

Sustainable Waste Management in Developing Economies: Reviewing Circular Economy Approaches

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Abstract

The emergence of large amounts of waste due to factors such as urbanization, population growth, industrial development, and changes in consumption patterns has become an environmental and socio-economic concern for developing countries. Traditional waste management models based on activities such as collecting and disposing of waste have been unable to manage emerging waste streams. As a result, the concept of circular economy has been introduced to promote sustainability through efficient use of resources, waste minimization, and value recovery from discarded materials. This paper reviews the use of circular economy methods to foster sustainable waste management in developing nations. Specifically, the review will focus on some of the major strategies adopted for managing waste sustainably within the circular economy model. Strategies include waste prevention, reuse, recycling, valorisation of organic wastes, energy production from waste streams, and industrial symbiosis. It is important to analyse challenges that exist in developing countries for implementing these practices. In addition, the review will consider the contribution of the informal waste sector in developing countries and make comparisons between Asia, Africa, and Latin America. It is evident from the results that the application of circular economy strategies could lead to waste reduction, natural resources conservation, employment creation, and climate change prevention. Yet, the successful adoption and implementation of such strategies need better policies, investment, collaboration among stakeholders, and capacity building. On the whole, a circular economy offers a realistic path to sustainability in developing countries.

Keywords: Circular economy; Sustainable waste management; Developing economies; Resource recovery; Recycling.

1. INTRODUCTION

1.1 Background

Increasing population size in urban areas, industrialization, and changing consumer behavior have led to the rise in waste production globally. The situation in developing nations is more difficult since the pace of waste production may outstrip the available waste collection, transportation, treatment, and disposal capacities. In the case of most developing nations, inefficiency in waste management can be attributed to factors such as poor infrastructure, lack of funding, and ineffective institutional structures leading to environmental pollution, public health problems, and depletion of natural resources. Over the last five decades, there has been significant improvement in waste management in developing nations as the process has shifted from disposal to sustainability; nevertheless, there is still much room for improvement (Maalouf & Agamuthu, 2023).

1.2 Sustainable Waste Management

Sustainable waste management involves the processes through which waste is collected, treated, recycled, recovered, and disposed of in a way that minimizes its impact on the environment while at the same time optimizing economic and social gains (Dewasiri et al., 2025). As opposed to traditional waste management practices that mainly focus on collecting and disposing of wastes, sustainable waste management emphasizes waste prevention and waste recovery. Moreover, such forms of management not only ensure resource efficiency but also reduce pollution and improve public health while ensuring sustainable development. Sustainable waste management becomes very important for developing countries, which have an increasing amount of waste (Kabir & Kabir, 2021).

1.3 Circular Economy as an Alternative Model

Linear economic model that operates on the “take–make–dispose” paradigm has faced wide criticism due to its environmentally unsustainable exploitation of natural resources and overproduction of waste. To counter the negative consequences associated with the linear model, the concept of circular economy has been introduced as a revolutionary approach to ensure retention of materials, products, and resources within economic activities for as long as possible by means of such activities as reduction, reuse, recycle, repair, refurbishment, and recover. Through treating waste as a precious resource instead of a burden, circular economy offers an array of solutions aimed at dealing with environmental problems and stimulating economic growth (Adami & Schiavon, 2021).

1.4 Rationale for the Review

While there has been a lot of discussion around the circular economy in the last few years, most of the research conducted on this topic, as well as its implementation, has mainly been done in developed nations. There are some specific social, economic, technical, institutional, and infrastructural aspects that affect the use of the circular economy in different ways. There is thus a rising necessity to analyse carefully the applicability of a circular economy strategy in developing nations and to evaluate what evidence exists to confirm the potential benefits of using such strategy in sustainable waste management (Halog & Anieke, 2021).

1.5 Objectives of the Study

The present review aims to:

- Examine the major waste management challenges faced by developing economies and assess their implications for environmental sustainability and resource efficiency.
- Critically review circular economy approaches, including waste prevention, reuse, recycling, resource recovery, and waste-to-energy strategies, as sustainable solutions for waste management.
- Identify barriers, opportunities, policy implications, and future research directions for promoting circular economy adoption in developing countries.

2. Importance of Circular Economy for Sustainable Waste Management

2.1 Growing Need for Sustainable Waste Management in Developing Economies

Economically developing countries are witnessing explosive growth in their populations, urbanization, industries, and consumer demand; all of these factors have contributed towards an increase in the production of waste. Traditional methods of waste management prove inadequate in handling the increasing amount and complexity of waste production, thus posing environmental hazards, health risks, and wasteful use of resources (Bahramimianrood et al., 2024). There has been a need to shift towards sustainable waste management to protect the environment while facilitating economic and social progress at the same time. Sustainable waste management is associated with efficient use of resources along with recovering reusable materials from waste (Marshall & Farahbakhsh, 2013; Khan et al., 2025).

2.2 Circular Economy as a Sustainable Development Strategy

The concept of the circular economy has been developed as another development model that aims at retaining the resources, materials, and products in the economy as much as possible. While the linear economy relies on producing as much waste as possible, the circular economy model emphasizes the aspects of waste prevention and reuse. Moreover, such a development model helps in reducing pressure on the environment while providing opportunities in terms of secondary resource use (Awino & Apitz, 2024; Aiguobarueghian et al., 2024).

