



Investigation of Improving Measures in the Iranian Plastic Waste Management System to Determine Gaps and Formulate Future Strategies

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Article Info	ABSTRACT
Article type: Research Article	Effective plastic waste management is a critical challenge in achieving sustainable development. This study evaluates the gaps in Iran's plastic waste management system through the lens of Environmentally Sound Management (ESM) principles, with a focus on enhancing its sustainability and alignment with international standards. The Basel Convention Toolkit was utilized as the primary framework to assess ESM components, including waste prevention, minimization, reuse, recycling, and energy recovery. Two customized questionnaires were developed, validated using the Delphi method (by participation of 10 experts), and tested for reliability with Cronbach's alpha values of 0.85 (ESM) and 0.9 (SWOT). The Green Productivity Methodology was applied to systematically identify gaps and formulate actionable strategies. Main causes of gaps were explored using Ishikawa diagrams, which revealed critical issues in regulatory frameworks, technological adoption, financial resources, and public awareness. Additionally, a tailored SWOT analysis evaluated internal and external factors affecting the waste management system, highlighting strengths (e.g., legislative frameworks), weaknesses (e.g., operational inefficiencies), opportunities (e.g., technological advancements), and threats (e.g., not integrating the formal and informal sectors of waste management). Based on the findings, 34 strategic recommendations were proposed, including the integration of formal and informal waste management sectors, promotion of advanced recycling technologies, establishment of supervisory structures, and implementation of awareness campaigns. These strategies aim to address the identified gaps, optimize the system's performance, strengthen its resilience, and enhance its compliance with global sustainability standards. This study offers a comprehensive analytical framework and actionable insights that can serve as a model for improving plastic waste management systems in similar contexts.
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INTRODUCTION

Plastic waste has been recognized as one of the most critical environmental challenges (Ali et al., 2021), affecting all life forms, natural ecosystems, and the (Rodic & Wilson, 2017) community sustainability (Wilcox et al., 2015; Kaiser, 2010; Geyer et al., 2017). The global production, consumption, and disposal of plastics—particularly single-use items and packaging—have increased over recent decades at a pace unmatched by global waste management (Alhazmi et al., 2021) systems (Borrelle et al., 2020; Jambec et al., 2015). According to a recent estimate, between 19 and 23 million tonnes, or 11 percent of the plastic waste generated globally, entered

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aquatic ecosystems in 2016 (Edelson et al., 2021). The same study predicts that this leakage will increase to between 20 and 53 million tonnes annually over the next decade, despite ambitious efforts to reduce plastic leakage (Walker & Fequet, 2023). Now, waste management systems seriously need new ideas and innovations by collaboration of governmental and private sectors, especially in developing countries (Junejo et al., 2025).

Plastics are essential materials in modern civilization, and many products manufactured from plastics (Fayshal, 2024), in numerous cases, pose risks to human health and the environment (Proshad et al., 2018; Edvode et al., 2021; Pilapitiya & Ratnayake, 2024). At the 14th meeting of the Basel Convention, members approved amendments to the Convention's Annexes II, VIII, and IX to clarify its position on plastic waste. Plastic waste was added to Annex II, which focuses on household waste and waste resulting from the incineration of household waste, as this annex includes plastic waste and mixtures containing such waste. If these types of waste are hazardous, they are categorized as A3210 in Annex VIII; if non-hazardous, they are categorized as B3011 in Annex IX (Basel Convention Plastic Waste Amendment, 2019). The first step in managing plastic waste involves countries conducting self-assessments to evaluate their progress in promoting ESM, including waste prevention, minimization, reuse, recycling, and energy recovery at the national level. Documents prepared by the Secretariat of the Basel Convention provide a framework for reviewing ESM components and identifying gaps in sound waste management systems (UNEP, 2017). The results of these assessments can serve as valuable references for countries when designing national policies, offering a list of potential policy and regulatory approaches to promote and incentivize ESM practices in the waste management sector.

The SWOT matrix is a valuable planning tool (Yuan, 2013) used to analyze the strengths, weaknesses, opportunities, and threats of plastic waste management laws before formulating strategies (Longshenj et al., 2022). By identifying existing gaps in the plastic waste management system and assessing the strengths, weaknesses, opportunities, and threats of waste management laws, appropriate strategies can be developed to enhance the management of plastic waste.

In several countries, self-assessments of the status of ESM have been conducted at the national level under the guidance of the Secretariat of the Basel Convention. For example, an initial inventory of plastic imports was carried out in Nigeria to serve as a basis for more sustainable management policies (Babayemi et al., 2018). Similarly, a national inventory of plastic waste was developed in Bangladesh (Basel Convention, 2019), and efforts to promote ESM of plastic waste and prevent or minimize plastic waste generation were implemented in Ghana (UNEP & Basel Convention, 2019).

Studies have been conducted to determine the strengths, weaknesses, opportunities, and threats of the plastic waste management law using the SWOT matrix. Based on the results obtained, strategies have been presented to improve the waste management system, which can be mentioned as follows: In Indonesia, a study was conducted to determine waste management system strategies, with an emphasis on improving household waste management (Wilujeng & Rachmawati, 2023). In Iran, a similar study has been conducted regarding dry waste management and prioritizing the determined strategies (Majlessi et al., 2015).

This study aims to evaluate measures to improve the plastic waste management system at the national level, identify existing gaps and find their root causes. Then, with the help of SWOT matrix, strategies to cover these gaps are presented. In fact, we investigated the gaps in the waste management law in Iran from a new perspective, no study has examined these gaps in a process-oriented manner and this is the first study in this field.

MATERIALS AND METHODS

The study employed the Basel Convention Toolkit as the assessment framework. Approved

during the 2016 Conference of the Parties (COP) to the Basel Convention, this toolkit is an internationally recognized resource that provides practical guidance for assessing and improving waste management systems. It includes detailed methodologies and indicators for evaluating the components of ESM. Specifically, the toolkit was used to evaluate the adequacy of policies and practices for waste prevention, minimization, reuse, recycling and energy recovery.

By leveraging this toolkit, the study ensured a standardized and globally accepted approach to analyzing ESM components, enabling findings to be comparable with international benchmarks.

The study population comprised 10 highly qualified experts selected through a purposeful sampling method to ensure the inclusion of individuals with direct influence or specialized insight into Iran's plastic waste management system. Participants were chosen based on their professional qualifications, practical experience (at least ten years), and familiarity with relevant policies and frameworks (working/worked in governmental, non-governmental, or private waste management organizations). This deliberate approach ensured that the study captured diverse perspectives from key stakeholders while maintaining the relevance and depth of the findings. It is worth noting that if an expert left the group, another expert would be replaced using a snowball method.

