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Analysis social and economic effects of industrial waste recycling

 Lokupitumpa Appuhamillage Vidushi Shanika Ranasinghe
Postgraduate, Assistant of the Department of strategic and innovation development. Faculty of Higher School of Management Financial University under the Government of the Russian Federation, Moscow.
E-mail: ranasinghe_shanika@yahoo.com

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The industrial waste system is in a transitional phase in developing economies, and local municipalities and waste management companies are stepping toward integrating a waste treatment approach in the scheme of waste handling. However, there is an urgent need to explore cost-effective techniques, models, and potential revenue streams to sustain the state-run waste sector self-sufficiently. This article discussed the economic aspects of industrial waste processing, the negative consequences and risks of waste processing, as well as government support for waste management in Russia.

Introduction. Industrial waste is generated from residential, commercial, institutional, and housing societies. Cities worldwide are experiencing rapid population growth due to improved job opportunities, economic prosperity, and access to quality education and healthcare in urban areas. As a result, local governments and municipalities strive to improve their service delivery to meet the needs of their citizens, driven by the desire to enhance urban living standards and habits. Asian countries such as Japan (Tokyo), Korea (Seoul), Taiwan (Taipei), and Malaysia have policies and legislations on direct waste removal, fee systems, and food and household waste.

Waste is mainly categorized into recyclables, bulk (debris), and households collected by the government by deploying advanced fleets with some private sector participation. Economically, high-value waste is collected without charges, and a service fee is recovered for bulk waste collection. Recycling and incineration are reported as dominant treatment methods, with some incidents of illegal open waste disposal associated with environmental hazards.

In collecting this information, an analysis was made of the number of countries that have made efforts to research and publish material on the circular economy over the years. Significant growth has been observed in this area, particularly in countries with a global impact. Countries that stand out in terms of research and development on the circular economy include Italy, China, Canada, the United Kingdom, Russia and France. These countries have shown a remarkable commitment to investing in education and developing initiatives related to the circular economy. Italy was recognized for its leadership in implementing circular strategies, such as waste management, and promoting circularity in different sectors. China, on the other hand, has made significant efforts to transition to a more sustainable economy, with a focus on resource efficiency and emissions reduction. Canada focuses on the circular economy in areas such as waste management, renewable energy, and sustainable production. The UK has put in place strong legislation and support programs to promote the circular economy, particularly in sectors such as construction and manufacturing. France has implemented ambitious policies and strategies to promote the circular economy, with a focus on reducing waste and promoting sustainable production and consumption.

These countries have demonstrated a strong commitment to promoting the circular economy, and their investment in education and the development of related initiatives has led to a greater impact on the sustainable development of their respective countries. It is important to note that this analysis only mentions some of the countries that have shown a greater focus on the circular economy, but many other countries are also making significant efforts in this area. The global drive toward a circular economy reflects a growing global awareness of the importance of sustainability and the efficient use of resources. Industrial waste challenges are shown in Table 1.

A key challenge in the sector is existing buildings that were not designed for deconstruction, which contain materials that are difficult to reuse or recycle and lack detailed documentation. Reused materials require additional time and more qualified labor, and there is a lack of market mechanisms to aid recovery. A system needs to be developed that supports the use of circular materials, including procedures for quality assurance, standardization, certification, and classification, as well as mechanisms for transport and storage and access to the market. Finances, or lack of understood financial benefit, was identified as a leading barrier to circular economy uptake for stakeholders. In the context of construction materials, this includes the high availability and low cost of virgin raw material, cost of deconstruction, work involved in providing and preparing material for reuse, cost of recycled or reused materials, and lack of reward or penalty. Institutional or informational challenges include a lack of knowledge compounded by a lack of guidance or support tools. Stakeholders throughout construction value chains in Europe are not sufficiently familiar with how circular economy principles would operate in the built environment, and many were unable to identify the first steps toward a circular economy transition. Overcoming these barriers will pave the way for more widespread adoption of circular construction materials; however, there is a need initially to provide evidence, compile best practice examples, and develop guidance.

The dynamics of production, disposal and disposal of industrial waste and consumption are presented in Figure 1.

Research methodology

To achieve a socio-economic effect, the author conducted a survey of 152 Russian top managers of industrial companies and analyzed the survey results. Author considered the following to be the main scientific results:

1. Analyse of factors that influence waste recycling and considered which factors have the greatest influence
2. Analyse the economic aspects of industrial waste recycling
3. Analyse the risks faced by waste recycling and created a risk map
4. Analyse of government measures to support waste recycling

At the first stage of factor analysis, the author considered the main 10 factors that influence waste processing and considered the main factors that influence waste processing. The author used the Likert method to conduct surveys and then used regression models to conduct analysis.

