

Original research

## **A sustainable solid waste management framework for Egyptian cities based on synthesis the integrated solid waste management approach and urban environmental governance tool**

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### **Abstract:**

Understand waste management, a challenging environmental issue in urban places, requires an understanding of urban environmental governance. In this paper, an appropriate urban waste management model is discussed together with urban environmental governance in the waste management process. In order to prevent the development of waste, the integrated waste management process employs preventative measures and reuse initiatives. The purpose of this study is to investigate and assess the role of Urban Environmental Governance in solid waste management, focusing on its essential components, problems, and best practices. Policymakers, practitioners, and researchers can develop strategies and policies that improve the sustainability of solid waste management in urban settings by appreciating the role of governance in this environment. The research results are manifested in identifying the interrelationships between different industries and the outcomes of various waste streams for each industry. Understanding these relationships assists decision-makers in planning industrial applications and distributing factories to make the most of each industry's waste, thereby contributing to achieving sustainable solid waste management in the city. The research outcomes encompass the identification of interrelationships between various industries and the diverse outcomes of waste generated by each industry. This is accompanied by a detailed study of the solid waste management system in the city and an analysis of sectoral indicators. These findings aid decision-makers in planning industrial applications and distributing factories to maximize the utilization of each industry's waste, thereby contributing to achieving sustainable solid waste management in New Damietta City.

**Keywords:** Urban Environmental Governance, sustainable solid waste management, Integrated Solid Waste management

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## **1- Introduction**

Understanding urban environmental governance is necessary to comprehend waste management, a difficult environmental issue in cities. Government environmental programs must be implemented, and businesses must understand the need of sustainable resource use. An effective urban waste management model and urban environmental governance in the waste management process are examined in this study. Understanding urban environmental governance is necessary to comprehend waste management, a complex environmental challenge in urban settings. The integrated waste management method uses preventative measures and reuse activities to stop the growth of waste ( Rahman ,2020; Sakib et al. 2023).

Ecological values and climate change are promoted in order to sustain social management systems, which may be done by keeping an eye on a system that ensures a secure social environment and effective collaboration. The compatibility of requirements and reciprocal agreements between social systems and environmental ecosystems is known as urban environmental governance (Sakib et al. ,2023).

Public education and understanding about environmental concerns are critical for effectively addressing environmental difficulties in metropolitan settings. The commitment of communities and international organizations to protect the world from pollution and destruction is known as urban environmental management. Understanding the complexity of waste management in urban locations requires an understanding of urban environmental governance. It is impacted by the

community's minimal involvement in environmental cleanliness and their reluctance to pay for cleaning services owing to poor quality. The sanitation department plays an important role in trash management by preventing the community from using inefficient waste disposal techniques. Inadequate waste management has far-reaching implications, including negative effects on the environment, public health, and human quality of life overall. Effective waste management requires collaboration between the state, social organizations, and the public to address trash-related issues. But the policy component is routinely ignored. In an urban setting, the environmental government's function is particularly important, with a focus on bottom-up policy initiatives that aim to empower waste pickers. These policies should not only target the community, but also include them as active participants. Neglecting waste management can worsen difficulties as garbage continues to accumulate with fast population expansion, resulting in environmental contamination, floods, and serious public health risks. As a result, it is critical to pay close attention to waste management regulations and to address these issues head on (Chang, 2015)

The Urban Environmental government must seek to eliminate social exclusion, which is a problem that scavengers experience in many parts of their lives. Scavengers are excluded, which means they have restricted access, involvement, and freedom in terms of access to goods, rights, and requirements of life. Natural resources and environmental quality have deteriorated since the beginning of the decentralization era, demonstrating the complexities of the problem. Building without harming the environment but still protecting it necessitates a suitable environmental management policy and plan, as well as an ecologically sound development concept, in order for development to be sustainable. (Development, 2015)

In order to establish a framework for sustainable solid waste management, the researcher heavily leaned on the concept of urban environmental governance. This approach involved a

meticulous exploration of various methodological steps. The initial phase encompassed a comprehensive study of Integrated Solid Waste Management (ISWM), encompassing its definition, historical evolution, benefits, and operational mechanisms. In the pursuit of sustainability within this domain, it became imperative to delve into the challenges that arise from the implementation of ISWM. Additionally, a thorough investigation was conducted into urban environmental governance, encompassing its conceptual essence, profound significance, inherent challenges, multifaceted dimensions, guiding principles, and constituent elements. They also looked at a number of effective models that have used urban environmental governance to achieve sustainability in the solid waste industry. The researcher's last step was using this strategy to manage solid waste in New Damietta City in order to create sustainable solid waste management in the community. (Hossain, 2018) The following figure shows the research methodology

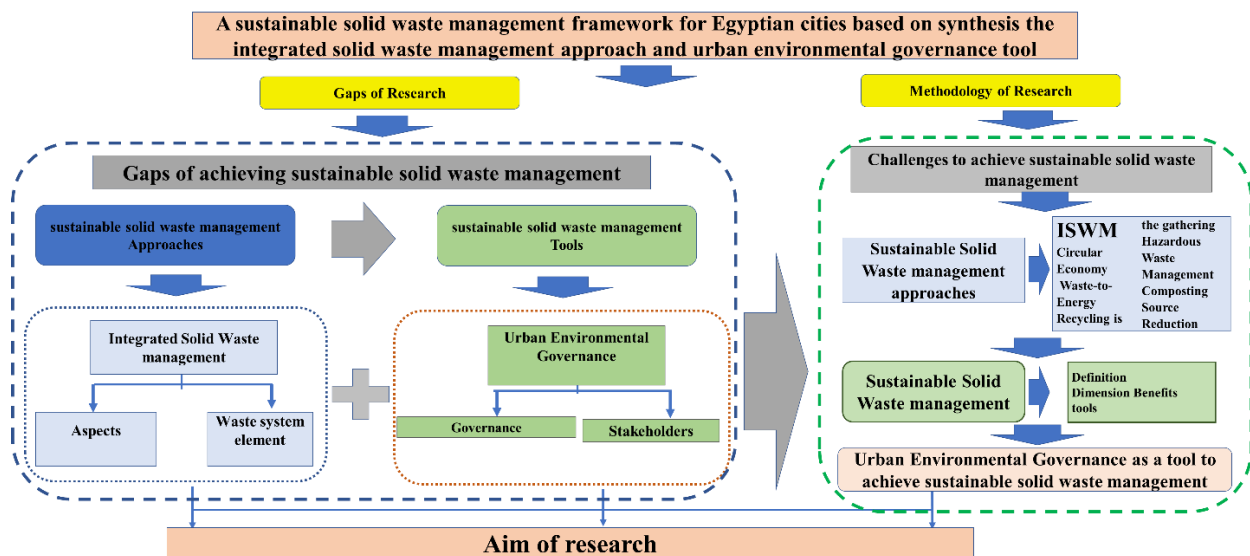


Fig 1 The research methodology  
 Source: by authors

### 1. 1Challenges to achieve sustainable solid waste management systems

Managing solid waste presents a significant challenge for cities worldwide, given the rising waste generation, budgetary strains, and the complex web of factors influencing waste management. Successful solid waste management systems necessitate addressing fundamental issues (Development, 2015)

**Complexity of Waste Management:** Handling solid waste requires not just technical solutions but also consideration of environmental, socio-cultural, legal, institutional, and economic aspects. A holistic approach is crucial for effective waste management.

**Involvement of Multiple Stakeholders:** Effective waste management involves various stakeholders with diverse interests. Clear understanding of their roles and effective communication is vital, especially in developing city contexts.

**Institutional Challenges:** Many municipalities lack resources and expertise, leading to suboptimal waste management practices. Building capacity is essential to handle waste adequately. **Cost Recovery Challenges:** Municipalities struggle to cover waste management

costs. Financial resources are essential for the required infrastructure, equipment, and skilled personnel.

**Beyond Municipal Boundaries:** Accurate waste data is vital for effective waste management both within and between municipalities.

**Best practices globally highlight key approaches: (Godfrey et al., 2019)**

- Enhance Sanitary Disposal Capacity: Improve landfill management and disposal facilities.
- Build Waste Management Infrastructure: Develop robust waste collection and disposal infrastructure.
- Integrate Social Inclusion: Link waste management with social development.
- Innovate Collection Services: Encourage innovative garbage collection methods.
- Promote Recycling Economy: Establish a market for waste recycling.
- Digital Mapping: Utilize technology for waste management via digital mapping.
- Implement Integrated Systems: Ensure comprehensive waste management systems.

The **Egyptian solid waste management (SWM) sector faces critical challenges**, impacting efficiency, health, the environment, and resources. Addressing these concerns is pivotal for sustainable growth, necessitating sector restructuring and investment. Inadequate planning, limited resources, institutional gaps, and stakeholder involvement deficits are key hurdles. **Integrating the informal sector, fostering public-private partnerships, strengthening human resources, and improving cooperation among regulatory bodies are crucial steps.** Public awareness and proper waste separation play vital roles, as improper waste disposal threatens public health and the environment. (Ministry of Environment Affairs, 2020; Bank, 2012)

Traditionally, **waste management in Egypt has focused on waste collection, but the sector requires comprehensive change.** Financial incentives across the entire waste management chain need restructuring. This shift demands revisiting economic incentives to align with the Integrated Solid Waste Management (ISWM) approach. The challenge is to ensure a holistic understanding of waste's lifecycle, prioritizing reduction, reuse, recycling, and environmentally sound disposal. The objective is to mitigate negative impacts on health, environment, and society while conserving resources and promoting sustainability. (Godfrey et al., 2019; Hahn & Pinkse, 2014)

**1. 2Sustainable Solid Waste management concepts and approaches**

The many strategies and approaches used to successfully treat and manage solid waste are referred to as solid waste management approaches. Solid waste management is an important part of environmental sustainability and public health since incorrect trash disposal and management can result in pollution, health concerns, and resource depletion. Source reduction, recycling, composting, waste-to-energy conversion, and correct disposal are all ways to solid waste management. These techniques seek to reduce waste output, increase resource recovery, and assure waste management that is both safe and ecologically sound. Implementing efficient solid waste management strategies necessitates a thorough grasp of waste characteristics, technology improvements, legal frameworks, and community participation. Communities and governments should aim for an environment that is healthier and cleaner while saving resources for future generations by adopting and implementing suitable waste management practices. The following is an overview of sustainable solid waste management approaches

(Ahluwalia and Patel ,2018)

