

## Advances in Earth and Environmental Science

# The Circular Economy and Municipal Solid Waste Management : Challenges and Innovations in Developed and Developing Countries

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**Abstract**

*As populations grow and living standards improve, more waste is generated for developed and developing countries. Appropriate municipal solid waste management (MSWM) is necessary to avoid harm to the environment, wildlife, and human health. Developed countries are constantly adapting their policies and legislation to promote green development for the sake of sustainable development benefiting for both environment and socioeconomic. In some countries, landfills have been prohibited, promoting the use of more sustainable technologies such as incineration, recycling, and composting. However, the corresponding disposal strategies, along with constraints in land resources and finances, compounded by unorganized public behaviour, have resulted in ineffective policy implementation and monitoring. The transition from a linear to a circular economy presents both opportunities and challenges for municipal solid waste management systems in developed countries and much more in developing countries. As urbanization intensifies and consumption patterns evolve, cities face mounting pressure to reduce waste, enhance recycling, and closed loop approach. The integration of circular economy principles into municipal waste management frameworks, focusing on technological, policy, and behavioural innovations play a crucial role in MSWM. Key challenges include fragmented regulatory environments, technological limitations in waste sorting and recycling, lack of systematic, blind mapping and public resistance to behavioural change. Conversely, developed countries are at the forefront of adopting innovative solutions such as smart waste tracking systems, extended producer responsibility (EPR) schemes, and circular design in consumer products, while the developing nations are still far behind. Ultimately, the circular economy offers a transformative pathway toward resilient resource-efficient cities, but its implementation requires adaptive governance, investment in innovation, and strong stakeholder engagement.*

**Keywords:** Municipal Solid Waste; Circular Economy; Innovation; Challenges; Waste Management.

**Introduction**

Developed countries are moving from linear “take-make-dispose” waste models to circular economy systems. Countries like Germany, Japan, Sweden, and the Netherlands offer strong case studies for municipal solid waste management (MSWM). Legislative tools (like the EU Waste Framework Directive or bans on single-use plastics) are critical in SWM. According to the United Nations (UN), by 2050, two-thirds of the world’s population will live in urban spaces, which necessitates the improvement of infrastructure, energy, health, and waste management services for the upcoming urban level of population (Baltac, 2019; Espinoza-Arias et al., 2018; Jagtap & Rahimifard, 2019; Macke et al., 2019).

With the increasing city population, waste management is a serious concern in urban spaces and requires a sustainable ecosystem for an urban population for efficient city life (Baltac, 2019; Jagtap & Rahimifard, 2019; Jatinkumar & Jørgensen

2018; Valenzuela-Levi, 2019). Waste generation in cities will double every decade, with an increasing population of 3–5 % every year. It imposes severe pressure on waste collection and waste processing activities (Chatterjee & Kar, 2018). Municipal solid waste (MSW), is a major environmental and policy challenge in developed countries due to high consumption rates, dense urban populations, and increasing pressure on natural resources. Developed nations are adopting innovative strategies to manage waste more sustainably, focusing on reduction, recycling, energy recovery, and circular economy principles. Most of the developed and developing nations focus on the transformation of city livelihood through the development of smart cities. Levels of collection coverage and controlled disposal of 95% in middle-income, and 50% in low-income, cities are already commonplace; whereas recycling rates of 20–30% are often achieved by the informal sector (Wilson et al., 2012; Wilson et al., 2013). Developed

countries the root causes of waste management cannot focus only on end-of-pipe waste management, we do need to consider also upstream issues (Srivastava et al., 2014).

### Current State of Municipal Solid Waste in Developed and Developing Countries

The current state of municipal solid waste management differs significantly between developed and developing countries due to variations in economic capacity, technological advancement, population growth, and governance (Khan et al., 2022). However, developed countries face challenges related to high waste generation and complex waste streams, developing countries struggle with inadequate collection systems, limited infrastructure, and rapid urbanization. Developed countries have sophisticated systems for collecting, treating, and

disposing of municipal solid waste, at the same time they face persistent issues due to high amount of waste generated and the limits of recycling systems. The shift toward a circular economy, increased waste prevention, and technological innovation play a critical role to reduce environmental impacts and achieving long-term sustainability. Developing countries is a multidimensional challenge with environmental, health, economic, and social implications. While rapid urbanization increases pressure, there is significant potential for improvement through integrated waste-management strategies, community engagement, better governance, and support for the informal recycling sector. Transforming waste systems not only reduces pollution but can also create jobs, recover valuable resources, and build more resilient cities. Table 1 shows the current state of MSWM in developed and developing countries.

