Formation of Performance Indicators for Organizations in the Field of Municipal Waste Management in the Context of Regional Sustainable Development

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Abstract
The article presents the developed information-analytical support system for municipal waste management based on the Balanced Scorecard (BSC) concept, allowing for the assessment of ecological, economic, and social effectiveness of waste management in accordance with the strategic objectives of sustainable economic development. The study employed methods including analysis, synthesis, comparison, logical generalization, grouping, analogy-based conclusions, as well as systemic and comprehensive approaches. The municipal waste management system, based on the key performance indicators developed by us, aligns with the target priorities for the development of companies in the municipal waste sector. This enables planning, continuous monitoring, and control over the achievement of objectives in resource conservation, activation of recycling processes, and minimization of the harmful impacts of waste on the environment and society.
Keywords: balanced scorecard system, sustainable development strategy, municipal waste management, accounting for municipal waste, management effectiveness assessment, circular economy

1. Introduction

Due to the depletion of resource potential and the deterioration of the ecological state of the global ecosystem, effective management of secondary resources (waste) has become particularly relevant. This management ensures that companies meet three fundamental components of sustainable development: environmental sustainability, economic feasibility, and social acceptability, as outlined in the UN General Assembly resolution of September 25, 2015, No. 70/1, "Transforming our world: the 2030 Agenda for Sustainable Development."

In recent decades, the Republic of Belarus, like many other countries, has seen a significant increase in the volume of solid municipal waste and an increase in the content of hazardous components in waste that are harmful to health and resistant to decomposition in the natural environment. This is related to radical changes in consumption patterns.

Municipal waste is recognized as waste generated from human activities not related to economic activities, as well as certain production waste included in the list of waste classified as municipal (Ministry of Housing and Communal Services of the Republic of Belarus, 2019). The management of all types of municipal waste falls under the jurisdiction of housing and communal services organizations.

As cities grow and populations increase, waste accumulation is projected to rise by 70% by 2050, reaching an annual total of 3.4 billion tons of waste (World Bank, 2024). In the Republic of Belarus,

approximately 4 million tons of solid municipal waste is generated each year, accounting for more than 6% of the total waste generated in the country. Therefore, issues related to reducing their harmful impact and promoting recycling are addressed at the legislative level in the National Action Plan for the Development of the "Green" Economy of Belarus (Kulbeda-Kamshilova, 2020).

Currently, the issue of municipal waste disposal has become a top priority in Belarus, as a large portion of the country's municipal waste is disposed of in landfills (there are about 156 large landfills and 5 mini-landfills in operation). Plans are in place to transform the existing landfills into 30 regional landfills that comply with environmental safety requirements .

The state policy of the Republic of Belarus in the field of waste management aims not only to reduce harmful impacts but also to promote the use of waste, as municipal waste contains valuable components that can be used as material and energy secondary resources. The Law of the Republic of Belarus dated July 20, 2007, No. 271-Z "On Waste Management" establishes the principle of prioritizing waste utilization over their disposal or landfill.

In the republic, there are eight waste processing plants located in the cities of Brest, Vitebsk, Gomel, Grodno, Mogilev, Minsk, Baranovichi, and Novopolotsk, along with 82 sorting lines. Approximately 1,600 collection points for secondary raw materials operate, and more than 200,000 modern containers have been installed in populated areas across the country. Thanks to the collection of secondary raw materials and the utilization of organic waste, the level of municipal waste utilization in the republic reached 37.9% in 2024 (Semyonkova, 2024). Guided by the National Strategy of the Republic of Belarus for the Management of Solid Municipal Waste and Secondary Material Resources, aimed at minimizing municipal waste disposal, there are plans to increase waste utilization in the country to 90% by 2035.

According to the concept of sustainable development, the waste management system must satisfy three fundamental components: environmental sustainability, economic feasibility, and social acceptability. It should aim to minimize waste generation, maximize recycling, promote reuse, and ensure environmentally safe disposal of waste. In this regard, the purpose of this article is to develop a system for assessing the effectiveness of municipal waste management, which will enable companies to ensure proper management of municipal waste to achieve strategic sustainable development goals. To achieve this, it is necessary to identify the company's target objectives in waste management and, accordingly, improve management practices to attain economic, environmental, and social sustainability. Additionally, a system of indicators should be developed for planning purposes, continuous monitoring, and evaluating the effectiveness of municipal waste management based on operational information.

The term "integrated or comprehensive waste management" was first mentioned in a technical context in the 1970s in the works of scholars Murray R.U., Shivers R.U., and Inglefinger A.L.(Murray, Shivers, Ingelfinger, & Metzger, 1971). The issues of comprehensive sustainable waste management have been addressed by authors such as Van de Klundert A., Anschutz J., Sheinberg A., Wilson D.K., and Rodik L.(Van de Klundert & Anschütz, 2001). Thorpe S.D., Daskalopoulos E., Badr O. and Probert S.D. (Daskalopoulos, Badr, & Probert, 1998), Afzal Hussein Khan, Mufid Sharholi, Pervez Alam (Husain Khan, Sharholy, & Alam, 2022), Ruby Medina-Mihangos, Luis Segui-Amorteghi (Medina-Mijangos & Seguí-Amórtegui, 2020), Wender Freitas Reis, Christian Gomes Barreto, Mauro Guilherme Maidana Capelari (Reis, Barreto, & Capelari, 2023), Muhammad Farook, Tse Cheng, Nur Ullah Khan (Farooq, Cheng, Khan, & Saufi, 2022), Neama Derhab, Zakaria Elkhwesky (Derhab & Elkhwesky, 2023), Florence Barbara Awino, Sabine E. Apitz (Awino & Apitz, 2023) studied the circular economy, analyzed waste indicators and waste management, analyzed the costs associated with waste management. The challenges of establishing a waste management system for industrial waste within the context of a circular (zero-waste) economy and its inclusion in accounting and financial reporting systems have become the focus of research for many foreign and domestic authors, including S.G. Vegera, E.B. Maley, I.I. Sapeha, O.A. Sushko (Vegera, Malei, Sapeha, & Sushko, 2018), Sara Corrado,Carla Caldeira ,Mattias Eriksson (Corrado, Caldeira, Eriksson, & others, 2019), Di Vaio A., Hasan S., Palladino (Di Vaio, Hasan, & Palladino, 2023), Almasyhari A. K., Rachmadani W. S., Priatnasari, Y (Almasyhari, Rachmadani, & Priatnasari, 2024), Sri Wahjuni Latifah, Noorlailie Soewarno (Latifah & Soewarno, 2023), O. Vysochan, V. Hyk (Vysochan, Hyk,

O. Vysochan, & Yasinska, 2024), Ralp Adler, Mansi Mansi, Rakesh Pandey (Adler, Mansi, & Pandey, 2021) and others.

In examining the problems of waste accumulation, scholars continue to refine management methods, emphasizing comprehensive management. Consequently, several approaches to waste management have emerged in the scientific literature: those based on the assessment of economic efficiency; eco-economic effects; and comprehensive sustainable management across multiple parameters (political, institutional, social, financial, economic, and technical).