We considered 10 factors such as an economic factor, social factor, technological factor, Information factor, Formation of partnerships and development of communications (external environment), The need to increase the efficiency of waste pro-

Table 1. Challenges of the industrial waste recycling.

Category	Challenges
Economic	Cost of upfront investment, Lack of financial aid, incentives, or short-term benefits, Low value of circular materials, Lack of grants or unclear financial case
Informational	Lack of awareness, interest, and knowledge Lack of research, education, and information, Lack of best practice case studies and leadership
Institutional/Structural	Fragmented supply chains, Lack of strategic vision and collaborative platforms, Lack of market mechanisms for recovery
Political/Governmental	Lack of regulatory instruments or pressure, Lack of tax actions, Lack of circular vision
Technological	Lack of integrated processes, tools, and practices, Lack of an information management system, Complexity of buildings Technology and infrastructure readiness

Source: made by author using resources [5; 6; 8–10].

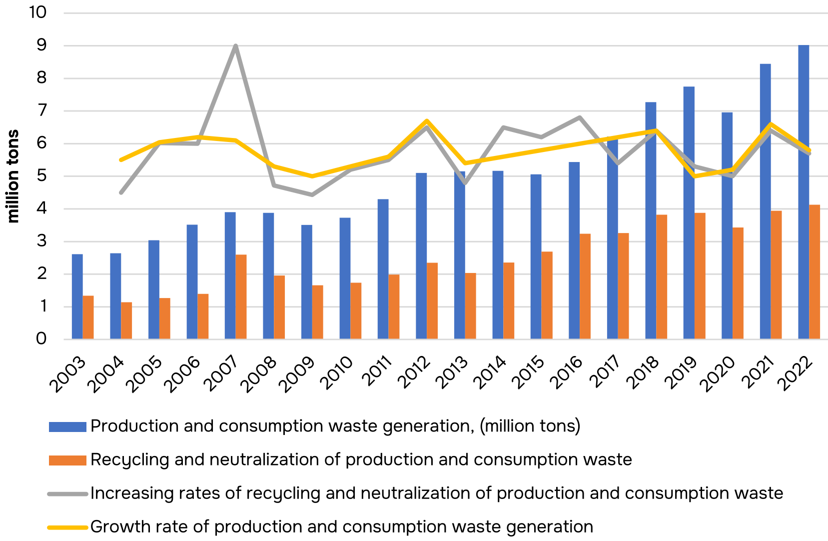


Figure 1. Dynamics of production, disposal and disposal of waste from industry and consumption. Source: compiled by the author.

cessing production, Market factor, government incentives, Availability of a regulatory framework in the field of waste recycling and Logistical aspect.

According to the results of the analysis, government incentives have the greatest impact. To verify this result, the author considered an analysis of variance by 100 respondents from different fields. The results are presented below.

For considering the results of both studies, the results do not show the same.

Out of these 10 factors, government incentives, technical factors and economic factors affect waste management the most. Recycling waste and using this "recycled" material can reduce the burden on the environment when waste reduction or replacement is not possible or would result in greater environmental impacts. By selling products made from recycled waste, the consumer has the opportunity to buy the product at a lower price than the current price. For example, hats, gloves and carpets made from recycled waste are in demand, but many consumers are reluctant to buy them. Because changes in global economic conditions, consumer behavior or government policies may affect market dynamics. Therefore, the market for secondary waste among the population is still inactive.

Table 2. The results of the regression analysis.

