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Measures to stimulate the recycling of industrial waste

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The growth of varies industries creates an increasing level of generated industrial waste. The limited implementation of ISO 14001 in the Russian industries might indicate the limited implementation of waste management based on sustainability principles. Therefore, this study aims to explore the how to stimulate waste management and utilization in varies industries.

Introduction

Population growth, unsustainable consumption patterns and the current profit-driven linear economic systems result in uncontrolled solid waste production. The world's waste generation is expected to increase by 70% by 2025 and industrial waste-related emissions are expected to total 2.38 billion tons of CO_2 equivalent by 2050. This has the potential to cause serious environmental, economic, and social implications. Hence, to effectively handle this multifaceted problem of industrial waste, a decoupling of the current linear economy model and a subsequent shift to a tight-loop economy is required. Authors [1; 3] opined that such a transformation will speed up the process of achieving Sustainable Development Goals (SDGs).

Industrial waste management services primarily encompass activities such as waste collection, transportation, and treatment. These services hold significant importance in maintaining the cleanliness of tourist regions, thus serving as a crucial component. Consequently, they also contribute to the sustenance of economic and social dynamics within tourist destinations.

Methodology

In this study, the results obtsined from a survery conducted with experts related to industrial waste management in 338 Russian industries such as energy, textile, metallurgy, petrochemical and construction. This study consists of 3 main parts. Exploring concepts to stimulate industrial waste management and recycling, the study of the instruments used to encourage waste recycling and the study of risks.

In today's world, there is an increasing concern about the rate at which we are consuming the earth's resources. The traditional linear economy, based on a "take-make-dispose" model, is no longer sustainable [6]. It is now widely acknowledged that we need to shift to a more circular economy that aims to reduce waste and create

more sustainable products and processes. A circular economy is a system that aims to keep products, components, and materials in use for as long as possible, maximizing their value and reducing the amount of waste generated.

By experimenting with various local and foreign researches [2; 4; 5], the author studied several different concepts of waste management, the following section shows about those concepts. Table 1 shows industrial waste concepts.

Various concepts have emerged to encourage waste recycling but the end result is to improve the efficiency of waste management.

Decentralized waste treatment systems provide a customized, locally driven approach to waste management, ensuring that solutions are in line with the particular requirements and circumstances of each location. Decentralized waste management is an example of a locally driven, sustainable system. It acknowledges that the waste issues that various areas deal with are as varied as the communities themselves. Therefore, it aims to enable neighborhood communities, local governments, and even specific homes to assume control of their waste-related duties. The flexibility, adaptability, and reactivity of decentralized waste management are its defining characteristics. It customizes trash solutions to the particular requirements and traits of each locality, maximizing resource allocation and minimizing environmental effect. By integrating citizens in waste sorting, recycling, and composting initiatives, this strategy also promotes community engagement and environmental awareness. Decentralized waste management helps to lower carbon emissions and conserve resources by minimizing the need on centralized facilities and extensive transportation networks. Additionally, it supports local self-sufficiency and resilience while aligning with the larger objectives of sustainability.

The author classified various tools used for stimulate industrial waste management and recycling. These tools are divided into two main categories as economic tools and other tools and after interviews with experts the methods used to encourage waste management using these tools were named. Table 2 presents economic instruments and incentives for recycling industrial waste.

The author further classified the tools into five categories and suggested the following ways to improve the tools. Such as Regulatory, Organizational, personnel, informational, innovative.

Regulatory – Tightening existing rules for waste management, bringing a law that industries must use a certain amount of secondary raw materials in the production of something.

Organizational – Develop various programs and online platforms to improve existing linkages between industries and recycling organizations.

Personnel – Providing financial and emotional incentives to people engaged in waste management. Especially providing free opportunities to look after their health.

Informational – In short, this tool aims to make the public, industries aware of the importance of waste management.

Innovative – Creation of various innovative methods and laboratory facilities.

As people become more educated, they become more aware of the environmental dangers of excessive waste generation. If this proposition holds, cleaner environments would enter their utility function and rank high on their list of preferences, which would help adjust their behaviors by reducing waste generation and/or engaging in more recycling services. Unfortunately, our results indicate otherwise. This emphasizes the need for recycling education to be incorporated into our educational systems so that individuals can be fully cognizant of waste disposal effects on the planet and accept the mantle of responsibility to do something about it, even if it entails major lifestyle adjustments. Previous research has shown that recycling and waste management educational programs have a positive impact on reducing waste generation and disposal.