2.3 Circular Economy and Sustainable Development Goals

The circular economy helps address various goals of sustainable development, including responsible consumption and production, sustainable cities, climate action, and environmental protection. Through effective use of resources and reducing the creation of wastes, the concept of circular economy plays an important role in supporting sustainable development goals, especially in overcoming the issue of limited resources and protecting the environment. Thus, the circular economy has become essential to promoting sustainable development in developing economies (Lamba et al., 2024; Halog & Anieke, 2021).

3. Conceptual Foundations

3.1 Waste Management: Definitions and Evolution

Management of waste involves the activities of collecting, transporting, treating, recovering, and disposing of wastes in such a way that human health and environment are protected from its hazards. Waste management was basically limited to the activities of collection and disposal for maintaining sanitation levels. But due to the quick pace of urbanization and industrialization, especially in underdeveloped economies, the need for environmental sustainability in the process of waste management came into the forefront (Mandpe et al., 2023).

Traditional Waste Management

The traditional way of managing wastes uses a linear approach where the process starts by extracting resources, using them, and then disposing of them. Collecting, transporting, and disposal of wastes in either landfills or open dumping sites make up the key stages of this strategy. Even as this process ensures waste is removed, it often causes pollution, contributes to carbon emissions, and loses resources (Kabir & Kabir, 2021).

Integrated Waste Management

Integrated Waste Management was developed due to the shortcomings associated with traditional waste management practices. This system includes waste reduction, sorting, recycling, composting, energy recovery, and proper disposal. An Integrated Waste Management System ensures that waste is managed throughout its lifecycle, which makes it efficient and environmentally friendly. Such systems are very essential for developing nations that want to upgrade their waste management practices (Awino & Apitz, 2024).

Sustainable Waste Management Framework

Sustainable waste management goes further than waste management as it takes into consideration not only waste management but also environmental protection, economy, and society. Sustainability is based on the principle of life cycle management, viewing waste as a valuable material which is recyclable, recoverable, and convertible into valuable products or even energy sources. Sustainable waste management facilitates resource efficiency and sustainable development, mitigating effects of climate change as well as avoiding landfills and illegal dumping (Ijimdiya et al., 2026). Table 1 presents the evolution of waste management approaches from traditional disposal-based systems to circular waste management frameworks.

Table 1. Evolution of Waste Management Approaches and Key Characteristics

Approach	Main Characteristics	Primary Objective	Limitations	References
Traditional Waste Management	Collection and disposal-focused system	Public sanitation	Resource loss and environmental pollution	Marshall & Farahbakhsh (2013)

Integrated Waste Management	Combines collection, recycling, recovery, and disposal	Resource optimization	Requires coordination among stakeholders	Awino & Apitz (2024)
Sustainable Waste Management	Incorporates environmental, economic, and social dimensions	Long-term sustainability	High implementation requirements	Kabir & Kabir (2021)
Circular Waste Management	Closed-loop material flows and resource recovery	Waste minimization and circularity	Policy and infrastructure challenges	Adami & Schiavon (2021)

3.2 Circular Economy Principles

Circular economy is an innovative approach aimed at replacing the conventional pattern of consumption and production with a sustainable model that ensures maintenance of value of the materials, products, and resources involved for as long as possible. Circular economy principles are aimed at preventing environmental degradation, waste generation, and sustainable development. Such principles are typically applied in a series of methods related to reducing, reusing, recycling, recovering, and regenerating resources.

Reduce

Reduction is a method aimed at decreasing the number of materials and energy utilized during product lifecycle. The goal of reduction approaches is to prevent the formation of waste at all stages, starting from designing the product, manufacturing it, consuming the product itself, and using materials involved in manufacturing process. For emerging economies, applying this principle may help in reducing pressure on waste management infrastructure and conserve natural resources. It has been proved that waste prevention is one of the best approaches according to waste hierarchy since it prevents environmental impact even before waste formation (Khan et al., 2025).

Reuse

Reuse means prolonging the lifespan of products, components, and materials by using them several times prior to discarding them. Such processes stimulate the actions of repairing, rebuilding, remanufacturing, and redistribution, which help preserve products' utility while avoiding the necessity of extracting additional resources. The concept of reuse contributes to minimizing waste generation and resource consumption through efficient use of the products that have been created. It should be noted that informal markets in some developing nations have long ago adopted this approach to reuse activities (Parvaresh & Amini, 2024).

Recycle

Recycling involves the conversion of waste materials into secondary raw materials that can be used again in production processes. The process of recycling helps minimize reliance on natural sources, as well as lower the ecological effects of extracting and processing new raw materials. Systems of recycling are crucial for plastic, metal, paper, glass, and electronic wastes. Efficient recycling helps achieve resource productivity, emission reductions, and wealth creation in line with the goals of a circular economy (Ramli et al., 2024).

Recover

The concept of resource recovery refers to the process of recovering value either in terms of materials or energy from the waste stream that cannot be immediately reused or recycled. These methods include waste-to-energy processes, anaerobic digestion, biogas generation, and material recovery, which turn waste products into useful products through various technologies. Resource recovery allows the waste product to make its contribution towards energy security and economic efficiency by minimizing the amount of waste left behind that needs to be disposed of (Rezania et al., 2023).