- ◆ **Source Reduction:** Source reduction, also known as waste minimization or waste prevention, aims to reduce waste at its source. Efforts to encourage sustainable production and consumption habits, such as designing products with minimal packaging or encouraging the use of reusable items, fall under this category.
- ◆ **Composting:** is the process of turning organic waste, such as leftover food and yard waste, and into compost that is nutrient-rich. It is an environmentally friendly alternative to landfilling that may be utilized to improve soil quality and promote sustainable agriculture.
- ◆ **Hazardous Waste Management:** Hazardous waste, which endangers human health and the environment, need specific management procedures. This involves correct storage, transportation, treatment, and disposal techniques for hazardous chemicals to guarantee safe handling. (European Environment Agency, 2019)
- ◆ **Recycling** is the gathering, sorting, processing, and production of waste materials into new products. It aids in keeping natural resources protected, the reduction of energy use, and the reduction of garbage sent to landfills. (Lavadinho, 2011)
- ◆ **Waste-to-Energy** systems turn solid waste into energy forms like electricity, heat, or fuel. These technologies, which include incineration and anaerobic digestion, can help decrease trash while also producing renewable energy( Chandak ,2010)
- ◆ **Circular Economy:** The concept of a circular economy advocates the idea of extending the life of resources as much as possible by recycling, reuse, and remanufacturing. It seeks to reduce waste creation and to establish a closed-loop system in which resources are continually cycled and reused.
- ◆ **ISWM (Integrated Solid Waste Management):** ISWM is a comprehensive approach to waste management that incorporates diverse waste management methods and techniques to accomplish long-term waste management It emphasizes the need for a harmonized and efficient amalgamation of waste reduction, recycling, composting, waste-to-energy conversion, and appropriate disposal techniques.
- ◆ **Integrated Solid Waste Management (ISWM)** constitutes a comprehensive strategy for **waste** management with the objective of establishing a sustainable and efficient waste management system. This approach emerged as a response to the escalating challenges posed by escalating waste volumes and their detrimental impacts on both the environment and public health. The integrated approach encompasses the coordination of every facet of waste management, spanning from waste generation and segregation to collection, sorting, treatment, recycling, and ultimate disposal. This strategy is centered on curtailing waste generation while simultaneously reaping the manifold benefits associated with ecologically sound waste management, extending to environmental, economic, and social spheres. The merits of integrated waste management encompass decreased ecological footprints, preservation of finite resources, enhancement of air and water quality, generation of employment opportunities, and advocacy for sustainable progress. Moreover, this methodology bolsters ecosystem sustainability and contributes to the upliftment of living standards within local communities. The study will employ the principles of urban environmental

governance to realize sustainable solid waste management through the application of the Integrated Solid Waste Management (ISWM) concept (E.E.S., 2018)

### **1.3 Integrated Solid Waste Management As a approach of Sustainable solid waste management**

#### **1.3.1 Integrated Solid Waste management definition**

Integrated Solid Waste Management (ISWM) stands as a holistic strategy in tackling the mounting issues emanating from the surge in waste production and its subsequent ecological repercussions. This inclusive approach encompasses an array of tactics and methodologies devised to curtail waste output, optimize the reclamation of resources, and foster the establishment of enduring waste management systems. With the persistent escalation in waste generation across the world, the need for adept waste management takes on paramount importance in assuaging environmental contamination, safeguarding resources, and upholding human well-being. (Authority, 2020)

The inception of ISWM materialized as a reaction to the shortcomings of conventional waste management approaches like landfilling and incineration. These conventional methods frequently resulted in ecological deterioration and posed health hazards. ISWM emphasizes a holistic and integrated approach that combines waste prevention, recycling, composting, and responsible disposal techniques. It recognizes that waste management is not solely a technical issue but also requires social, economic, and policy considerations.

**The integrated waste management process** is carried out by making efforts to minimize and reuse waste in order to prevent it from forming. The effort concentrated on the utilization of commodities at the most fundamental level, and the process of recycling waste was maintained as straightforward as possible. After being sliced and melted, the material is printed into ready-to-use material. There are other ways to get rid of waste and use it, such as dropping it in a pit and covering it with dirt one layer at a time so that it is not exposed. Garbage should be dumped into pits without being piled high with earth, exposed above ground, and dumped into bodies of water like rivers or the sea. Waste is burned on a large scale and covered by incinerators; waste is burned by individuals in the home; vegetable waste is processed for animal feed; organic waste is managed into fertilizer that is helpful for fertilizing the soil; mashed garbage is then thrown into the water channel; waste is recycled by reusing items that can still be used; and reduction, destroying waste into small pieces and the results are utilized. The term "waste management" refers to a variety of techniques and endeavors to control waste in order to maintain a clean, healthy, and comfortable environment. The ultimate disposal location's waste management practices include exposing the surface for garbage disposal, discharging waste into pits without stacking it with layers of soil, composting, incinerators, and cutting-edge reuse technologies. waste bin accessibility at home must be considered while engaging the community in garbage management. Without the community's support or involvement, this waste management initiative will not be able to produce the desired results—most notably, environmental and public health—and must have the full backing of the community. The following figure shows the concept of Integrated Solid Waste Management (ISWM) (Chang,2015).

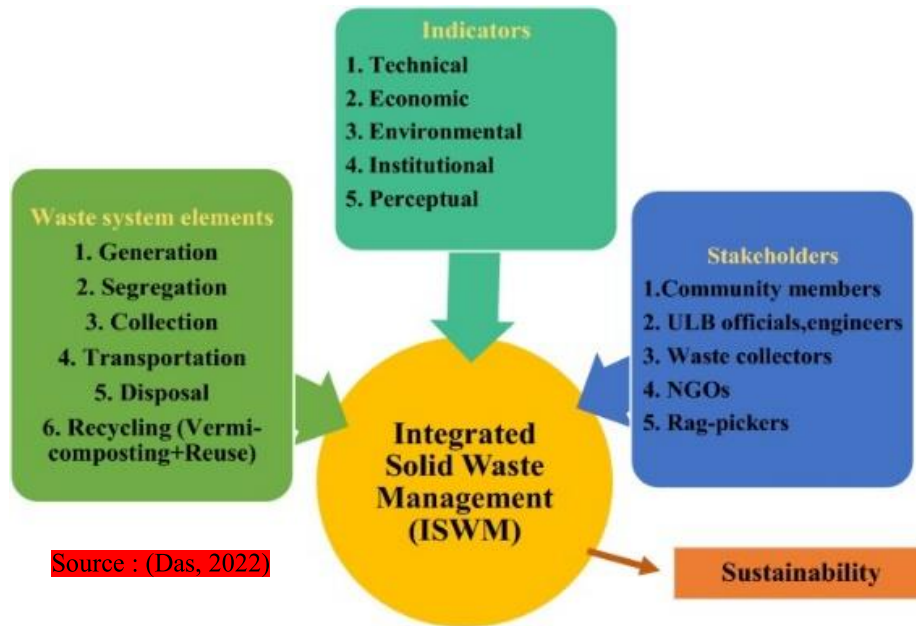


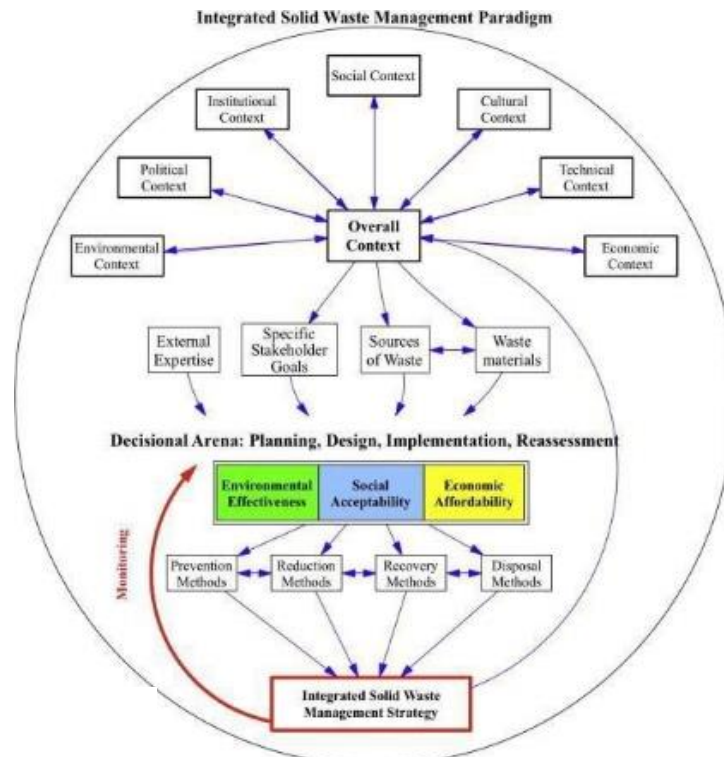
Fig 2 The concept of Integrated Solid Waste Management (ISWM) ( Das, 2022)

### 1..3.2 The integrated solid waste management (ISWM) Dimension

Integrated Sustainable Solid Waste Management (ISWM) encompasses a comprehensive strategy for waste handling that prioritizes prevention, reuse, recycling, treatment, and disposal. Despite the significance of prevention and reuse, policymakers often overlook these aspects. ISWM has proven successful globally, spanning three dimensions discussed later. Originating in the mid- 1980s by Dutch NGO WASTE and its partners, and expanded in the mid-1990s by the Collaborative Working Group (CWG), ISWM has become a norm. For efficient waste management, cities must shift from traditional approaches to ISWM, a holistic system covering prevention, recycling, treatment, and disposal. It seeks to manage solid waste in an environmentally friendly and humane manner, necessitating considerations of institutional, financial, legal, and socio-economic aspects. ISWM also aims for ecologically sound and financially viable SWM, involving technical, environmental, legal, and financial factors. It emphasizes stakeholder involvement at multiple levels. ISWM planning involves policy formulation, institutional development, and technical design of waste management systems. It diverges from traditional methods by prioritizing stakeholder engagement, waste prevention, and effective management. ISWM recognizes waste management as more than technical, involving political and social facets. (Alhassan, 2020; Bodin, 2017)

The success of ISWM hinges on three dimensions: stakeholders, waste system elements, and SWM system aspects. Various stakeholders—local governments, NGOs, private sectors, service consumers, and donor agencies—have distinct roles and interests in waste management. Collaborative stakeholder engagement is crucial. Waste system elements encompass technical components, key for designing efficient systems. Sustainability demands consideration of technical, environmental, health, socio-cultural, and legal factors. The

framework below illustrates the ISWM approach's interconnected elements, highlighting its role in promoting efficient and sustainable waste management. Through a unified approach, ISWM aims to optimize waste management practices and their environmental impacts, ultimately fostering a cleaner and healthier future. The following figure shows integrated sustainable solid waste management (ISWM) framework. (Chang, 2015)



Source : (R. Marshall, 2013)

Fig 3 Integrated sustainable solid waste management (ISWM) framework.