A custom-designed ESM questionnaire was developed to gather expert insights on the current state of Iran's plastic waste management system. The questionnaire comprised 11 questions that were specifically designed to evaluate critical ESM components. The questions were structured to address the following key areas:

1-Waste Management Strategies: Assessment of the effectiveness and comprehensiveness of existing strategies for achieving ESM objectives, 2-Public Information and Awareness Initiatives: Evaluation of mechanisms to educate and inform the public about sustainable waste management practices, 3-Incentive Mechanisms: Analysis of financial and non-financial incentives provided to stakeholders to encourage environmentally responsible behavior, innovation, and compliance with regulations, 4-Economic Factors: Examination of measures to formalize informal waste management activities, ensuring their integration into the formal system to improve efficiency and sustainability.

To ensure the validity of the questionnaire, the Delphi method was employed. This structured, iterative process involved multiple rounds of feedback from a panel of environmental and waste management experts. The Delphi method allowed for: Refinement of questions based on expert input to ensure alignment with study objectives, Consensus-building among experts to validate the relevance and clarity of the questions and Incorporation of insights from diverse professional perspectives to enhance the robustness of the questionnaire.

The iterative nature of the Delphi process ensured that the final questionnaire was both precise and comprehensive, capturing all critical aspects of ESM.

The reliability of the ESM questionnaire was rigorously tested using Cronbach's alpha, calculated with SPSS software. The resulting reliability coefficient of **0.85** indicated a high level of internal consistency, signifying that the questions were well-aligned and produced dependable results. This reliability score is consistent with best practices in questionnaire design, underscoring the robustness of the data collection instrument.

The analysis of gaps in ESM components was conducted using the Green Productivity Methodology, a structured approach that integrates principles of environmental sustainability with productivity improvement. The expert teams evaluated the current state of ESM practices, identifying gaps in areas such as waste prevention, minimization, reuse, recycling, and energy recovery. These gaps were:

- Lack of mechanism for periodic review and update of the strategy of plastic waste management
- Lack of mechanisms for public access to waste management system information
- Non- cooperation with technical consultants

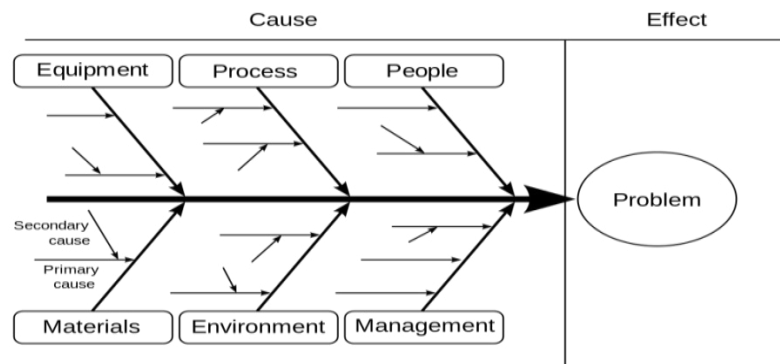


Fig. 1. Ishikawa diagram (Coccia, 2018)

- Lack of transparency in the collection and recycling sector to improve cost effectiveness
- Lack of communication channels with the informal sector
- Lack of economic and other incentives to formalize activities in the informal waste management sector

To systematically analyze the root causes of these gaps, the study applied the Ishikawa technique, also known as the cause-and-effect diagram or fishbone diagram (Luca, 2016; Cox & Sandberg, 2018). Developed in 1968 by Kaoru Ishikawa, this technique is one of the seven quality control tools used to identify relationships between different contributing factors (Coccia, 2018). The Ishikawa diagram visually represents how various factors contribute to a specific problem. The defect or issue appears as the fish head on the right side, while the main causes extend as ribs from the spine. Each main cause branches further into root causes, forming a structured analysis framework (Figure 1). This approach provides a clear, systematic method for identifying inefficiencies and guiding improvements in plastic waste management.

Ishikawa diagrams provided a visual representation of the hierarchical relationship between the identified gaps, their main causes, and the underlying root causes. The main causes were categorized into four key domains: 1-Management issues, including weak regulatory frameworks and poor coordination among relevant stakeholders, which hindered effective implementation of waste management policies, 2-Technological gaps, characterized by the absence of modern waste management technologies and insufficient adoption of innovative solutions, 3-Financial constraints, such as inadequate funding for essential waste collection, processing, and recycling infrastructure, which limited the system's capacity to operate efficiently and 4-Awareness and behavior, where limited public awareness and insufficient education on proper waste management practices contributed to the persistence of unsustainable behaviors.

By systematically mapping the root causes and their relationships, these diagrams ensured that the analysis was thorough and aligned with the overarching goals of environmental sustainability and productivity enhancement.

To conduct the SWOT analysis, a tailored 29-question questionnaire was developed to capture expert opinions on the internal and external factors affecting Iran's plastic waste management system. The internal factors section focused on identifying: The system's existing Strengths, such as legislative frameworks, institutional structures, and technical capacities and Weaknesses, including operational inefficiencies, resource limitations, and gaps in policy enforcement.

The external factors section evaluated: Opportunities, such as advancements in recycling technologies, potential international collaborations, and growing public awareness of environmental issues and Threats, including policy uncertainties, not integrating the formal and informal sectors of waste management, and socio-economic constraints affecting waste

management practices.

The Delphi method was employed to ensure the questionnaire's content validity and relevance. The reliability of the SWOT questionnaire was tested using **Cronbach's alpha**, calculated through SPSS software. The resulting reliability coefficient of **0.9** indicated a very high level of internal consistency, confirming that the questionnaire was a robust tool for collecting reliable and actionable data.

The SWOT analysis utilized a systematic scoring methodology to evaluate the internal and external factors affecting Iran's plastic waste management system. The overall weighted score for each factor was calculated by multiplying its weight by its assigned score. These weighted scores were then used to populate the SWOT matrix, which categorized factors into four strategic areas: 1-SO Strategies (Strength-Opportunity): Leveraging internal strengths to capitalize on external opportunities, 2-ST Strategies (Strength-Threat): Using strengths to mitigate or address external threats, 3-WO Strategies (Weakness-Opportunity): Reducing internal weaknesses by exploiting external opportunities, 4-WT Strategies (Weakness-Threat): Minimizing vulnerabilities by addressing both internal weaknesses and external threats.

RESULTS AND DISCUSSION

In Iran's national plastic waste management system, several gaps have been identified across various components. Under the strategy component, a significant gap exists titled "Mechanism for periodic review and update of the strategy," indicating the absence of any law or legal provision addressing this issue.

For the information/awareness-raising component, a gap was revealed in establishing a "Mechanism for appropriate public access to information concerning ESM," such as government records on waste disposal facilities, waste transport, inspection records, and notices of violations.

Two gaps were identified under the incentives component: first, the lack of favorable investment conditions to attract technical expertise; and second, insufficient transparency in the collection and recycling sector, which hinders cost-effectiveness.

Additionally, in the component related to economic and other incentives to transform or formalize activities in the informal waste management sector, two gaps were highlighted: first, the absence of effective channels of communication with the informal waste sector; and second, a lack of economic and other incentives to formalize activities within this sector. Table 1 provides a detailed summary of the gaps identified in the measures promoting Environmentally Sound Management of plastic waste in Iran.

