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MULTI-LEVEL ORGANIZATIONAL AND ECONOMIC MODEL FOR SUSTAINABLE WASTE MANAGEMENT¹

Introduction. Ukraine faces significant challenges in waste management, including low efficiency in waste handling and insufficient institutional capacity. Strengthening the organizational and economic mechanisms of waste management is essential for achieving sustainable development and aligning with European environmental standards. The purpose of this article is to develop a conceptual framework for improving Ukraine's waste management system by adapting successful elements of the Swedish model, particularly extended producer responsibility and circular economy principles. **Methods.** The study applies methods of comparative analysis, systemic approach, synthesis, and generalization to evaluate existing Ukrainian waste management practices and to identify applicable components of the Swedish system. **Results.** The research outlines a multi-level governance model that enhances coordination among stakeholders, promotes eco-conscious consumer behavior, and supports the modernization of waste management infrastructure. Practical recommendations are proposed for incorporating economic incentives, such as public-private partnerships, tax benefits, and grant programs, to stimulate innovation in recycling, waste sorting, and resource recovery. **Conclusions.** Adapting the Swedish model can significantly improve Ukraine's environmental governance by fostering efficient waste management, strengthening institutional capacity, and promoting a circular economy. This approach will contribute to sustainable development and enhance Ukraine's integration into the European environmental framework.

Keywords: sustainable development, circular economy, waste management system, multi-level governance, organizational and economic mechanism, extended producer responsibility (EPR), public-private partnership (PPP).

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БАГАТОРІВНЕВА ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНА МОДЕЛЬ СТАЛОГО УПРАВЛІННЯ ВІДХОДАМИ

У статті досліджено теоретичні та методологічні підходи до формування ефективного організаційно-економічного механізму управління відходами, з урахуванням особливостей багаторівневої взаємодії між державою, регіонами, підприємствами та домогосподарствами. Актуальність теми зумовлена зростанням обсягів утворення відходів, необхідністю виконання міжнародних зобов'язань. Запропоновано комплексну концептуальну модель удосконалення національної системи управління, яка інтегрує управлінські інструменти, адаптовані до українських умов, та передовий міжнародний досвід, зокрема елементи шведської моделі, що поєднує принципи циркулярної економіки та розширеної відповідальності виробника. Використано поєднання системного та інституційного аналізу, порівняльне вивчення зарубіжних практик, методи синтезу та узагальнення, що дозволило визначити ключові напрями підвищення ефективності політики управління відходами. Особлива увага приділена інструментам менеджменту, які забезпечують координацію між стейкхолдерами, впровадження економічних стимулів для екологічно відповідальної поведінки, розвиток сучасної інфраструктури роздільного збору, удосконалення системи моніторингу та звітності, а також підвищення прозорості прийняття управлінських рішень. Модель передбачає формування багаторівневої організаційно-економічної структури управління, що поєднує інтереси держави, бізнесу та громад, використання податкових пільг, грантових інструментів і механізмів державно-приватного партнерства для стимулювання інновацій у сфері сортування, перероблення та утилізації відходів. Запропонований підхід сприяє оптимізації ресурсних потоків, підвищенню інвестиційної привабливості галузі та створенню умов для екологічної модернізації виробництва. Адаптація зарубіжних практик з урахуванням соціально-економічних і культурних особливостей України забезпечить зміцнення інституційної спроможності, підвищення ефективності екологічного менеджменту на всіх рівнях, розширення міжсекторальної взаємодії та інтеграцію України в європейський екологічний простір.

Ключові слова: Сталый розвиток, циркулярна економіка, система управління відходами, багаторівневе управління, організаційно-економічний механізм, розширена відповідальність виробника (РВВ), державно-приватне партнерство (ДПП).

Problem statement and its significance. While Ukraine has undertaken important steps toward aligning its waste management policies with the principles of the European Green Deal and the circular economy, significant challenges remain in ensuring effective coordination among the state, regional, enterprise, and household levels. The existing system often demonstrates limited coherence and lacks an integrated organizational and economic mechanism to facilitate systemic collaboration across all governance levels. This fragmented approach may hinder the practical implementation of circular economy principles, including waste minimization, recycling, and resource efficiency. Moreover, insufficient incentives and support instruments for stakeholders, particularly at the enterprise and household levels, constrain the transition toward sustainable waste management practices.