### 1.3.3 Benefits of Integrated solid waste management systems

The goal of effective waste management systems is to create the least amount of waste possible while maximizing the usefulness of materials. In addition to reducing emissions, which may be the main driver of waste management action, efficient waste management systems may produce significant benefits. These co-benefits include: (Alhassan, 2020)

**1- Public health:** Uncontrolled waste typically ends up in water drains or on the ground, where it attracts vermin and pests. Subsurface water can be harmed by toxic leachate from trash disposed of in unsanitary landfills or dumps. Public health, access to clean water, and the local environment may all be directly impacted by better waste collection and disposal practices.

**1- Air quality:** Open waste combustion is a widespread practice and a significant source of black carbon across the world. The use of outdated vehicles for collecting waste and a lack of planning for waste disposal routes both increase vehicle emissions and have a negative



effect on the air quality.

**3. Reducing poverty:** In many cities, waste is a significant source of income for a significant percentage of the population as well as a supply of raw materials for several economic sectors. Waste collectors may be found in many places, working in landfills and on the streets to collect, sort, clean, recycle, and sell items that have been dumped by others. The actions of cities may have a considerable impact on the economic standing and standard of living of those societal groups involved in waste disposal.

**2. Social justice: Solid waste management is very visible and affects how people see society and government. Planning investments in municipal solid waste management systems that are effective and sustainable requires consideration of a wide range of stakeholders' service delivery, financial, and environmental and social effects.**

#### **1.3.4 Integrated solid waste management tools**

By studying the historical development of the Integrated Solid Waste Management (ISWM) approach, it is clear that there has been a growing emphasis on urban environmental governance since 2020, emphasizing the importance of collective participation and the role of stakeholders in achieving sustainable waste management. The ISWM method will be used to demonstrate the role of urban environmental governance in attaining sustainability in the solid waste sector. The graph below depicts the historical evolution of the idea of integrated solid waste management across time. (Chiemchaisri, 2018)

1970s: The concept of ISWM gains traction as a more comprehensive and long-term approach to waste management. Waste Hierarchy becomes a guiding philosophy for ISWM in the 1980s, stressing waste avoidance, reuse, recycling, energy recovery, and disposal in that order. waste Characterization and Assessment studies becoming more widespread in the 1990s, giving data on waste composition and characteristics for improved waste management planning. 1992: Rio de Janeiro hosts the United Nations Conference on Environment and Development (UNCED), which emphasizes the significance of sustainable waste management. 1990s-2000s: waste separation and recycling programs gain traction, encouraging waste separation at the source to promote recycling and resource recovery. Composting and Organic Waste Management gain popularity in the 2000s, with composting, anaerobic digestion, and other treatment methods being promoted. The idea of the Circular Economy arises in 2005, emphasizing the need to reduce waste creation while maximizing resource recovery. Energy recovery methods such as waste-to-energy incineration, gasification, and anaerobic digestion gain popularity as a method of recovering energy from non-

recyclable waste in the 2010s. The Sustainable Development Goals (SDGs) are adopted by the United Nations in 2015, including Goal 12 on Sustainable Consumption and Production, which supports sustainable waste management methods. 2015-2020: Increased emphasis on Plastic Waste Management in response to growing concerns about plastic waste and its environmental impact. 2020s: Increased emphasis on Extended Producer Responsibility (EPR), with the goal of holding manufacturers accountable for the whole life cycle of their goods, including waste management. Ongoing: Urban Environmental Governance: Ongoing efforts in public awareness and education, policy and regulation creation, and international cooperation to promote and implement ISWM principles across the world (Development, 2015)

ISWM (Integrated Solid Waste Management) refers to a combination of instruments and strategies aimed at attaining effective and sustainable solid waste management. Waste reduction and source separation, recycling and resource recovery, composting, waste-to-energy conversion, correct disposal procedures, and urban environmental governance are among the tools available. ISWM stresses the integration of various techniques in order to develop a holistic and complete waste management system that lowers trash creation, maximizes resource usage, and minimizes waste's environmental effect. Communities and governments may solve solid waste management concerns, promote circular economy concepts, and move toward a more sustainable future by combining these methods. ISWM implementation involves strategic planning, stakeholder participation, technical breakthroughs, and strong regulatory frameworks to ensure optimal resource allocation and protection of public health and the environment. (European Environment Agency , 2019)

In order to ensure effective waste management procedures in urban environments, urban environmental governance is a crucial component of ISWM. To execute waste management laws, rules, and practices, many parties, including government organizations, neighborhood associations, and the private sector, must cooperate and work together. It emphasizes the value of stakeholder participation, public education, and the inclusion of environmental considerations in decision-making processes. By including urban environmental governance inside the ISWM framework, cities and communities may work to enhance their waste management practices, encourage resource conservation, reduce environmental pollution, and eventually work to achieve sustainable development goals.

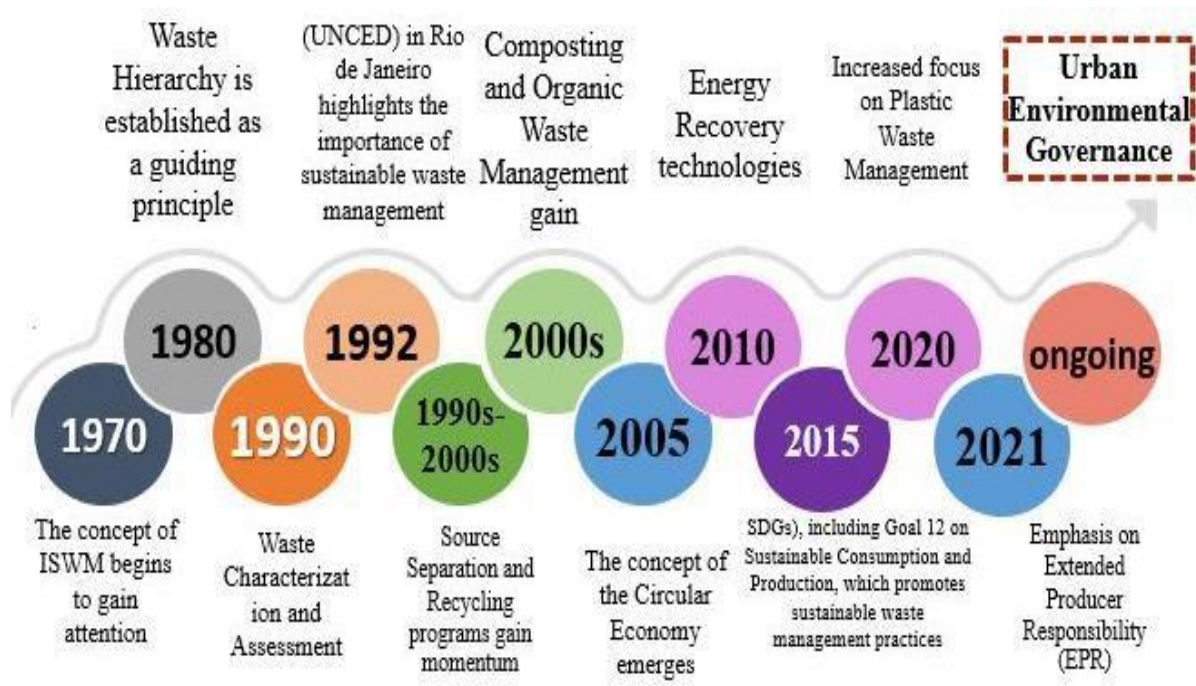


Fig 4 Integrated Solid Waste management tools

Source : By authors based on Alam and Qiao (2020), (Sakib ,2023),  
 (European Environment Agency , 2019)

Urban environmental governance is incorporated as a tool within ISWM to address the social, economic, and environmental aspects of waste management, leading to more effective and sustainable waste management practices. Tools for managing integrated solid waste are shown

in the following figure. (Hossain, 2018)

#### **1.4 Urban Environmental Governance as a tool to make integrated solid waste management sustainable:**

The term "urban environmental governance" refers to the system of decision-making, planning, and management procedures that strive to solve environmental challenges and promote sustainable development in metropolitan settings. It entails the coordination and collaboration of many stakeholders, including government institutions, local governments, communities, corporations, and civil society groups, to guarantee effective and integrated management of urban environmental resources and issues (Sakib ,2023)

##### **1.4.1 Definition and Importance**

In 1960s-1970s, the focus of urban government was mostly on economic growth and infrastructure planning during this time period. Environmental concerns were frequently disregarded, resulting in increased pollution and depletion of natural resources in metropolitan areas. As the 1980s witnessed the elaboration of the environmental movement, the conception of civic environmental governance began to gather instigation. The United Nations Environment Programme( UNEP) played a vital part in backing sustainable development and accentuating the significance of environmental governance in civic settings. The Rio Earth Summit of 1992 marked a watershed moment in global environmental governance, pressing the imperative of holistic approaches to civic development that take into account environmental, social, and profitable angles. The notion of sustainable development gained remarkable traction, egging the integration of sustainability principles into the realm of civic environmental governance. (OECD, 2015)

In the 2000s, more people began to see the value of participatory governance and citizen involvement in environmental decision-making. Beyond traditional government institutions, the focus broadened to encompass civil society organizations, community groups, and other stakeholders. The role of municipal governments in supporting sustainable urban development and enforcing environmental rules has grown in importance. The concept of urban environmental governance expanded in the 2010s to encompass climate change resistance and adaptation. Cities faced issues such as growing urban populations, environmental threats, and the need for long-term infrastructure and planning. Integrated methods to urban environmental governance have gained popularity, highlighting the interdependence of social, economic, and environmental variables. Present: urban environmental governance is evolving in response to the critical need to manage environmental issues in urban settings. It includes sustainable urban design, green infrastructure, circular economy concepts, and the utilization of new environmental technology. In order to achieve sustainable urban development, the idea stresses multi-stakeholder engagement, information exchange, and evidence-based decision-making. (OECD, 2015)

#### **Urban environmental governance plays a crucial role in achieving sustainable urban development and addressing environmental challenges in cities. Some key reasons highlighting its importance are: (OECD, 2016)**

- 1- **Urban environmental governance fosters sustainable development** by incorporating environmental factors into urban planning, policy-making, and decision-making

processes. It contributes to the long-term survival of cities by balancing economic growth, social well-being

- 2- **Environmental Protection:** Urban governance ensures that urban environmental resources such as air, water, land, and biodiversity are protected and conserved. It makes it easier to put measures in place to decrease pollution, waste output, preserve energy, and encourage sustainable resource management practices.
- 3- **Mitigation and Adaptation to Climate Change:** Urban environmental governance is critical in resolving climate change concerns in cities. It involves creating and putting into action plans to reduce greenhouse gas emissions, improve resiliency to the effects of climate change, and advance environmentally friendly urban planning and transportation options.
- 4- **Public Health and Well-Being:** Urban governance practices help to improve urban public health and well-being. Urban environmental governance contributes to healthier and more livable cities by managing environmental concerns, providing access to clean water and sanitation, and fostering green areas and healthy living conditions.
- 5- **Stakeholder Engagement and engagement:** Active engagement of stakeholders, such as communities, corporations, and civil society groups, is encouraged in urban environmental governance. It promotes cooperation, openness, and accountability by ensuring that varied viewpoints are taken into consideration in decision-making processes and by encouraging ownership and shared responsibility for urban environmental issues.
- 6- **Resource Efficiency and the Circular Economy:** In cities, effective governance supports resource efficiency and the transition to a circular economy. It promotes trash reduction, recycling, and resource sustainability, reducing environmental consequences and fostering sustainable consumption and production habits.

