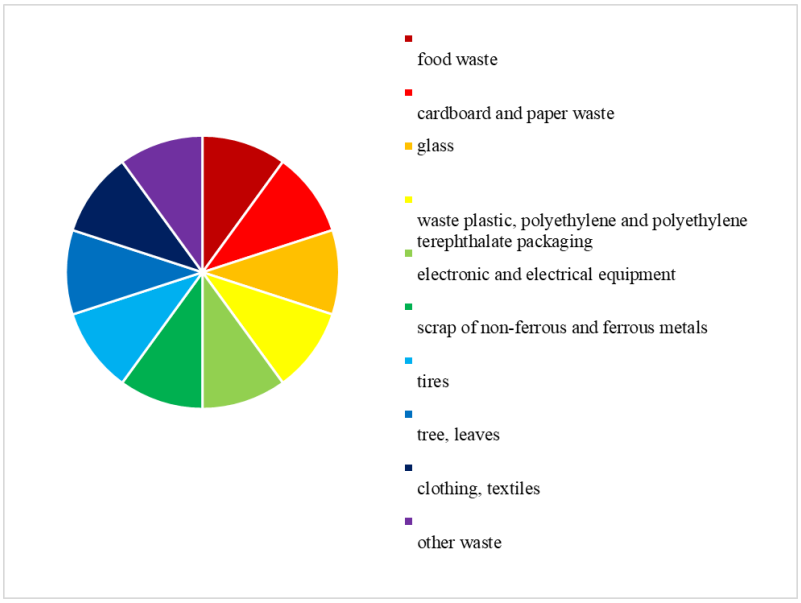
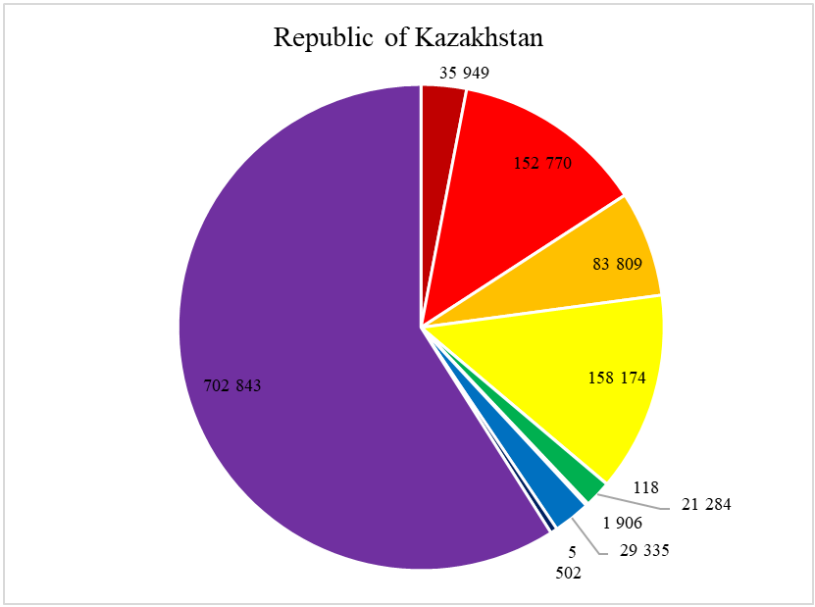
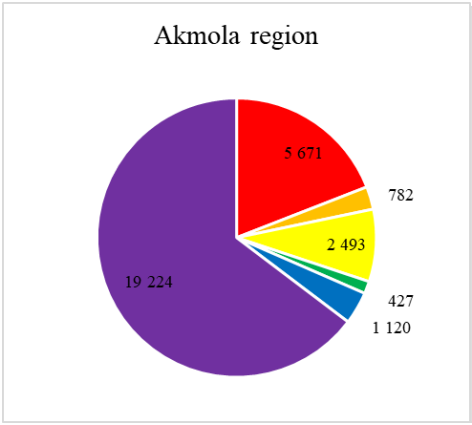
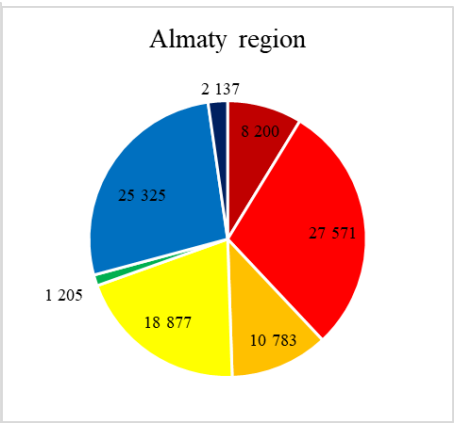
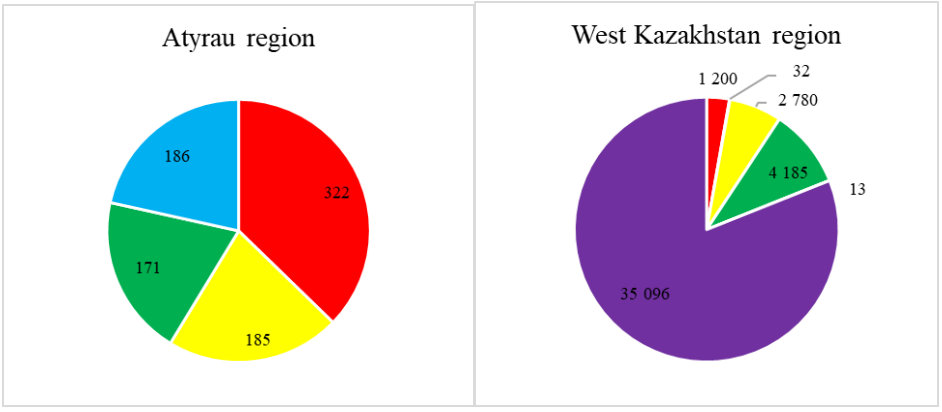
Annex 1 – Total volume of sorted waste by regions of the Republic of Kazakhstan