Analysis of recent research and publications. Recent studies increasingly emphasize the need to develop integrated models that enable companies to assess and improve their sustainability performance within the framework of the circular economy. One notable contribution in this field is the research by scholars such as Battistoni E., Ren J., and Mazzi A. [1], who present a Sustainability Circular Performance (SCP) model designed for manufacturing enterprises. This multi-criteria model allows for the evaluation of environmental, economic, and social dimensions of sustainability, demonstrating that reducing industrial waste mitigates environmental impact and brings tangible economic benefits such as cost reductions, operational efficiency, and enhanced workplace safety.

Aryee R. and Kanda W., in their study Corporate CE practices and firm performance (Ghana/Sweden) [2], propose the strategic CEP-EM model, which analyzes how circular economy practices, particularly upcycling and waste recovery, affect firm performance indicators, including investment attractiveness and ESG outcomes. This research is especially valuable for countries with emerging economies, as it demonstrates approaches to adapting circular economy principles at the enterprise level. A study on Ghanaian integrated waste firms (Daniel Agyapong, Gloria K. Q. et al.) evaluates how upcycling and waste recovery influence economic, environmental, and governance performance. It demonstrates that firms investing in CE practices improve sustainability outcomes and financial preparedness [3]. AHP-based assessment models for waste treatment scenarios are applied in Italian contexts to compare options like landfilling, composting, recycling, and incineration. This methodology enables enterprises to distinguish between sustainability pathways and select optimal operational scenarios (Milutinović, B; Stefanović et al.) [4]. In the studies by Akomea-Frimpong I., Tetteh P. A., Ofori J. N. A. et al. [5], a bibliometric review of over 1,700 articles identifies structural barriers to CE implementation, particularly in the solid and industrial waste sectors, including weak institutional frameworks, limited financing instruments, and low levels of inter-level coordination. These challenges reflect gaps identified in the Ukrainian context at the enterprise level. Gavkalova et al. [6] develop a conceptual framework for innovative circular business models applicable to public and private sectors. The study emphasizes multi-stakeholder

collaboration and stakeholder innovation as core drivers to embed circularity in enterprise operations. At the macro level (state policy), research by the OECD [7] and the European Commission [8] emphasizes the importance of state-driven frameworks, including legal alignment with the EU Waste Framework Directive, extended producer responsibility (EPR) schemes, and dedicated waste management funds. These tools are crucial for integrating circular economy principles into national strategies and meeting international sustainability commitments. At the regional level, the European Environment Agency (EEA) [4] and Naturvårdsverket (Sweden) [9] demonstrate that regional waste management efficiency stems from tailored regional waste plans, investments in sorting and energy recovery infrastructure, and transparent public accountability systems. Swedish municipal practices illustrate how combining local tax mechanisms with gamified citizen engagement programs has increased household waste recycling rates to over 99% (Heshmati A., Rashidghalam M.).

At the household level, studies by Zero Waste Europe [6] and the Ellen MacArthur Foundation [7] highlight the role of behavioral and motivational tools, including pay-as-you-throw schemes, eco-bonus programs for sorting, and digital tracking technologies (QR and RFID systems), as critical drivers of sustainable consumer behaviour and household-level circularity.

However, research by Gavkalova et al. [6] and bibliometric analyses of over 1,700 studies [5] underscore that Ukraine faces structural barriers such as limited regional financing, weak institutional coordination across governance levels, insufficient business incentives, and low public environmental awareness. These challenges justify the need for a comprehensive organizational and economic mechanism (OEM) integrating the four key levels – state, region, enterprise, and household – into a single waste management ecosystem based on circular economy principles. Thus, recent literature suggests that adapting Sweden's OEM model, which is grounded in systemic, multi-level coordination and balanced use of organizational, financial, and motivational instruments, can serve as a viable strategy for Ukraine to advance towards sustainable waste governance and circular economy goals.

The purpose of the article is to develop a scientifically grounded organizational and economic mechanism for waste management in Ukraine based on the multi-level interaction system “state–region–enterprise–household”, taking into account the principles of the circular economy and the experience of Sweden. The article seeks to substantiate the need for a comprehensive, integrated model that harmonizes regulatory, financial, and motivational instruments at all levels of governance, thereby ensuring systemic improvements in waste management and aligning national policy with EU sustainability commitments.

Summary of the main research material. In the context of advancing Ukraine's sustainable development goals and fulfilling its commitments under the Association Agreement with the European Union, the issue of enhancing the efficiency of the waste management system is gaining increasing relevance. According to the Ministry of Environmental Protection and Natural Resources of Ukraine, over 300 million tons of waste are generated annually, a substantial portion of which is neither properly recycled nor safely disposed of. The current waste management framework exhibits significant inefficiencies, highlighting the urgent need to develop new, integrated approaches encompassing all levels of interaction – from national policy to individual households.