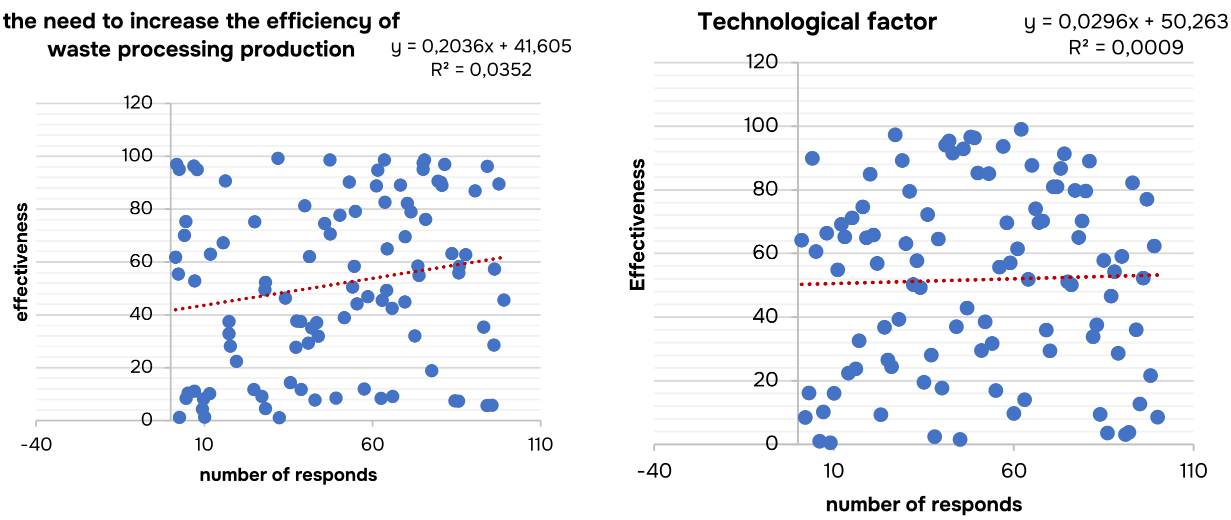
Independent Variables	Regression coefficients	Standardized regression coefficients
β	0.201 (0.019)	
economic	0.478** (0.073)	0.491***
social	0.198** (0.025)	0.205***
technological	0.552*** (0.125)	0.561***
informational	0.061** (0.014)	0.065***
Formation of partnerships and development of communications (external environment)	0.317** (0.091)	0.323**
The need to increase the efficiency of waste processing production	0.148** (0.031)	0.159***
Market factor	0.231*** (0.037)	0.242**
government incentives	0.631*** (0.101)	0.640***
Availability of a regulatory framework in the field of waste recycling	0.167** (0.064)	0.176**
Logistics aspect	0.031** (0.014)	0.035***

* significance of the coefficient $p < 0.10$
** significance of the coefficient $p < 0.05$
*** significance of coefficient $p < 0.01$
Source: compiled by the author.
Notes:
$R = 0.679$
$R2 = 0.609$
$AdjustedR2 = 0.603$
$p < 0.0000$
Standard error of estimate: 0.259.

The financial sustainability of the waste sector is a critical challenge for developing economies; hence, improving service delivery is achieved through outsourcing waste management services, but financial sustainability still needs to be clarified . Therefore, there was a need to explore a cost-effective approach for Pakistan's urban areas to sustain the waste sector in a self-sufficient, environmentally affordable, and technically suitable mode.

According to authors [1; 4], recycled water can substantially reduce potable water consumption, thereby contributing to water conservation. The researchers discovered that using recycled water in residential structures can result in a notable reduction of up to 50% in the demand for potable water. Moreover, water recycling systems can substantially benefit commercial and industrial buildings, which frequently exhibit elevated water demands. According to a study [3], it was shown that there is a possible decrease in water use of up to 75% in the types mentioned above of buildings.

The utilization of recycled water might also yield economic benefits. Buildings have the potential to achieve substantial reductions in their water expenses by decreasing the demand for potable water. In the study [2], it was observed that buildings utilizing recycled water had a noteworthy decrease in water expenses, with reductions of up to 30% being recorded. The utilization of recycled water can effectively mitigate the environmental burden by alleviating the pressure on freshwater resources and minimizing the discharge of wastewater into the natural environment. The significance of this matter is particularly pronounced in areas with a limited availability of water resources, as it facilitates the adoption of a more environmentally responsible and enduring water management strategy.



a) b)

Figure 2. a) The efficiency of waste processing production. b) Efficiency of technological factor.

The use of recycled water in buildings has obvious environmental and economic positive effects. This topic is worthy of further study for human beings and will contribute to the sustainable development of the earth's water resources.

To analyze the economic aspects, the processing of industrial waste must be divided into 4 aspects. The cost of preparing industrial waste, the cost of transporting industrial waste, the cost of storing industrial waste and the consumer value for processing industrial waste. To analyze costs and effectiveness, the author used a survey method and open resources of the waste management industry in Russia. Table 3 examines the costs of preparation, transportation and storage of industrial waste in Russia.

Regarding the efficiency of industrial waste recycling, the author considered the income from the recycling of industrial waste using the formula.

$$B = V - (P + T + S)$$

B = Income from recycling industrial waste;

P = preparation;

T = transportation;

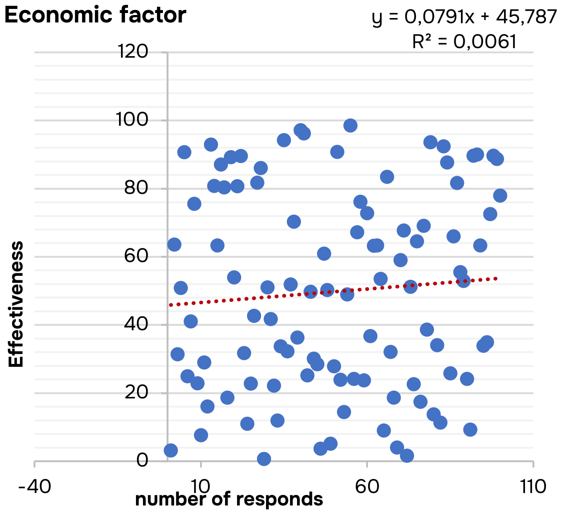
S = storage;

V = customer value.