Informal workers typically participate in the sector

Table 1. Industrial waste concepts.

concept	Efficiency of concepts
concept of ownership	With this concept, the businesses or organizations that generated the waste are responsible for the waste until it is sent for waste management or recycling. Because of this, businesses are responsible for their own waste
zero waste	The concept aims to eliminate waste completely using various strategies. As a result, the country is moving towards circular economy.
Product stewardship	With this concept, the businesses or organizations that generated the waste are responsible for the waste until it is sent for waste management or recycling. Because of this, businesses are responsible for their own waste
Waste hierarchy	This concept aims to the waste management methods.
Precautionary concept	This concept is environmentally friendly. In this concept, the laws affecting waste are studied and as a result, the responsibility of not releasing harmful waste into the environment is dealt with.
circular economy	This concept refers to the effect of waste management on the country's economy and business efficiency. This has an impact on the competitiveness of businesses as it increases the variety of innovations made by using waste. The CE concept emphasizes the need for collaboration among stakeholders, such as universities, students, staff, and local communities, to create a sustainable and circular waste management ecosystem.
industrial symbosis	This concept observes the exchange of waste by various industries. Cooperation between industries can be improved and thus a market is created for secondary goods produced from waste.
upcycling and downcycling	This concept refers to the existing demand for products made from waste. Here, the demand for waste determines the price.
waste to energy	This refers to the concept of generating electricity using waste. This concept confirmed that generating electricity from waste greatly affects the economic efficiency of the country.
sustainability	Decentralized waste management

Source: compiled by the author.

due to poverty, so they are vulnerable to financial exploitation. For example, these actors collect wastes, such as plastics, to sell to material aggregating intermediaries who subsequently sell to processors or recycling companies. Aggregators often pay extremely low rates. for the materials, which do not reflect the true cost of the labor involved. so, teaching them how to make products out of waste (e.g., jewelry) to sell at markets to improve earnings.

Participants put forth that some level of formalization is needed to prevent exploitation of these workers. For example, strategies could include incentivizing registration; creating transfer stations for waste sorting and exchange; and, setting minimum pricing. There are potential benefits for the government too (e.g., revenue collection) but formalization may not always be appealing for informal actors given top-down monitoring implications.

According to the survey experts gave ratings of these six types of tools, and the results are explained using the median range.

Concluding, after the calculations, we can say that, according to experts, it is worth paying special attention to economic, innovation and personnel tools.

Recycling enterprise refers to the industrial waste classification, recycling, resource processing and reproduction of professional industrial waste treatment company, is one of the core enterprises of cross-regional industrial waste disposal. In the process of cross-regional industrial waste treatment, the site of recycling enterprises in developed areas is insufficient, which is difficult

Table 2. Economic instruments and incentive measures.

Economic instruments	Stimulating measures
Funding and subsidies	The main point is that the government supports the waste recycling institutions in purchasing the equipment to use the new technology.
Tax benefits	Tax breaks for waste recycling enterprises
Deposit and return systems (DRS)	Implementation of programs such as financial incentives and guarantees for bringing used waste to recycling centers.
Pay as you throw	Paying a tax on dumping waste into the environment. Encouraging workers in industries not to throw these wastes into the environment
Green procurement policy	Providing subsidized incentives to individuals and businesses that manufacture various products using waste.
Credit programs for recycling	Creation of a market for products obtained from waste processing for the sale of waste to other enterprises and individuals.
Discounts on tariffs and commissions	Taking action to reduce the cost of transporting and storing waste for collection
Financing	Encouraging investors to make financial investments in waste recycling companies should attract their attention by implementing various programs.

Source: compiled by the author.

Table 3. Calculation results using the arithmetic mean method and the median method.

number	A	B	C	D	E	F
Average Rank	0,104	0,177	0,177	0,161	0,229	0,141
Medians of ranks	2	4	4	3	5	2
final rank by medians	1	4	4	3	5	2

Source: compiled by the author.
Note: A — economic instruments; B - Regulatory; C — organizational; D — personnel; E — informational; F — innovative.

to meet the needs of industrial waste treatment generated by the rapid development of cities, while the site of recycling enterprises in underdeveloped areas is sufficient, but the processing equipment is relatively backward. If the recycling enterprises of developed areas and underdeveloped areas cooperate efficiently, it can effectively solve the industrial waste treatment problems faced by different regions, promote the sustainable development of the recycling market, and help the construction of urban ecological civilization. In the cross-regional cooperation market, numerous recycling enterprises cooperate to form a collaborative network model of multi-agent interaction, which can effectively break the boundary restrictions of enterprises and realize resource complementarity, both risk and benefit sharing. However, industrial waste treatment standards of recycling enterprises in different regions and demands of various stakeholders driven by reciprocity and opportunism are different, which seriously hinder the cooperation between enterprises.

The author classified the risks to waste management into six categories. That is, economic, social, technical, environmental, political and managerial. The following section provides expert responses to each of these risk mitigation analyses.