Regenerate

Regeneration constitutes the ultimate goal of the circular economy since it aims not only at minimizing negative environmental impacts but also at rejuvenating and improving nature. Such methods involve ecosystem restoration, maintaining soil fertility, preserving biodiversity, and sustainable use of renewable resources. Waste composting, nutrients extraction, and ecological restorations represent regenerative processes that recycle waste into useful resources for renewing the environment. The incorporation of the concept of regeneration within the framework of waste management enables circular economies to foster sustainability and ecological resilience. (Adami & Schiavon, 2021). Figure 1 below displays the waste hierarchy model and highlights the stages involved in sustainable waste management such as waste prevention, reuse, recycling, recovery, and final disposal.

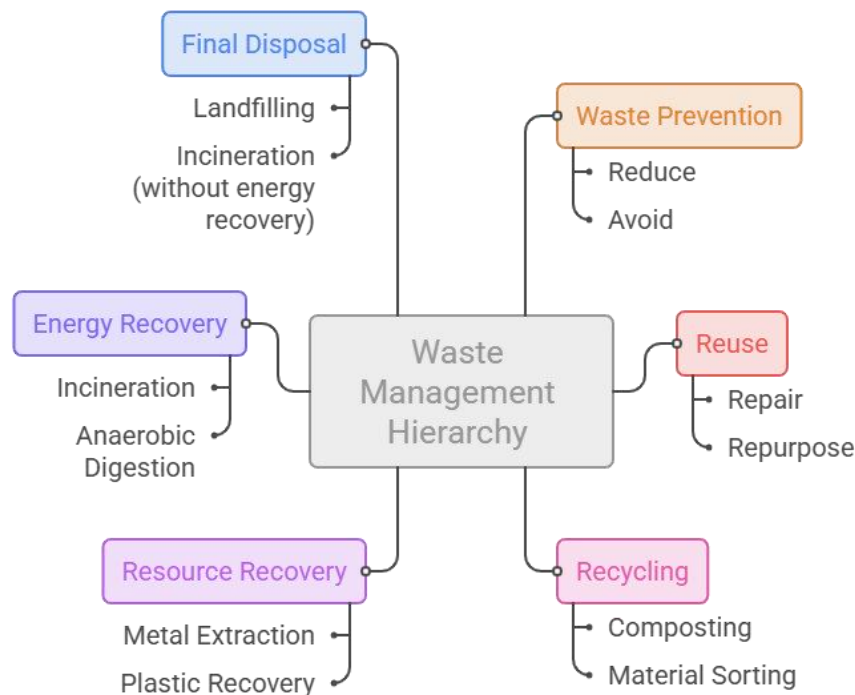


Figure 1. Waste Hierarchy in Sustainable Waste Management

3.3 Theoretical Frameworks Supporting Circular Economy

There are several theoretical models upon which the creation and adoption of circular economy strategies is based. These models help make sense of the way in which the economic system can be transformed in order to embrace a closed-loop system of resources and their use.

Industrial Ecology: Industrial ecology offers a holistic approach that conceptualizes the relationship between industrial processes and the larger ecological systems within which such processes operate. Industrial ecology promotes the use of industrial symbiosis; a strategy aimed at the optimization of material and energy flows through utilizing the waste products from one process as resources for other operations. Through replicating the continuous cycling of resources in natural ecological systems, industrial ecology can help facilitate the establishment of a closed system of production and consumption (Bao & Lu, 2020)

Cradle-to-Cradle Theory

In contrast to the cradle-to-grave system, where a product is designed without taking into consideration future reuse or regeneration opportunities, cradle-to-cradle theory calls for designing items which can be recycled endlessly in biological or technical spheres without leaving any waste behind. According to this approach, the key aspects include eco-design, new materials, and responsible stewardship of resources in order to guarantee that products continue to be valuable during several rounds of life cycles. According to this theory, waste generation represents a flaw in design (Halog & Anieke, 2021).

Resource Efficiency Theory

On the other hand, resource efficiency theory calls for ensuring economic prosperity while at the same time using as little resource input and environmental damage as possible. Resource efficiency suggests using natural resources most effectively to achieve the greatest economic benefit from production and consumption activities. From the point of view of implementing circular economy practices, the theory explains why it is necessary to prevent waste generation and recover wasted resources to avoid resource depletion in the course of economic development (Yang et al., 2023).

Sustainable Development Framework

The principles of sustainable development serve as the overall basis on which the concept of a circular economy can be built, taking into account such dimensions as environmental protection, prosperity, and social well-being. The measures aimed at creating a circular economy have a direct impact on achieving the aims of sustainable development through waste minimization, efficient use of resources, creation of green jobs, and addressing climate change issues (Schroeder et al., 2019).

Systems Thinking Approach

A systems thinking approach acknowledges that the complexities of the issue of waste management are determined by intricate interactions between the environment, economy, technology, institutions, and society. Contrary to focusing on resolving waste management issues in isolation, systems thinking focuses on comprehending how different relationships and feedback loops determine the patterns of wastage creation and resource consumption. Such an approach holds particular significance for countries that are still in their growth stages because their waste management systems include various players facing various related issues (Petit-Boix & Leipold, 2018).