Authors such as V.V. Buzirev, N.V. Vasilieva, V.F. Martynov, A.N. Ryakhovskaya, A.K. Shreiber, A.N. Kirillova, P.V. Nemkin, V.S. Chekalin (Buzyrev et al., 2016; Nemkin & Chekalin, 2017; Ryakhovskaya et al., 2019)], and others pay attention to the analysis of the activities of housing and communal services organizations. However, the issues of assessing the effectiveness of municipal waste management in housing and communal services considering the concept of sustainable development have not been addressed by these authors

Currently, municipal waste management is based on isolated economic or environmental performance indicators. However, considering the concept of sustainable development and international standards such as ISO 14000, it is important to emphasize the need to minimize municipal waste generation through the implementation of zero-waste production technologies, the activation of recycling, reuse, disposal, and landfilling practices, taking into account the harmonization of environmental, economic, and social components.

Thus, the existing municipal waste management system has several shortcomings:

1. It is based on indicators calculated for the organization as a whole, without detailing the stages of the municipal waste life cycle. This prevents the effective assessment of environmental protection measures and the achievement of target indicators for waste management from the moment of generation to disposal, whereas the EU waste management strategy implies an analysis of the entire life cycle (the "cradle-to-grave" concept).

2. It does not consider data on municipal waste in monetary terms or the actual costs incurred by the organization at each stage of the life cycle, which are necessary for assessing the economic potential of the organization in waste management, due to the lack of an appropriate information base.

3. It is not aligned with the strategic development goals of the company.

In this regard, a highly relevant and practically significant issue is the development of informational and analytical support for the municipal waste management system at all stages of its life cycle. This support would contribute to increasing the economic efficiency of housing and communal services organizations, reducing the environmental burden on the ecosystem, and enhancing social responsibility towards personnel and society.

2. Results

The European Union Directive "2008/98/EC on Waste and Repealing Certain Directives" (Directive 2008/98/EC, 2008) outlines the following possible stages of municipal waste management — from the most prioritized methods in terms of environmental safety to the least prioritized: from waste prevention, waste reduction (minimization), to reuse and recycling of waste, utilizing waste for energy recovery, to waste incineration without energy recovery and waste landfilling.

In the legislation of the Republic of Belarus, the prevention and reduction of waste generation is not fully regulated. Measures to facilitate this should be implemented at the design stage of products (packaging) as well as during the production of goods and construction of facilities. The country has adopted a number of legislative acts aimed at reducing the generation of the most problematic waste, such as plastic packaging and single-use dishes. Used glass packaging is collected, cleaned, and reused for bottling beverages. Waste paper and cardboard (waste paper), glass, plastic, worn-out tires, and used oils are sent for recycling. The process of disposing of mercury-containing lamps, thermometers, and other mercury-filled devices has also been established. Hazardous components are sent for safe disposal at municipal waste landfills. In Belarus, there are specific examples of using solid municipal waste for energy recovery. For instance, waste from worn-out tires is partially used as fuel in cement plants. Additionally, landfill gas is extracted from municipal waste landfills to generate energy.

Clearly, achieving the presented sustainable development goals in the field of municipal waste management is only possible through continuous monitoring of organizational activities by developing a system of indicators that define the economic, environmental, and social effectiveness of waste management from the moment of generation to the point of disposal (landfilling). The most well-known tool for measuring the effectiveness of a company's operations in achieving strategic management goals is the Balanced Scorecard (BSC), developed by R. Kaplan and D. Norton in the early 1990s (Kaplan & Norton, 1996). The Balanced Scorecard is a management concept for implementing strategy that ensures targeted monitoring of enterprise activities, allowing for the forecasting and preemptive identification of problems. It seamlessly integrates strategic and operational management levels while controlling the most significant financial and non-financial performance indicators of the enterprise. Significant contributions to the development of scientific and practical approaches for assessing the effectiveness of enterprises using the Balanced Scorecard have been made by authors such as L.R. Batukova, T.L. Bezrukova, I.D. Bunimovich, N.A. Kalmakova, T.V. Krasheninnikova, A. Tawse, P. Tabesh (Tawse & Tabesh, 2023), S. Kumar, W. M. Lim, R. Sureka(Kumar et al., 2024), Hristov, I., Cristofaro, M. (Hristov et al., 2024) and others.

The main feature of the Balanced Scorecard is that it directs company management towards sustainable strategic development, in contrast to traditional management, which tends to be overly focused on financial metrics. The Balanced Scorecard can be tailored for specific organizations and should be developed considering production conditions and strategic objectives. Accordingly, the indicators for assessing a company's effectiveness included in the Balanced Scorecard depend on its target objectives.

To date, there is no Balanced Scorecard system developed specifically for municipal waste management. In the article (Vegera, Malei, Afanasyeva & Sushko, 2024), the authors developed a Balanced Scorecard system for managing industrial waste; however, the analysis of municipal waste management has its own specifics. In our opinion, it is necessary to create a waste management system based on the BSC concept and the strategic goals of the company to achieve economic, environmental, and social sustainability throughout the life cycle of municipal waste. This, in turn, would link potential changes in environmental and social burdens to the company's economic activities, enhance the organization's image regarding corporate social responsibility and the principles of "green economy," and increase the company's competitiveness on an international level in accordance with the concept of sustainable development.

The foundation for developing a sound methodology for municipal waste management is a reliable information base, which should be continuously accessible for operational management purposes. The primary database for municipal waste management should be the accounting system. Although the entities managing municipal waste include legal persons, individual entrepreneurs (as waste producers), legal entities servicing residential buildings, property owners transferring buildings and other facilities for use, and citizens (individuals who are not individual entrepreneurs), the necessary information base in the accounting system and document flow for municipal waste is formed only by legal entities. Therefore, the methodology for assessing the efficiency of municipal waste management will be developed only for legal entities involved in the life cycle processes of municipal waste.

However, at the current stage, the existing accounting system for legal entities regarding municipal waste is insufficiently informative to ensure a comprehensive and thorough assessment of effectiveness. This lack of informativeness from organizations leads to a decrease in their investment attractiveness, which somewhat hinders the development of a circular economy. In this regard, we propose the following innovations:

1. After studying various approaches to identifying the stages of the waste life cycle in the Republic of Belarus, the Russian Federation, European Union countries, and the United States of America, we suggest considering the life cycle of municipal waste for building an accounting system, analysis, and management of municipal waste consisting of the following stages:

Generation of municipal waste (formation of municipal waste during human activities not related to economic activity, waste generated in consumer cooperatives and gardening associations, waste produced by legal entities and individual entrepreneurs during economic activities, identification of waste types, classification and coding, sorting of municipal waste)

-Collection and/or accumulation of municipal waste (activities aimed at concentrating municipal waste at temporary storage sites)

-Recycling of municipal waste (preparation for the use of municipal waste, storage of municipal waste)

-Disposal (destruction) of municipal waste (incineration without energy recovery, landfilling, and using municipal waste for energy recovery).