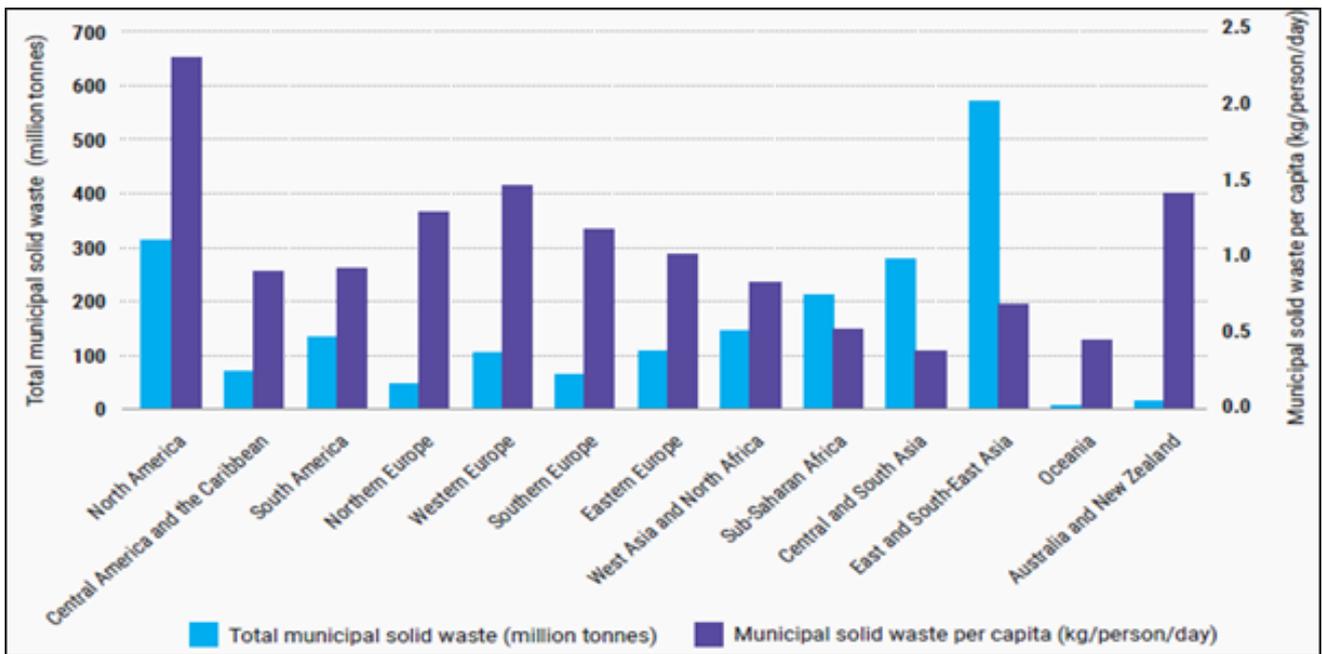
**Table 1:** Current State of MSWM in Developed and Developing Countries

Country	Waste Generation (kg/cap/day)	Waste Composition (organic-%)	Collection and Treatment	Key Challenges
Developed Countries	1.3-2.5	20-40	<ul style="list-style-type: none"> <li>Collection coverage~100%</li> <li>Sanitary landfills</li> <li>Waste-to-energy (WTE)</li> <li>Mechanical-biological treatment (MBT)</li> <li>Anaerobic digestion</li> </ul>	<ul style="list-style-type: none"> <li>Excessive waste generation</li> <li>Stagnating recycling rates</li> <li>Growing plastic and e-waste volumes</li> </ul>
Developing Countries	0.5-1.0	40-70	<ul style="list-style-type: none"> <li>Collection coverage~ 30-70%</li> <li>Uncollected</li> <li>Open dumping and uncontrolled landfill</li> <li>Recycling-informal sector</li> </ul>	<ul style="list-style-type: none"> <li>Inadequate collection systems</li> <li>Health risks</li> <li>Limited investment and technology</li> </ul>

### Municipal Solid Waste Generation by Region and Global

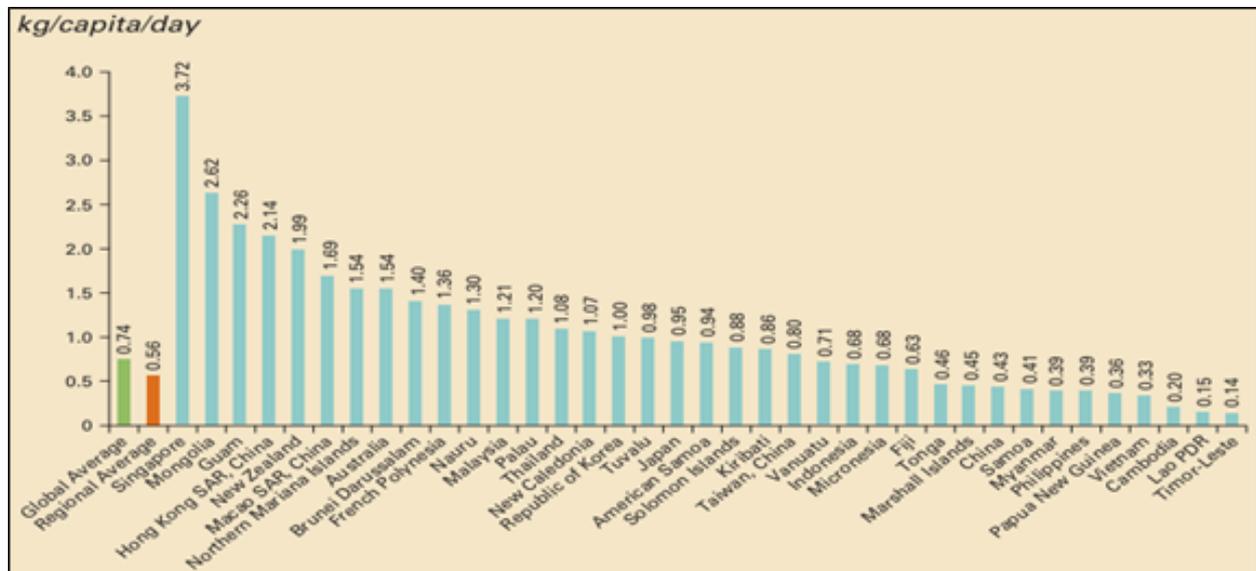
In the countries or regions with the highest total MSW generation, there is sometimes a relatively low rate of MSW generation per capita. Figure 1 shows that comparable quantities are generated by North America and Central and South Asia, although there is a marked difference in the quantities generated per capita. In addition, the number of fast-growing middle-income countries, where waste management issues are especially prominent, is increasing. Global municipal solid waste generation was projected to increase from approximately 2.01 billion tonnes in 2016 to 2.59 billion tonnes in 2023 and is projected to 3.8 billion tonnes by 2050, which accounted for a 30-40% increase (Blazso, 2010; Kaza et al., 2018). It is alarming to urgently take action to improve waste management