4. Waste Management Challenges in Developing Economies

Economies experiencing growth encounter a number of problems that impede their movement towards sustainable or circular systems. Issues such as rapid urbanization, increasing populations, new consumption trends, and institutional restrictions are leading to increased amounts of waste produced and a greater degree of complication in its production. Additionally, limited resources and technological constraints are posing a problem for efficient waste management within some nations.

4.1 Rapid Urbanization and Population Growth

The fast-growing trend of urbanization has made great contributions to waste production in developing countries. Urbanization is exerting stress on urban waste management systems; however, infrastructure development cannot always go hand in hand with urban development. Consumption levels, driven by population growth, will also add to the problems of waste management (Ijimdiya et al., 2026).

4.2 Increasing Municipal Solid Waste Generation

Economic development, urbanization, and changing lifestyles have caused an increase in the generation of municipal solid waste. Increase in consumption of packaged products, plastics, and electronic equipment has not only generated more waste but also complicated its composition. In many cities, waste generation has exceeded the capacity for its management, which causes environmental degradation and problems related to recycling (Mandpe et al., 2023).

4.3 Inadequate Collection Infrastructure

Developing countries also have inadequate waste collection infrastructure. This is because of limited availability of collection vehicles, waste bins, transportation network, and even service. This problem results in poor waste collection and contributes to littering and dumping practices that lead to environmental pollution (Yadav et al., 2023).

4.4 Open Dumping and Uncontrolled Landfills

Despite being expensive, landfilling and open dumping still continue to be prevalent ways of disposing of wastes because they are relatively cheaper. This method poses various environmental hazards including land pollution, air pollution, global warming, among others. It is imperative to lessen the reliance on landfills by recycling, reuse, and resource recovery (Khan & Ali, 2022).

4.5 Financial Constraints

The issue of financial constraints still constitutes a significant barrier to efficient management of waste. Inability by municipalities to fund the construction of the necessary infrastructure, purchase technologies, and invest in human capital training may hinder effective waste management. Besides, the large upfront costs that characterize circular economies pose additional hurdles (Khan & Haleem, 2021).

4.6 Weak Regulatory Frameworks

Many developing economies encounter issues associated with fragmented regulatory policies and inadequate enforcement structures. Poor policy and institutional coordination may lead to difficulties in implementing proper waste minimization, reuse, and resource recovery practices. The establishment of adequate regulatory policies is required for effective waste management and circularity principles (Bayeroju et al., 2021).

4.7 Limited Public Awareness

Involvement of the public is crucial in waste management, but the level of awareness regarding waste segregation and recycling is relatively poor in many developing countries. Inadequate levels of education and community involvement lead to improper waste disposal and little involvement in recycling (Salas et al., 2021).

4.8 Informal Waste Sector Challenges

The informal sector plays an important role in waste collection and recycling; however, informal workers work in risky environments, have no social security, and do not get due recognition. If informal workers were integrated better within formal mechanisms for waste management, then it would be a win-win situation (Schroeder et al., 2019).

4.9 Technological Limitations

The use of technology remains a significant factor influencing the effectiveness of waste management efforts in developing nations. The lack of appropriate technologies for effective recycling, treatment, and reuse limits both efficiency and the recycling process. This problem should be addressed since technological improvements are key in facilitating the transition towards circular economies (Yang et al., 2023). Table 2 shows the various problems that hinder effective implementation of waste management programs in developing countries. Figure 2 outlines the key issues hindering waste management efforts in developing economies.

Table 2. Major Waste Management Challenges in Developing Economies

Challenge	Impact on Waste Management	Consequences	References
Rapid urbanization	Increased waste generation	Infrastructure pressure	Ijimdiya et al. (2026)
Inadequate collection systems	Low collection efficiency	Waste accumulation	Yadav et al. (2023)
Financial constraints	Limited investment capacity	Poor service delivery	Khan & Haleem (2021)
Weak regulations	Ineffective enforcement	Environmental degradation	Bayeroju et al. (2021)
Technological limitations	Low recovery rates	Inefficient resource utilization	Yang et al. (2023)



Figure 2. Major Waste Management Challenges in Developing Economies

5. Circular Economy Approaches in Waste Management

The main goal of circular economy principles is to convert linear waste management processes into regenerative ones, in which the value of resources, materials, and products is preserved for as long as possible. With the help of the principles mentioned above, such as prevention, reuse, recycling, recovery, and cooperation, it is possible not only to protect the environment but also to promote resource efficiency and sustainable economic growth. Implementation of circular economy principles in emerging markets provides many opportunities regarding decreasing landfill usage and raw material extraction.

5.1 Waste Prevention and Minimization

Prevention of waste is one of the strategies that is viewed as the best approach when dealing with waste. This involves promoting the practice of circular economy through clean production practices that will ensure optimal usage of resources with minimal losses and impacts to the environment. Ecological design is another approach to reducing waste in that it advocates for the design of durable, repairable, recyclable, and resource-efficient products. Sustainable consumption also helps minimize the production of waste in the sense that it promotes responsible consumerism (Aiguobarueghian et al., 2024).