For the conclusion, the author can prove that the recycling of industrial waste has economic efficiency across all industries in Russia. Especially the production of building materials.

The construction industry faces a major challenge in adopting circular economy practices: the higher cost of resources associated with deconstruction compared to demolition. Recycled materials are cheaper than virgin materials, and the cost of recycling is higher than other disposal methods. Unfortunately, the COVID-19 pandemic has further worsened these challenges by halting economic development and increasing the use of single-use materials. Implementing circular economy practices in construction requires significant investments, such as renewing equipment. Moreover, outdated legislation and the lack of standardized guides related to design and procurement procedures are other leading major regulatory barriers to circular economy development.

The construction industry faces many obstacles when adopting innovative practices, particularly those related to circular economy and sustainability. The industry is known for conservatism and reluctance to embrace new ideas that challenge established attitudes, customs, and beliefs. These



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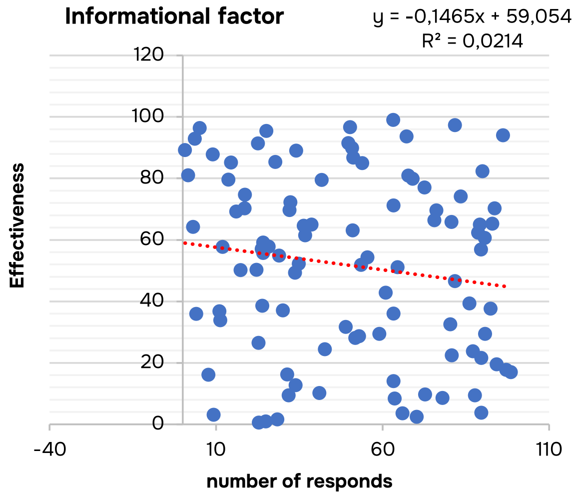

b)

Figure 3. a) Efficiency of economic factor. b) Efficiency of informational factor.

Table 3. Share of preparation, transportation and storage of industrial waste (Utilities and electric power, Production of building materials, Chemical and petrochemical, Ferrous and non-ferrous metallurgy, Textile industry).

Share of preparation. transportation and storage	Share of industrial waste (per ton) %						
	Central	North-western	South-ern	Privolzh-sky	Ural	Siberian	Far Eastern
Share of industrial waste for prepare	72	85.5	83.2	70.8	80.5	116.1	104.4
Share of transportation costs to processing sites	146.5	171.8	150.3	142.3	164.6	157.6	144.1
Share of the cost of storing industrial waste	154	142	157.4	131.2	160	188.4	156.9

Source: compiled by the author.
Note: calculated for all types of waste (class I-IV).

cultural and behavioral issues pose significant challenges to adopting sustainable practices. One primary cultural challenge is the need for more awareness among construction stakeholders regarding circular economy and sustainability practices. Many stakeholders are unfamiliar with these concepts and, therefore, need to understand their potential benefits. This lack of awareness can lead to a reluctance to invest in sustainable practices. Another cultural challenge is the inherent risk aversion in the construction industry. This risk aversion can make it difficult to adopt innovative practices, particularly when there is a perceived risk that they may not work as intended. As a result, many stakeholders may be hesitant to invest in new technologies or processes that are not proven. There is also a preference for virgin construction materials over reused and recycled products. This preference is often reinforced by ingrained beliefs that circular economy practices are not feasible. Many construction stakeholders believe that using recycled materials may compromise the quality and safety of construction projects. To analyze risks, the author conducted surveys of 25 managers and compiled a risk map. The risks are divided into economic, social, ecological and technological (Table 5). The result is presented in the form of a risk map in figure 4.

Table 4. Income from the recycling of industrial waste (per ton).

Secondery waste material	Income from recycling of industrial waste per ton. in rubles.						
	Central	North-western	South-ern	Privolzh-sky	Ural	Siberian	Far Eastern
Electric power	33	27.1	29.5	30	17	30.4	27.1
Production of building materials	20.5	20.9	32.9	43.6	39.8	45.3	34.2
Chemical and petrochemical	37.5	–11.3	–9.5	28	21.5	–24.5	–1.4
Ferrous and non–ferrous metallurgy	29	29.8	27.6	32.1	26.7	–8.7	24.4
Textile industry	40	39.3	35.4	27.2	–4.1	–0.6	16.4

Source: compiled by the author.