strategies globally, particularly in regions of rapid urbanization. Of this waste, almost one-third is projected to originate from Asia alone (Chen et al., 2021). Furthermore, Plastic pollution is also a main part of MSW which can afflict land, waterways and oceans. It is estimated that 1.1 to 8.8 million tonnes of plastic waste enters the ocean from coastal communities each year (Jambeck et al., 2015). The results of several researches indicated by 2050 there could be more plastic than fish in the oceans by weight (Sutter, 2016). Globally, predictions indicate that plastic production could exceed 650 million tons by 2050, representing a staggering more than 22000 % increase compared to 1950 (World Bank, 2023c). However plastic pollution is out of the scope of this.



**Figure 1:** MSW Generation by region: million tonnes and kg/person/day  
**Source:** (World Bank 2023c).

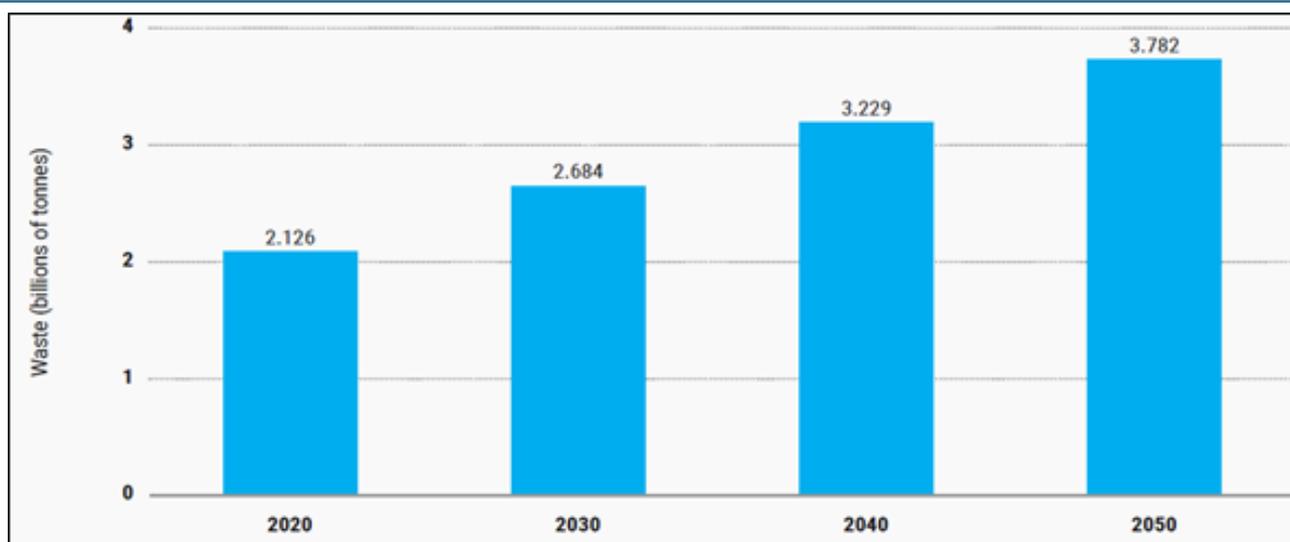
Global municipal solid waste generation varies by region, income level, and urbanization. The average amount of MSW generated per capita per day (kg/cap/day) can differ greatly between high-income countries and low-income countries (Fig 2). It means that high income countries have more purchasing power than low-income countries. The global average is estimated to be around 0.74 kg/cap/day based on data from organizations like the World Bank, but this is rising as developing countries continue to urbanize and consumption levels increase. Waste generation is expected to keep growing worldwide, with projections suggesting that global MSW could increase by up to 70% by 2050 due to urban population growth and higher income levels (Kaza et al., 2018).



**Figure 2:** Global municipal solid waste generation (kg/cap/day)  
**Source:** (Kaza et al., 2018)

**Projection of global municipal solid waste in 2030, 2040 and 2050 if urgent action is not taken**

In 2020, global MSW generation is estimated to have been 2.1 billion tonnes per year. Owing to a combination of economic and population growth, it is projected to increase by 56 per cent to 3.8 billion tonnes by 2050 if urgent action is not taken (Fig 3).



**Figure 3:** Global Municipal solid waste projection for 2030, 2040 and 2050

Source: The Global Waste Management Outlook 2024 adopted from World Bank (2018). “What a Waste 2.0” (Kaza et al., 2018).

### Municipal Solid Waste Management Approach and Challenges for Developed and Developing Countries

Municipal Solid Waste management (MSWM) approaches differ significantly between developed and developing countries due to differences in income level, technology, infrastructure, governance, and public awareness.

### Municipal Solid Waste Management Approach in Developed Countries

#### The Circular Approach

The circular approach is a sustainable waste management strategy that aims to keep materials and resources in use for as long as possible, minimize waste generation, and reduce environmental impacts. It shifts away from the traditional linear model (take → make → use → dispose) to a circular model (design → use → recover → regenerate) or closed loop system. Core Principles of the Circular Approach include reduce, reuse, recycle, recover and regenerate which play a crucial role in minimizing waste.