After identifying the gaps, their causes were analyzed using the Green Productivity method and Ishikawa diagrams, as follows:

Lack of Mechanism for Periodic Review and Update of the Plastic Waste Management Strategy

The main causes of this gap are related to management, technology, financial resources,

Table1. The gaps identified in the sector of measures to promote Environmentally Sound Management of plastic waste in Iran

ESM Component	Description/Available legislation and regulation (Yes/No)
National waste management strategy	Mechanism for periodic review and update of the strategy/No
Information/ Awareness raising	Mechanism for appropriate access of public to information concerning ESM (e.g., government records on waste disposal facilities and waste transports, inspection records, notices of violations, etc.)/No
incentives	Favorable investment conditions to attract technical expertise/No Transparency in the collection and recycling sector to improve cost effectiveness/No
Economic and other incentives to transform or formalize the activities in the informal waste management	Channels of communication with the informal waste sector/No Lack of economic and other incentives to formalize activities in the informal waste management sector/No

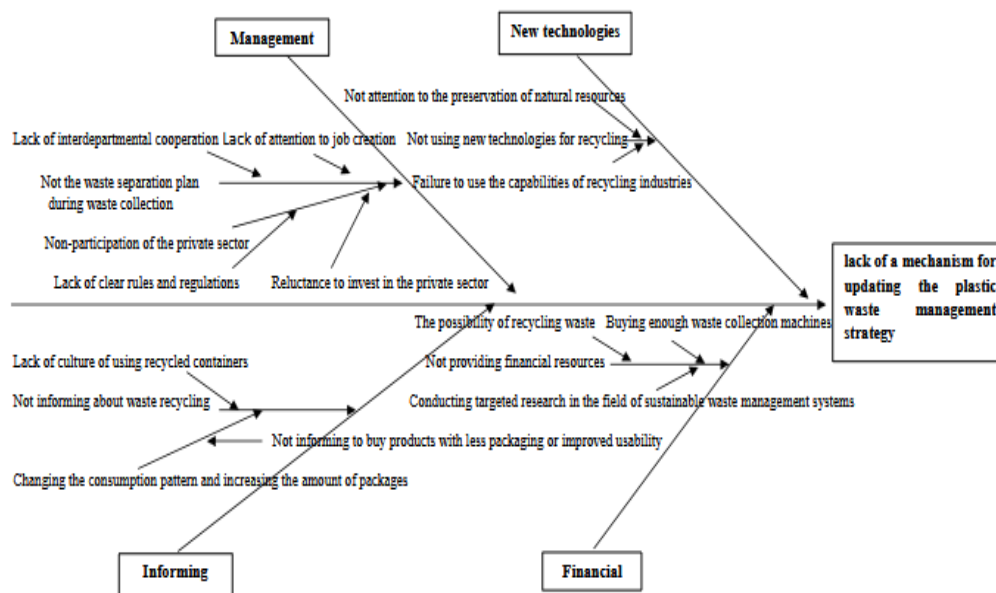


Fig. 2. lack of a mechanism for updating the plastic waste management strategy

and public awareness (see Figure 2). In terms of management, the primary issue is the failure to implement waste segregation during collection. All relevant organizations, including municipalities, waste management agencies, and environmental bodies, should adopt new waste management methods focused on productivity and resource management, which is achievable only through the separation of dry waste and recycling. The root causes of not adopting new technologies include neglecting natural resources and failing to utilize the capabilities of recycling industries (Vaez Maddani, 2017).

Financial constraints also contribute significantly to this gap. Specifically, there is a lack of funds to purchase the necessary waste collection machinery and to implement recycling measures. Public awareness is another critical factor; there is insufficient media advertising promoting waste segregation and reduction. Changing consumption patterns, population growth, and advancements in technology and the food industry have led to increases and changes in the quantity and quality of waste. Strategies for purchasing products with less packaging or reusable packaging are not adequately taught (Norouzi, 2018).

Lack of Mechanisms for Public Access to Waste Management System Information

As illustrated in Figure 3, the primary causes of this gap pertain to management and regulatory bodies. A significant management issue is the conflict of interest arising from undefined roles within the waste management structure. The analysis identified three distinct roles: 1) Executive The director represents the district municipality, while contractors handle operations and the Waste Management Organization supervises. Contractors face conflicts between maximizing waste collection versus promoting source separation, paying municipal rent while being barred from using informal labor, and paying rent while being prohibited from assigning service areas. The executive director struggles with balancing municipal duties against organizational interests, as well as performance evaluations based solely on waste tonnage. The Waste Management Organization fails in its oversight role by accepting contractor gifts and ignoring violations. Further weakening the system, regulatory bodies like the Department of Environment and municipalities provide inadequate supervision over waste management mechanisms (Source: "Situations and Examples of Conflict of Interest in the Waste Management Sector and Solutions to Address It," 2019).

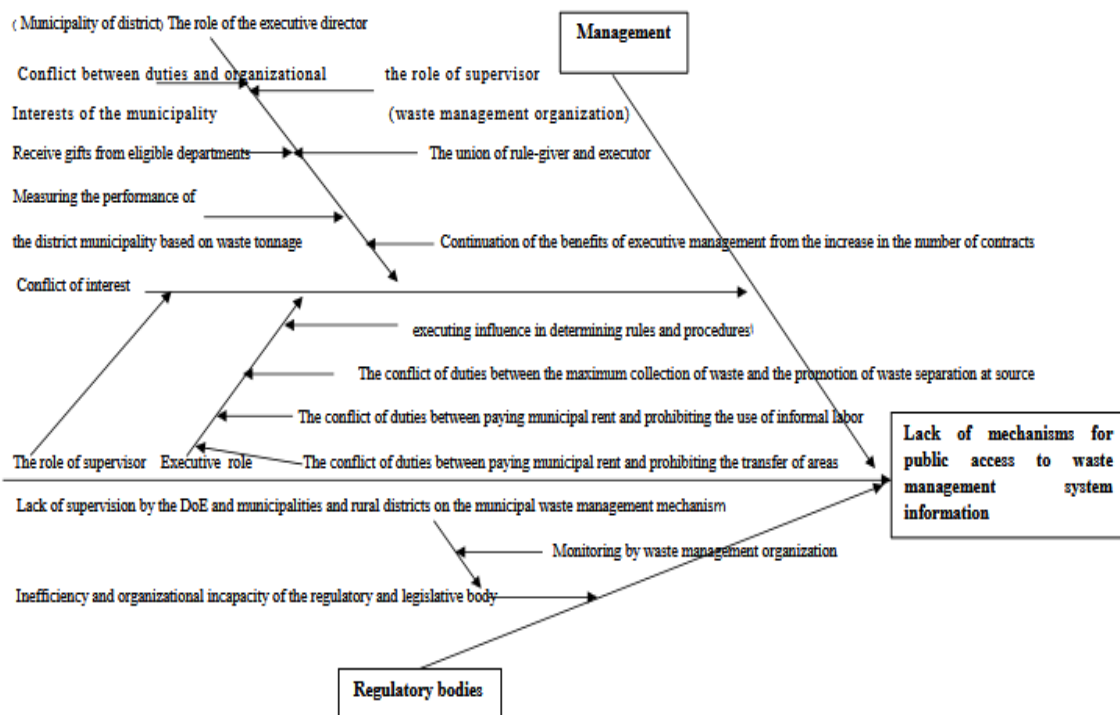


Fig. 3. Lack of mechanisms for public access to waste management system information