**Urban Environmental Governance dimensions:** (Rahman, (2020).

**1. Urban governance frameworks:** Since urban governance is carried out at various levels of government, it is essential to outline each level's roles and responsibilities as well as how they function together. Critical elements include multi-level and sectoral collaboration and coordination structures, official and informal connections outside of city bounds, national urban policies, among other institutional frameworks.

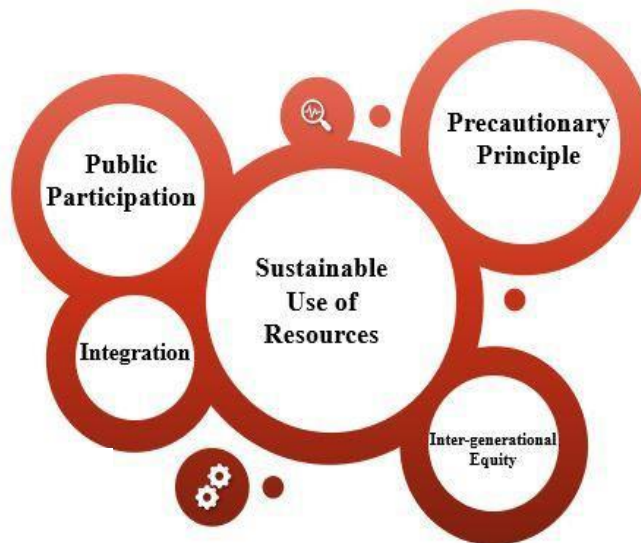
**2. Intercity cooperation:** The cornerstone of excellent urban governance is effective cooperation and partnerships among municipal governments, the business community, and civil society. It is crucial to find and develop the appropriate mechanisms and spaces for disadvantaged groups to engage in cooperative and decision-making processes.

**3. transformational urban governance:** To address global concerns in the sense of really transformational development, key characteristics of climate-friendly governance at the city level, pertinent to both mitigation and adaptation measures, must be outlined.

**Principles of Urban Environmental Governance:** (Authority, 2018)

- To ensure sustainable development, environmental factors must be **integrated into decision-making processes** across sectors and levels of governance. (Nations, 2015).

- **Precautionary Principle:** Protecting human health and the environment by taking precautionary steps to prevent or minimize environmental harm, even in the lack of scientific assurance. (Nations, 2021)
- **Public Participation:** Involving the public, especially impacted communities, civil society organizations, and indigenous groups, in environmental decision-making processes ensures inclusivity, transparency, and accountability (Development, 2015)
- **Sustainable Resource Management:** Promoting the long-term availability and resilience of natural resources such as land, water, air, and biodiversity via sustainable management and usage.
- **Intergenerational equity** is the consideration of future generations' needs and rights in environmental decision-making and resource management to ensure the protection of their interests and well-being.. The following figure shows Principles of Urban Environmental Governance. (Chang, 2015)



Source : By authors based on (European Environment Agency, 2019)

Fig 5 Principles of Urban Environmental Governance

#### 1.4.2 Components of Urban Environmental Governance: (Nations, Development Programme. , 2015)

- **Participation and Engagement:** Ensuring the active participation of all key stakeholders, including communities, civil society organizations, and indigenous groups, in environmental decision-making processes.
- **Transparency and Accountability:** Encouraging transparency, information sharing, and access to environmental data, as well as making organizations and people accountable for their environmental activities and decisions.
- **Establishing and implementing effective environmental laws,** rules, and policies that are compatible with international standards and offer a strong legal foundation for environmental preservation and sustainable management. (Bank, 2012)
- **Integration and coherence refer to the promotion of coordination** and collaboration across various sectors and levels of government in order to promote a

comprehensive and integrated approach to environmental decision-making and policy implementation..

- **Capacity Building and Knowledge Sharing:** Improving individuals', institutions', and communities' skills, knowledge, and capabilities to successfully address environmental concerns and promote sustainable behaviors. (OECD, 2015). The following figure shows Components of Urban Environmental Governance.



Fig 6 Components of Urban Environmental Governance

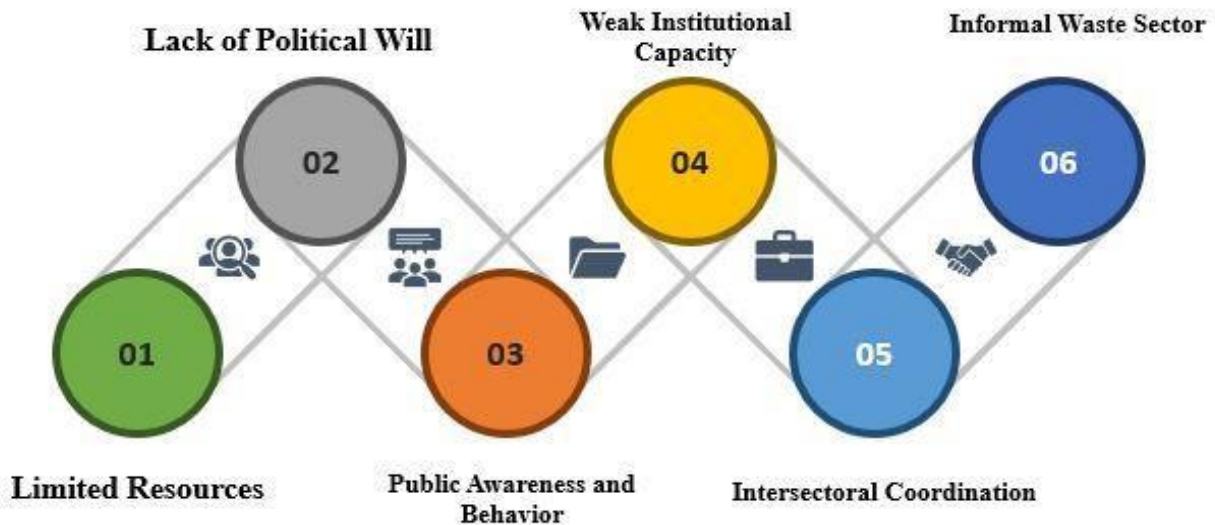
Source: authors based on (Haregu et al., 2017) (Hoornweg & Bhada-Tata, 2012) (Hossain, 2018)

#### 1.4.3 Challenges in Implementing Urban Environmental Governance in solid waste management: (Nations U , 2021)

- **Lack of Political Will:** One of the major issues is the government's lack of political will and commitment to prioritize environmental concerns and invest in sustainable waste management procedures. This might make it difficult to design and administer effective policies and laws.
- **Inadequate Financial Resources:** Inadequate financial resources and infrastructure offer substantial barriers to implementing sustainable environmental governance. Due to a lack of funds, adequate waste management facilities, such as recycling centers or waste treatment plants, may be unable to be established, resulting in inefficient trash disposal practices.
- **Weak Institutional ability:** Many nations encounter issues connected to waste management due to a lack of institutional ability. This includes insufficiently trained people, insufficient monitoring and enforcement measures, and ineffective coordination among key agencies and parties. Building institutional capacity is critical to ensuring

successful waste management governance and execution.

- **Public knowledge and Behaviour:** It is critical, but sometimes difficult, to change public behaviour and raise knowledge about the need of waste management. Inadequate waste disposal methods, such as littering or unlawful dumping, can result from a lack of public knowledge and involvement. To encourage appropriate waste management behaviour, efforts should focus on education, awareness campaigns, and community engagement
- **Informal waste Sector:** An informal waste sector coexists with formal waste management systems in many locations. The difficulty of integrating and formalizing the informal waste sector must be addressed. This includes providing informal waste workers with assistance, training, and capacity building, as well as assuring their compliance with environmental requirements.
- **Coordination across sectors:** Effective waste management necessitates collaboration across many sectors, including government agencies, municipalities, environmental authorities, and private sector entities. However, efficient intersectoral coordination can be difficult to achieve due to competing agendas, bureaucratic impediments, and a lack of engagement among stakeholders. The following figure shows Challenges in Implementing Urban Environmental Governance in solid waste management.



Source : By authors based on Chandak (2010) Ba (2021) Alam and Qiao (2020)

Fig 7 Challenges in Implementing Urban Environmental Governance in solid waste management

### 1.5 Urban Environmental Governance framework as a tool to achieve sustainable solid waste management

Environment-related concerns and resource management are handled through environmental urban governance. Several parties, including the government, corporations, civic society, and the general public, are involved. A comprehensive approach to trash management called integrated solid waste management aims to reduce the negative effects of garbage on the environment and society. The whole waste life cycle, from creation to disposal, is included (Ahluwalia and Patel ,2018)

ISWM and environmental urban governance are interconnected. The successful

implementation of ISWM depends on efficient environmental urban governance. The reason for this is that environmental urban governance may contribute to ensuring that there is a clear regulatory framework for waste management, that there is coordination between many stakeholders, and that the public is involved in decision-making about trash management. In order to effectively manage solid waste in cities, urban environmental governance is essential. Proper solid waste management has turned into a challenging environmental issue due to rising urbanization and population growth. Urban regions generate a lot of waste, and if it isn't properly handled, it might have a bad impact on the environment, public health, and everyday quality of life. Urban Environmental Governance for Sustainable Solid Waste is depicted in the following figure( Xin-gang et al. ,2016; Sakib ,2023)

Government organizations, commercial sector groups, and the community are all involved in solid waste management. Urban Environmental Governance provides a framework for the coordination, decision-making, and execution of solid waste management policies and initiatives. It includes the procedures of waste collection, treatment, and disposal that are gathered, regulated, monitored, and enforced in an ecologically sustainable approach.( Rasheed et al. ,2019)

In solid waste management, the goals of Urban Environmental Governance include reducing waste generation through source reduction, promoting recycling and reuse, implementing proper waste collection systems, adopting environmentally friendly treatment and disposal methods, and encouraging public participation and awareness. Multiple players, including government agencies, waste management firms, community groups, and individual citizens, are required for effective governance (Rahman ,2020)

The purpose of this study is to investigate and assess the role of Urban Environmental Governance in solid waste management, focusing on its essential components, problems, and best practices. Policymakers, practitioners, and researchers can develop strategies and policies that improve the sustainability of solid waste management in urban settings by appreciating the role of governance in this environment. (Rahman, 2011)

Through the above, the application of the concept of urban environmental governance to achieve sustainable solid waste management is carried out through three main Phases: The first Phase involves studying the current situation of the solid waste sector. The second Phase entails studying the urban system by examining various sectors (economic, social, demographic, urban, and environmental). The third Phase focuses on urban environmental governance, which includes studying current and proposed policies and strategies to achieve sustainability in the solid waste sector. In the next step, the researcher will apply these Phases to New Damietta City to achieve sustainable solid waste management in the city using urban environmental governance. The following figure shows the research Phases.