#### Innovations

Innovations in municipal waste management have grown rapidly in response to the challenges posed by growing urban populations, climate change, and resource scarcity. The shift towards sustainable, efficient, and tech-driven solutions has led to some exciting advancements. Here are some of the most important innovations currently shaping municipal waste management:

#### Smart Technologies

Most of the developed and developing nations focus on the transformation of city livelihood through the development of smart cities. Internet of things (IoT)-enabled waste bins, AI sorting systems, real-time tracking of waste. Example: Smart waste collection in cities like Amsterdam or San Francisco. IoT & AI Innovations for Smart bins with fill-level sensors, dynamic routing, and real-time analytics are optimizing collection (e.g., Singapore achieved a 70% reduction in collection frequency). Waste-sorting robots and AI-enabled

reuse are improving efficiency in recycling facilities across Europe and South Korea. Automated Vacuum Collection Systems using underground tubes to transport waste efficiently are operational in many cities like Helsinki, Copenhagen, and New York (Roosevelt Island), reducing collection costs and environmental impact. For developing countries, smart city development is also a potential solution for problems arising from the growing urbanisation process. Future prospects of smart cities and their potential to attract investments support the city’s and nation’s financial requirements (Sharma et al., 2020).

#### Advanced Waste-to-Energy and Circular Solutions

Converting municipal waste into electricity or heat. Pros and cons exist as it is efficient but controversial due to emissions. Waste-to-Energy (WtE), Sweden extensively uses incineration to power district heating and electricity, minimizing landfill use. Singapore’s integrated Tuas Nexus facility combines waste and wastewater treatment for optimal resource recovery. Emerging technologies such as plasma gasification and anaerobic digestion offer cleaner energy recovery. Meanwhile, bioplastics and compostable alternatives are gaining traction, dependent on infrastructure and regulation as well as Plasma gasification, anaerobic digestion, and pyrolysis. Recycling of previously non-recyclable materials (e.g., multi-layer plastics) and Closed-loop recycling, biodegradable packaging and advanced material recovery are examples.

#### Regulatory Frameworks & Policies

Plastic bans and landfill restrictions. Circular economy roadmaps (e.g., EU Green Deal, Japan’s Sound Material-Cycle Society), Extended Producer Responsibility (EPR) is expanding globally, most recently in the UK, this shifts waste disposal costs to producers, driving eco-friendly packaging and operational innovation. Circular Economy Legislation. France’s ground-breaking law bans incineration of unsold goods, imposes mandatory reparability labels, and promotes repurposing, encouraging systemic waste reduction. Pay-As-You-Throw (PAYT) and usage-based pricing models are

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effective in reducing waste generation. Examples include Taipei, 35% reduction in waste and Hong Kong implementing similar systems.

### Global Coordination and Sustainability Goals

UN Sustainable Development Goals (SDG 11 & 12) and Negotiations for a Global Plastics Treaty is also keys for waste management. International cooperation on e-waste, marine litter, and climate-friendly waste practices.

### Municipal Solid Waste Management Challenges in Developed Countries

Despite having advanced technologies, strong institutions, and well-established waste management systems, developed countries continue to face several significant challenges in managing MSWM. These challenges are largely driven by high consumption patterns, changing waste composition, and sustainability goals. Below are main challenges:

**Complexity & diversity of waste streams:** As urban populations grow, and consumer lifestyles diversify, waste composition becomes more heterogeneous (organic waste, plastics, e-waste, construction debris, etc.), making sorting, treatment and recycling more difficult.

**Technological and institutional inertia:** Transitioning to circular systems often requires advanced technologies (sorting, recycling, waste-to-resource, e-waste processing) and institutional coordination, both of which may be lacking or inefficient even in developed contexts.

**Behavioral and cultural barriers:** Even where infrastructure exists, public participation (e.g. source segregation, reuse, recycling) may be low. Without widespread behavioural change, circular systems struggle to realize their potential.

### Municipal Solid Waste Management Approach in Developing Countries

Below is an overview of the approach in managing MSW in developing countries, along with emerging solutions.

#### Waste Prevention & Reduction

Encouraging waste minimization: While often not a primary focus, some cities are adopting initiatives to reduce waste generation, such as reducing packaging or promoting product reuse.

**Public awareness campaigns:** Programs aimed at educating citizens about reducing waste, avoiding single-use plastics (SUP), and reusing products can be effective. For example, Kenya has banned plastic bags to reduce plastic waste.

#### Improving Collection Systems

**Door-to-door collection:** To combat illegal dumping and overflowing bins, cities are implementing door-to-door collection services. This helps improve waste management and ensures that waste is properly disposed.

**Waste segregation at source:** Some cities, like Mumbai and Kolkata, are promoting waste segregation at the household level, with separate bins for organic waste, recyclables and non-recyclables.

**Public-private partnerships (PPP):** Some local governments are entering into PPP agreements to build infrastructure for waste collection and treatment, improving service delivery. An example is Lahore, Pakistan, where private companies assist in waste collection and disposal.

#### Improved Recycling Systems

**Integration of informal sector:** Recognizing the contribution of informal waste pickers, several cities are formalizing waste picking. This can be done by providing training, safety gear, and legal protection, and by integrating them into formal waste collection and recycling systems.

**Setting up local recycling centers:** Communities can set up small-scale recycling units for plastic, paper, and glass recycling. Philippines and India are examples of countries where informal and formal systems are beginning to work together to promote recycling.

#### Waste-to-Energy (WtE) and Organic Waste Management

**Biogas production:** Organic waste from households and agriculture can be used to produce biogas through anaerobic digestion. This can provide clean energy and fertilizer for agriculture. Some communities in India and Bangladesh are using organic waste to generate biogas.

**Composting:** Encouraging community-based composting for organic waste helps reduce the volume of waste sent to landfills and provides compost for agriculture. Cape Town, South Africa, has implemented small-scale composting projects in local communities.

**Waste-to-energy plants:** A few developing countries, such as China and Brazil, are investing in WtE plants that burn waste to generate electricity. However, the technology can be costly and requires substantial investment.