Despite the presence of strategic policy documents, such as the National Waste Management Strategy until 2030 and the Law of Ukraine “On Waste Management”, the country's waste management policy still requires significant improvement. In particular, the issue of ensuring consistency and coordination of actions among the key governance actors remains a pressing challenge. The practical implementation of circular economy principles necessitates coordinated interaction across all levels – from the national and regional to the enterprise and household – which, in turn, calls for a comprehensive organizational and economic approach.

Currently, Ukraine lacks an effective organizational and economic mechanism to ensure comprehensive coordination across all levels of waste management. State policy is often limited to regulatory and legal frameworks, without providing sufficient economic incentives for regions, enterprises, and the population. Regional authorities, in turn, face constraints in terms of financial resources and management tools. Businesses do not always recognize the economic viability of implementing environmental initiatives, while the level of environmental awareness among households remains insufficiently developed.

Developing an effective organizational and economic mechanism for waste management, which ensures the synergy of efforts among all stakeholders – the state, regions, enterprises, and households – is a critically important objective for achieving the Sustainable Development Goals and advancing the circular economy in Ukraine.

Sweden's organizational and economic mechanism for waste management is considered one of the most effective globally, owing to its well-structured system of interaction among the state, regional authorities, businesses, and citizens.

Sweden has successfully developed and implemented a comprehensive organizational and economic framework for waste management, grounded in the principles of the circular economy, extended producer responsibility, and active public engagement.

According to the European Environment Agency, more than 99% of all household waste in Sweden is recycled or recovered, while less than 1% goes to landfills. Approximately 50% of the waste is recycled, while the rest is incinerated to generate energy, providing electricity to more than 1.4 million households and heat to about 800,000 households. The system's high efficiency is achieved through well-established cooperation among government agencies, regional authorities, enterprises, and households within a unified waste management system [10].

The key elements of the organizational and economic mechanism of waste management in Sweden are:

- institutional integration: government policy stimulates the development of recycling technologies, invests in infrastructure, and supports public-private partnerships [11];
- economic incentives: tax benefits, a system of fines for landfilling, differentiated tariff setting, and extended producer responsibility (EPR) [12];
- educational and informational campaigns: active public involvement in waste sorting through incentive systems and a high level of environmental awareness [13];
- technological infrastructure: implementing innovative solutions for energy recovery and digitalizing waste management [14].

Given these circumstances, Sweden's experience can serve as an effective model for adaptation in Ukraine, which currently faces low levels of waste recycling, insufficient infrastructure, and an imbalance of authority among governing entities [15].

Adopting an organizational and economic waste management model based on the Swedish experience offers Ukraine strategic advantages in environmental governance. It promotes a structured, multi-level approach – from households to national policy – ensuring coordinated stakeholder action.

The key goal is to develop an efficient, eco-friendly infrastructure that reduces environmental impact and supports a circular economy by reusing resources.

This model also boosts private sector involvement through economic incentives like tax breaks, grants, and public-private partnerships, encouraging innovation in waste sorting and recycling.

Finally, it strengthens Ukraine's international standing as a responsible, sustainability-oriented member of the European environmental community.

Thus, adopting and implementing a Swedish-style organizational and economic waste management mechanism represents a well-founded strategic response to current challenges in Ukraine's environmental policy. A generalized model of this mechanism within the interaction system "state – region – enterprise – household" is presented in Figure 1.

Adapting the Swedish organizational and economic waste management mechanism to Ukrainian conditions

is justified by establishing an integrated system that unites all levels – state, region, private sector entities, and households – into a single sustainable resource management ecosystem. This approach is grounded in scientific principles of hierarchical governance, institutional economics, strategic partnership, and the circular economy.

The organizational and economic waste management mechanism in Ukraine, adapted based on the Swedish model, envisages the coordinated functioning of four key levels: state, region, private sector entities, and households. Each level incorporates a set of organizational, managerial, financial, economic, and motivational instruments that ensure systematic waste flow management within the circular economy framework.