## **2- Materials and Methods**

### **Urban Environmental Governance as a Tool to achieve sustainable Solid Waste Management in New Damietta city**

On Egypt's northeastern coast, New Damietta City was founded in 1980 to relieve urban strain on the historic city of Damietta and advance contemporary urban development. However, because of population increase and continued growth, the city currently has trouble managing its solid waste. In order to provide sustainable waste management and upgrade trash disposal



infrastructure, effective methods and urban environmental governance are required. New Damietta City can attain a clean, healthy, and environmentally resilient urban environment for future generations by putting into practice sustainable solutions like waste recycling and working with appropriate authorities and the local population (Nations, U., 2015).

### **Phase one: The solid waste system in the New Damietta City**

#### **◆ The current status of the solid waste sector**

The city of New Damietta City faces significant challenges in managing solid waste due to rapid population growth and urbanization. Approximately 317 tons of solid waste are produced daily in the city, including municipal, commercial, and industrial waste such as plastic, paper, glass, metals, and organics. As the quantity of waste increases, the city faces challenges in disposing of it in a healthy and environmentally friendly manner. The current landfills are insufficient to accommodate the growing waste, leading to increased use of space and waste accumulation, which poses risks to the environment and public health, including air and water pollution and soil degradation (Affairs,2020).

Additionally, there is a lack of improvement and development in safe waste disposal methods, which hinders the efforts of solid waste management in the city. The recycling and sorting infrastructure exhibits deficiencies, resulting in the depletion of valuable resources and a rise in landfill-bound waste. Addressing this issue necessitates investments in enhancing the waste management system for environmental purposes in New Damietta City. More modern and sustainable landfills should be provided, and waste collection and sorting services should be enhanced. Efforts to recycle and sort waste should also be strengthened to reduce waste volume and achieve better environmental sustainability in the city. The following figure show the quantity of solid waste in New Damietta City and the type of industrial waste and its percentage in the city:( E.E.S.,2018).

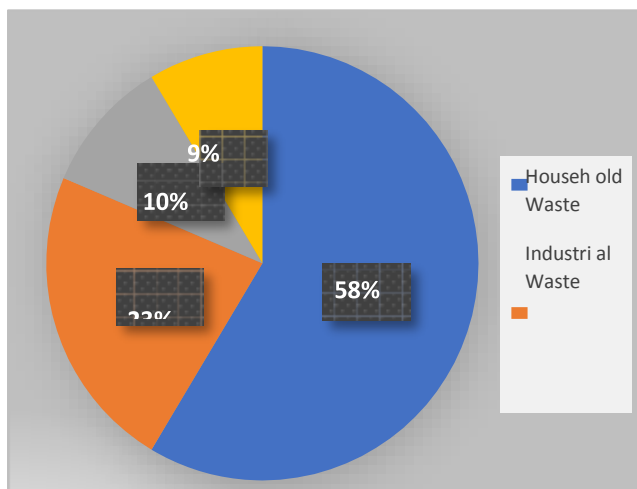


Figure 9 The quantity of solid waste in New Damietta City (Alhassan, 2020)

Utilizing the available land and creating a thorough waste management system for both domestic and commercial waste are both important aspects of developing the industrial zone. In order to establish a balanced environment, it also entails the construction of green spaces inside

the industrial zone. This 20-acre green space is also taking into account the installation of cutting-edge waste treatment equipment to guarantee compliance with safety and health regulations. To lower hazards to the environment and public health, the initiative seeks to better integrate waste management inside the industrial zone. To limit the emissions that have a detrimental influence on the environment and public health, it is intended to install modern waste treatment technology. The following figure illustrates the actual and permissible emission limits resulting from industrial waste in the city. (UNDP., 2021)

In New Damietta City, there exists a diverse range of factories and industrial units contributing to the production of industrial waste. These wastes encompass residuals from production processes, manufacturing, unused raw materials, and pollutants. Industrial waste poses a significant environmental challenge in the city, necessitating proper and environmentally sound handling to mitigate negative impacts on the environment and public health. One crucial approach to address industrial waste is recycling. Interconnected relationships between factories and recycling processes exist in New Damietta City. Some factories adopt internal recycling practices, utilizing waste generated from industrial processes as secondary raw materials in other production processes. This reduces waste sent to landfills and optimizes resource utilization.

Furthermore, there are independent recycling projects and units operating to process and transform industrial waste into reusable or sellable materials. These projects encompass plastic processing, metal recycling, and the treatment of chemicals and toxins. However, New Damietta City faces challenges in terms of effective recycling and complete utilization of industrial waste. There may be infrastructure and technological gaps required for efficient material processing and separation. Enhanced awareness and training among industrial companies might also be necessary to embrace sustainable waste management practices and maximize resource utilization.

The recycling efforts in the city aim to achieve environmental sustainability and alleviate pressure on natural resources. Collaborative efforts among factories, local authorities, and relevant entities are crucial to boost recycling and achieve sustainable improvements in industrial waste management in New Damietta City. The following table illustrates the type and quantity of industrial waste generated from each industrial sector and the type of industry associated with this industrial waste. (Affairs,2020).

Table 3 the type and quantity of industrial waste generated from each industrial sector and the type of industry associated with this industrial waste.

<b>Industrial activity</b>	<b>Type of waste generated</b>	<b>Quantity of residues produced ton/day</b>	<b>Percent of waste generated</b>	<b>Result from recycling of residues</b>	<b>Industrial waste industry</b>
<b>Wood and furniture industry</b>	Wood residue.	15 ton	22 ton	Organic manure.	Fertilizer industry
<b>Food industries</b>	Organic substances	6 ton	9 ton	Cartoon + cardboard	Packing and packaging
<b>Paper industry</b>	Paper	3 ton	4 ton	Plastic + bags	Packaging, packaging and plastic industries
<b>Plastic industries</b>	Plastic.	4 ton	6 ton	Organic manure.	Fertilizer industry

<b>Medicine industry</b>	Medical waste	7 ton	10 ton	Paintings + cleaning materials	Paintings and chemicals
<b>Chemical industry</b>	Kimoi.			Textiles	Clothes ready.
<b>Deer making and weaving.</b>	Cotton fibers and fibers.	6 ton	9 ton	Construction materials	The brick and tile industry.
<b>Construction materials industry</b>	Demolition and construction residues	4 ton	6 ton	Metal pieces.	Small metal industries
<b>Metal industries</b>	Residues of metals and glue	5 ton	7 ton	Electronics	Small electronic industries
<b>Electrical and electronic</b>	Metals and electronics	5 ton	7 ton	Crushed wood boards	Wood board factories
<b>Source :</b>					

Source :(Authority ,2018 )

♦ **The issues and problems of the solid waste sector in the New Damietta City**

**Rapid Population Growth and Urbanization:** New Damietta City is experiencing rapid population growth and urbanization, leading to an increase in solid waste production. The existing waste management infrastructure struggles to keep up with the growing demand, resulting in inadequate services for waste collection and disposal. ( Authority")2020 ‘

**Inadequate Waste Collection Coverage:** New Damietta City suffers from insufficient waste collection services, particularly in certain areas. This exacerbates littering in public spaces, illegal dumping, and waste accumulation, contributing to environmental pollution and health hazards.

**Limited Recycling Infrastructure:** New Damietta City lacks suitable recycling infrastructure. The absence of recycling facilities and programs hampers the separation and recycling of recyclable materials, leading to the loss of valuable resources and an increase in waste sent to landfills.

**Improper Landfill Management:** The existing landfill in New Damietta City faces several challenges in its management. It lacks proper waste compaction, covering systems, and leachate treatment, resulting in environmental pollution, including soil and groundwater contamination.

**Lack of Public Awareness and Participation:** Public awareness of proper waste management practices, including waste reduction, sorting, and recycling, is limited in New Damietta City. Insufficient education and awareness programs hinder public participation in waste management efforts, impeding waste reduction and recycling effectiveness.

**Governmental and Institutional Challenges:** The governmental framework for solid waste management in New Damietta City faces challenges related to coordination among government bodies, waste management regulations, and resource allocation. Ineffective institutional arrangements and limited financial resources hinder the development and implementation of effective waste management strategies. (Authority, 2018)

**Health and Environmental Impact:** Improper waste management practices in New Damietta City lead to negative health and environmental impacts. Open dumping, uncontrolled burning of waste, and improper landfill management contribute to air and water pollution, soil

degradation, and disease spread, posing risks to public health and the ecosystem.

**Air Pollution:** Improper disposal and burning of waste in unauthorized areas can result in the emission of harmful gases and pollutants into the air. This can contribute to poor air quality and respiratory issues for the residents of New Damietta City.

**Water Pollution:** Insufficient waste management practices can lead to the contamination of water sources, such as rivers and groundwater, through the leakage of toxic materials from landfill sites or improper disposal of hazardous waste. This can have detrimental effects on aquatic ecosystems and public health.

**Soil Degradation:** Improper waste disposal, especially organic waste, can lead to soil degradation. Landfills that are not properly covered according to health standards can contaminate the soil with Improper Landfill Management: The existing landfill in New Damietta City faces several challenges in its management. It lacks proper waste compaction, covering systems, and leachate treatment, resulting in environmental pollution, including soil and groundwater contamination.

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**Soil Degradation:** Improper waste disposal, especially organic waste, can lead to soil degradation. Landfills that are not properly covered according to health standards can contaminate the soil with

pollutants, affecting its fertility and agricultural potential, which may have long-term negative impacts on food security and the local economy.

**Negative Aesthetics:** Ineffective waste management practices, such as littering and waste accumulation in unsightly areas, can negatively impact the aesthetics of New Damietta City.

This can affect domestic tourism, the local economy, and the appeal of areas with poor waste management.