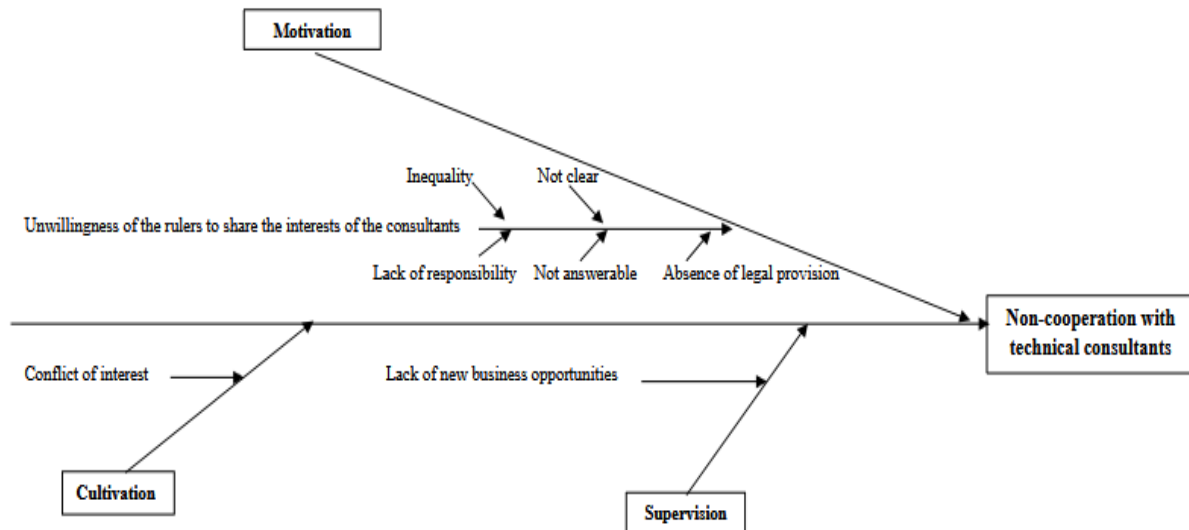


Fig. 4. Non-cooperation with technical consultants

Non-Cooperation with Technical Consultants

As illustrated in Figure 4, motivation is a primary cause of this gap. The unwillingness of authorities to share benefits with technical consultants is a significant factor. Root causes include a lack of transparency, inefficiency, inequality, irresponsibility, unresponsiveness, and the absence of legal provisions. Another major cause is inadequate information dissemination, primarily due to conflicts between the interests of authorities and citizens in the market sector. Secondary causes encompass non-transparent and non-competitive waste market relations. Lastly, supervision is a contributing factor, with root causes such as monopolistic

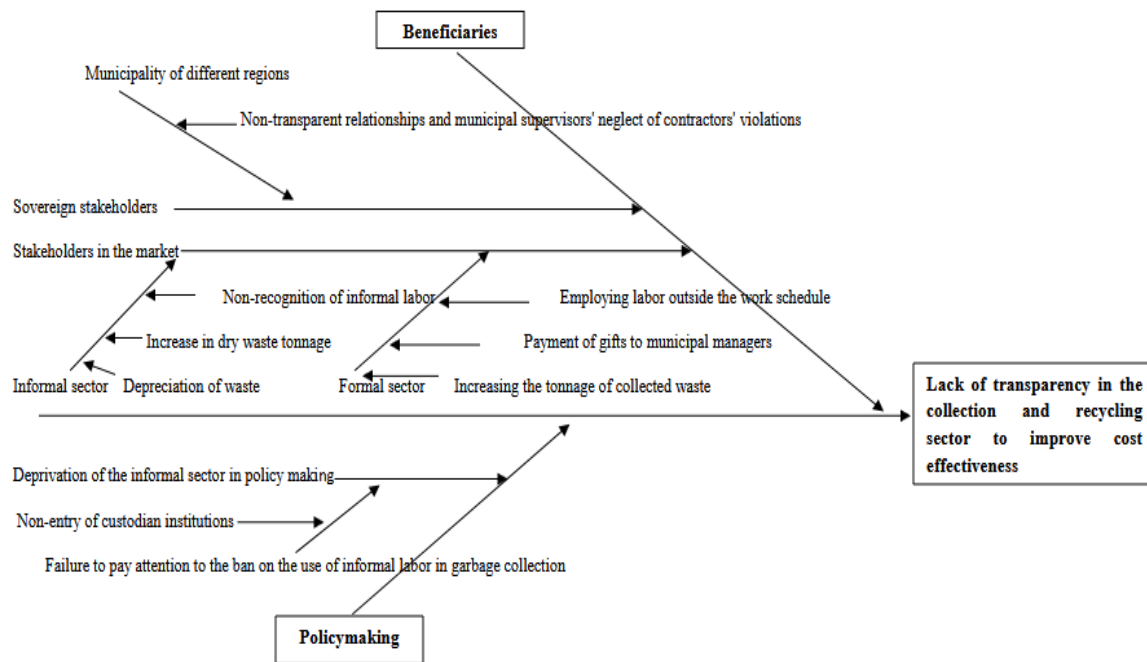


Fig. 5. Lack of transparency in the collection and recycling sector to improve cost effectiveness

and discriminatory practices, obstacles to the development of new businesses, and neglect of efficient roles.

Lack of transparency in the collection and recycling sector to improve cost effectiveness

Beneficiaries and policymaking are the main causes of this gap (Figure 5). Numerous organizations, groups, and individuals play direct or indirect roles in waste management, often with both aligned and conflicting interests. To accurately identify these dynamics, beneficiaries are categorized into three general groups: 1-**Sovereign stakeholders**, which include governmental organizations and institutions responsible for dry waste management, 2-**Municipalities**, the primary custodians of waste management. Their duties include: a. Monitoring contractor performance, b. Outsourcing executive tasks related to dry waste collection, and c. Implementing measures to ensure the health, hygiene, and safety of the workforce, 3-**Stakeholders in the market**, comprising the formal and informal sectors. The formal sector includes contracting companies that often employ informal and illegal labor outside the framework of Iranian labor laws. The informal sector consists of waste collection start-ups, recycling factories, illegal waste buyers, and garbage collectors. This sector increases the tonnage of dry waste while reducing waste collection costs in domestic markets.