2. To reflect the connection between the indicators of municipal waste utilization and the performance indicators of the enterprise, it is proposed to organize analytical accounting of municipal waste on the balance sheet of legal entities involved in the life cycle processes of municipal waste, with a division into the following management objects:

- The volume of municipal waste in physical terms and at fair value by types, hazard classes, and locations of collection, accumulation, recycling, and disposal;
- Actual costs for the collection, accumulation, recycling, and disposal of municipal waste;
- Revenue from the sale (recycling) of municipal waste by types, hazard classes, and accumulation locations.

Special attention should be given to the organization of accounting for entities that carry out the disposal of municipal waste and extract landfill gas from the landfill body. Various users of the accounting information from these organizations are interested in data about the economic potential of the landfill. However, currently, in the accounting and financial reporting of organizations involved in municipal waste disposal, data on the incoming organic municipal waste (as a resource in the production process), as well as the formed stocks of organic matter and landfill gas within the landfill, are not recorded. As a result, this distorts the cost indicators of the produced energy, the organization's income, and the financial results generated.

Based on the studied principles of ecological-economic waste accounting, approaches to financial reporting according to GRI (Global Reporting Initiative) standards, and the requirements of the international system of national accounts, as well as relying on researched definitions of concepts such as "organic waste," "municipal waste," and "biomass" by both foreign and domestic authors, new accounting objects have been identified for organizations operating landfills(Malei & Trubovich, 2024):

- "Biomass of municipal waste," which represents organic substances (resources) within municipal waste that possess energy potential, transforming under natural processes from a material-state heterogeneous form to a gaseous state, subsequently suitable for use in energy production (waste from parks, squares, and yards of plant origin, as well as consumption and production waste, predominantly food waste);
- "Gaseous resource produced from the biomass of municipal waste" - a short-term asset within the "Materials" account, reflecting the transformation of biomass from solid to gaseous state and showing the energy potential of the landfill.

Alongside the recognition of the gaseous resource produced from the biomass of municipal waste, it is necessary to account for a long-term asset, "renewable gaseous resource," which reflects the stocks of biogas within mineral resources and possesses energy potential that is maintained over a long period and is renewed as biomass of municipal waste is landfilled.

The introduction of new accounting objects allows for the formation of an information base regarding the energy potential of municipal waste in organizations that carry out disposal and extraction of landfill gas. Recording in accounting the information about the incoming stocks of biomass of municipal waste within the landfill and its energy potential for energy production will provide stakeholders with the necessary information to assess the economic potential of the landfill; account for the residual value of organic waste (in the substance transformation chain "product - waste - secondary resource") in energy production; and analyze the utilization level of the secondary resource in the overall cost of energy resources in the region, area, or republic.

Since the market for the organic fraction of municipal solid waste (MSW) is not developed in domestic practice, it seems appropriate to consider the value of biomass from municipal waste, referring to its qualitative characteristics (energy potential) and the fair value of an identical (comparable) resource in another market. The value of biomass is determined by its energy potential in the production of combustible substances, characterized by the volume of biogas produced and its methane content. Cow manure produces biogas at a yield of 0.34 m^3 per 1 kg of raw material and contains 65% methane (Malei & Trubovich, 2024). The yield of biogas from municipal waste exceeds that from cow manure by 0.06 m^3 per 1 kg of raw material, with the same methane content.

In this regard, we propose to determine the fair value of biomass from municipal waste based on the current market price of a benchmark raw material (manure), adjusted for the methane content percentage in the biomass of municipal waste and in the "benchmark" resource. The gaseous resource produced from the biomass of municipal waste is assessed based on expert evaluations of the established biogas reserves within the landfill at the fair value of decomposed biomass. The renewable gaseous resource is suggested to be evaluated at fair value, based on the market price of the "benchmark" resource (natural gas), adjusted for the methane content percentage in the biomass of municipal waste and in the "benchmark" resource.

Reflecting municipal waste at various stages of its life cycle in both physical indicators and fair value will contribute to assessing the economic potential of municipal waste and reducing environmental damage risks. Separate accounting for actual costs related to the collection, accumulation, recycling, and disposal of municipal waste, as well as revenues from the sale and use of municipal waste, will enhance the evaluation of the effectiveness of waste management activities. Furthermore, this will ensure integration with the national accounting system, allowing for accurate statistical analysis of environmental protection expenditures in key sectors of the economy.

The recommended changes in accounting practices will establish an information base for developing a system of indicators to assess the ecological, economic, and social effectiveness of municipal waste management in line with the strategic objectives of economic entities.

Based on the improvement of the information base for municipal waste management, we have identified management objects for the waste management process at each stage of the municipal waste life cycle and developed strategic goals for the company in the field of waste management, which should serve as the foundation for a balanced scorecard system (Table 1).

Thus, at each stage of waste management, the organization should strive to achieve the defined strategic goals in ecological, economic, and social directions. Therefore, for the purposes of municipal waste management, it is necessary to develop indicators that allow for setting target quantitative and qualitative benchmarks and planning activities related to waste management throughout the life cycle. Ultimately, this will help determine the effectiveness of the implemented measures.

The evaluation of waste management effectiveness should consider both the specifics of the life cycle and the management's efforts to implement measures aimed at achieving strategic sustainable development goals. In support of this, the ISO 14031 standard for assessing environmental performance highlights two groups of indicators: 1) Management Performance Indicators: Provide information about the management actions taken to impact the organization's environmental performance; 2) Operational Performance Indicators: Inform about the environmental performance of the organization based on the specifics of the production process.

This approach can be used to assess not only the ecological but also the economic and social effectiveness of municipal waste management. The social effect is manifested in the reduction of disease incidence among the population due to the harmful effects of waste, as well as improvements in working and resting conditions for personnel involved in waste collection, accumulation, recycling, and disposal, which do not have a monetary form. The economic effectiveness of municipal waste management is determined by the full utilization of resources through the development of recycling processes, reduction of actual costs related to waste management, and generation of additional income from waste sales and gas recovery at landfill sites.