5.2 Reuse Strategies

Reusing methods are important when it comes to prolonging the lifecycle of goods as well as minimizing the usage of raw materials. The prolongation of goods' lifecycles may be possible due to maintenance, improvement, and further use of goods after they have fulfilled their initial purpose. Repair and restoration practices extend the usability period of goods and thus prevent them from being discarded, thus preserving their value and decreasing the number of products that need to be disposed of. Likewise, sharing schemes make it possible to share goods and minimize raw material usage (Parvaresh & Amini, 2024).

5.3 Recycling Systems

Recycling is among the best-known circular economy models that have been put in place for waste management. Efficient recycling systems ensure that valuable materials contained in waste are extracted and used again in the manufacturing process. Recycling plastic helps in mitigating environmental degradation from the use of single-use plastics; on the other hand, paper, glass, and metal recycling contribute towards saving natural resources and lowering the amount of energy required compared to virgin materials. The importance of electronic waste recycling can be seen in the

context of increasing e-waste from the increasing number of electronic products, coupled with the presence of metals and other reusable parts in them. The development of efficient recycling systems not only lowers the demand for waste disposal space but also provides economic incentives through recycling and reuse of materials (Ramli et al., 2024; Gaur et al., 2024).

5.4 Waste Valorisation

The processes of transforming waste materials into valuable resources- such as raw materials, energy, or new products- rather than treating them as useless residues. In industrial waste sharing, waste from one industry becomes an input resource for another industry, creating a closed-loop or circular system. Methods of waste valorization include among others material valorization where by-product exchanges adopted in case of thermal power plant, steel as well as cement and brick industries. Here waste characterization, quality standardization and inter -industry contacts are necessary. Biological valorization methods include bio-conversion where organic waste converted using microorganisms. In the processes biodegradable waste converted into usable products which will then be fed back into the economy and environment. Processes like composting and vermicomposting turn organic waste into fertilizer that increases agricultural efficiency and improves soil conditions. In addition to composting, anaerobic digestion offers another option for processing organic waste through its creation of both biogas and fertilizer. Another example of sustainable organic waste utilization is the process of biofertilizer production, which reduces reliance on commercial fertilizers (Tamasiga et al., 2022). Valorization processes however, incurred some costs that arises before, during and after valorization processes. This costa includes economic, technological, social and institutional expenditures. Waste valorization costs should be seen as productive investment, not merely expenses as because these processes reduced raw material costs, lower disposal fees as well as environmental and social benefits.

5.5 Waste-to-Energy Technologies

The use of waste-to-energy technologies has proven to be a useful approach to reclaiming valuable energy from waste materials that can neither be recycled nor reused. Waste-to-energy approaches include the use of techniques like incineration, gasification, pyrolysis, production of biogas, and refuse-derived fuels. These waste-to-energy techniques not only solve waste disposal problems but also assist in generating energy. The use of waste-to-energy technologies is becoming popular in developing countries due to their ability to solve problems related to waste management and energy security (Rezania et al., 2023). Adoption of waste to energy (WtE)technology incurred some capital investment costs.

5.6 Industrial Symbiosis: Industries engaging in industrial symbiosis practice circular economy to a high degree where the waste produced by one industry becomes a useful material used by another industry. .IS was established based on an analogy to a biological system (where organism or species depend on each other for survival or received significant benefit) and operate through an exchange of the flow of resources between or among companies , such as materials and by products. IS relationships involve various forms of resource exchange which can be within a company or organization between companies located in a specific eco-industrial park between local companies outside industrial park or even companies connected virtually in a wider region. Although physical exchanges are the central elements in the formation of IS network , the exchange of knowledge as well as human and technical resource is fundemental for providing environmental and competitive benefits of all sharing network. However, the application of IoT (Internet on Things) in Industrial Symbiosis can significantly improve the identification and management of waste-to-resource linkages among industries. By providing real-time data on waste availability and resource demand, IoT facilitates dynamic matching between industries, overcoming one of the major limitations of traditional symbiosis models, which rely heavily on static or manually collected data. Furthermore, IoT-based systems support predictive analytics, enabling industries to anticipate waste generation patterns and optimize resource utilization accordingly. In these ways Industries achieve savings in resource use and waste production, thereby becoming more efficient through networks of resource exchanges, circular industrial parks, and waste product use techniques. In addition, such collaborative models provide a closed loop system that facilitates the development of industries in a sustainable manner. The success of industrial symbiosis in some of the rapidly growing economies is proof that industrial symbiosis can greatly increase resource efficiency with both economic and environmental gains (Bao & Lu, 2020). Table 3 illustrates different circular economy models and the applications of these models in sustainable waste management. Figure 3 shows the circular economy model for sustainable waste management.

Table 3. Circular Economy Approaches and Their Applications in Waste Management

Circular Economy Strategy	Application	Expected Outcome	References
Waste prevention	Cleaner production and eco-design	Reduced waste generation	Aiguobarueghian et al. (2024)
Reuse	Product repair and refurbishment	Extended product lifespan	Parvaresh & Amini (2024)
Recycling	Recovery of plastics, paper, metals, and e-waste	Resource conservation	Ramli et al. (2024)
Organic waste valorization	Composting and anaerobic digestion	Production of biofertilizers and biogas	Tamasiga et al. (2022)
Waste-to-energy	Pyrolysis, gasification, and RDF	Energy generation	Rezania et al. (2023)
Industrial symbiosis & IoT	Resource exchange among industries	Improved resource efficiency	Bao & Lu (2020)