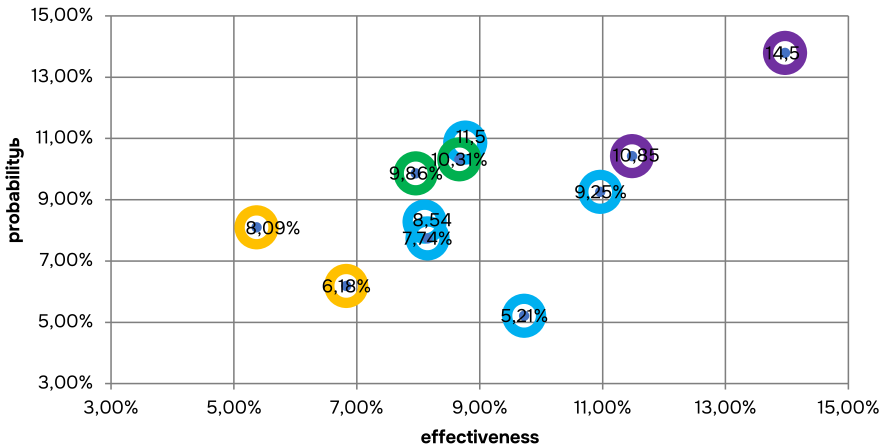

Figure 4. Risk map.
Source: compiled by the author.

Figure 5 shows a summary of the main risks affecting industrial waste recycling mentioned above.

This result shows that the problem under study is cross-sectoral in nature. The fact that economic risks are important only at the micro level or for the economy of individual producing enterprises explains why they are less significant than other meta-risks. Although possible hazards related to the environment, society and technology can affect many aspects of life, both small and large. Positive and negative consequences are shown in Table 6.

Humans generate waste while extracting ecosystem goods and services from their land, waterways, and cities. With the population growing apace, growth-dependent capitalism drives ever-greater consumption, waste production, and its management challenges (disposal, inclusive). Poor waste disposal methods and other factors, including urbanization, industrialization, limited resources, cultural and socioeconomic disparities, poor institutional enforcement of policies and regulations, governance, and institutional issues (corruption, lack of political will, political interference), and social exclusion (lack of cooperation from citizens), exacerbate these challenges. An extract from documents indicates that global waste generation has increased from 1.3 (2010) to 2.0 (2016) billion tons and is expected to increase to 2.2 (2025; Hoornweg & Bhada-Tata, 2012), 2.59 (2030), and 3.4–3.8 (2050) billion tons. In 2016, high-income countries generated 0.683 billion tons compared with 0.655, 0.586, and 0.093 billion tons produced by lower-middle-, upper-middle-, and low-income nations, respectively [7].

Table 5. Description of risks.

Risks	Risk associated with maintaining the current system	code
economic	Increased costs for waste treatment plants.	Eco1
	introduction of additional fees (taxes) for waste processing enterprises due to their harmful impact on the environment	Eco 2
social	Declining demand for recyclable waste leads to job losses in waste management industry	Soc1
	Residents' dissatisfaction with the air condition	Soc2
	The government lacks in-depth knowledge of circular economy practices	Soc 3
	Increasing number of hospital visits for respiratory illnesses as a result of unresolved air pollution problem	Soc 4
	lack of education and awareness in waste management	Soc 5
Technological	Opportunities for exporting local waste processing technologies are decreasing, and the technical "gap" between Russia and other countries in the field of processing and disposal of industrial waste is increasing.	Tech1
	Reducing the volume of domestic R&D spent on the disposal and processing of industrial waste	Tech 2
ecological	Increased dusting of industrial waste.	Env1
	Increased environmental damage to land plots taken out of economic circulation due to an increase in the amount of buried waste.	Env 2

Source: compiled by the author.

In the same year, the USA and China each generated 0.28–0.29 and 0.24 (rural) to 0.32 (urban) billion tons, respectively. Although poorer regions and nations generate less waste than richer ones, there has been a remarkable increase in waste generation trends across all countries, and this is projected to continue to do so in the coming years. Increasing waste volumes exert pressure on the environment, global population, and their respective governments, prompting countries to devise waste management strategies (regulations) and practices needed to reduce environmental impacts (e.g., nuisance, toxicity, gaseous emissions) and health risk [4].