At the macro level, the state performs the function of strategic regulation in waste management. Among the key organizational and managerial instruments are the development of a comprehensive regulatory framework, including the Law of Ukraine "On Waste Management", harmonized with the provisions of the EU Waste Framework Directive 2008/98/EC; the establishment of inter-agency coordination mechanisms (involving the Ministry of Environmental Protection and Natural Resources, Ministry of Finance, and the State Environmental Inspectorate); and the institutionalization of national targets and performance indicators, such as the share of waste recycling, reduction of waste generation, and mitigation of greenhouse gas emissions in the sector [16]. Financial and economic instruments include environmental taxes, the implementation of extended producer responsibility (EPR) policies, the establishment of a National Waste Management Fund, and a system of grants, subsidies, and preferential loans to support infrastructure development [17]. Motivational mechanisms comprise public awareness campaigns on environmentally responsible behaviour and subsidies and tax incentives for individuals and businesses engaged in separate waste collection activities [18].

At the meso-level, regional authorities (oblast administrations, communities, and local self-government bodies) are responsible for developing regional waste management plans, constructing infrastructure facilities (such as landfills, sorting stations, and logistics networks), and implementing mechanisms for public accountability and the evaluation of local government performance [19]. Financial and economic instruments at this level include budgetary funding of infrastructure projects, pay-as-you-throw (PAYT) schemes, and co-financing of initiatives within public-private partnership (PPP) frameworks. Motivational mechanisms are realized through local educational campaigns, gamified waste sorting practices, and eco-bonus incentive programs [20].

At the micro level, private sector entities act as drivers of innovation. They implement environmental management