Table 1. – The connection between municipal waste management objects and the strategic goals of sustainable development of the organization within the life cycle framework

Stage of the Life Cycle of Municipal Waste	Stage I: Generation of Municipal Waste	Stage II: Collection and/or Accumulation of Municipal Waste	Stage III: Recycling of Municipal Waste	Stage IV: Disposal (Destruction) of Municipal Waste, Including Waste Utilization for Energy Recovery
Management Object	– Volume of Municipal Waste in Physical Terms (by types, hazard classes, and sources) – Volume of Municipal Waste in Monetary Terms (fair value) (by types, hazard classes, and sources)	- Volume of Municipal Waste in Physical Terms (by types, hazard classes, and collection/accumulation points) - Volume of Municipal Waste in Monetary Terms (fair value) (by types, hazard classes, and collection/accumulation points)	– Volume of Municipal Waste Subject to Recycling in Physical Terms (by types, hazard classes, and recycling locations) – Volume of Municipal Waste in Monetary Terms (fair value) (by types, hazard classes, and recycling locations)	– Biomass of Municipal Waste for Disposal (Destruction) in Physical Terms (by disposal locations) – Biomass of Municipal Waste for Disposal (Destruction) in Monetary Terms (fair value) (by disposal locations))
	-Actual Costs Related to the Generation of Municipal Waste	-Actual Costs Related to the Collection and Accumulation of Municipal Waste (by types, hazard classes, and accumulation points)	-Actual Costs Related to the Recycling of Municipal Waste (by types, hazard classes, and recycling locations)	- Actual Costs Related to the Disposal of Municipal Waste (by disposal locations) - Actual Costs Related to the Use of Disposed Biomass from Municipal Waste (by disposal locations)
	-	-Revenue from the Sale of Municipal Waste (by types, hazard classes, and accumulation points)	-Revenue from the Recycling of Municipal Waste (by types, hazard classes, and recycling locations)	-Revenue from the Use of Biomass from Municipal Waste (by disposal locations)
	-	-	-	- Gaseous Resource Produced from Biomass of Municipal Waste in Physical Terms (by disposal locations) - Gaseous Resource Produced from Biomass of Municipal Waste in Monetary Terms (by disposal locations)

				- Renewable Gaseous Resource in Physical Terms (by disposal locations) - Renewable Gaseous Resource in Monetary Terms (Fair Value) (by disposal locations)
Strategic Goals of Municipal Waste Management, including:	Reduction of Waste Volume Generated by All Types, Hazard Classes, and Points of Origin	- Reduction of Accumulated Municipal Waste Volume by All Types and Accumulation Locations -Increase in the Share of Municipal Waste Sold Externally by All Types and Hazard Classes	Increase in the Volume of Waste Involved in Secondary Circulation by All Types, Hazard Classes, and Recycling Locations	-Reduction of Waste Volume for Landfilling (Disposal) by All Types and Hazard Classes -Increase in the Volume of Landfilled Waste Used for Producing Gaseous Resources by All Types and Hazard Classes
Environmental	Reduction of Environmental Damage from Waste of Hazard Classes I-IV			
Economic	Savings of Material Resources	-Reduction of Actual Costs for Waste Collection and Accumulation - Gaining Additional Benefits from Waste Sales	- Reduction of Actual Costs for Waste Collection and Accumulation -Generation of Additional Benefits from Waste Sale	- Reduction of Environmental Tax - Gaining Economic Benefits from Using Waste for Energy Recovery
Social	Reduction of Harmful Effects of Generated Waste on Personnel and Society			

Note- own development

After studying the existing approaches to waste management, we have developed a comprehensive system of ecological, economic, and social indicators (coefficients) to assess the effectiveness of municipal waste management within the context of the waste life cycle stages. This system will allow us to determine the degree of achievement of the organization's strategic sustainable development goals (see Table 2).

The proposed methodology is based on a multidimensional comparative analysis. For an overall assessment of the effectiveness of municipal waste management, we suggest calculating a composite index based on the calculation of indices for each type of indicator from Table 2: social, economic, and ecological. When calculating each component of the composite effectiveness index, it is essential first to establish the minimum and maximum values of the indicators (coefficients) based on the standards of the housing and communal services sector, against which actual results will be compared.

The methodology for determining the composite effectiveness index is presented in Table 3.

Table 3. - Methodology for Determining the Composite Effectiveness Index for Municipal Waste Management

Analysis Stage	Calculation Formula	Explanation
Calculation of effectiveness indices for municipal waste management for each indicator (coefficient) to convert them to relative values and a unified measurement scale.		
-If the improvement in the dynamics of the analyzed indicator is expressed in its growth.	$I_i = \frac{F_i - min_i}{max_i - min_i}$	Where: *Ii* – index for a specific indicator (coefficient); *Fi* – actual value of the indicator (coefficient); *mini* – minimum value of the indicator (coefficient); *maxi* – maximum value of the indicator (coefficient).
-If the improvement in the analyzed indicator is expressed in its reduction	$I_i = \frac{max_i - F_i}{max_i - min_i}$	

Calculation of social (*Is*), economic (*Ie*), and environmental (*Iec*) effectiveness indices for municipal waste management.	$I_x = \sum I_i$	где: I_i– index for a specific indicator (coefficient) of environmental, economic, or social direction; I_x– index of environmental (economic, social) effectiveness for municipal waste management.
Comparison of social, economic, and environmental effectiveness indices to determine which direction is developing more effectively: -If the environmental effectiveness index is higher, then waste management is aimed at implementing the principles of a green economy, even with a low economic effect; -If the economic effectiveness index is higher, the organization pays more attention to the efficient use of resources, etc.		
Calculation of the composite index of effectiveness in municipal waste management (*Iy*) as a summary indicator using the geometric mean of the social, economic, and environmental effectiveness indices.	$I_y = \sqrt[3]{I_{ec} \times I_e \times I_s}$	где: I_{ec}– Index of environmental effectiveness in municipal waste management I_e– Index of economic effectiveness in municipal waste management I_s- Index of social effectiveness in municipal waste management.

Note- own development

The composite index of effectiveness in municipal waste management will capture the level of efficiency of an organization's waste management practices and can be used to compare the activities of different organizations in the housing and communal services sector, operating under various conditions and performing their tasks differently.

Table 2. – Proposed system of indicators for assessing the effectiveness of municipal waste management in an organization.

Type of indicators	Indicator	Formula	Characteristic
1) Indicators of the effectiveness of the organization's functioning in the field of municipal waste management			
ENVIRONMENTAL	Indicators of the dynamics of waste generation (recycling, disposal) of municipal solid waste (by types of waste, by hazard classes of waste, by locations of occurrence), in natural terms: -Growth coefficient (Cg MWi) -Increase coefficient (ΔCg MWi)	$Cg\ MWi = MWi_1 / MWi_0$ $\Delta Cg\ MWi = Cg\ MWi - 1$ MWi_1 – Volume of municipal solid waste in natural terms during the reporting period at the stage of generation (recycling, disposal) (by types of waste, by hazard classes of waste, by locations of occurrence). MWi_0 - Volume of municipal solid waste in natural terms during the base period at the stage of generation (recycling, disposal) (by types of waste, by hazard classes of waste, by locations of occurrence).	Reflect changes in the volumes of municipal solid waste in natural terms during the reporting period compared to the base period at various stages of the waste life cycle (generation, recycling, disposal). This is conducted by types of waste, by hazard classes of waste, and by locations of occurrence. If waste is accounted for in different natural indicators (pieces, tons, cubic meters, etc.), the analysis of dynamics as a whole across the life cycle stage (location, organization) is only possible in natural mass units. An increase in dynamic indicators of municipal solid waste in natural terms at the generation or disposal stage reflects a decrease in the efficiency of waste management processes. Conversely, an increase in dynamic indicators at the recycling stage reflects an improvement