Policymaking is another main cause of this gap. The root causes include the exclusion of the informal sector from policymaking processes and the failure to enforce bans on the use of informal workers in waste collection (Situation and examples interest' conflict in the waste management sector and solutions to deal with it, 2019).

Lack of communication channels with the informal sector

As illustrated in Figure 6, the main causes of this gap are deficiencies in policymaking, productivity, investment, and supervision. The failure to consider the informal sector in policymaking is a significant issue, rooted in the absence of legal provisions and non-comprehensive policies. Investment challenges also contribute to this gap, with obstacles

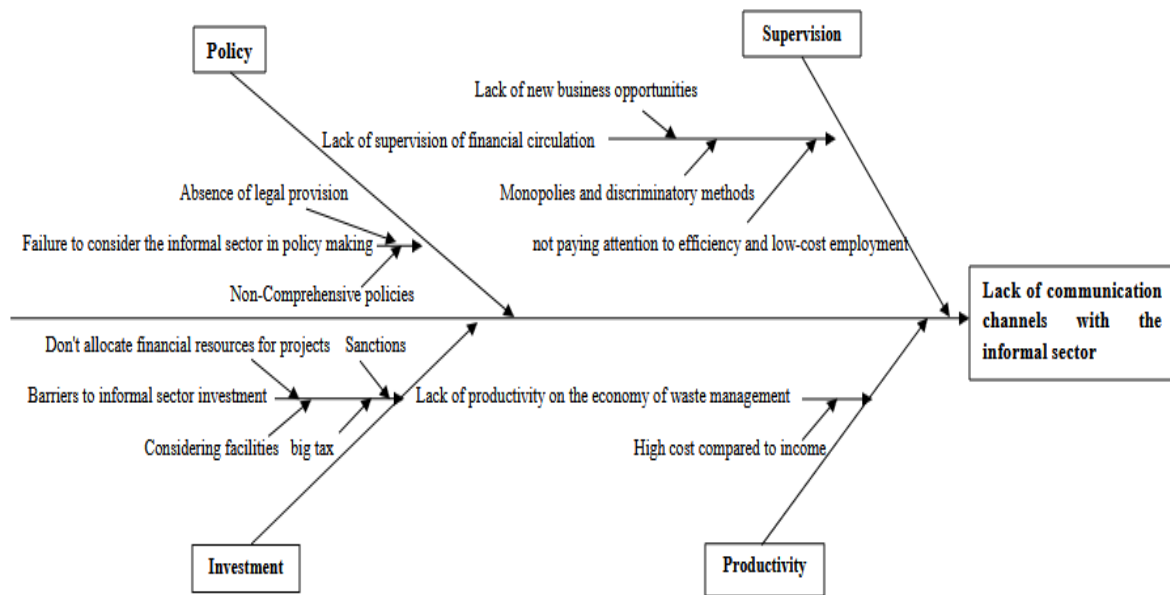


Fig. 6. Lack of communication channels with the informal sector

hindering informal sector investment. Secondary causes include the failure to allocate financial resources for project implementation, the impact of sanctions, high taxes, and the lack of supportive facilities.

Regarding productivity, a primary concern is the lack of economic efficiency in waste management, stemming from high costs relative to income. In terms of supervision, inadequate oversight of financial transactions is problematic. Root causes encompass a lack of attention to efficiency, reliance on low-cost labor, and insufficient opportunities for new businesses (Isari & Shojaei Zand, 2020).

Lack of economic and other incentives to formalize activities in the informal waste management sector

Conflict of interests and policymaking are two primary causes of this gap. The root causes of the deprivation of the informal sector in the waste management system include: (a) the absence of a legal provision addressing the informal sector in waste management law, (b) the lack of comprehensive waste management policies, and (c) the frequent changes to rules and regulations related to waste management laws (Figure 7).

Conflict of interests is another critical factor contributing to this gap. Contractors are tasked with two main responsibilities: collecting dry waste and promoting waste separation and reduction practices. However, these tasks are inherently conflicting. For dry waste collection, the municipality charges rent from contractors, with areas generating more garbage requiring higher rent. This rent reduces the contractors' profits, leading them to employ cheap labor from the informal sector to compensate for the financial shortfall. Furthermore, contractors' agreements with municipalities typically span only two years. Since educational efforts and promoting waste segregation practices yield benefits over the long term, contractors are discouraged from investing in these initiatives. Thus, the task of collecting as much waste as possible conflicts directly with the task of promoting waste separation practices.

Policymaking is the second main cause of this gap, with the lack of consistent and inclusive policies exacerbating the challenges faced by both formal and informal sectors in waste management (Isari & Shojaei Zand, 2020).

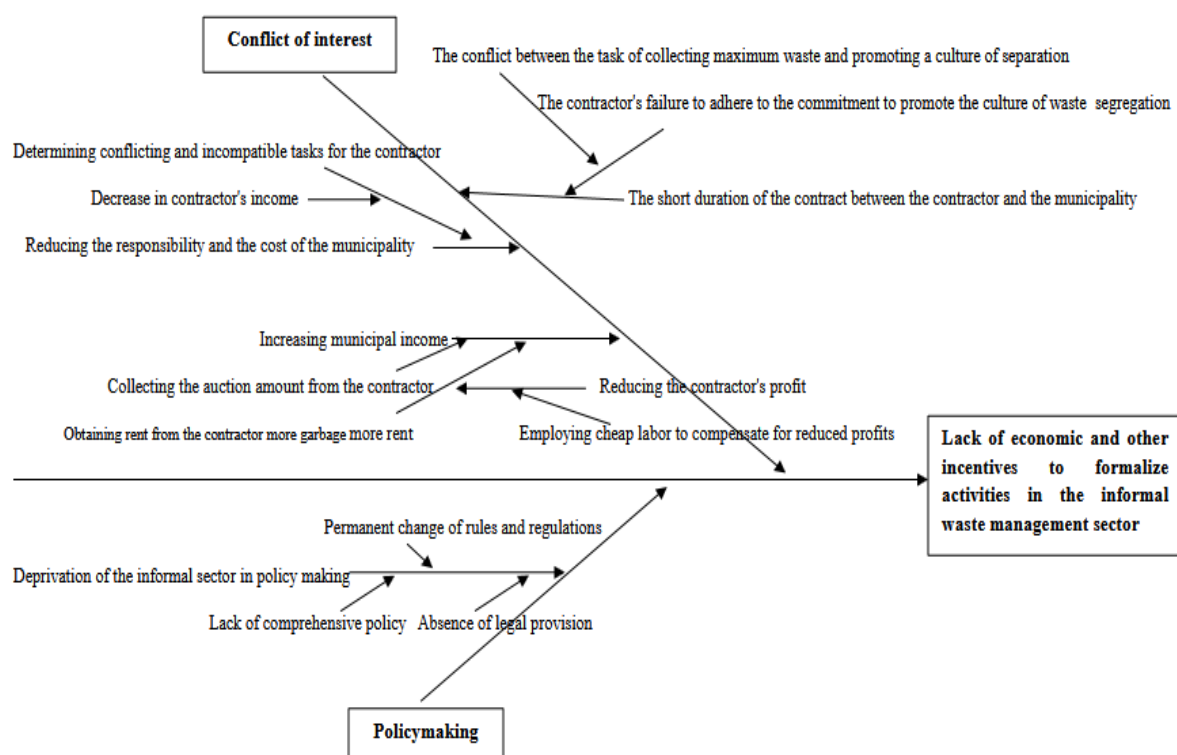


Fig. 7. Lack of economic and other incentives to formalize activities in the informal waste management sector