#### Landfill and Open Dumping Control

**Sanitary landfills:** Some cities are improving their landfill management by implementing sanitary landfills, which are designed with proper lining to prevent leachate from contaminating groundwater. Mexico City and Santiago (Chile) have upgraded landfills to minimize environmental impacts.

**Landfill gas recovery:** Some countries are capturing methane from landfills and using it as a source of energy. Brazil has several projects where methane is recovered from landfills and used for electricity generation.

#### Innovative Solutions

**Mobile waste management apps:** Mobile apps and platforms that allow citizens to report uncollected waste or request waste collection services are becoming more common in developing countries. In Lagos (Nigeria), a mobile app helps residents track waste collection services.

**Plastic recycling initiatives:** Some developing countries are exploring innovative solutions to deal with plastic waste, such as plastic road construction (recycling plastic into road materials). India has been pioneering the use of plastic waste in road construction.

## Municipal Solid Waste Management Challenges in Developing Countries

In developing countries, managing municipal solid waste (MSW) presents unique challenges due to factors such as rapid urbanization, limited infrastructure, insufficient financial resources, and a lack of public awareness. However, these countries are increasingly adopting innovative solutions to improve waste management systems, often with the help of international aid, technological advancements, and public-private partnerships.

Below is an overview of the key challenges in managing MSW in developing countries, along with emerging solutions.

**Rapid Urbanization:** Developing countries often experience high rates of urbanization, leading to growing waste generation. Cities like Lagos, Dhaka, and Nairobi face immense pressure to handle waste efficiently as populations rise.

**Limited Infrastructure:** Many cities lack modern waste collection systems, such as formal sorting or processing facilities. Waste is often collected manually or via rudimentary systems. Collection and transportation are inefficient, leading to overflowing waste bins, uncollected waste, and poor sanitation.

**Financial constraints:** Circular-economy infrastructure and technologies require significant upfront investment. Developing countries often prioritize essential services (health, education, basic infrastructure), leaving little budget for waste-management modernization. Private sector investment may also be limited due to perceived risk and uncertain returns.

**Informal Sector Involvement:** The informal sector, including waste pickers, plays a significant role in waste collection and

recycling in many developing countries. This sector often lacks recognition, legal protection, and safety, yet they contribute substantially to recycling and resource recovery.

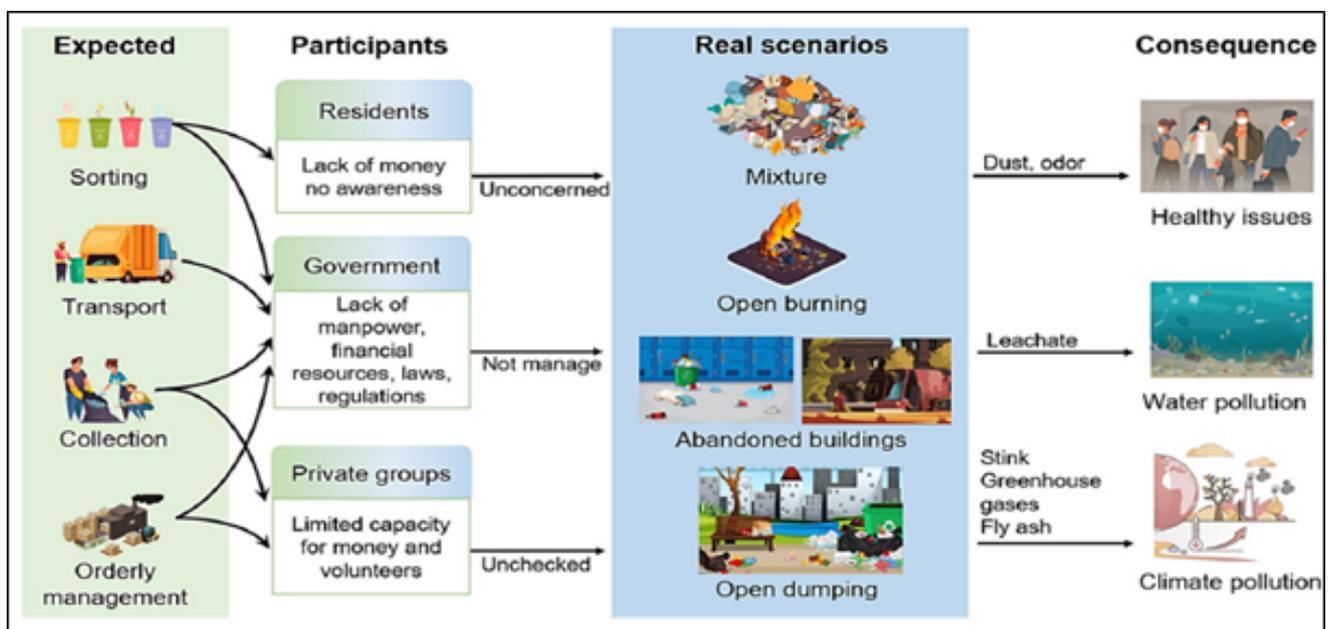
**Low Recycling Rates:** Recycling in developing countries is often done informally, with materials like plastics, metals, and paper being sold by waste pickers to informal recyclers. Formal recycling systems are usually underdeveloped.

**Limited Public Awareness:** There is often a lack of education and awareness about waste segregation, recycling, and composting. Many communities do not understand the importance of separating recyclables from organic waste, making waste management more difficult.

**Waste Disposal Challenges:** Open dumpsites and landfills are common in developing countries, and they often lack the necessary environmental controls (e.g., leachate treatment, gas recovery). This can lead to environmental and health hazards, such as groundwater contamination, air pollution, and diseases.