			in the efficiency of waste management processes.
	Indicators of the structure of generation, use, treatment, and disposal of municipal solid waste (by types of waste, hazard classes of waste, locations of occurrence), in natural terms: -Share of waste type i (hazard class, location of occurrence) (d MWi); -Structural shifts of waste type i (hazard class, location of occurrence) (Δd MW)	d MWi = MWi / MW Where: MWi - volume of municipal solid waste at the generation (recycling, disposal) stage of type *i* (hazard class, location of occurrence) in natural terms; MW - total volume of municipal solid waste at the generation (recycling, disposal) stage in natural terms. $\Delta d\ MW = d\ MW_1 - d\ MW_0$ Where: $d\ MW_1$ - share of waste type *i* (hazard class, location of occurrence) at the stages of generation (recycling, disposal) in the reporting period; $d\ MW_0$ - share of waste type *i* (hazard class, location of occurrence) at the stages of generation (recycling, disposal) in the base period.	Reflect the structure and changes in the structure of municipal solid waste production in natural terms at various stages of the waste life cycle (generation, recycling, disposal). This is conducted by types of waste, by hazard classes of waste, and by locations of occurrence. An increase in the share of waste of hazard classes I-IV leads to a decrease in the ecological efficiency of municipal waste management.
	Share of utilized (treated, disposed of) municipal solid waste in the total amount of generated municipal solid waste (d MWy)	$d\ MW_y = MW_y / MW$ MWy - volume of utilized (treated, disposed of) municipal solid waste in natural terms; MW - volume of generated municipal solid waste in natural terms.	Reflects what portion of municipal solid waste in natural terms is utilized (treated, disposed of) from the total volume of waste. An increase in the share of waste utilization (treatment) indicates an improvement in the ecological efficiency of public utility organizations. Conversely, an increase in the share of waste disposal indicates a decrease in the ecological efficiency of public utility organizations.
	Recovery coefficient of municipal solid waste (d MWi y)	$d\ MWi\ y = MWi_{y} / MWi_{y-1}$ MWi y - volume of municipal solid waste of type *i* (hazard class, location of occurrence) at the recycling (utilization) stage in natural terms; MWi y-1 - volume of municipal solid waste of type *i* (hazard class, location of occurrence) at the generation stage in natural terms.	Reflects what portion of municipal solid waste in natural terms is reused from the total volume of waste. An increase in this indicator indicates an improvement in production ecological efficiency. The value of the indicator should strive towards one.
	Resource provision (Rg)	$R_g = G / G_d$ G - gaseous resource generated from the biomass of municipal solid waste in natural terms, m^3; Gd - volumes of utilized (extracted) gaseous resource, m^3.	Resource provision characterizes the ratio of renewable gaseous resource reserves to the volumes of their utilization. Calculating resource provision is necessary for long-term forecasting of the use of available resources. The higher the indicator, the longer the duration for which the gaseous resource reserves should last.

	Coefficient of energy value of the landfill (Ce)	$Ce = G / MW_b$ G - gaseous resource generated from the biomass of municipal solid waste in natural terms, m^3; MWb - biomass of municipal solid waste in natural terms, m^3	It reflects the output of gaseous resource in natural terms from 1 m^3 of biomass of municipal solid waste. The higher the indicator, the greater the energy value of the landfill.
ECONOMIC	Indicators of the dynamics of waste generation (recycling, disposal) from production (by types of waste, by hazard classes, by places of origin), in monetary terms: Growth coefficient (Cg MWsi) Increase coefficient (ΔCg MWsi)	$Cg\ MWci = MWci_1 / MWci_0$ $\Delta Cg\ MWci = Cg\ MWci - 1$ $MWsi_1$ – volume of waste in monetary terms in the reporting period at the stage of generation (recycling) (by types of waste, by hazard classes, by places of origin). $MWsi_0$ – volume of waste in monetary terms in the baseline period at the stage of generation (recycling) (by types of waste, by hazard classes, by places of origin).	They reflect changes in waste volumes in monetary terms in the reporting period compared to the baseline period at various stages of the waste life cycle (generation, recycling). This is conducted by types of waste, by hazard classes, and by places of origin. The monetary valuation of waste is established at current market prices. At the disposal stage, the biomass of municipal solid waste is valued at fair market value. An increase in waste dynamics indicators in monetary terms at the generation stage reflects a decrease in the efficiency of production processes. An increase in waste dynamics indicators in monetary terms at the recycling stage reflects an improvement in waste management efficiency.
	Indicators of the structure of waste generation, utilization, treatment, and disposal (by types of waste, by hazard classes, by places of origin), in monetary terms: Share of waste in monetary terms of type *i* (hazard class, place of origin) (d MWsi) Structural shifts of waste of type *i* (hazard class, place of origin) (Δd W)	$d\ MWc_i = MWc_i / MWc \cdot 100$ MWsi - volume of waste in monetary terms at the generation (recycling) stage of type i (hazard class, place of origin). MWs - total volume of waste in monetary terms at the generation (recycling) stage. $\Delta d\ MW = d\ MW_1 - d\ MW_0$ $d\ MW_1$ - share of production waste of type i (hazard class, place of origin) at the stages of generation (recycling) in the reporting period. $d\ MW_0$ - share of production waste of type i (hazard class, place of origin) at the stages of generation (recycling) in the baseline period.	They reflect the structure and changes in the structure of waste in monetary terms at various stages of the waste life cycle (generation, recycling). This is conducted by types of waste, by hazard classes, and by places of origin. An increase in the share of waste of type i at the generation stage indicates a decrease in the effectiveness of waste reduction policies. An increase in the share of waste of type i at the recycling stage indicates an improvement in the effectiveness of waste reuse policies.
	Share of municipal solid waste in monetary terms (by types of MSW, by hazard classes of MSW, by places of origin) that is being recycled, in the volume of generated MSW (d MWsi y)	$d\ Wci\ y = MWci_y / MWci_{y-1}$ $MWsi_y$ - volume of municipal solid waste (MSW) in monetary terms of type i (hazard class, place of origin) at the recycling stage of MSW. $MWsi_{y-1}$ - volume of municipal solid waste (MSW) in monetary terms of type i (hazard class, place of origin) at the generation stage of MSW.	It reflects what portion of municipal solid waste in monetary terms is being reused from the total volume of MSW. An increase in this indicator indicates an improvement in economic efficiency of production. The value of the indicator should aim to approach one.
	Waste intensity (MWEi)	$MWE_i = MWc_i / Vi$ MW*ci* - volume of municipal solid waste in monetary terms at the generation stage of type i (hazard class, place of origin), in rubles.	It reflects how many rubles of municipal solid waste (MSW) are generated per 1 ruble of services provided (or work performed) that resulted in waste. An increase in this indicator signifies a decrease in the economic efficiency