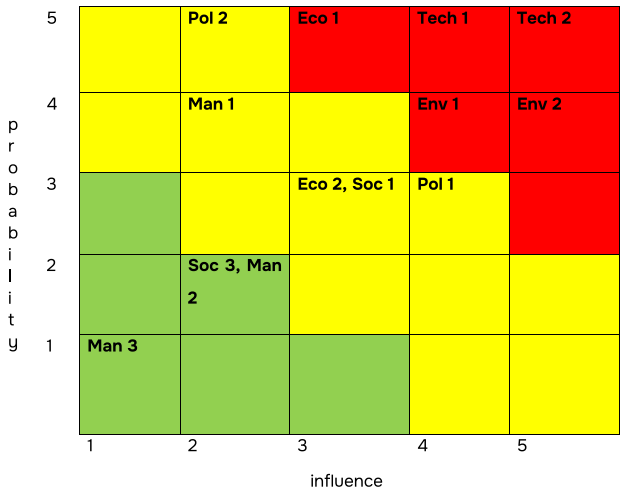

Figure 1. Probability and consequence matrix. Source: compiled by the author.

Table 4. Risk analysis.

Type of risks	Risk reduction measures
Eco 1. Increased costs for waste treatment plants	Government and private sector cooperation, providing subsidies to waste recycling companies
Eco 2. introduction of additional fees (taxes) for waste processing enterprises due to their harmful impact on the environment	Cancellation of existing taxes on waste recycling establishments
Soc 1. Declining demand for recyclable waste leads to job losses in waste management industry	Educate employees for waste management, develop a program to exchange ideas of employees between industries.
Soc 2. number of health care visits to hospitals for respiratory illnesses as a result of unaddressed air pollution	Setting up safe centers for collection of waste, using non-intrusive route for transportation of waste
Soc 3. lack of education and awareness in waste management	Setting up labs for students in universities to conduct experiments on secondary products made from waste.
Tech 1. 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.	Encouraging industries to use foreign technology to manage waste, creating digital platforms.
Tech 2. Reducing the volume of domestic R&D spent on the disposal and processing of industrial waste	Providing support to the government to carry out experiments and preparing a platform for the exchange of knowledge of employees working in foreign industries
Env 1. Increased dusting of industrial waste	Providing subsidies by the government to develop the infrastructure of businesses.
Env 2. Increased environmental damage to land plots taken out of economic circulation due to an increase in the amount of buried waste	Use of different methods to manage waste, tightening of legal regulations on landfilling.
Pol 1. Barriers to the international industrial waste management market	Providing opportunities by the government to develop international relations.

Continued on next page

Table 4. Risk analysis. (Continued)

Type of risks	Risk reduction measures
Pol 2. Lack of proper legal system for each type of waste	Modification of existing laws and regulations for waste management
Man 1. Ineffective logistics management for waste management (collection and transportation)	Using digital technology to manage waste and reduce the cost of waste collection.
Man 2. Receiving inaccurate information or missing information on waste recycling	Providing information on all available wastes in one web network.
Man 3. Reluctance of industrial enterprises to reuse industrial waste	Sensitizing the higher authorities in the industries about the productivity gains from waste recycling.

Source: compiled by the author.

Based on the survey results, the author built a matrix of probabilities and consequences, and then analyzed measures to eliminate this negative consequence according to experts.

According to an expert survey, the main risks associated with the high degree of involvement of industrial waste in the economy are related to the economy, environment and technology. This result shows that the problem being studied is cross-sectoral in nature. The fact that economic risks matter only in the economy of individual entrepreneurs engaged in the production of products explains why they are of greater importance.

The escalation in waste generation is inevitable. The old paradigm of 'collect-transport-disposal' (end-of-pipe concept) waste management and the use of poorly managed facilities and informal uncontrolled dumping or open waste burning occurs frequently in cities in Russia. In developed countries governments have developed various programs and policies regarding waste that reflect the government's awareness of the threat and environmental effects of the waste problem. The choice of waste treatment strategy for a specific city remains one of the most complex challenges in waste management. Environmental, social, and economic considerations must be thoroughly assessed to ensure an integrated and truly sustainable approach, aiming for a cleaner and more resilient future.

Unfavorable economic effects result from lopsided waste management practices. The expense of cleanup and upkeep for local governments and businesses is increased by ineffective garbage disposal systems. Instead of funding vital infrastructure projects and public services, the funds used to manage trash could be better spent elsewhere, impeding the growth of the economy. The detrimental effect also affects property values and tourism. Local companies and localities see a drop-in revenue when visitor appeal is harmed by inappropriate rubbish disposal. Insufficient recycling and landfill space exhaustion lead to higher disposal fees, which burden local governments and taxpayers. Additionally, the economy is further strained due to the degradation of land and water resources by improperly managed garbage.

Industrial waste and its management, which is everyone’s responsibility, cannot be attributed solely to the responsibility of local authorities. The protagonists that generate waste must be the same people responsible for its management, that is, society, public administrations, private initiatives, and even tourists. Gradually, From the moment experiences of waste management are shared collectively, socio-ecological methods can be incorporated to encourage commitment and reciprocity to preserve the environment and improve the quality of life of local people., that is, the sustainable one. The next step to identify the criteria’s that stimulate waste recycling according to energy, textile, metallurgy, petrochemical and construction industries.

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