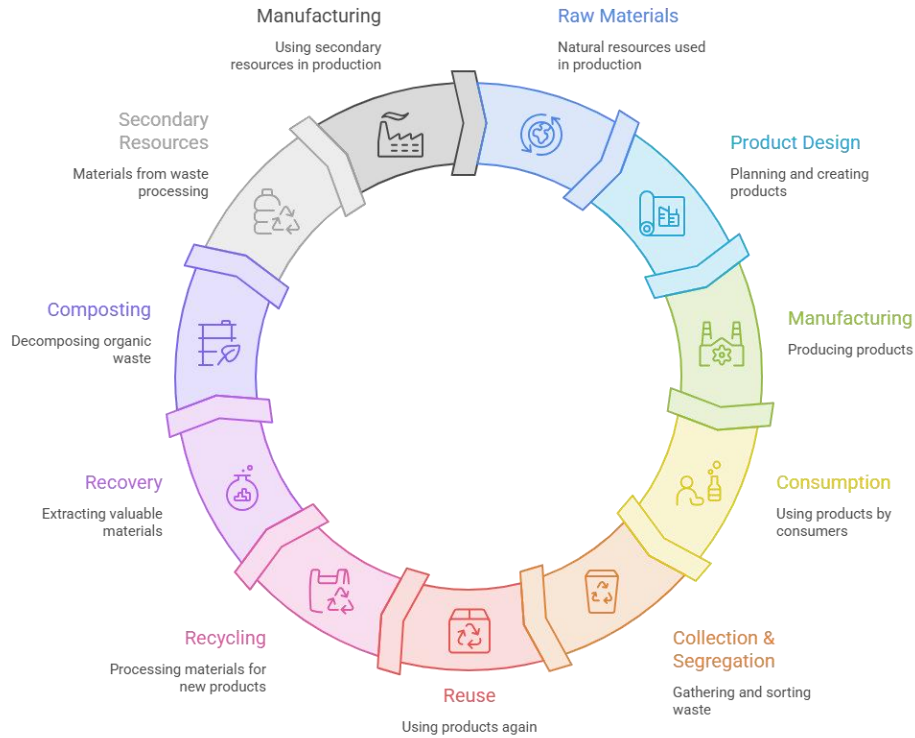
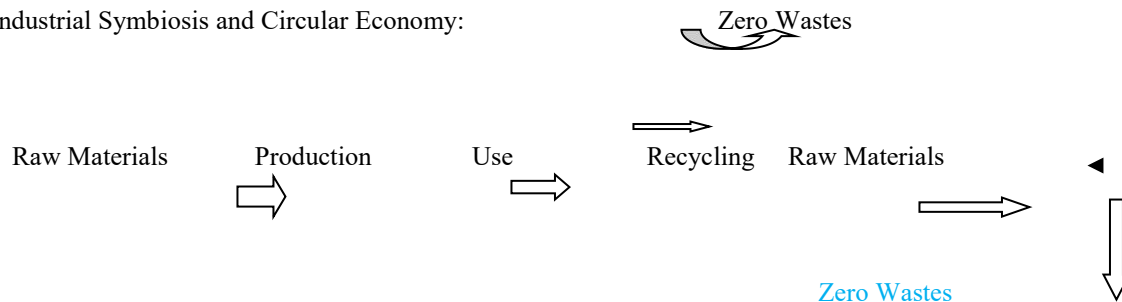


Figure 3. Circular Economy Framework for Sustainable Waste Management

Industrial Symbiosis and Circular Economy: This industrial symbiosis network creates a resilient circular economy where materials flow continuously between different sectors, minimizing waste and maximizing resource efficiency.

Industrial Symbiosis and Circular Economy:



6. Role of the Informal Sector in Circular Economy

The informal sector is an important part of waste management systems in numerous developing nations. In areas where there is insufficient formal infrastructure for waste collection and recycling, the informal sector helps in the recycling of waste materials. The informal sector helps achieve goals of circular economy by ensuring that large amounts of waste do not go into landfills and are recycled into production systems. Despite the absence of a formal framework in the operations of the informal sector, the sector has become an integral part of sustainable waste management in many nations.

6.1 Waste Pickers and Recycling Networks

Waste pickers form the basis of informal recycling systems in developing countries. They gather, sort, and recycle various recyclables from homes, roads, marketplaces, dumping grounds, and other waste disposal facilities. As a result of these activities, waste pickers build wide networks of recyclers through which recyclables can easily be sent to other parties such as recycling businesses and manufacturers. The efficiency of these networks is remarkable even without much technology and structure in place. The recovery of materials such as plastics, metals, paper, and glass helps informal recyclers recycle resources (Chisholm et al., 2021).

6.2 Economic Contributions

Economic benefits from the informal waste sector are created through recovery and recycling operations. The recovered materials can be used as secondary raw materials in industrial processes, thus saving costs in manufacturing products and minimizing the consumption of virgin materials. Moreover, the informal recycling sector offers income and job creation avenues to millions of people who might not necessarily be involved in formal economic sectors. Economies are supported through the creation of jobs within the entire process of recycling, which ranges from gathering, sorting, transporting, processing, and reselling recyclable products (Moshawih et al., 2025).