Every waste management stage, including planning, collection, storage, transportation, separation, and treatment (e.g., recycling, incineration, composting), can generate risks. Without proper waste handling, negative socioeconomic, environmental, and associated health challenges are observed at local, national, and international scales. Past and present waste disposal practices are linked to harmful organic and inorganic (metals from electronic and other wastes) chemicals in the air, surface water, groundwater, sediments, compost , soils, and the food chain. Some waste-associated chemicals are toxic to the environment and humans, even at trace concentrations. These chemicals can initiate ecotoxicity, neurogenicity, and carcinogenicity, resulting in growth defects, reduced fertility, obesity, thyroid effects, and brain disorders in humans. The World Health Organization (WHO) report of 2010 presented an annual estimate of 600 million foodborne illnesses and 420 000 deaths, whereas, in 2015, it ascribed the death of more than 2 million people including children to harmful food and water microbial and chemical contaminants, some of which were from poorly managed waste streams. In comparison to the Global North, the Global South is reported to be subject to the most air, food-, and waste-borne disease burdens. Likewise, food bans, reduced food availability, export market closures, and costly solutions to address such environmental and health threats affect economies and livelihoods.

Over the years, easily available and affordable waste disposal practices have included open dumping, open burning, landfilling, stockpiling,

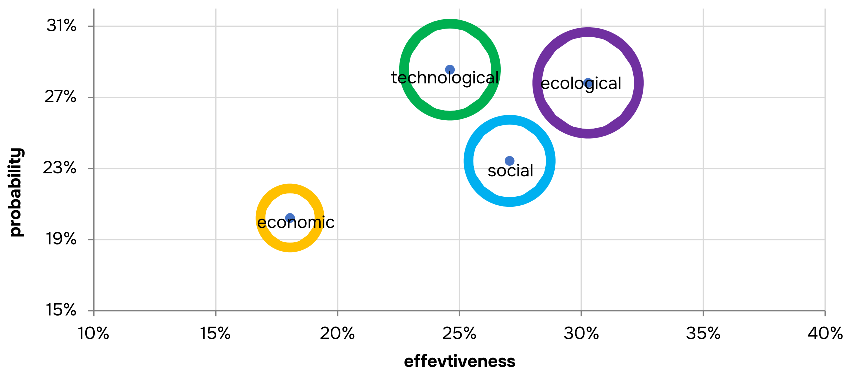

Figure 5. Risk map.
Source: compiled by the author.

Table 6. Consequences of industrial waste processing.

Favorable results	Adverse consequences
Cost reduction	Environmental impact
Easy to use	Resource depletion
Improved waste Management Practices	Health problems
Provide financial incentives to the company	Regulatory Compliance and Fines
Environmental awareness	Lost economic opportunities

Source: compiled by the author.

dumping into oceans and other water bodies, and, more recently, waste trading (the international trade and/or export of waste between the rich [urban] and poor [rural] regions or countries for further treatment, disposal, or recycling. Given the consequences, the European sanitary revolution, 150 years of slow advancement, led to the adoption of sustainable development approaches including a waste hierarchy (WH) concept that prioritizes waste reduction, reuse, recycling, and recovery over controlled and/or unregulated disposal.

The most impactful WH strategies, which reduce or avoid waste, result from changes in production or consumption (reduce, refuse). Once the waste is generated, WH strategies are prioritized from left to right. Separated waste can remain a resource through reuse, recycling (which requires added energy and sometimes materials), or recovery, which generates organic matter or energy. In the absence of these options, waste is either disposed of in a sanitary landfill or a controlled dump (which controls much of the emissions or leachate) or is openly dumped or burned, with no containment or control.

Influential factors for sustainable waste management systems Stakeholders play different roles in the implementation of influential factors. The success or failure of any waste management system depends on stakeholder awareness, inclusion, and participation (commitment) and how this influences the incorporation of influential (enabling) factors. A sustainable waste management system requires appropriate technical solutions, adequate and strong organizational capacity, and stakeholder cooperation and partnerships, with integrated treatment methods to manage waste across the WH. Such a system must incorporate good governance, sound institutions, proactive policies, economic affordability, environmental efficiency, social acceptability, and public participation, where citizens can communicate and take part in planning, monitoring, and other decision-making processes.

Systems must be market oriented, with flexibility for continued improvement, and tailored to community needs on a case-by-case basis. Sustainable systems must also initiate collective actions, promote transparent decisions, and provide free access to information. The system must further empower the capacities of public and private stakeholders, incorporate appropriate local community perspectives and needs, and encourage networking at local, regional, and national levels. Influencing factors (e.g., technical, sociocultural, political, environmental, financial, economic, legal, and institutional) must also be interlinked and implemented in unison.