Internal and external factors of evaluation matrix of Iranian plastic waste management law

After determining and scoring the strengths, weakness, opportunities and threats of plastic waste management law, the matrix of internal and external factors was set up in Tables 2 and 3 as follows:

The final score of the Internal Factors Evaluation (IFE) matrix is 3.027 (greater than 2.5), indicating that the waste management system is strong in terms of internal factors. Similarly, the final score of the External Factors Evaluation (EFE) matrix is 2.855 (greater than 2.5), suggesting that the performance of the waste management system is acceptable in utilizing opportunities and addressing threats. Based on the pairwise comparison of internal and external factors, 34 strategies have been developed to improve the plastic waste management system, as presented in Table 4.

The results of the 2018 inventory of plastic waste in Bangladesh revealed several gaps in the country's plastic waste management policies and strategies (Basel Convention, 2019), including: (1) a lack of experience regarding the import and export of hazardous wastes, and (2) technical and legislative challenges in the environmental courts of Bangladesh. The second gap which identified in waste management policies of Bangladesh is in line with the results of the present study.

The objective of the Nigerian polymer study was to develop an initial inventory of plastics to serve as a foundation for creating an effective plastics management framework (Babayemi et al., 2018). The findings indicated that: (1) this first plastic inventory of an African country used a novel approach, analyzing international trade data of raw polymers and polymer-containing product categories to estimate total plastic volumes; (2) less than 12% of plastic waste was treated through recycling; (3) the use and production of virgin plastics are increasing; (4) there is currently no thermal recovery in Nigeria except for cooking; and (5) most plastic waste is burned

Table2. Internal Factors Evaluation Matrix

Strategic Internal Factors	weight	Rating	Score	Description
Strengths				
1-The effectiveness of waste management laws and regulations in improving their management.	0.1	4	0.4	The existence of preventive laws in the articles of the waste management law and the executive regulations (such as Article 12 of the Executive Regulations of the Waste Management law).
2-Formulation of required standards for plastic recycling, plastic products and biodegradable plastic products.	0.083	4	0.332	All manufacturers of biodegradable plastic bags are required to comply with relevant national or international standards for their biodegradable products.
3-Organizational structure of the Department of Environment in Iran for surveillance of proper law implementation	0.054	3	0.162	Setting up the comprehensive waste management system in the Department of Environment in Iran in line with the implementation of Article 32 of the Executive Regulations of the Waste Management Law.
4-The Laws and approvals related to the use of plastic bags.	0.082	4	0.328	Resolution of the Board of Ministers No. 133196/T 57096H dated 18/10/2022 regarding reducing the use of plastic bags (Articles 4 and 6 of the Waste Management Law and Articles 8, 12 and 15 of its regulations).
5-Taking advantage of the technical knowledge and expertise of experts in organizations related to waste management	0.081	3	0.243	Taking advantage of the technical knowledge of experts in organizations related to waste management is an important factor in the sustainable implementation of waste management laws.
6-Researches and studies in the field of plastic waste recycling (innovations).	0.1	3	0.3	Recycling innovations reduce the consumption of raw materials and preserve natural resources.
Weaknesses				
1- Failure to update the land fill site (for hazardous wastes and other wastes) regularly	0.037	2	0.074	Ignoring environmental criteria, lack of budget allocation and lack of new technologies.
2-The number of gaps in the waste management law	0.06	3	0.18	For example, the lack of a legal article related to the training of waste management informal sector.
3-Lack of transparency in the collection and recycling sector to improve cost effectiveness.	0.042	3	0.126	Deprivation of the informal sector in policymaking.
4- The disproportion of deterrence of fines and punishments determined in dealing with violators.	0.06	3	0.18	Enactment of the law without taking into accounts the criminal and deterrent rules and regulations causes procrastination of its audience.
5-lack of adequate tools (e.g., financial resources, software/hardware, analytical capability) to implement waste management laws.	0.04	2	0.08	Not using new technologies, not continuously evaluating activities based on strategies.
6- Lack of knowledgeable experts on environmental issues in the judiciary	0.05	3	0.15	Inadequacy of criminal response to crimes.
7- Lack of inspection related to hazardous wastes and their capacity.	0.041	2	0.082	Sampling, analysis, monitoring and verification of plastic waste in the environment, to support policymakers in measuring the impact of implemented targets and policies.
8-lack of supervision of waste management facility staff training	0.05	3	0.15	Ignoring the skills, knowledge and attitude of the staff from the aspects of management system requirements.
9-No decrease in demand for the production of primary plastic polymers	0.07	2	0.14	Reduced use of primary plastic polymers and increased use of recycled material would see a greater flow of plastic being cycled back into the economy as "secondary plastic", and would result in smaller inflows of new "virgin" plastic and fewer outflows into final disposal (with zero plastic leaking into the environment).
10- Not banning, or reducing the production, consumption and use of polymers with hazardous additives.	0.05	2	0.1	Chemicals used in plastics are a potential concern for human health and safety.
Total	1		3.027	