6.3 Social and Environmental Benefits

In addition to its economic significance, there are several social and environmental advantages provided by the informal sector. These include lessening the use of landfills, reducing pollution, and conserving natural resources because of their waste management. The informal sector is also responsible for cutting down on greenhouse gas emissions because of recycling and reducing resource extraction. There are many social benefits as well since the informal sector provides employment for disadvantaged groups such as low income families and marginal communities (Alighardashi et al., 2024).

6.4 Challenges Faced by Informal Workers

However, despite their significant contribution, informal waste collectors confront various challenges, which affect their efficiency and health status negatively. The first one is that most informal waste collectors conduct their activities in extremely dangerous environments where there exist dangerous items and waste, such as sharp items, infectious wastes, and toxic substances. Informal waste collectors lack sufficient protective equipment, medical care, and legal protection, thus making them more vulnerable. Moreover, economic unpredictability due to volatile prices in the markets and poor institutional mechanisms makes informal waste collectors' work unstable (Kumar et al., 2023).

6.5 Strategies for Integration into Formal Systems

Inclusion of the informal economy into waste management systems has been acknowledged to be a crucial element in ensuring the success of circular economy initiatives. Integration of the informal sector into formal waste management systems will help in optimizing waste collection and improving recycling processes, in addition to improving labor conditions in the informal economy. Formalization of the informal economy, capacity building, cooperation arrangements, and public-private partnerships are some ways through which collaboration between informal recyclers and city officials can be improved. Smart waste management systems can also enhance integration and resource recovery from waste without compromising the role played by the informal economy in recycling waste (Fatimah et al., 2020).

7. Comparative Analysis of Circular Economy Practices in Developing Economies

The application of circular economy principles within the developing countries depends on the specific conditions prevailing within each country. However, despite the differences between the conditions that prevail in these countries, the countries have applied several unique methods of dealing with wastes efficiently.

7.1 Asia

Several Asian countries have been able to make substantial progress in the development of circular economy approaches. For example, in India, there have been several attempts to improve the recycling processes and overcome issues linked to electronic waste management, which continues to be one of the environmental concerns (Mahanth et al., 2023). China has implemented circular economy concepts in its industrial production using such mechanisms as resource recovery schemes and recycling of construction waste (Bao & Lu, 2020). Indonesia, like China, has implemented industry 4.0 waste management approaches involving the use of digital technologies (Fatimah et al., 2020).

7.2 Africa

While several nations within the African continent still struggle with infrastructure and financial challenges, the adoption of the circular economy is slowly becoming a reality. There has been more emphasis placed on recycling, resource recovery, and even the management of medical waste due to the environmental and health threats. This shows that there has been an acceptance of the circular economy concept (Chisholm et al., 2021).

7.3 Latin America

Latin American nations have been advocating for the implementation of a circular economy system to enhance their resource management and waste management efforts. One example is that of Brazil, which has seen advancements in recycling its electronic wastes and engaging in urban mining techniques. This has enabled the extraction of useful resources from the waste materials in electronic gadgets (Xavier, Ottoni, & Lepawsky, 2021).

7.4 Lessons Learned from Successful Initiatives

Experience from developing countries shows that proper policy formulation, stakeholder cooperation, innovations, and public engagement are critical factors to ensure successful adoption of the circular economy strategy. Moreover, initiatives are more successful when tailored to specific socio-economic conditions as opposed to being directly copied from outside sources. This indicates that contextual circular economy approaches can be more efficient regarding resource optimization and sustainability (Xavier et al., 2021). Table 4 represents the comparison of circular economy applications that have been applied in different developing regions as a means of promoting sustainable waste management. Figure 4 presents a comparison of circular economy applications that have been used in Asia, Africa, and Latin America.

Table 4. Comparative Circular Economy Practices in Developing Regions

Region	Key Circular Economy Practice	Major Outcome	References
India	E-waste recycling initiatives	Resource recovery	Mahanth et al.

			(2023)
China	Construction waste recycling and industrial symbiosis	Reduced landfill dependence	Bao & Lu (2020)
Indonesia	Smart waste management systems	Improved operational efficiency	Fatimah et al. (2020)
Africa	Medical waste management improvements	Better environmental protection	Chisholm et al. (2021)
Brazil	Urban mining and e-waste recycling	Material recovery	Xavier, Ottoni, and Lepawsky (2021)

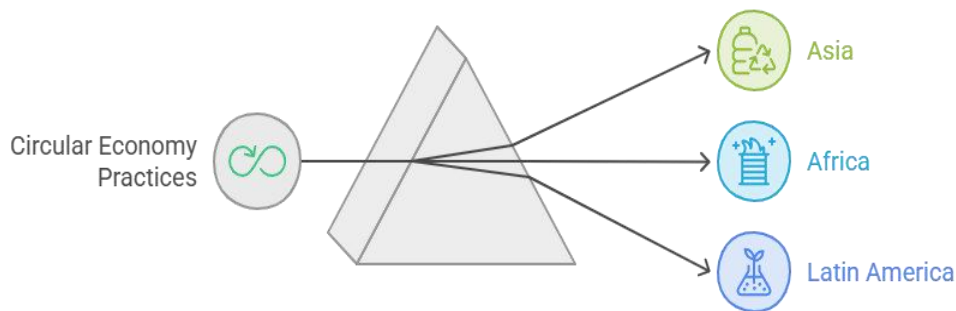


Figure 4. Comparative Circular Economy Practices Across Developing Regions

8. Environmental, Economic, and Social Impacts

Circular economy systems provide substantial gains environmentally, economically, and socially by encouraging efficiency and decreasing dependence on waste dumping. The relevance of such gains is especially critical in developing countries, which must deal with the problem of growing waste.