**Weak regulatory frameworks and governance:** Policies may be absent, outdated or poorly enforced. Coordination across agencies (waste management, environment, urban planning) may be fragmented, leading to inefficiencies or overlapping responsibilities.

Based on Ogwueleka (2013) and Ayodele et al. (2017), corruption represents the most significant resistance to policy advancement for less developed countries. Represented here by Nigeria, the organic content of solid waste in Nigeria is 63.6%, which can be used not only to generate energy but also to provide numerous jobs locally. However, due to corruption and embezzlement, the policy in 1999 has not been implemented to date. Figure 4 shows the challenges of the inappropriate treatment of MSW.



**Figure 4:** The challenges derived from the inappropriate treatments of MSW. Source: (Zhang et al., 2024).

Figure 5 shows the barriers and challenges for MSWM in developing countries, most Asian, in which contain socio-economic, waste sorting, awareness, income, government intervention, financial support, collection frequency and the like (Zhang et al., 2024).



Figure 5: MSWM management barriers, challenges and future directions in Developing countries  
Source: (Zhang et al., 2024).

### Case Studies of Successful Municipal Solid Waste Management

Municipal solid waste management is crucial for maintaining environmental sustainability, public health, and the overall quality of life in cities. Several developed countries, including Austria, Germany, New Zealand, the USA, the UK, Japan, Singapore, Switzerland, South Korea, and Canada, have already begun to adopt artificial intelligence technologies to maximize resource utilization, efficiency, and recycling opportunities throughout the solid waste management cycle (Soni et al., 2019). Here are some successful case studies of municipal waste management from various cities around the world that can provide insights into effective practices:

#### Sweden: Waste-to-Energy Pioneer

Nearly 99% of municipal waste is diverted through recycling, composting, or waste to energy processes. This success stems from strong incentives, public participation, and robust systems that discourage improper disposal. 99% of waste diverted from landfills and uses incineration with energy recovery for district heating including strong recycling infrastructure, producer responsibility, and public engagement.

#### Japan: Hyper-Sorted Recycling System

With extremely detailed waste sorting rules, Japan achieves up to an 80% recycling rate. Rigorous resident compliance and education are key to its approach. 80% recycling rate in some municipalities, residents follow detailed sorting rules and high civic discipline and education.

#### South Korea: Volume-Based Waste Fee System (VBWF)

Introduced a Volume-Based Waste Fee (VBWF) system in 1995, charging households based on waste volume. Over time, this encouraged recycling, reduced waste generation, and prompted innovation like decomposable bags and refillable products. Citizens pay based on the volume of waste generated.

Recycling rates increased dramatically. Government support for biodegradable alternatives

#### San Francisco, USA: Zero Waste by 2030

Enforced recycling mandates and composting, achieving a waste diversion rate of about 80%. Mandatory recycling and composting. Waste diversion rate of ~80%. Public-private partnerships (Recology).

#### Parma, Italy: Data-Driven Waste Management

Launched a “zero waste” initiative featuring RFID enabled bins, CCTV monitoring, fines up to €10,000, and strong incentives. Recycling rates have surpassed 80%, with the system drawing global attention. Uses RFID bins and fines to enforce compliance. Achieved over 80% recycling rates. Transparent system with real-time data and education.

#### Singapore: Integrated Resource Management

As part of its broader “City in a Garden” vision, Singapore recycles nearly all construction waste and minimizes landfill through effective reuse strategies. Focus on land scarcity and waste minimization. Advanced WtE plants and waste-water integration (Tuas Nexus). High recycling of construction and demolition waste. However, there are some challenges exist such as: Economic, Behavioral, Technical, and Policy Gaps.

#### Lessons Learnt

Based on the evidence so far, some general insights/recommendations for policymakers, city planners, NGOs and communities:

**Adopt a multi-stakeholder, inclusive approach:** Combine government, private sector, community groups, and importantly informal waste workers. Inclusion of informal recyclers helps avoid social exclusion and leverages existing local capacities.

**Develop comprehensive policies & regulatory frameworks:** CE needs enabling regulations, e.g. for source segregation, extended producer responsibility (EPR), incentives for recycling/composting, bans or taxes on single-use plastics, and support for waste-to-resource technologies.

**Invest in infrastructure and technology — but adapt to local context:** While waste-to-energy plants or automated sorting might be feasible in advanced economies, in developing cities decentralized composting, community-based recycling or small-scale sorting may be more realistic and effective.

**Promote public awareness and behavioural change:** Education campaigns, community participation, and economic incentives (e.g. “exchange waste for value” schemes) help foster sustainable waste habits.

**Support innovation and scalable business models:** Encourage startups, social enterprises, and private sector actors to develop circular-economy business models from waste-to-resource, recycling marketplaces, digital platforms for waste collection, to waste-based manufacturing.

## Conclusion

Municipal solid waste management in developed countries is evolving rapidly. The shift toward smart technologies, strict policies, and circular economy models demonstrates how cities can manage waste more sustainably. As global environmental concerns intensify, the success of municipal waste strategies in developed countries may serve as a blueprint for emerging economies and future global agreements, but challenges remain around behavior, costs, and complexity. The circular economy offers a powerful alternative to traditional waste management, one that can transform municipal waste from a liability into an asset as it is preserving resources, reducing pollution, creating jobs, and supporting sustainable development. However, realizing this transformation is not easy.

In developing countries, structural gaps (infrastructure, regulation, finance, inclusion) make the transition harder, yet the potential payoff is perhaps greater as it is improved public health, livelihoods, environmental protection, and sustainable urban growth. Given accelerating urbanization worldwide, especially in developing Asia and Africa, integrating circular-economy principles into municipal waste management is not just desirable, it's increasingly imperative.

The success of circular-economy waste management depends heavily on local context.