**Health Risks:** Inadequate waste management can pose significant health risks to the residents of New Damietta City. Exposure to hazardous materials, disease-carrying insects attracted to improperly managed waste, and poor sanitary conditions can lead to the spread of diseases and threaten public health.

**Integrated solid waste management system**

In New Damietta City, there are interlocking and potential relationships between factories that contribute to the optimal utilization of industrial waste. This is achieved through the exchange of raw materials among factories and using waste as raw materials in production processes. These relationships are further enhanced by jointly addressing shared waste issues. Factories located in close proximity can collaborate in treating common waste. For instance, a wastewater treatment plant can collaborate with another factory to manage its chemical waste, reducing treatment costs and achieving mutual benefits.

Recycling and conversion are also part of this approach. Factories collaborate in treating and utilizing waste collectively to attain economic and environmental benefits. For instance, a plastic waste-producing factory can partner with another factory to incorporate such waste into their manufacturing process instead of using new raw materials.

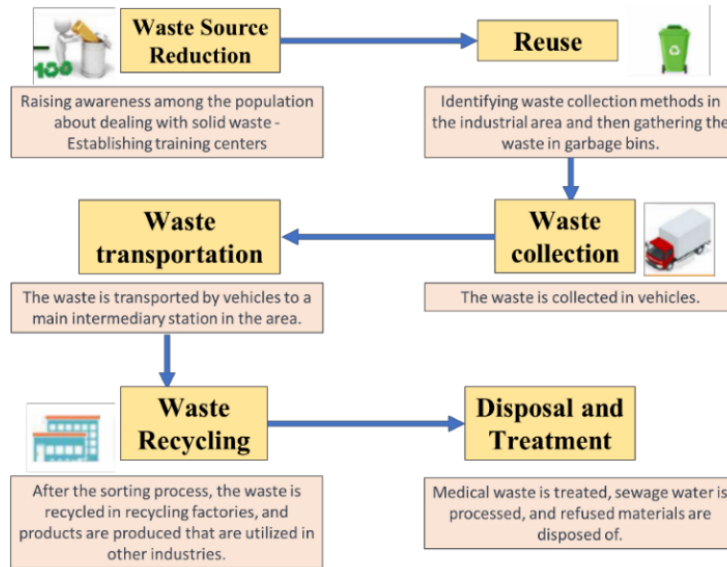


Fig 10 Integrated solid waste management system in New Damietta City. Source: By authors based on (Authority", D., 2020) (Bank, W., 2012) (Gequinto, 2017)

Moreover, integrated industrial zones group factories in one location, facilitating greater opportunities for cooperation and exchange between factories in efficiently and effectively utilizing waste. This is enabled by the presence of shared infrastructure and services. As a result, optimal utilization of industrial waste is achieved, reducing its environmental impact in New Damietta City. The following figure shows Integrated solid waste management system in New Damietta City.

**3. Results and Discussion.**

The researcher has reached A sustainable solid waste management framework for Egyptian cities based on synthesis the integrated solid waste management approach and urban

environmental governance tool applying on New Damietta City, It will be explained in the following steps.

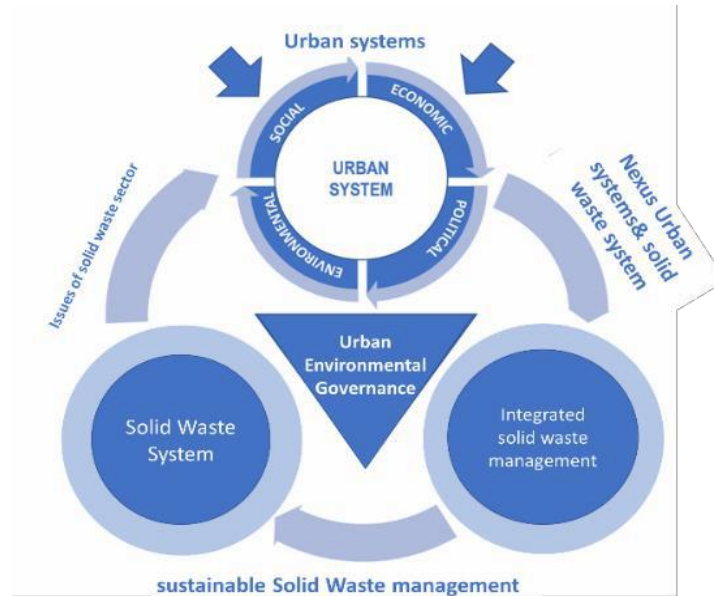


Fig 11 Sustainable solid waste management framework Source: authors

### Interconnected Relationships of Solid Waste

The interconnectivity relationships between different industries in New Damietta City play a vital role in promoting sustainable development and achieving a knowledge-based economy. These relationships allow diverse industries to collaborate and interact directly, leading to multiple benefits and enhancing economic growth. Through industry interconnectivity, resource and expertise exchange can be achieved, improving production efficiency and reducing costs. For instance, by-products of one industry can become inputs for another, reducing natural resource consumption and minimizing waste. Moreover, interconnectivity fosters innovation and the development of new products and services, as different industries can share technology and ideas. Interconnectivity also contributes to employment enhancement and increased economic opportunities within the city. By developing various sectors, new jobs can be created, and employment opportunities can be provided to the local population, ultimately improving living standards and overall economic development in the community. In general, promoting industry interconnectivity in New Damietta City is a pivotal factor in achieving sustainable growth and comprehensive development. By enhancing collaboration and interaction among different industries, economic and social sustainability can be attained for the benefit of all stakeholders. The following figure illustrates the interconnectivity relationships between industries in New Damietta City.

The concept of Proposed Industries Based on Solid Waste in New Damietta City revolves around harnessing the potential of various types of solid waste to drive economic growth and sustainability. By strategically utilizing recyclable and recoverable materials from the waste stream, innovative industries can be established. These industries may involve recycling centers, waste-to-energy facilities, and production units that transform waste materials into valuable

products. This approach not only contributes to reducing the environmental impact of waste but also creates job opportunities, promotes resource efficiency, and supports the overall development goals of the city. Through the integration of waste management and industrial processes, New Damietta City can pave the way for a circular economy, where waste becomes a valuable resource for new production cycles, fostering both environmental and economic benefits. The following table illustrates the proposed industries based on solid waste in New Damietta City.

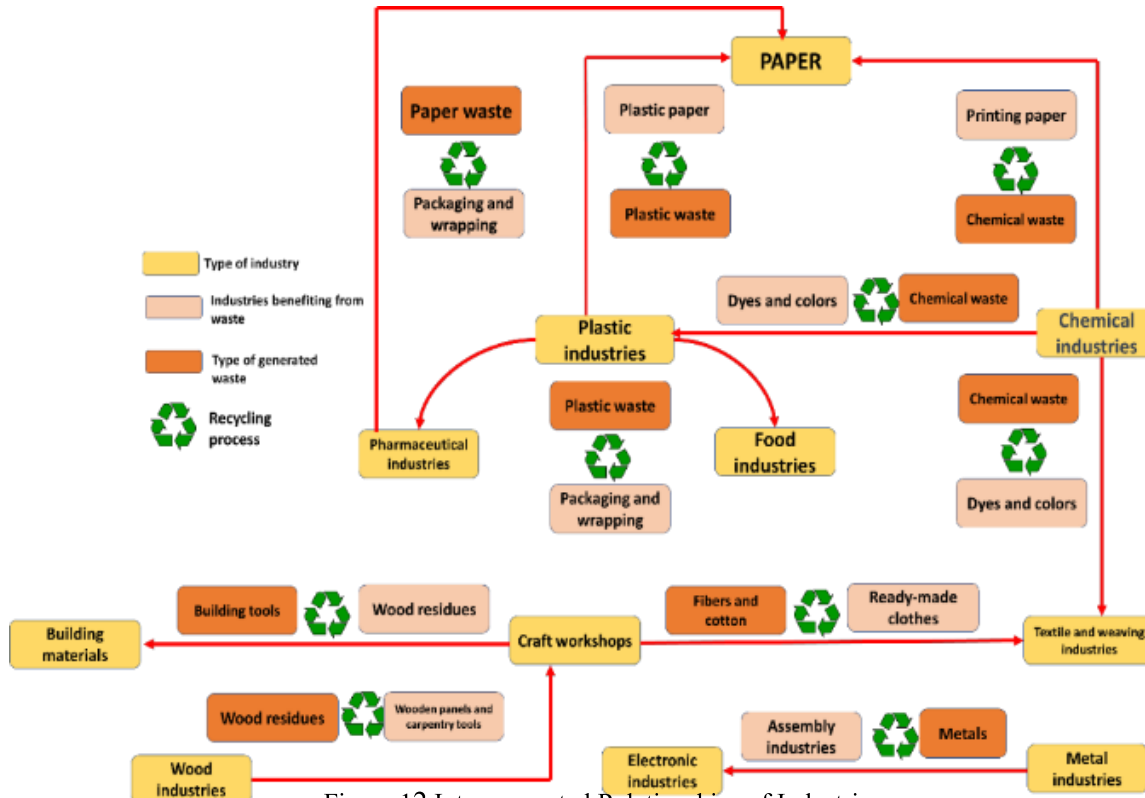


Figure 12 Interconnected Relationships of Industries

Source : By authors based on (Kaza et al., 2016) (Murad et al., 2012) (Narethong, 2020)

The New Damietta City exhibits a complex network of interconnected relationships among various industrial wastes. These relationships rely on mutual interactions between different sectors, as industrial wastes are generated from a diverse range of industries, including chemical, metal, food, electronics, and others. These wastes serve as sources of valuable materials that can be reused or transformed into new products. Precise coordination and close collaboration between different industries, governmental bodies, and local institutions are required to ensure the exploitation of available opportunities for recycling and converting these wastes in environmentally friendly and sustainable ways. These interconnected relationships highlight the significant importance of achieving environmental sustainability and reducing pressure on natural resources by optimally utilizing industrial wastes and transforming them into economic and environmental benefits for the city and its residents. The following diagram illustrates the interconnected relationships of industrial wastes in New Damietta City.