Table3. External Factors Evaluation Matrix

Strategic External Factors	Weight	Rating	Score	Description
Opportunities				
1- Strengthening waste management (options to promote EPR and activate the market for recycling according to the conditions of Iran)	0.3	4	0.12	Extended Producer Responsibility (EPR) schemes can make producers responsible for the environmental impact of their products throughout the life cycle, accelerating the market for waste recycling, incentivizing producers to create products with circularity in mind and reducing leakage of plastic waste into the environment.
2- Establish circularity criteria for design and production of plastic products and packages.	0.12	4	0.48	Improving the design of plastic products and packaging for recycling could expand the share of recyclable plastic by improving its profitability. It may be appropriate to delegate certain recycling activities to the informal sector and other activities to the formal sector. The goal should be to capitalize on efficiencies and take into account social and employment creation aspects while reducing occupational and environmental exposures to hazardous and unsafe materials.
3- Creating economic and other incentives to formalize activities in the informal waste management sector	0.09	4	0.36	To create new businesses, efficient and low-cost employment growth.
4- Creating favorable investment conditions for technical experts and using the capacity of scientific and research centers.	0.09	4	0.36	Conflict of interests in different parts of waste management.
5- Mechanisms for public access to waste management system information	0.06	3	0.18	Resolution of the Board of Ministers No. 133196/T 57096H dated 18/10/2022 regarding reducing the use of plastic bags in Iran.
6- Replacing the production of plastic bags with a thickness of less than (25) microns with environmentally friendly or biodegradable bags during a five-year plan, twenty percent (20%) annually	0.065	3	0.195	
Threats				
1- Not using new and appropriate technologies in waste management	0.09	2	0.18	For instance, support innovative wastewater treatment mechanisms to prevent the release of microplastics into waterways.
2-The extent and manner of granting facilities to units engaged in waste recycling.	0.07	2	0.14	Government-backed loans, low-interest loans, or subsidies are the first step in creating an Environmentally Sound Management plan.
3-Not integrating the formal and informal sectors of waste management and economic loss.	0.08	2	0.16	Establish guidelines to encourage investment in waste management infrastructure.
4- Failure to encourage foundations, individuals and businesses to make voluntary contributions to support initiatives aimed at combating plastic pollution	0.065	2	0.13	Payment of government subsidies and investments in this regard
5- Lack of arrangements to facilitate communication, coordination and cooperation between different national authorities involved in the implementation of waste management laws.	0.085	2	0.17	Lack of support from politicians (Development policies have priority over environmental considerations).
6-Not allocating financial credits to implement waste management projects in the country.	0.06	2	0.12	EPR can be an important financial source for the implementation of waste management projects in the country.
7-The ineffectiveness of officials in educating the public to reduce plastic consumption.	0.05	2	0.1	Due to the conflict in interests of different management departments.
Total	1		2.855	

Table4. Strategies of plastic waste management system

SO Strategies	ST Strategies
1-Development a legal mechanism and an appropriate guaranty in the Iranian National Waste Management Law in order to implement Article 12 of the regulation for producers of polymer materials.	1- Considering sustainable financial options through receiving taxes from producers of polymer materials by implementing Article 12 of the Waste Management Regulations for the implementation of waste management projects.
2-Tacking advantages of research center capacity in order to design and production of plastic products based on circular economy	2-Government financial support for plastic waste recycling units for researching on new recycling method
3-Utilizing the scientific capacity of technical experts to produce biodegradable plastic bags	3-Strengthening the provision structure of the Department of Environment in Iran to support policy makers from environmental consideration in policy making
4-Establishing the suitable supervisory structure in the Department of Environment in Iran to ensure public access to waste management system information	4-Government support for businesses to use recycled and biodegradable plastic product standards
5-Government support for investment on the scientific and researcher centers capacity to develop the required standards for recycled products	5- Government support for investment on innovation and new technology of plastic waste recycling
6-Integrating of formal and informal waste management sectors through associations, cooperatives and so on	6-Formulating guidelines for the integration of formal and informal sectors, taking into account social aspects and job creation with the help of expertise of organizations related to waste management
7-Offering economic incentives for plastic production manufacturers to activate the recycling market and reduce plastic bags consumption	7-Production of educational curricula on reduce plastic consumption and use of recycled plastic by Islamic Republic of Iran Broadcaster
WO Strategies	WT Strategies
1-Tacking advantages of the research center capacity in order to develop appropriate guidelines for the location of waste burial	1-Government support for investment on new technologies of waste burial location
2- Developing a sustainable model of communication between formal and informal sectors in reducing waste management costs	2-Development awareness raising strategies for waste management informal sector through associations and, cooperatives
3- Establishing proportionality between the amount and type of punishment for violators to reduce the risk of committing a violation	3- Financial support and tax exemptions for plastic waste recycling projects
4- Using the scientific capacity of research centers to use new technologies in the implementation of waste management laws	4- Continuous monitoring of the implementation of the waste management law and the necessary proportionality between penalties and crimes
5- Development of specific educational curricula for all employees of environmental courts and implementation of capacity-building programs with a greater focus on all relevant authorities	5- Government support for new technologies in implementing laws related to plastic waste management
6- Determining the competence to monitor and control plastic waste produced to strengthen waste management	6- Establishing environmental courts and hiring experts with knowledge of environmental issues
7- Increasing the expertise of waste management system staff	7- Allocating financial resources for implementation of plastic waste management projects and analyzing of their results
8- Attention to environmental issues in policymaking for plastic waste management and modification of the framework of waste management laws	8- Allocating financial resources from the income of the EPR system to improve the capabilities of waste management system staff
9- Development of criteria for circular economy on design and manufacture of plastic productions for increasing recycled plastic consumption	9-Creating financial incentives for plastic product manufacturers to use recycled plastics instead of primary polymers with the aim of combating plastic pollution
10- Offering incentives for manufacturers of plastic products to manufacture environmentally friendly plastic bags	10-Establishment of EPR system for polymer manufactures to invest in recycling equipment

in the open, released into the environment, or ends up in dumpsites, often subjected to open burning with associated environmental releases. The study conducted in Nigeria with the aim of developing more sustainable plastic waste management policies shows that this inventory is a prerequisite for developing national strategies related to plastic waste management. Therefore, the results of this study are in line with the results of the present study.

In Ghana, a project similar to the one conducted in Bangladesh was carried out in 2018, yielding the following results (UNEP & Basel Convention, 2019): (1) gaps in waste management regulations, strategies, and policies, including deficiencies in specific waste classification regulations and methods; and (2) shortcomings in the informal waste management sector, particularly in door-to-door collection, transportation, treatment, and disposal facilities. The two gaps identified in the waste management regulations of Ghana are similar to those in the present study.

After evaluating the strengths, weaknesses, opportunities, and threats of an organization in the Tehran region (Majlesi et al., 2015), the internal and external factors of the waste management system were scored. The final score for the Internal Factors Evaluation (IFE) matrix was 2.42 (less than 2.5), while the final score for the External Factors Evaluation (EFE) matrix was 2.64. These results indicate that there are more organizational opportunities than threats, allowing the organization to leverage these opportunities to improve its activities. Consequently, a conservative strategy (WO) was recommended, which includes: (1) simultaneous training of workers and citizens to promote mechanization and improve municipal service equipment, (2) formulation of regulations and guidelines to encourage participation in waste management and attract private sector investment, and (3) upgrading recycling industries through financial support to develop and promote recycling industries and market recycled products.

The results of a study in Indonesia (Wilujeng & Rachmawati, 2023) revealed that the final score for the IFE matrix was 3.00, while the final score for the EFE matrix was 2.83. These scores suggest that the weakness-opportunity (WO) strategy is suitable, minimizing weaknesses by taking advantage of existing opportunities. Strategies for plastic waste management in Indonesia include community education, providing waste collection mechanisms via waste banks, planning for waste collection, and implementing technical guidance and periodic monitoring by the Environmental Organization.

CONCLUSION

This study identified six key gaps in Iran's plastic waste management system, primarily related to deficiencies in policymaking, lack of supervision, financial constraints, and technological shortcomings. Using the Ishikawa method, the root causes of these gaps were systematically analyzed, failure to consider the informal sector in policymaking, lack of regulatory enforcement, mismanagement, and interest conflict hinder the efficiency of plastic waste management. The SWOT analysis further highlighted legislative weaknesses.