		Vi - volume of product output in monetary terms from which waste of type i (hazard class, place of origin) is generated, in rubles.	of production processes in the housing and utilities sector.
	The share of municipal solid waste (MSW) in material costs (d wmi)	d wmi = MWci / M Wsi - volume of municipal solid waste (MSW) in monetary terms at the generation stage of type i (hazard class, place of origin), in rubles. M - cost of materials used in the production of goods that generate waste.	It reflects how many rubles of municipal solid waste are generated per 1 ruble of material costs. This indicates the efficiency of material resource usage. The higher the share of MSW, the lower the efficiency of material resource utilization.
	Coefficient of economic value of the landfill (Ec)	$Ec = G / MW_b$ G- renewable gaseous resource in monetary terms. W_b - biomass of municipal waste in natural terms, in cubic meters (m^3).	It reflects the output of gaseous resources at market prices from 1 m^3 of biomass of municipal waste. The higher the indicator, the greater the economic value of the landfill.
SOCIAL	Harm coefficient for personnel (d w / sw)	d w / sw = ∑(ki*MWj)/ Sw ki – concentration of the i-th harmful substance in 1 ton of j-th generated municipal waste of hazard classes I-IV, kg/ton MWj – total mass of j-th generated municipal waste of hazard classes I-IV, tons Sw – number of workers directly involved in waste management, persons	It reflects the mass of harmful substances attributed to one worker. An increase in this indicator signifies a rise in harmful impact on the personnel of the enterprise and a decrease in the social efficiency of waste management.
	Coefficient of harmful impact of municipal waste on society (d w/s)	d w/s = MWv / S MW_v – volume of municipal waste of hazard classes I-IV to be landfilled, tons S – population of the city (country, region) according to statistical data, persons	It reflects the volume of harmful municipal waste to be landfilled per resident of the region. An increase in this indicator signifies a rise in harmful impact on society and a decrease in the efficiency of municipal waste utilization.
2) Indicators of management efficiency in waste management			
ENVIRONMENTAL	Percentage of compliance with the plan (norm) for the volume of generated (used, realized, landfilled) municipal waste (Pl)	Pl =MWif / MWi pl *100 % MWif – actual volume of municipal waste in physical terms at the stage of generation (use, realization, landfilling) (by types of municipal waste, by hazard classes, by sources of generation). MW_{ipl} – planned (normative) volume of municipal waste in physical terms at the stage of generation (use, realization, landfilling) (by types of municipal waste, by hazard classes, by sources of generation).	Waste management will be effective if the percentage of compliance with the plan does not exceed 100% for the volume of generated and landfilled municipal waste, and is achieved at 100% for the volume of used and realized municipal waste.
	Percentage of compliance with the plan (norm) for the volume of landfill gas extracted (Plg)	Plg =MWgf / MWg pl *100 % MWgf – actual volume of extracted gaseous resource in physical terms (by sources of generation). $MW_{(g)pl}$ – planned (normative) volume of gaseous resource in physical terms (by sources of generation).	Waste management will be effective if the percentage of compliance with the plan is achieved at 100% for the volume of extracted gaseous resource.

	Share of the organization's divisions that have achieved compliance with the established environmental targets and planned indicators for the generation (collection, realization, recycling, landfilling) of municipal waste.	$d_j = N_j / N$ Nj – Number of the organization's divisions that have achieved compliance with the established environmental targets and planned indicators for the j-th stage of the waste management life cycle. N – total number of the organization's divisions where municipal waste is generated.	The value of the indicator in effective management should approach 1.
	Activity coefficient of the organization in managing industrial waste. (d Cmw)	d Cmw = Cmw / C Cmw Total costs for managing municipal waste, rub. C – total expenses of the organization for environmental protection, rub	Reflects what portion of environmental expenses is made up of costs for managing municipal waste. An increase in the indicator indicates enhanced activities in waste management. .
	Effectiveness of implementing environmental protection measures aimed at preventing pollution from waste. (E)	E=Ef / Cw , Ef – Annual effect from the management of industrial waste production, RUB. Cw – total costs for waste management, RUB.	The higher this indicator, the more effective the environmental protection measures were in preventing (reducing) pollution from municipal waste. The annual economic damage (Ef) from managing municipal waste is the change in the amount of the environmental tax influenced by the damage caused. If the environmental tax rate changes, the impact of this factor should be eliminated. If the environmental tax has increased, the effect of waste management is negative. Revenues from recycling municipal solid waste can be determined by the monetary valuation of the products obtained from recycling.
ECONOMIC	Indicators of the dynamics of waste management costs (by types of municipal solid waste, by hazard classes, by stages of management): -Absolute deviation, RUB (ΔCmw) -Growth coefficient (Cg Cmw) -Increase coefficient (ΔCg Cmw))	$\Delta Cmw = Cmw_1 - Cw_0$ $Cg\ Cmw = Cmw_1 / Cw_0$ $\Delta Cg\ Cmw = Cg\ Cmw - 1$ Cmw_1 – Total costs for waste management in the reporting period (by types of municipal solid waste, by hazard classes, by stages of management), RUB. Cmw_0 - total costs for waste management in the base period (by types of municipal solid waste, by hazard classes, by stages of management), RUB.	Reflect changes in the volume of waste management costs in the reporting period compared to the base period. This is conducted overall for the organization, by stages of the municipal solid waste life cycle (collection, recycling, disposal), by types of municipal solid waste, by hazard classes, and by cost locations. An increase in costs for managing industrial waste at the stages of generation, collection, and disposal indicates a deterioration in the effectiveness of waste management. An increase in costs for managing industrial waste at the recycling stage indicates enhanced activity in the recycling of municipal solid waste.
	Indicators of the structure of waste management costs (by types of municipal solid waste, by hazard classes,	$d\ Cmw_i = Cmw_i / C$ Cmw_i Total costs for waste management (by types of costs) for the i-th type of municipal	Reflects the structure and changes in the structure of waste management costs. This is conducted overall for the organization, by stages of the municipal solid waste life cycle (collection, recycling, disposal), by types of