Diagram interpretations (per tonn):







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West Kazakhstan region
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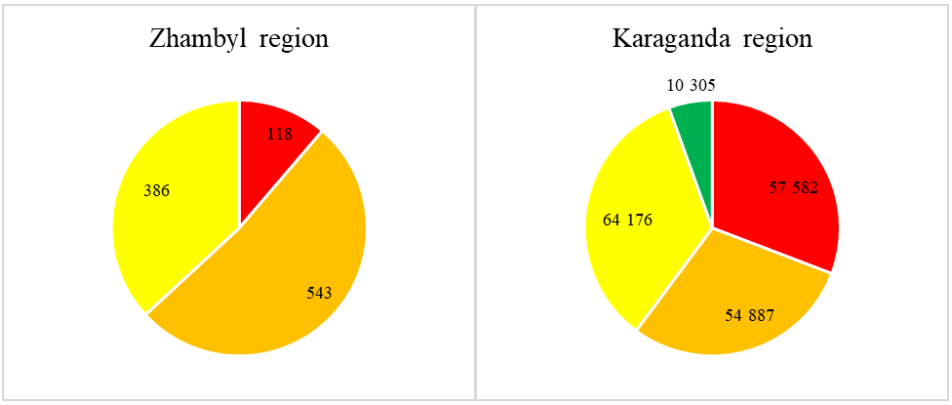
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Karaganda region