Governance, policy, and regulation. Ideally, governments strongly enforce waste management service provisions and/or regulations in communities, regardless of the public ability to accept or afford waste fees. Clean cities or communities exhibit good waste management frameworks and governance. Good governance should be participatory, consensus-oriented, accountable, transparent, responsive, effective, efficient, equitable, and inclusive while supporting and respecting the rule of law and human rights. Such governments also serve stakeholders irrespective of race, gender, economic status, religion, or political ideologies, and encourage dialogues on public issues. In such systems, transparent public information flow exists, and free participation and collaboration are encouraged, especially during decision-making.

In the Global South, many countries are creating waste management supporting policies and frameworks. For example, China and Colombia, India and South Africa, Brazil, and Turkey have extended producer responsibility, guaranteed fixed budgets, and regulated waste management guidelines. In Uganda and Botswana (Gaborone), the decentralization or privatization policy mandates urban councils to make by-laws and engage private sectors through contracts. In Rwanda, the public–private partnerships align with strong proactive policies, governance, and zero tolerance for corruption. Rwanda also enforces a national plastic bag ban using border patrol guards to prevent illegal imports, with penalties, including fines, jail time, and public shaming. Morocco adopted a strategy for sustainable development, making environmental sustainability a national priority.

Finance and economics (local, national, and global). Effective and sustainable waste management systems offer acceptable and affordable services to all stakeholders. But a system's sustainability also depends on stakeholder willingness to respond to issues and funding ability. This ability of stakeholders to pay is determined by their economic status, which also influences waste collection service fees, frequency, nature of collection, and disposal sites. In the Global North, waste service users are generally more willing and able to pay collection fees than their counterparts in the Global South. For compliance, some governments have devised approaches, such as tagging charges to rent fees, property taxes, product fees, utility bills, or waste quantity as well as providing government allocations or incentives for the separation of recyclables. In China, collection fees are recovered from central government allocations; in Zambia (Lusaka) from the franchise fees, and in Brazil (Belo Horizonte) from municipal property taxes. Governments in China and India also charge low waste collection fees with no penalty for nonpayers. In Brazil (Belo), the government pays 100% of the waste collection fees and incorporates that cost into utility bills. In Tanzania (Moshi) and Nepal, poor urban households are not charged. In Rwanda (Kigali), fees to households depend on income, with the poorest communities getting free service. In some Kenyan, Tanzanian, and Ugandan communities, the elite users are willing to pay for waste management services. The inability of some central governments to provide sufficient financial support results in inadequate and irregular income sources, limiting industrial waste management sustainability. Many countries in the Global South depend on donor grants and loans to establish waste management projects and obtain technologies. Such costly technologies and the inability or reluctance of users to pay for services create unsustainable systems, undermining project success and triggering recurring waste challenges. This explains the different waste service coverage in countries of the Global North

(100%) and Global South. Effective consultation with service users, providers, and other enablers from the inception phase results in appropriate requirements and cost–benefit analysis for system components. Using consultation, Brazil, Nepal, Malaysia, Zambia, China, and Tanzania have effectively engaged local stakeholders in managing their waste streams, sometimes without donor funding. Nepal has well functioning waste systems, and charges no fees on household service despite not receiving external funding.

In Russia have a lot of recycling disposal methods. In general, open dumping is the most prevalent disposal method in the majority of Russian cities, particularly small towns. In this method, wastes are disposed of in a manner that does not protect the environment, are susceptible to open burning, and are exposed to the elements, vectors, and scavengers. The other cities (especially large cities) use controlled landfills, which is a significant improvement on the communal open dump. The area is fenced to control access, and the waste is covered with soil at the end of each day. This prevents the waste from being blown around, stops flies from breeding on the waste, makes it less accessible to scavenging animals, and prevents the waste from catching fire. A controlled landfill site is staffed, and some machinery (such as a loader) is available to spread, compact, and cover the waste with soil. The other methods (recycling, composting, and incineration) have a very small share of the current waste management system in Russianian cities due to a lack of effective source separation plans.

The most important bottlenecks and shortages of waste disposal systems in Russia can be categorized as follows:

- Lack of precision and data on waste characterization (especially waste composition)
- Inefficient source separation systems, which in turn hinder the utilization of methods with a high rate of material recovery (especially recycling and composting)
- Insufficient financial sources to cover the cost of new technologies
- Inappropriate supervision of waste disposal sites by Russian's Department of Environment as a supreme authorized organization
- Absence of reasonable and scheduled national targets for landfill diversion The simplicity of implementation and operation, as well as the lower cost, have made landfilling the main method of waste disposal in Russia (about 88%).