	by stages of management): -Share of costs (by types of costs) in total costs for managing industrial waste (d Cwi) -Structural shifts in costs for management (by types of costs) (Δd Cmwi)	solid waste (hazard class, stage of management), RUB. Cmw – total costs for waste management, RUB. $\Delta d\ Cmwi = d\ Cwi_1 - d\ Cwi_0$ $d\ Cmwi_1$ – share of costs for managing waste (by types of costs) for the *i*-th type (hazard class, stage of management) in the reporting period. $d\ Cmwi_0$ - share of costs for managing waste (by types of costs) for the *i*-th type (hazard class, stage of management) in the base period.	municipal solid waste, by hazard classes, by locations of generation, and by types of costs.
	Specific costs for waste management (by types of municipal solid waste, by hazard classes, by locations of generation) (UCmw i)	$UCmw\ i = Cmw\ i / W_i$ Cmwi – Total costs for managing waste of the i-th type (hazard class, location of generation), RUB. MWi – volume of municipal solid waste in physical terms for the i-th type (hazard class, location of generation) at the generation stage.	Reflects the total costs for waste management allocated to a unit of municipal solid waste in physical or monetary terms for the i-th type (hazard class, location of generation) at the generation stage. An increase in this indicator characterizes a rise in the cost of managing a specific i-th type (hazard class, location of generation) and indicates an increase in the intensity of waste operations.
	Cost intensity of municipal solid waste	$Z_i = Cmw_i / MWc_i$ Cwi – Total costs for managing waste of the *i*-th type (hazard class, location of generation), RUB. Wci – volume of municipal solid waste in monetary terms for the *i*-th type (hazard class, location of generation) at the generation stage.	
	Turnover coefficient of municipal solid waste, turnovers (Tri) (Tr_i)	$Tr_i = Rv_i / MWc_i$ Rvi – Revenue from the sale of products obtained from the recycling of municipal solid waste of the i-th type (hazard class, location of generation). MWci – volume of municipal solid waste in monetary terms for the i-th type (hazard class, location of generation) at the generation stage.	Reflects the number of turnovers of municipal solid waste subject to recycling. An increase in this indicator indicates an acceleration of waste management processes.
	Duration of municipal solid waste turnover, days	$Td_i = d / Tr_i$ d - Duration of the analyzed time period, days Tri – turnover coefficient of municipal solid waste, turnovers	Reflects the duration of municipal solid waste turnover in the organization. A decrease in this indicator indicates an acceleration of waste management processes.
	Profitability of secondary use of municipal solid waste (P_r), %	$P_r = P_i / C_i$ P_i - Profit derived from the processing (use) of the i-th type of municipal solid waste; Ci – total actual costs for the processing (use) of the i-th type of municipal solid waste.	Reflects the efficiency of recycling the i-th type of municipal solid waste. The higher the indicator, the more effective it is to subject the i-th type of waste to secondary use. If, as a result of processing, the income from secondary use is lower than the costs of

			processing, then recycling the i-th type of waste is economically unfeasible.
SOCIAL	Percentage of plan execution for the number of activities aimed at protecting personnel from the harmful effects of municipal solid waste.	Pp=Nf / Np *100 % Nf - Number of activities actually implemented to protect personnel from the harmful effects of municipal solid waste Np - Number of planned activities aimed at protecting personnel from the harmful effects of municipal solid waste.	Reflects the execution of the plan for activities aimed at protecting personnel from the harmful effects of municipal solid waste. The closer the result is to 100%, the higher the social effectiveness of the waste management system.
	Coefficient of municipal solid waste load per resident in the service area. (d w/s)	d w/s = W / S W – Volume of collected municipal solid waste in physical terms; S – Population in the service area, persons.	Reflects the volume of generated municipal solid waste per resident in the service area. An increase in this indicator reflects a decrease in the effectiveness of waste reduction strategies among the population.
	Level of staff qualification in waste management.	d s = Sl / Sw Sl - the number of employees trained in waste management, people Sw – number of employees directly involved in waste management, people	Reflects the proportion of employees who have received training in waste management

Note- own development

3. Conclusion

In summary, it should be noted that due to the annual increase in the generation of solid municipal waste worldwide and the deterioration of the ecological state of ecosystems, the aspects of effective waste management have become particularly relevant. This management must ensure the fulfillment of three fundamental components of sustainable development: environmental sustainability, economic feasibility, and social acceptability.

The result of this study is a developed methodology for assessing the effectiveness of municipal waste management throughout the stages of their life cycle for management purposes, which:

1. Is based on an enhanced information base in the accounting system, allowing for the formulation of data on the fair value of municipal waste and the actual costs of managing it across the stages of waste management: generation, collection (accumulation), recycling, and disposal.

2. Includes a comprehensive system of ecological, economic, and social indicators (coefficients) of organizational performance and management effectiveness in the field of municipal waste management, aligned with the Balanced Scorecard concept and the developmental priorities of organizations.

3. Is linked to the strategic business objectives in the area of waste management, defined by the concept of sustainable economic development.

The waste management system, based on the key performance indicators we developed for organizational functioning and management effectiveness, which align with the strategic goals of sustainable development across the stages of waste management, allows for planning, continuous monitoring, and control over the completion of tasks related to resource conservation, the activation of recycling processes, and the minimization of the harmful impact of waste on the environment and society.

References

1. Resolution of the Ministry of Housing and Communal Services of the Republic of Belarus dated December 26, 2019 No. 31 "On the establishment of a list of waste related to municipal waste" Online resource – Access mode: 8.-postanovlenie-ministerstva-zhilishhno-kommunalnogo-hozjajstva-respubliki-belarus-ot-26-dekabrja-2019-g.-31-ob-ustanovlenii-perechnja-othodov-otnosjashhihsja-k-kommunalnym-othodam-.docx
2. World Bank Report (2024). Global Waste to Grow by 70 Percent by 2050 Unless Urgent Action is Taken:. Online resource – Access mode: https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank report#:~:text=WASHINGTON%2C%20September%2020%2C%202018%E2%80%94,Waste%20Management%20to%202050%20report.
3. Kulbeda-Kamshilova N.A. (2020) Practical Guide for Preparing for the Certification of Housing and Communal Services Specialists / N.A. Kulbeda-Kamshilova. – Zhilmizdat: Minsk, 2020. – 100 pages. Online resource – Access mode: 100 с. https://jilkom.by/wp-content/uploads/2021/09/obrashhenie-s-tverdymi-kommunalnymi-othodami.pdf
4. Tatyana Semyonkova. In the first nine months of 2024, the level of waste utilization in Belarus was 37.9% " Online resource – Access mode: https://www.sb.by/articles/za-devyat-mesyatsev-2024-goda-uroven-ispolzovaniya-tko-v-belarusi-sostavil-37-9-.html?ysclid=ma4a9a2fbm255194332
5. Ingelfinger, A. L., Metzger, C. A., Murray, R. W., & Shivers, R. W. (1971, July). Integrated waste management-Water system using radioisotopes for thermal energy. In *LIFE SUPPORT AND ENVIRONMENTAL CONTROL CONFERENCE* (No. ASME PAPER 71-AV-4). AMERICAN SOCIETY OF MECHANICAL ENGINEERS,.Online resource – Access mode: https://ntrs.nasa.gov/citations/19710055674
6. Klundert, V. D. A., & Anschütz, J. (2001). Integrated Sustainable waste management-the concept. *WASTE, Gouda, The Netherlands*, *252*.Online resource – Access mode: https://www.ircwash.org/sites/default/files/Klundert-2001-Integrated.pdf
7. Daskalopoulos E, Badr O and Probert SD. An integrated approach to municipal solid waste management. Resources Conservation and Recycling. -1998. - № 24(1), pp. 33–50.
8. Khan, A. H., Sharholy, M., Alam, P., Al-Mansour, A. I., Ahmad, K., Kamal, M. A., ... & Naddeo, V. (2022). Evaluation of cost benefit analysis of municipal solid waste management systems. *Journal of King Saud University-Science*, *34*(4), 101997. Online resource – Access mode: https://www.sciencedirect.com/science/article/pii/S1018364722001781?via%3Dihub https://doi.org/10.1016/j.jksus.2022.101997
9. Medina-Mijangos, R., & Seguí-Amórtegui, L. (2020). Research trends in the economic analysis of municipal solid waste management systems: A bibliometric analysis from 1980 to 2019. *Sustainability*, *12*(20), 8509. Online resource – Access mode: https://www.mdpi.com/2071-1050/12/20/8509
10. Reis, W. F., Barreto, C. G., & Capelari, M. G. M. (2023). Circular economy and solid waste management: Connections from a bibliometric analysis. *Sustainability*, *15*(22), 15715. https://www.mdpi.com/2071-1050/15/22/15715
11. Farooq, M., Cheng, J., Khan, N. U., Saufi, R. A., Kanwal, N., & Bazkiaei, H. A. (2022). Sustainable waste management companies with innovative smart solutions: A systematic review and conceptual model. *Sustainability*, *14*(20), 13146.Online resource – Access mode: https://www.researchgate.net/publication/364323381_Sustainable_Waste_Management_Companies_with_Innovative_Smart_Solutions_A_Systematic_Review_and_Conceptual_Model
12. Derhab, N., & Elkhwesky, Z. (2023). A systematic and critical review of waste management in micro, small and medium-sized enterprises: future directions for theory and practice. *Environmental Science and Pollution Research*, *30*(6), 13920-13944.https://doi.org/10.1007/s11356-022-24742-7