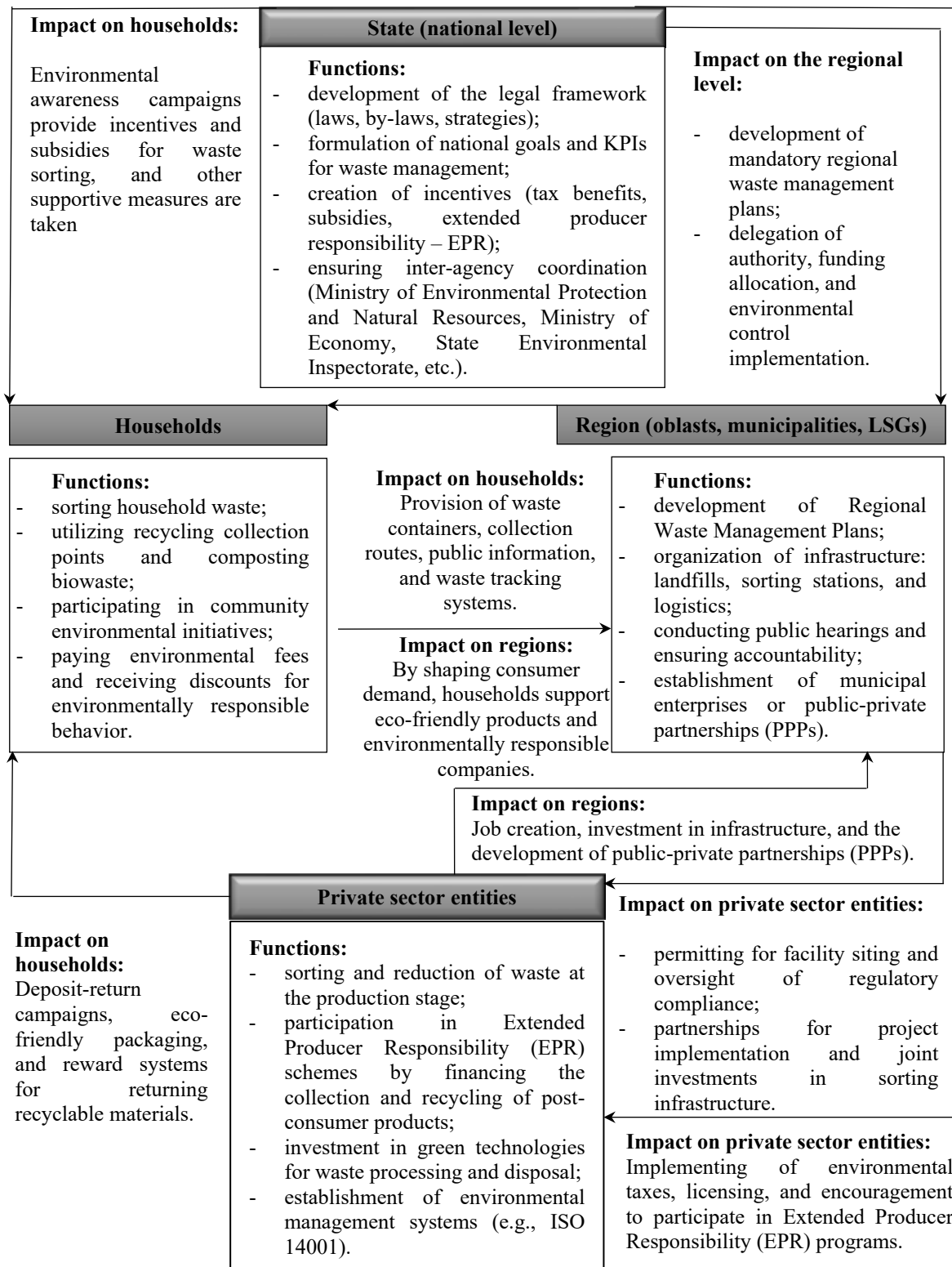


Figure 1. Organizational and economic mechanism of waste management within the “state–region–private sector entities–households” system

Source: developed by the authors based on data from [11–15]

systems (such as ISO 14001 and EMAS), comply with extended producer responsibility (EPR) requirements, and attract green investments by adopting ESG-oriented approaches [21]. Financial and economic instruments

include investment incentives for environmentally friendly technologies, access to dedicated waste management funds, and certification-related benefits for companies adhering to zero-waste principles. Motivational policies are promoted

through sustainable branding strategies, public awareness campaigns, and container deposit-return systems with consumer bonuses [22].

At the local level, households serve as key actors in implementing the principles of separate waste collection, composting, and environmentally conscious consumption. Organizational and managerial tools include educational programs and digital waste tracking systems using QR codes and RFID technologies. Financial and economic instruments comprise subsidies, discounts for properly sorted waste, and compensation for composting bio-waste. Motivational mechanisms are implemented through loyalty programs, social recognition, and environmental education in schools and the media [20].

Consequently, adapting the Swedish model in Ukraine is feasible, provided there is sufficient political will, practical multi-level cooperation, stable funding, and consistent motivation of all stakeholders. Such a mechanism fosters institutional trust, encourages responsible waste behavior, and facilitates a gradual transition to a circular economy with increased value creation.

The organizational and economic mechanism of waste management (OEM_{iv}) is understood as a set of actions, instruments, and interactions that shape an effective waste management policy.

This mechanism is based on a combination of three interconnected blocks of instruments, expressed as a function:

$$f(O_i + F_i + M_i),$$

where O_i – organizational and managerial (institutions, regulations, standards, strategic planning);

F_i – financial and economic (taxes, subsidies, investment tools, tariffs);

M_i – motivational (information campaigns, social incentives, gamification, discounts).

The mechanism operates within a multi-actor system. The inclusion of four key levels ($\text{Index } i \in \{D, R, B, H\}$) is defined as follows:

D (state/macro level) – strategic regulation, coordination, legislative framework;

R (regional/meso level) – planning, infrastructure, communication with local authorities;

B (business/enterprises) – innovation, environmentally friendly production, product responsibility;

H (households) – waste sorting, behavioral changes, program participation.

Thus, $OEM_{iv} = f(O_i + F_i + M_i)$, where $i \in \{D, R, B, H\}$, represents a systematic scientific model of the organizational and economic mechanism of waste management (OEM_{iv}). It enables a structured understanding of the relationships between governance levels and the types of policy instruments applied in this domain. This approach is grounded in systematic and hierarchical analysis, which is characteristic of contemporary environmental

economics, public administration, and sustainable development theory.

This approach is based on the following principles:

- systematization. Classification of all available instruments and identification of their roles within the overall waste management system;

- integrated analysis. Consideration of vertical (between governance levels: National–Regional–Business–Household) and horizontal (between types of instruments: Organizational, Financial, Motivational) interconnections, creating the basis for a comprehensive, multi-level analysis;

- identification of weaknesses. Empirical application of the formula allows the detection of imbalances (e.g., underestimation of the motivational component at the local level), which facilitates policy adjustments;

- universality and adaptability. The model can be applied in various contexts: interstate (comparison of practices), interregional (e.g., among Ukrainian oblasts), and intersectoral (e.g., construction, agro-industrial complex);

- principle of instrument integration. Efficiency is achieved through a balanced combination of organizational, financial, and motivational tools, reinforcing each other's impact.