Table 4 Proposed Industries Based on Solid Waste

The stage	Type of waste	Components of waste	Quantity of waste	Outputs of the recycling process	Proposed industry
Extraction of recyclable raw materials from the sorting process	All types of waste		<b>711</b> ton		Intermediate stations - Waste collection and sorting stations
Recycling and waste reprocessing	Non-organic waste	Paper	30 ton	Cardboard + corrugated paper	Establishment of a cardboard paper recycling factory
		Plastic	18 ton	Plastic packaging and bags	Plastic packaging and bags factory
					Plastic spare parts factory
					Packaging and wrapping factory
		Glass	10 ton	Round glass + construction sand	Glass packaging factory
		Metals	25 ton	Small Metal Pieces	Machinery and equipment spare parts factory
					Car metal spare parts factory
		Wood	40 ton	Compressed Wood Panels	Wood recycling factory.
		Car tires	8 ton	Artificial grass + Rubber	Rubber production factory
					Artificial turf production factory for sports fields
Building materials	7 ton	Tiles + Clay bricks	Tiles and ceramic production factory		
Chemicals	7 ton	Dyes + Colors + Cleaning agents	Chemical materials factory		
			Chemical cleaning products factory		
			Dyes and colors factory		
Clothing	16 ton	Fibers and cotton.	Yarn production factory		
			Ready-made clothing factory.		
Energy recovery and generation	organic waste	Organic materials 35%	130 ton	Organic fertilizers	Organic Fertilizer Production factory
		Refused 56%	380 ton	alternative fuel	Refuse-Derived Fuel (RDF) Production factory
Reuse	Equipment		5 ton	Machinery	Engineering Industries
Disposal and Treatment	Hazardous Waste	Medical Waste	35 ton	Municipal Waste	Medical Waste Treatment Facility
Source : By Authors					



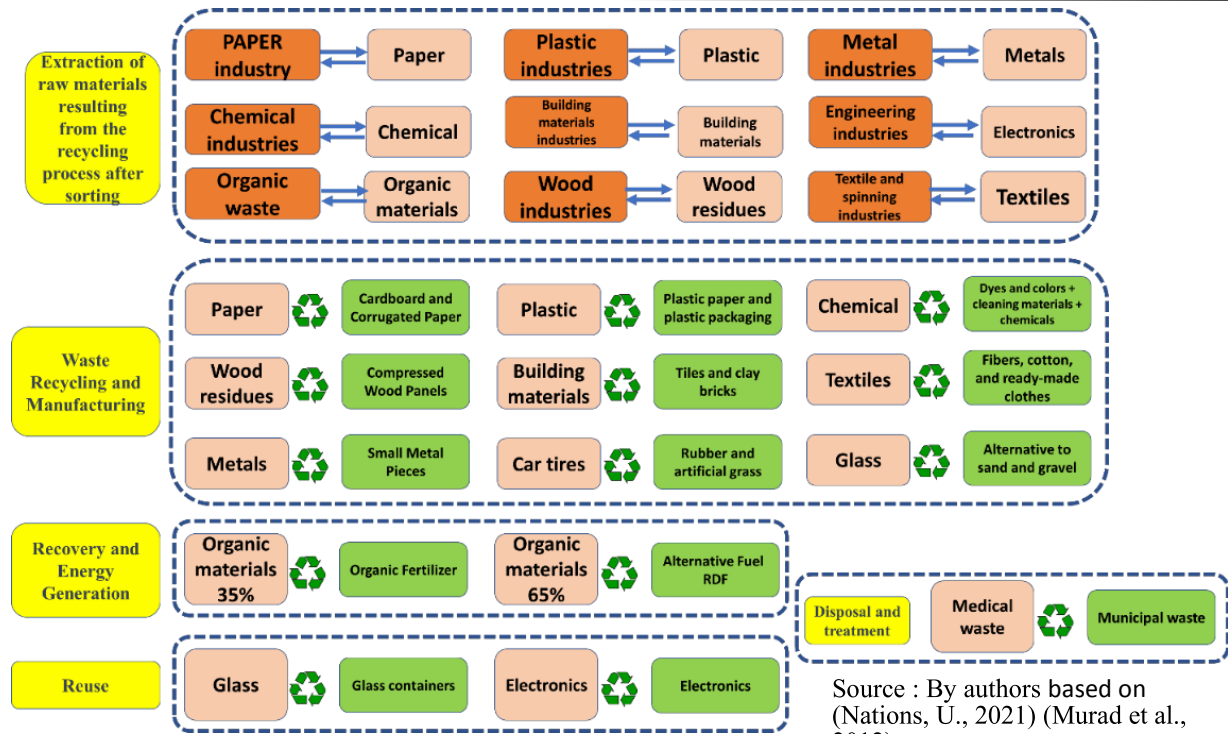


Figure 13 .Interconnected Relationships of Solid waste

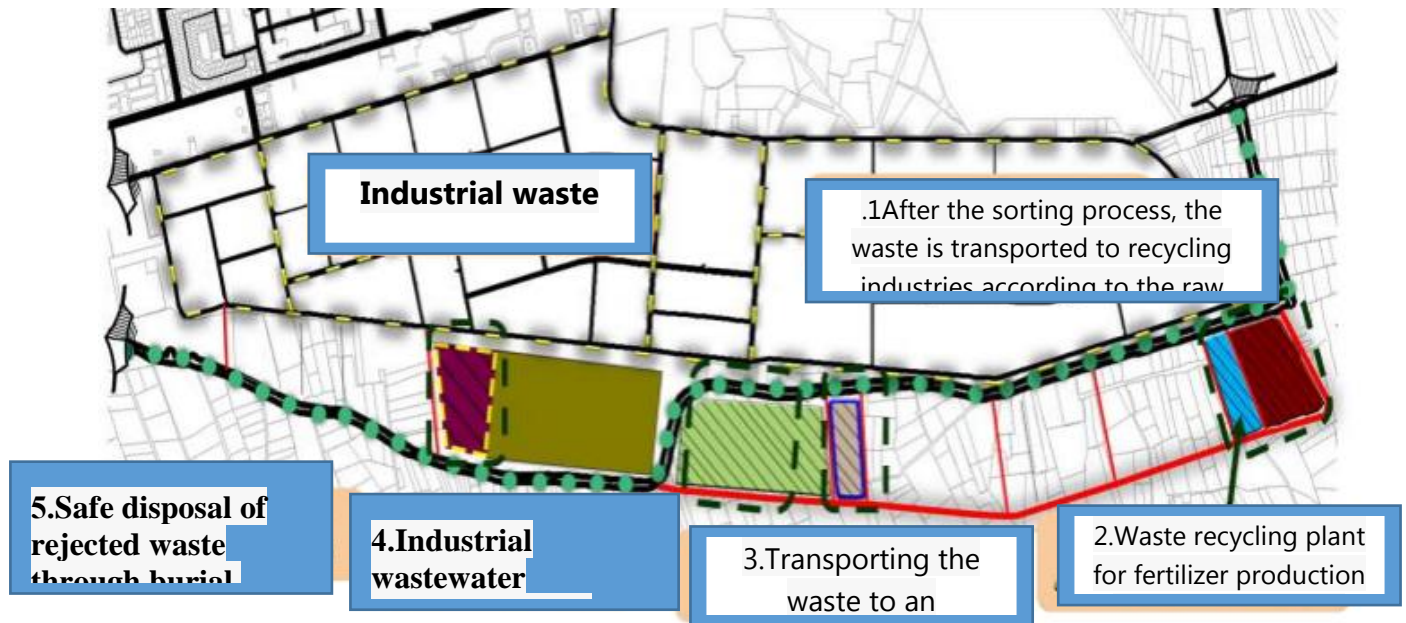


Figure 14 .Interconnected Relationships of Solid waste

### Phase two Urban system (Aspects) of New Damietta City

In order to comprehend and identify the features of New Damietta City, the researcher studied a variety of sectoral indicators throughout this phase. The results of the sectoral indicators for several sectors in New Damietta City are shown in the following table.

Table 5 the urban system of new Demietta city

<p><b>Social Indicators''</b></p>	<ul style="list-style-type: none"> <li>• Around 90% of the city's population lives in urban areas.</li> <li>• The literacy rate of the population aged 12 and above is approximately 12%.</li> <li>• Unemployment among the youth aged under 26%.</li> <li>• The illiteracy rate among females is around 5%.The increase in population from 2006 to 2017 was about 2.5%, indicating a rise in birth rates and a growth in the number of households.</li> </ul>
<p><b>Economic Indicators:</b></p>	<ul style="list-style-type: none"> <li>• The annual tourism revenue contributes 12% with an average of 6000 visitors.</li> <li>• The main source of the city's income is the local tourism sector, including the seasonal tourism activities and various cultural events.</li> <li>• The per capita income in the urban areas is estimated to be around 22%, averaging 10533 units.</li> <li>• The local agricultural sector, mainly consisting of olive cultivation, constitutes 12% of the total agricultural land, covering 5593 acres.</li> <li>• The total area of the local agricultural land reaches 523 acres, primarily dedicated to cultivating crops and providing supplementary resources for the local economy.</li> <li>• This cultivated area is instrumental in boosting agricultural productivity, increasing employment opportunities, and enhancing food security.</li> <li>• The agricultural sector plays a significant role in augmenting income and reducing unemployment, contributing positively to the overall economic balance.</li> </ul>
<p><b>Urban Indicators:</b></p>	<ul style="list-style-type: none"> <li>• Urban Expansion: The planned urban expansion is around 200 acres, aimed at accommodating the growing population.</li> <li>• Green Spaces: Approximately 2% of the total land area is designated for public parks and green spaces to enhance urban aesthetics.</li> <li>• Housing Development: Affordable housing projects are being initiated to accommodate the increasing urban population's housing needs.</li> <li>• Infrastructure Enhancement: Infrastructure development includes road expansion and construction, with a focus on enhancing road networks to accommodate increasing traffic.</li> <li>• Industrial Zone: The industrial zone hosts a total of 648 factories, out of which 213 factories (33%) are operational while 435 factories remain unallocated and inactive.</li> <li>• Green Spaces in Industrial Zone: The industrial zone lacks sufficient green spaces, which play a crucial role in preserving the environment and separating different industries with green pathways.</li> </ul>
<p><b>Infrastructure Indicators:</b></p>	<ul style="list-style-type: none"> <li>• Electricity Distribution: The electricity distribution project is being executed, involving installing a 50 MVA transformer station and a 11/66 kV substation.</li> <li>• Water Supply: 25 water distribution stations are planned to meet the water demand of the city.</li> <li>• Wastewater Treatment: Two wastewater treatment plants with a combined capacity of 1900 m3/day are under development</li> </ul>
<p><b>Environmental indicators</b></p>	<ul style="list-style-type: none"> <li>• Geological Composition: The city's geological composition consists of clay, sandy clay, and silty sand, with sedimentary deposits from the Nile Delta reaching depths of over 30</li> </ul>

	<p>meters. Beneath these deposits lie ancient marine deposits composed of sand and gravel.</p> <ul style="list-style-type: none"><li>• Soil Characteristics: The city's soil is cohesive, loamy, sandy, and silty in nature, suitable for agriculture, construction, and landscaping without any significant constraints.</li><li>• Groundwater Recharge: The city recharges its groundwater through a process of artificial recharge, with a capacity of 86400 m<sup>3</sup>/day.</li><li>• Average Water Consumption: The average daily water consumption for the city is 30 liters per capita, with an average daily water supply of 28239 m<sup>3</sup>/day. The non-revenue water ratio stands at 46.8% as a consequence of water losses and leaks within the distribution system. Initiatives are being undertaken to enhance the water networks, especially in regions experiencing insufficient water pressure. These endeavors encompass the replacement of outdated pipelines with more resilient materials to minimize leakage. Concurrently, improvements are being made to the sewage networks to accommodate the expanding population and guarantee the effective treatment and disposal of wastewater. This endeavor serves to enhance both the city's sanitation and environmental circumstances.</li></ul>
<p><b>Source :</b> By Authors based on (Affairs, M. o. (2020). Authority, N. U. (2020). Mmerekı et al., 2016) (Hoorweg &amp; Bhada-Tata, 2012)</p>	

### Phase three Urban Environmental Governance in New Damietta City

The city of New Damietta has started working on a comprehensive solid waste management plan that includes a number of collaborations and frameworks to ensure ethical and sustainable trash management. In order to reduce waste production and increase resource efficiency, the city's strategy blends political commitment, environmental planning, urban vision, and a sustainable development framework.