13. Awino, F. B., & Apitz, S. E. (2024). Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review. *Integrated Environmental Assessment and Management*, *20*(1), 9-35.. Online resource – Access mode: https://onlinelibrary.wiley.com/doi/10.1002/ieam.4774
14. Vegera, S., Malei, A., Sapeha, I., & Sushko, V. (2018). Information support of the circular economy: the objects of accounting at recycling technological cycle stages of industrial waste. *Entrepreneurship and Sustainability Issues*, *6*(1), 190-210.
15. Sara, C. O. R. R. A. D. O., Carla, P. C., Eriksson, M. A. T. T. I. A. S., Ole, J. H., Hans-Eduard, H. A. U. S. E. R., Van, H. F. H., . & Serenella, S. A. L. A. (2019). Food waste accounting methodologies: Challenges, opportunities, and further advancements.Online resource – Access mode: https://www.sciencedirect.com/science/article/pii/S2211912417301530. https://doi.org/10.1016/j.gfs.2019.01.002
16. Di Vaio, A., Hasan, S., Palladino, R., & Hassan, R. (2023). The transition towards circular economy and waste within accounting and accountability models: a systematic literature review and conceptual framework. *Environment, development and sustainability*, *25*(1), 734-810.https://doi.org/10.1007/s10668-021-02078-5
17. Almasyhari, A. K., Rachmadani, W. S., & Priatnasari, Y. (2024). The Role of Environmental Accounting on Waste Management. *Shirkah: Journal of Economics and Business*, *9*(2), 261-274.https://doi.org/10.22515/shirkah.v9i2.720
18. Latifah, S. W., & Soewarno, N. (2023). The environmental accounting strategy and waste management to achieve MSME's sustainability performance. *Cogent Business & Management*, *10*(1),2176444. https://www.tandfonline.com/doi/citedby/10.1080/23311975.2023.2176444?scroll=top&needAccess=true https://doi.org/10.1080/23311975.2023.2176444
19. Vysochan, V. H., & Olha Vysochan, A. Y. (2024). Accounting in the context of a circular economy for sustainable development: A systematic network study. *Journal of Sustainability Research*, *6*(1).. https://doi.org/10.20900/jsr20240005
20. Adler, R., Mansi, M., & Pandey, R. (2022). Accounting for waste management: a study of the reporting practices of the top listed Indian companies. *Accounting & Finance*, *62*(2), 2401-2437. https://onlinelibrary.wiley.com/doi/abs/10.1111/acfi.12869 https://doi.org/10.1111/acfi.12869
21. Housing economics: textbook V. V. Buzyrev, N. V. Vasilyeva, V. S. Chekalin, V. F. Martynov. - 2nd edition. - Moscow : 2016. - 363 p. - Online resource – Access mode: URL: https://znanium.com/catalog/product/508569
22. Ryakhovskaya AN, S. A., & Kirillova, A. N. (2018). Development of financing in housing and communal services: Monograph. *Moscow: INFRA-M*.Online resource – Access mode:: https://znanium.com/catalog/product/1012445
23. Nemkin, P. V. The economic mechanism of development of the housing and communal complex of large cities of Russia: a monograph / P.V. Nemkin, V.S. Chekalin. Moscow : INFRA-M, 2017. 124 p. — www.dx.doi.org/10.12737/2823. Online resource – Access mode: URL: https://znanium.com/catalog/product/768396
24. Kaplan R., Norton D. (1996). Balanced system of indicators. from strategy to action. Online resource – Access mode: https://pqm-online.com/assets/files/lib/books/norton1.pdf
25. Tawse, A., & Tabesh, P. (2023). Thirty years with the balanced scorecard: What we have learned. *Business Horizons*, *66*(1), 123-132./Online resource – Access mode: https://www.sciencedirect.com/science/article/pii/S0007681322000258 https://doi.org/10.1016/j.bushor.2022.03.005
26. Kumar, S., Lim, W. M., Sureka, R., Jabbour, C. J. C., & Bamel, U. (2024). Balanced scorecard: trends, developments, and future directions. *Review of managerial science*, *18*(8), 2397-2439.. Online resource – Access mode: https://link.springer.com/article/10.1007/s11846-023-00700-6
27. Hristov, I., Cristofaro, M., Camilli, R., & Leoni, L. (2024). A system dynamics approach to the balanced scorecard: a review and dynamic strategy map for operations management. *Journal of manufacturing technology management*, *35*(4), 705-743.https://doi.org/10.1108/JMTM-02-2022-0069

28. Vegera, S., Malei, A., Afanasyeva, K., & Sushko, V. (2024). *Analysis of industrial waste management efficiency as part of a sustainable business development strategy*. https://www.researchgate.net/publication/388738359_Analysis_of_Industrial_Waste_Management_Efficiency_as_Part_of_a_Sustainable_Business_Development_Strategy

29. Malei, A., & Trubovich, R. (2024). Decarbonization of an economy: creating economic prerequisites through the development of the waste recycling accounting at landfills. In *BIO Web of Conferences* (Vol.83,p.04004).EDP Sciences. https://doi.org/10.1051/bioconf/20248304004