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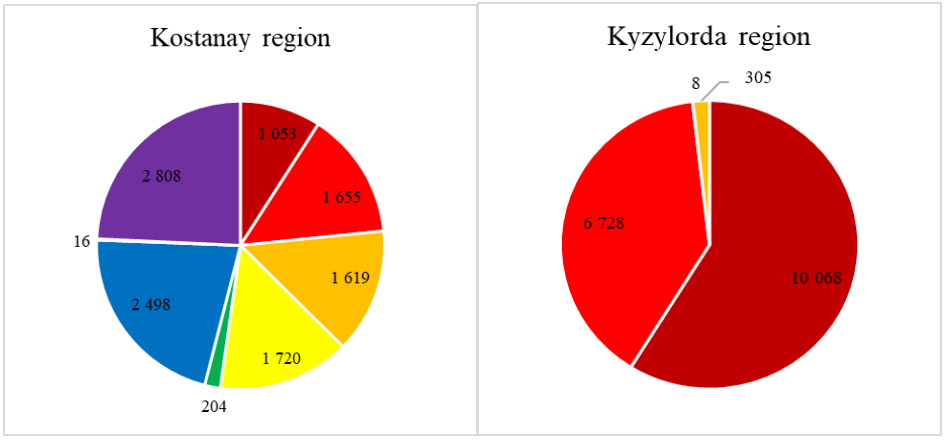
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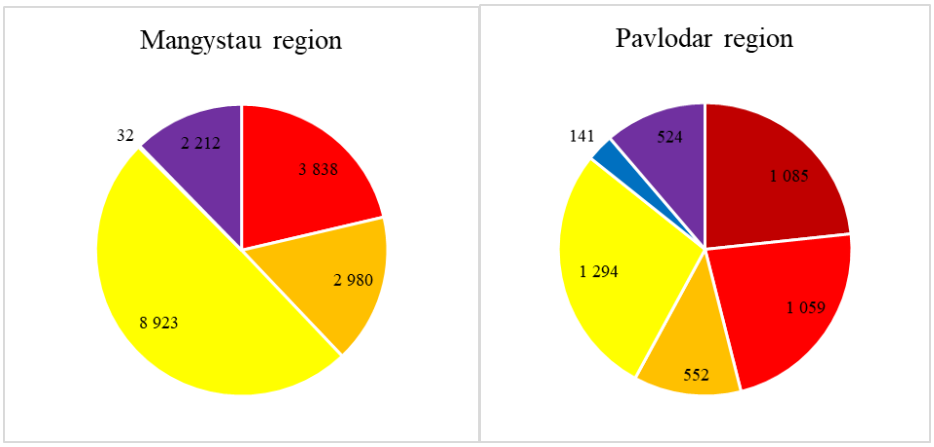
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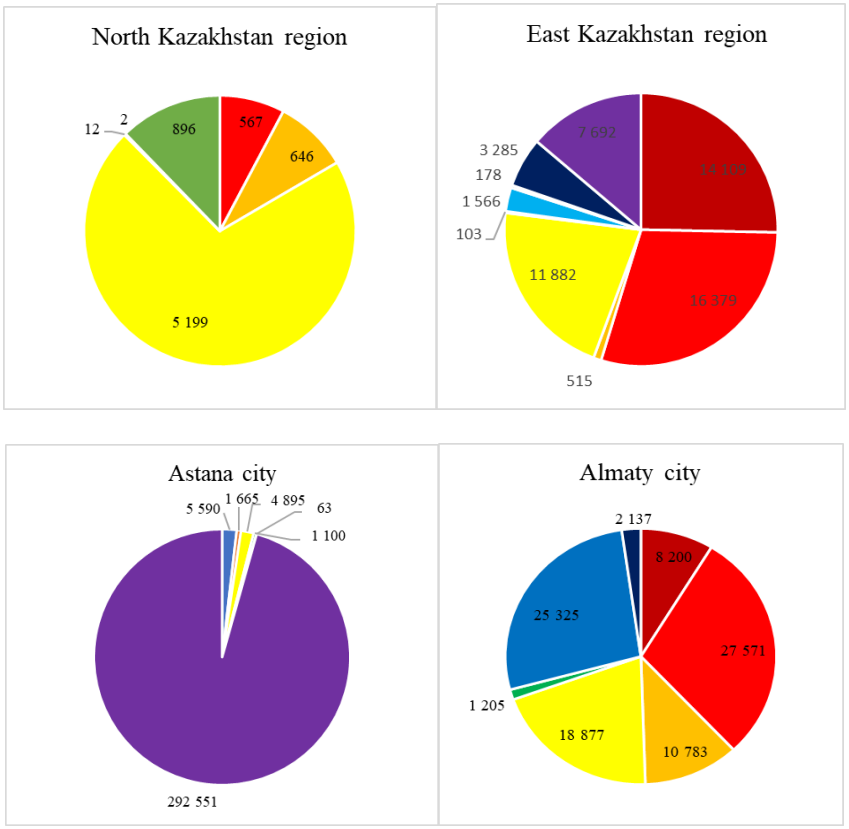

Annex 2 – Total volume of sorted waste by type of waste