**In developed countries:** strong institutions, regulatory frameworks, public funding, technical capacity, and consumer awareness often make it easier to implement advanced CE-oriented systems (e.g. waste-to-resource plants, regulatory instruments, formal recycling infrastructure). However, challenges are still remaining.

**In developing countries:** structural constraints, lack of infrastructure, limited funding, weak governance, informal waste sectors, low awareness, make CE adoption more difficult. But these contexts also offer certain opportunities because many systems are still nascent, there may be flexibility

to leapfrog to circular models by integrating informal waste workers can provide social inclusion; and low-cost, context-appropriate innovations (community composting, informal recycling, decentralized models) may succeed.

## References

1. Baltac, V. (2019). Smart cities—a view of societal aspects. *Smart Cities*, 2. *Faculty of Public Administration*, 2(4), 538-548. DOI: <https://doi.org/10.3390/smartcities2040033>
2. Espinoza-Arias, P., Poveda-Villalon, M., García-Castro, R., & Corcho, O. (2018). Ontological representation of smart city data: From devices to cities. *Applied Sciences*, 9(1), 32. DOI: <https://doi.org/10.3390/app9010032>
3. Jagtap, S., & Rahimifard, S. (2019). The digitisation of food manufacturing to reduce waste – Case study of a ready meal factory. *Waste Management*, 87(15), 387-397.
4. Macke, J., Sarate, J. A. R., & de Atayde Moschen, S. (2019). Smart sustainable cities evaluation and sense of community. *Journal of Cleaner Production*, 239(1), DOI: <https://doi.org/10.1016/j.jclepro.2019.118103>
5. Jørgensen, S., & Pedersen, L. J. T. (2018). The Circular Rather than the Linear Economy. RESTART Sustainable Business Model Innovation, [online] 103–120. DOI: [https://doi.org/10.1007/978-3-319-91971-3\\_8?urlappend=%3Futm\\_source%3Dresearchgate.net%26utm\\_medium%3Darticle](https://doi.org/10.1007/978-3-319-91971-3_8?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle)
6. Valenzuela-Levi, N., (2019). Factors influencing municipal recycling in the Global South: The case of Chile. *Resources, Conservation and Recycling*, 150, DOI: <https://doi.org/10.1016/j.resconrec.2019.104441>
7. Wilson, D. C., Rodic, L., Scheinberg, A., Velis C. A., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste Management & Research*, 30(3): 237–254. DOI: <https://doi.org/10.1177/0734242x12437569>
8. Wilson, D. C, Velis, C., & Rodic-Wiersma, L. (2013). Integrated sustainable waste management in developing countries. *Proceedings of the Institution of Civil Engineers, Waste and Resource Management*, 166(52), 52–68. DOI: <https://doi.org/10.1680/warm.12.00005>
9. Srivastava, V., Ismail, S. A., Singh, P., & Singh, R. J. (2014). Urban solid waste management in the developing world with emphasis on India: challenges and opportunities. *Rev Environ Sci Biotechnol*, 14, 317–337. DOI: [https://doi.org/10.1007/s11157-014-9352-4?urlappend=%3Futm\\_source%3Dresearchgate.net%26utm\\_medium%3Darticle](https://doi.org/10.1007/s11157-014-9352-4?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle)
10. Khan, A. H., López-Maldonado, E. D., Khan, N. A., Villarreal-Gómez, L. J., Munshi, F. M., Alsabhan, A. H., & Perveen, K. (2022). Current solid waste management strategies and energy recovery in developing countries - State of art review, *Chemosphere*, 291(3), DOI: <https://doi.org/10.1016/j.chemosphere.2021.133088>
11. Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development; © World Bank. <https://openknowledge.worldbank.org/entities/publication/d3f9d45e-115f-559b-b14f-28552410e90a>

12. Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., & Lechner, A. M. (2021). The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste, *SN Appl. Sci.*, 3(4), 1-15. DOI: [https://doi.org/10.1007/s42452-021-04234-y?urlappend=%3Futm\\_source%3Dresearchgate.net%26utm\\_medium%3Darticle](https://doi.org/10.1007/s42452-021-04234-y?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle)
13. Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). *Plastic waste inputs from land into the ocean. Science*, 347(6223), 768–771. DOI: <https://doi.org/10.1126/science.1260352>
14. Sutter, J. D. (2016). “How to stop the sixth mass extinction”. CNN. Retrieved 17 July 2025. <https://edition.cnn.com/2016/12/12/world/sutter-vanishing-help>
15. World Bank, (2023c). Supporting Informal Waste Pickers: NEPRA Lowers Risks and Increases Efficiency through Inclusive Employment Practices. <https://documents1.worldbank.org/curated/en/099037011102330756/pdf/IDU0d60cbfd40fe7b0481e089a106205b53f3cc0.pdf>.
16. World Bank, (2018). “What a Waste 2.0”: A Global Snapshot of Solid Waste Management to 2050 <https://documents1.worldbank.org/curated/en/697271544470229584/pdf/What-a-Waste-2-0-A-Global-Snapshot-of-Solid-Waste-Management-to-2050.pdf>
17. Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., & Purohit, H. C. (2020). Internet of Things (IoT) adoption barriers of smart cities’ waste management: An Indian context. *Journal of Cleaner Production*, 270(10), DOI: <https://doi.org/10.1016/j.jclepro.2020.122047>
18. Ogwueleka, T. C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria. *Resour. Conserv. Recycl.* 77, 52–60. <https://doi.org/10.1016/j.resconrec.2013.05.011>.
19. Ayodele, T. R., Ogunjuyigbe, A. S. O., & Alao, M. A., (2017). Life cycle assessment of waste-to-energy (WtE) technologies for electricity generation using municipal solid waste in Nigeria. *Applied Energy*, 201, 200–218. DOI: <https://doi.org/10.1016/j.apenergy.2017.05.097>
20. Zhang, Z., Chen, Z., Zhang, J., Liu, Y., Chen, L., Yang, M., Osman, A. L., Farghali, M., Liu, E., Hassan, D., Ihara, I., Lu, K., Rooney, D. W., & Yap, P. S. (2024). Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa. *Science of the Total Environment*, 930(20), DOI: <https://doi.org/10.1016/j.scitotenv.2024.172794>
21. Soni, U., Roy, A., Verma, A., & Jain, V. (2019). Forecasting municipal solid waste generation using artificial intelligence models—a case study in India. *SN Applied Sciences*. 1, DOI: <https://doi.org/10.1007/s42452-018-0157-x>
22. Bressanelli, G., Adrodegari, F., Pigosso, D.C.A., & Parida, V. (2022). Circular Economy in the Digital Age. *Sustainability*, 14(9), 5565. DOI: <https://doi.org/10.3390/su14095565>
23. Geyer, R., Jambeck, J. R., & Lavender Law, K. (2017). Law, Production, use, and fate of all plastics ever made, *Sci. Adv.* 3(7), DOI: <https://doi.org/10.1126/sciadv.1700782>
24. Shah, P. J., Anagnostopoulos, T., Zaslavsky, K., & Behdad, S., (2018). A stochastic optimization framework for planning of waste collection and value recovery operations in smart and sustainable cities. *Waste Management*, 78, 104-114. DOI: <https://doi.org/10.1016/j.wasman.2018.05.019>
25. Sasaki S., Araki, T., Tambunan. A. H., & Prasadja, H. (2014). Household income, living and working conditions of dumpsite waste pickers in Bantar Gebang: Toward integrated waste management in Indonesia, *Resources, Conservation and Recycling*, 89, 11-21. DOI: <https://doi.org/10.1016/j.resconrec.2014.05.006>
26. Stahel, W. (2016). The circular economy. *Nature* 531, 435–438. <https://doi.org/10.1038/531435a>
27. Valencia, M., (2019). Informal recycling sector (IRS), contribution to the achievement of the SDGs, and a circular economy. In: W.T. Leal Filho, A. Azul, L. Brandli, P. & Wall Ozuyar, (Eds.), *Responsible Consumption and Production - Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. DOI: [https://doi.org/10.1007/978-3-319-71062-4\\_107-1](https://doi.org/10.1007/978-3-319-71062-4_107-1).
28. Wilson, D. C, Velis, C., & Rodic-Wiersma, L. (2013). Integrated sustainable waste management in developing countries. *Proceedings of the Institution of Civil Engineers, Waste and Resource Management*, 166(52), 52–68. DOI: <https://doi.org/10.1680/warm.12.00005>
29. Wikipedia (n.d). Green urbanism, [https://en.wikipedia.org/wiki/Green\\_urbanism](https://en.wikipedia.org/wiki/Green_urbanism)
30. Mandard, S. (September 4, 2024). Parma, the city that declared war on garbage [https://www.lemonde.fr/en-environment/article/2024/09/04/parma-the-city-that-declared-war-on-garbage\\_6724691\\_114.html?](https://www.lemonde.fr/en-environment/article/2024/09/04/parma-the-city-that-declared-war-on-garbage_6724691_114.html?)
31. FHA (2025, April 17). The Future of Integrated Waste Management: Trends & Innovations <https://www.foodnhotelasia.com/blog/fnb/future-of-integrated-waste-management/>
32. Joshi, k. (n.d). Waste Management Challenges and Innovations Explored <https://luminwaves.com/articles/waste-management-challenges-innovations/>
33. IDB (2024, Sep 30). Urban Waste Management for Cleaner Cities: Towards a Circular Economy in LAC. <https://www.iadb.org/en/blog/urban-development-and-housing/urban-waste-management-cleaner-cities-towards-circular-economy-lac?>
34. Punchaban, P. (2025). Development of an Integrated Community Solid Waste Management Model Based On the Circular Economy Concept Khon Kaen Provincial Local Administrative Organization. *Journal of MCU Nakhondhat, Najar* <https://so03.tci-thaijo.org/index.php/JMND/article/view/293997?>
35. SEI, (2019–2021). Towards inclusive urban waste systems: integrating informal waste workers for a circular economy <https://www.sei.org/projects/circular-economy-urban-waste-system-thailand/?>

- 
36. Wikurendra, E. A., Csonka, A., Nagy, I., & Nurika, G. (2024). Urbanization and Benefit of Integration Circular Economy into Waste Management in Indonesia: A Review. *Circular Economy and Sustainability*, 4, 1219–1248. <https://link.springer.com/article/10.1007/s43615-024-00346-w?>
  37. Achilles, C., & Vlachokostas, C. (2025). Integrated Waste Management in the Circular Economy Era: Insights from Research and Practice. *Energies*, 18(3), 728, DOI: <https://doi.org/10.3390/en18030728>
  38. OECD (2019, 23 September). Waste Management and the Circular Economy in Selected OECD Countries, [https://www.oecd.org/en/publications/waste-management-and-the-circular-economy-in-selected-oecd-countries\\_9789264309395-en/full-report/component-6.html?](https://www.oecd.org/en/publications/waste-management-and-the-circular-economy-in-selected-oecd-countries_9789264309395-en/full-report/component-6.html?)
  39. Paul, L., Mohalder, R. D., & Alam, K. M. (2024, 31 Oct). An IoT Based Smart Waste Management System for the Municipality or City Corporations, *Computers and Society*, <https://arxiv.org/abs/2411.09710>

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