One of the weaknesses of the plastic waste management law in the SWOT matrix is the gaps in this law. Among the weaknesses, the options "The number of gaps in the waste management law" and "the disproportion of deterrence of fines and punishments determined in dealing with violators" with a score of 0.18 are the most important negative factors. Many of the causes for these gaps have also been threats of the Plastic Waste Management law including: not using new technologies in waste management, not providing financial resources, not integrating the formal and informal sectors of waste management and lack of new business opportunities.

To address the identified gaps and their causes, this study proposes 34 strategies, including the establishment of a supervisory structure for transparent waste management, the integration of formal and informal sectors, government financial support for recycling technologies, the adoption of an EPR system for polymer manufacturers and development awareness raising

strategies for waste management informal sector. These strategies aim to enhance regulatory effectiveness, promote sustainable waste management practices, and strengthen compliance with global standards such as the Basel Convention.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

REFERENCES

- Alhazmi, H., Almansour, F.H., & Aldhfeeri, Z. (2021). Plastic Waste Management: A Review of Existing Life Cycle Assessment Studies. *Sustainability*, 13(10); 5340.
- Ali, S. S., Elsamahy, T., Koutra, E., Kornaros, M., El-Sheekh, M., Abdelkarim, E. A., ... & Sun, J. (2021). Degradation of conventional plastic wastes in the environment: A review on current status of knowledge and future perspectives of disposal. *Science of the Total Environment*, 771, 144719.
- Babayemi, J., Weber, R., Ogundiran, M. B., & Osibanjo, O. (2018). Initial Inventory of Plastics Imports in Nigeria as a Basis for More Sustainable Management Policies. *J. health pollut.*, 8(18); 1-15.
- Basel convention. (2019). Noard project in Bangladesh plastic waste. Report on the Inception Workshop, from <https://www.basel.int/Default.aspx?tabid>.
- Basel convention plastic waste amendment. (2019). Basel convention Conference of Parties 14, from <https://www.basel.int/implementation/plasticwaste/amendments/overview/tabid>.
- Borrelle, S. B., Ringma, J., Law, K. L., Monnahan, C., & Lebreton, L. (2020). Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science*. 369, 6510; 1515-1518.
- Coccia, M.,(2018). The fishbone diagram to identify, systematize and analyse the sources of general purpose technologies. *J. soc. adm. sci.*, 4(4); 291-303.
- Cox, M., & Sandberg, k.(2018). Modeling Causal Relationships in Quality Improvement. Elsevier., 48(7); 182-185.
- Edelson, M., Håbesland, D., & Trald, R. (2021). Uncertainties in global estimates of plastic waste highlight the need for monitoring frameworks. *Mar. Pollut. Bull.*,171. 112720
- Edvode, N., Qamar, S.A., Bilal, M., Barcelo, D., & Iqbal, H. M. N. (2021). Plasic waste and its management strategies for environmental sustainability. *Case Stud. Chem. Environ. Eng.*, 4, 100142.
- Fayshal, M.A.(2024). Current practices of plastic waste management, environmental impacts, and potential alternatives for reducing pollution and improving management. *Science Direct.*, 23(10).
- Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science advances*, 3(7), e1700782..
- Isari, M., & Shojaei Zand, A. R. (2019). Urban policies and the informal life of garbage picking in Tehran. *Journal of Urban Sociological Studies*. 10(34); 1 – 32.
- Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., & Lavender Law, K. (2015). Plastic waste inputs from land into the ocean. *Science*. 347, 6223; 768-771.

- Junejo, S., Khan, J., Muhammad, M., & Hirawan, F.B. (2025). The Impact of Technological Innovations and Food Waste Management on Carbon Emissions: A Time Series Analysis of Indonesia. *Pollution*, 1(11); 95-116.
- Kaiser, J. (2010). The dirt on ocean garbage patches. *Science*. 328, 5985; 1506.
- Longshenj, C., Ali Shah, S.A., Solangi, y. A., & Ali, S. (2022). An integrated SWOT-multi-criteria analysis of implementing sustainable waste-to-energy in Pakistan. *Renew. Energy*. 1 (195); 1438-1453.
- Luca, L. (2016). A new model of Ishikawa diagram for quality assessment 20th Innovative Manufacturing Engineering and Energy Conference. IOP Conf. Series: Materials Science and Engineering. 161. 012099.
- Majlessi, M., Vaezi, A., & Mehdipour Rabori, M. (2015). "Strategic management of solid waste in Tehran: a case study in District no. 1". *Environmental Health Engineering Journal*., 2(2); 59-66.
- Norouzi, M. (2018). Green Product Design: A New Approach in Environmental Management Accounting. *Quarterly Journal of Humans and Environment*. 1(17);25-36.
- Pilapitiya, N. T., & Ratnayake, A. S. (2024). The world of plastic waste: A review. *Clean. Mater.*, 11. 100220.
- Proshad, R., Islam, S., Kormoker, T., Haque, M.A., & Rahman, M. (2018). Toxic effects of plastic on human health and environment: A consequence of health risk assessment in Bangladesh. *Int. J. Healthc.*, 6(1); 1-5.
- Rodic, I., & Wilson, D. C. (2017). Resolving Governance Issues to Achieve Priority Sustainable Development Goals Related to Solid Waste Management in Developing Countries. *Sustainability*., 9(3)
- UNEP & Basel convention. (2019). Meeting Report. Promoting the environmentally sound management of plastic wastes and achieving its prevention and minimization. Accra, Ghana. The Brs-Norad-1 Project.
- UNEP. (2017). A Set of Practical Manuals for the Promotion of the Environmentally Sound Management of Wastes. Developed by the Expert Working Group on Environmentally Sound Management (UNEP/CHW.13/4/ add.1).
- Vaez Maddani, B. (2017). Waste separation at source and presentation of a management and implementation model. *Efficiency Magazine*. 31
- Walker, T. R., & Fequet, L. (2023). Current trends of unsustainable plastic production and micro (nano) plastic pollution. *TrAC Trends in Analytical Chemistry*, 160, 116984.
- Wilcox, C., Heathcote, G., Goldberg, J., Gunn, R., Peel, D., & Hardesty, B. D. (2015). Understanding the sources and effects of abandoned, lost, and discarded fishing gear on marine turtles in northern Australia. *Conservation biology*, 29(1), 198-206.
- Wilujeng, A., & Rachmawati, F. (2023). SWOT analysis to determine waste management strategy in Tenggilis Mejoyo District, Surabaya City. 6th International Symposium on Sustainable Urban Development. IOP Conf. Series: Earth and Environmental Science. 1263. 012064.
- Yuan, H. (2013). A SWOT analysis of successful construction waste management. *Journal of cleaner production*, 39, 1-8.