- subsidiarity principle. Each level of governance (national, regional, micro, and local) performs the functions it can execute most effectively, with powers delegated to lower levels where appropriate;

- empirical verification. The model can be used for data collection, comparison, and substantiation of strategic decisions, including through quantitative assessment of instrument effectiveness;

- policy coherence principle. The formula enables the development of a comprehensive policy framework in which goals, instruments, and measures are aligned across all governance levels;

- analytical transparency. Using the model fosters openness in decision-making and stakeholder engagement by clearly structuring functional governance elements.

The formula is an analytical and methodological foundation for designing an effective, multi-level waste management policy oriented towards a sustainable economy and circular principles (see Fig. 2).

Thus, the proposed model systematizes waste management approaches and provides a theoretical foundation for developing effective regional or national waste management policies. Applying this approach enables the justification of strategic decisions regarding improving infrastructure, incentive mechanisms, and cross-sectoral cooperation.

Adapting the Swedish model in Ukraine is feasible given sufficient political will, fiscal support, and strong partnerships between the state and private sector entities. Such an approach fosters institutional trust, shared responsibility, and effective resource governance. Imple-

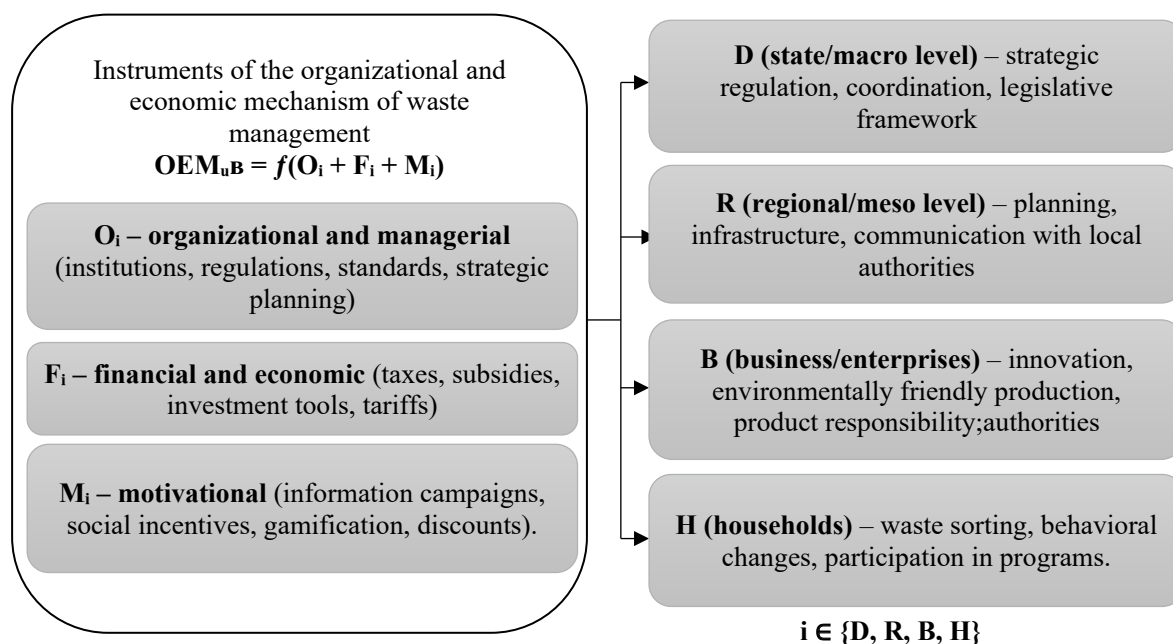


Figure 2. Diagram of the tools of the organizational and economic mechanism for waste management in a circular economy

Source: developed by the authors based on data from [11–15]

menting coordinated mechanisms across national, regional, business, and household levels will reduce waste volumes and transform waste into a source of added value.

Conclusions. This study highlights the importance of a comprehensive organizational and economic mechanism for effective waste management in Ukraine. The proposed model integrates the roles of all key stakeholders – government, regional authorities, private sector entities, and households – and emphasizes the synergy of their interaction to achieve sustainable development goals.

Drawing on Sweden's experience, the research confirms that successfully adapting such a model in Ukraine requires strong political will, stable fiscal support, effective

inter-level coordination, and active public and business engagement. The developed approach structures waste management practices and provides a theoretical framework for formulating strategic decisions on infrastructure improvement, economic incentives, and cross-sectoral cooperation. Implementing coordinated mechanisms at all governance levels contributes to developing institutional trust, shared environmental responsibility, and transforming waste into a resource with added value.

This model can serve as a foundation for developing regional and national waste management strategies, promoting a circular economy, and supporting Ukraine's transition toward environmental sustainability.

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