8.1 Environmental Benefits

The concepts of circularity decrease the quantity of waste that gets disposed of in landfills and open dumps through activities such as recycling, reuse, composting, and resource recovery. This practice assists in preventing the occurrence of air, soil, and water pollution while at the same time saving natural resources by using fewer virgin raw materials. Furthermore, a circular economy helps in mitigating climate change because of the reduction in greenhouse gas emissions due to the extraction of resources, their manufacture, and their eventual disposal (Papamichael et al., 2023; Yang et al., 2023).

8.2 Economic Benefits

Circular economy strategies add value through turning wastes into resources, leading to increased economic value and better resource efficiency. Resource recovery and reuse contribute recycled materials to industry and reduce costs associated with production and dependency on virgin materials. Job opportunities can be generated in areas including recycling, repairing, remanufacturing, and resource recovery. Better resource efficiency will result in decreased waste management costs in the long run. The use of circularity indicators will allow for the assessment of economic performance (Kristensen & Mosgaard, 2020).

8.3 Social Benefits

Circular economy actions aid in social sustainability by ensuring good public health and a healthy environment. Proper waste management means fewer people are exposed to hazardous environments that expose them to toxins. In addition, these actions create job opportunities and income-generating opportunities among the poor and marginalized sections of society participating in recycling and reuse.

Furthermore, community involvement in segregation and recycling creates environmental and social awareness. Circular economy practices help promote social inclusion as well as sustainable development (Strippoli et al., 2024). Table 5 below highlights some of the main impacts and obstacles faced by circular economies in developing countries.

Table 5. Benefits and Barriers of Circular Economy Adoption in Developing Economies

Dimension	Major Benefits	Key Barriers	References
Environmental	Reduced pollution and landfill waste	Weak environmental governance	Papamichael et al. (2023)
Economic	Job creation and resource recovery	Financial limitations	Kristensen & Mosgaard (2020)
Social	Improved public health and inclusion	Low public awareness	Strippoli et al. (2024)
Technological	Increased resource efficiency	Lack of advanced technologies	Alhawamdeh et al. (2024)
Policy	Support for sustainable development goals	Regulatory gaps	Fauzi et al. (2024)

9. Barriers to Circular Economy Adoption

Despite increasing acceptance of circular economic methods as efficient means of dealing with wastes sustainably, there are various constraints to their application in developing economies. Among such constraints is the fact that such countries lack effective policies and regulatory structures that lead to laxity in implementing regulations aimed at proper waste management. There are also cases of fragmented governance systems and lack of coordination of institutions, which pose as major obstacles (Ferriz-Papi et al., 2024).

Financial barriers pose another obstacle in transitioning to a circular economy system. Building recycling centres, energy-from-waste plants, and utilizing high-end recovery techniques demands a large amount of capital, which becomes difficult to raise in economies that face economic constraints (Mahanth et al., 2023). A lack of adequate funds coupled with the absence of proper economic incentives leads to poor involvement in circular economy practices by both the private and public sectors. The lack of technological advancements poses yet another problem. Most emerging economies do not have access to efficient waste sorting and processing technologies that ensure high rates of recovery (Alhawamdeh et al., 2024).

Apart from these obstacles, some market issues pose further difficulties in the promotion of circular economy efforts. Unpredictable costs of recyclables, lack of interest in buying recycled products, and inefficiencies within supply chains decrease the viability of recycling businesses. Furthermore, behavioural and cultural factors also play a role, as consumers may lack adequate information regarding circular practices and may be opposed to new consumption and waste disposal behaviours. Addressing these barriers calls for holistic approaches involving policies, innovation, stakeholder engagement, and increased consumer awareness.

10. Conclusion

The issue of sustainable waste management has gained significant importance in developing economies due to fast-growing cities, rapid increase in the number of people, changing consumer behaviour, and the emergence of numerous types of wastes. Existing models of waste management that mainly include waste collection and its disposal are becoming insufficient in solving environmental, economic, and social problems caused by increasing amounts of waste. Against such a background, the concept of the circular economy becomes especially relevant because it provides ways to turn waste into an invaluable resource for humans. According to the presented literature review, circular economy solutions such as waste avoidance, reusing and recycling, valorisation of biodegradable waste, waste-to-energy

technologies, and industrial symbiosis make it possible to boost the efficiency of resource usage while decreasing environmental degradation. Moreover, the incorporation of informal recycling systems, advancements in technology, and stakeholder cooperation can further improve the efficiency of circular economy waste management processes. Although these benefits exist, there are still numerous obstacles that need to be overcome in order for them to take place effectively. These include financial barriers, inadequate policy structures, limited technology, and lack of awareness among the general population. In overcoming such barriers, it is essential that governments adopt appropriate policies, invest in necessary infrastructure, and engage in capacity-building programs. Overall, the concept of circular economy-based waste management is a promising way forward for the achievement of sustainable development in developing countries.

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