However, new treatment and disposal technologies must be considered to move toward landfill diversion. New process and treatment technologies must be selected based on waste characterization and current bottlenecks and shortages in waste management systems in each area. The heterogeneous nature of generated waste in cities and the failure of source separation plans necessitate using preprocessing technologies at the entrance of waste disposal complexes. It must be considered that the insufficient efficiency of these facilities does not allow the use of highly sensitive technologies against mixed waste streams such as plasma or pyrolysis. But different kinds of sieves with various hole sizes can be helpful to separate recyclables from putrescible waste. Regarding the high percentage of organic materials in the waste stream (about 70%), a digestion-based method such as compost or anaerobic digestion can be used as the main method for putrescible waste (such as food waste). However, land requirements can restrict these methods in some regions due to limitations on land availability. In this situation, thermal technologies such as incineration can be considered as a solution to avoid landfilling and convert waste to energy. In this regard, biodrying can be applied as an appropriate preprocess method to reduce water content and increase the calorific value of industrial waste before feeding incinerators. Refuse derived fuel (RDF) from non-organic waste is another notable technology that helps increase landfill diversion as well as decrease consumption of non-renewable fossil fuels in different industries, such as cement factories. Clearly, a final decision on the selection of suitable technologies for waste disposal must be made based on the socioeconomic and physical situation in each city.

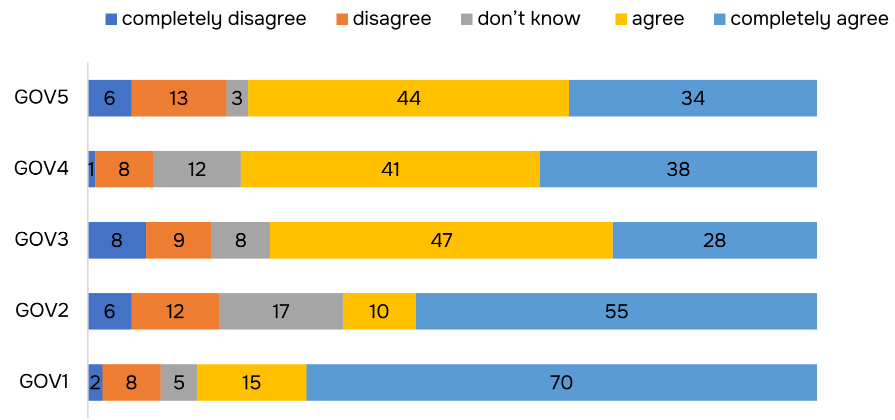

Figure 6. Percentage of confirmation on a 5-point scale.
Source: compiled by the author.
Note:
$GOV_{1.}$ – Exemption from taxation of transactions from sales of industrial materials for the purpose of their disposal;
GOV_2 – Creation of green technology parks;
GOV_3 – Mandatory use of industrial waste or products based on industrial waste within an effective distance when implementing contracts for state and municipal needs;
GOV_4 – Preferential loans for the implementation of technologies aimed at increasing waste disposal volumes;
GOV_5 – Budget funding for R&D in the development of industrial waste recycling technologies.

Public subjective evaluation of governmental environmental governance is an important indicator of satisfaction with environmental governance, and the public's assessment of the government's environmental governance predicts public emissions behaviors obtained information on satisfaction with environmental governance using the following Likert scale question: Do you think the local government has done a good job in protecting the environment and controlling pollution? The interviewees replied "terrible", "bad", "neutral", "good", or "excellent" and assigned a value of 1–5, respectively. The Likert scale is a measure used to assess a subjective attitude toward an opinion or phenomenon (Likert, 1932). The idea is to categories the subjects' attitudes towards an issue into five levels, which are "strongly disagree", "slightly disagree", "neutral", "slightly agree", "strongly agree", and assign the values 1–5 to each. A higher score indicated higher satisfaction with environmental governance. The analysis results are shown in Figure 6.

Among the measures to stimulate the involvement of industrial waste in economic circulation, the following can be highlighted: development of a strategy in the field of industrial waste disposal, economic incentives, information support, support for the development of new technologies for industrial waste disposal.

Conclusion

The study concluded that to improve the waste management system is to introduce industrial waste management schemes involving them in proper waste storage, collection, segregation, and recycling activities. What risks arise when recycling waste and how does this affect the social, environmental and technological spheres, as well as government support for waste recycling.

Methods that create opportunity is the circular economy, which encourages the reuse of materials and lowers production and consumer waste. Improper management of waste and pollution in major cities contributes to environmental degradation, public health issues and frightening environmental problems in the world. The circular economy is the economic activity which minimizes the negative impacts the economy has on the environment and is one important component of the sustainability process. Sustainable waste management is required in the world's main cities due to the requirement for environmental management, waste recycling, and alternative energy sources.

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