1. Political Setting The city's solid waste plan is supported by well-organized laws, regulations, and platforms for collaboration. It is rooted in a strong political commitment. This framework gives successful waste management the required push thanks to a focused allocation of resources and an emphasis on stakeholder engagement.
2. Environmental Planning Framework Environmental considerations are deeply bedded in the megacity's development plans. The environmental planning frame ensures that sustainable practices percolate all aspects of development. It promotes strategies that conserve natural coffers, minimize waste, and encourage responsible consumption and product.
3. Urban Planning Vision The megacity's civic planning vision focuses on orchestrating programs, regulations, and organizational setups to grease sustainable waste operation. This includes responsible waste running, avoiding dangerous waste generation, and administering eco-friendly waste operation practices.
4. 2030 Sustainable Development Blueprint: A comprehensive blueprint for achieving sustainable waste management sets forth distinct goals, accentuating waste minimization, streamlined collection, and holistic administration. This framework underscores investments targeted at waste reduction and handling, with a concentrated effort on devising plans and tactics for prudent waste handling practices.

5. **Organizational Framework:** The city's waste management strategy revolves around an interconnected web of organizations collaborating to ensure the efficacious execution of policies. This structure nurtures harmonization among governmental entities, research establishments, private enterprises, and the local community, ensuring an all-encompassing methodology towards waste management.
6. **Stakeholder Engagement:** A spectrum of stakeholders contributes to the intricate tapestry of waste management. Governmental bodies, exemplified by the Ministry of Environment and regulatory authorities, spearhead policy formulation. Municipalities at the grassroots level wield pivotal roles in hands-on waste management, while the private sector furnishes technological innovations. International organizations and academic institutions lend their expertise, while the local populace actively bolsters awareness and involvement.
7. **Legal Infrastructure:** The legal infrastructure constitutes a cornerstone in overseeing waste management endeavors. Legislative statutes and regulatory provisions encompassing environmental safeguards, waste transit mandates, and ministerial edicts furnish a legal framework for waste management operations. This foundation ensures that waste management is executed with safety at its core and is aligned with established environmental benchmarks.
8. **Financial Infrastructure:** A meticulously organized financial framework lends indispensable backing to waste management initiatives. Diverse funding streams encompassing the general budget, levies, taxes, external funding avenues, and collaborative endeavors with the private sector provide the vital sustenance for waste management undertakings, infrastructure enhancement, and educational initiatives.
9. **Data Governance and Knowledge Dissemination:** Proficient data governance and seamless information exchange stand as pivotal pillars in the city's waste management blueprint. A robust architecture adeptly captures and circulates data encompassing waste volume, categories, collection modalities, and disposal techniques. This reservoir of information plays a pivotal role in shaping decisions, fostering transparency, and assessing operational effectiveness.
10. **Skill Enhancement:** The augmentation of expertise, proficiencies, and resources forms the bedrock of fortified waste management competence. Educational initiatives, technological innovations, and updates in regulatory frameworks empower personnel to proficiently navigate waste management with competence and conscientiousness.
11. **Oversight and Appraisal:** Vigilant oversight and rigorous appraisal constitute cornerstones within the waste management blueprint. This robust framework not only guarantees service excellence but also evaluates environmental ramifications, pinpoints avenues for refinement, ensures conformity, and nurtures an ongoing process of amelioration.

### **The principles of urban environmental governance realized sustainable solid waste management through the application of the Integrated Solid Waste Management in New Damietta**

New Damietta City's waste management strategy constitutes a holistic initiative that encompasses a spectrum of frameworks, collaborations among stakeholders, legal regulations, financial mechanisms, data management, capacity building, and vigilant monitoring. Through the adoption

of an integrated approach, the city is primed to achieve a sustainable and conscientious waste management paradigm, ultimately contributing to a purer environment and a more flourishing future for its inhabitants. (Rahman 2020; Sakib et al. ,2023)

**Thorough Planning:** Craft a meticulously delineated and comprehensive waste management blueprint that takes into account the unique requisites and hurdles of New Damietta City. This master plan should encompass strategies spanning waste reduction, recycling, composting, and proper disposal, thereby establishing an interconnected and sustainable waste management network. (Das, 2022)

**Community Engagement:** Engage and enlighten the local populace on waste management methodologies, emphasizing the significance of waste reduction, recycling, and responsible disposal. Foster a sense of custodianship and commitment among residents, businesses, and other stakeholders to cultivate active involvement in waste management endeavors(Alhassan, 2020)

**Infrastructure Advancement:** Invest in suitable infrastructure and facilities designed for waste management, including recycling hubs, composting sites, and waste-to-energy installations. Ensure the strategic placement, accessibility, and equipped readiness of these facilities to effectively manage diverse categories of waste. (Alam and Qiao (2020)

**Regulatory Framework:** Pave the way for regulations and policies that advocate for sustainable waste management practices. This encompasses setting waste diversion objectives, instituting mandatory recycling initiatives, and enforcing regulations for proper waste disposal, thereby forestalling illicit dumping and littering. (Sakib et al. (2023)

**Synergistic Partnerships:** Cultivate a culture of collaboration and partnerships involving pertinent entities such as government agencies, waste management enterprises, non-governmental organizations, and private enterprises. Collaborative efforts possess the potential to augment the efficiency and sustainability of waste management strategies through the amalgamation of resources, knowledge, and expertise.

**Surveillance and Evaluation:** Instate an efficient mechanism for tracking progress, appraising the efficacy of waste management initiatives, and identifying avenues for enhancement. Routine data accumulation and analysis can serve as catalysts for policy adaptations, fortify accountability, and wield influence over decision-making processes.

**Proposed land uses for achieving Sustainable solid waste management**

In this step, a group of proposed uses will be identified that will help decision makers achieve sustainable waste management in New Damietta City, which has been divided into: Proposed environmental management services, recycle industries land uses Proposed services and Proposed Industries

Table 5 Proposed land uses for achieving Sustainable solid waste management for new Demietta city

Proposed land uses for achieving Sustainable solid waste management	
Urban environmental governance principles	<ul style="list-style-type: none"> <li>◆ Proposed Industries</li> </ul>
<ul style="list-style-type: none"> <li>○ Community Engagement</li> <li>○ Infrastructure Advancement</li> </ul>	<ul style="list-style-type: none"> <li>○ Metal industries , Electronic industries</li> <li>○ Pharmaceutical industries , Paper</li> </ul>

<ul style="list-style-type: none"> <li>○ Regulatory Framework</li> <li>○ Synergistic Partnerships</li> <li>○ Surveillance and Evaluation</li> </ul> <p>Solid waste management process</p> <p>.1.After the sorting process, the waste is transported to recycling industries according to the raw</p> <p>2.Waste recycling plant for fertilizer production and alternative fuel.</p> <p>3.Transporting the waste to an intermediate station for sorting</p> <p>4.Industrial wastewater treatment stage.</p> <p>5Safe disposal of rejected waste through burial.</p>	<p>industries, Textile industries ,m Chemical industries, Food industries, Plastic industries, Chemical industries</p> <p>Wooden furniture industries</p> <ul style="list-style-type: none"> <li>◆ Proposed services</li> </ul> <p>Religious services.                  Social, administrative, and healthcare services.</p> <p>Workshops and maintenance                  Heavy industries exhibitions.                  Medium industries exhibitions.                  Furniture exhibition.                  Craft workshops.</p> <ul style="list-style-type: none"> <li>◆ Proposed environmental management services</li> </ul> <p>Industrial consulting center.                  Training centers.                  Environmental monitoring station.                  Pollutant gas extraction station.                  Sanitary landfill.                  Main intermediate station.                  Industrial lake.</p> <ul style="list-style-type: none"> <li>◆ Recycle industries land uses</li> </ul> <p>Fertilizer manufacturing.                  Medical waste manufacturing.                  Industrial wastewater treatment plant.                  Main collection station.                  RDF (Refuse Derived Fuel) manufacturing.</p>
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#### 4. Conclusion.

In conclusion, the research underscores the success of implementing urban environmental governance principles for achieving sustainable solid waste management in Egyptian cities, focusing on the Integrated Solid Waste Management approach. The case study of New Damietta City serves as an exemplary model, showcasing a comprehensive waste management strategy that integrates various frameworks, collaborations, legal regulations, financial mechanisms, data management, capacity building, and vigilant monitoring. This holistic approach positions New Damietta City on a trajectory towards establishing a sustainable and conscientious waste management paradigm, contributing significantly to a cleaner environment and a more prosperous future for its residents.

To ensure the enduring success of sustainable waste management, key recommendations emerge. Firstly, a meticulously crafted waste management blueprint tailored to New Damietta City's unique requisites and challenges is essential. This master plan should encompass strategies spanning waste reduction, recycling, composting, and proper disposal, establishing an

interconnected and sustainable waste management network. Secondly, community engagement is crucial; educating the local populace on waste management methodologies and fostering a sense of custodianship and commitment among residents, businesses, and stakeholders will encourage active involvement in waste management endeavors. Lastly, infrastructure advancement, regulatory frameworks, synergistic partnerships, and effective surveillance and evaluation mechanisms are integral components for sustaining New Damietta City's commitment to a comprehensive and sustainable waste management paradigm.

By embracing these recommendations, New Damietta City can solidify its dedication to sustainable waste management, not only contributing to environmental preservation but also enhancing the well-being and prosperity of its residents.

Synthesis the integrated solid waste management approach and urban environmental governance tool will help to propose groups of proposed land uses like Proposed services , Proposed environmental management services, Recycle industries land uses ...etc to achieve sustainable solid waste management framework for Egyptian cities to help making decisions.

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