

# Assessing Solid Waste Management Systems at the Local Level: A Circular Economy Case Study

Engr. Jan Christer M. Dela Rosa, SE, MMEnp  
Philippine Christian University, 1004 Manila, Philippines  
Email: [jmdelarosa.se@gmail.com](mailto:jmdelarosa.se@gmail.com)

## Abstract

Solid waste management is a critical environmental and public health challenge in the Philippines, driven by rapid urbanization, population growth, and rising consumption, which overwhelm existing infrastructure and institutional capacities. Despite the Ecological Solid Waste Management Act of 2000 (RA 9003), waste governance remains decentralized, resulting in uneven policy implementation, reliance on disposal-based systems, and limited resource recovery. This study examines as a case study to evaluate policy effectiveness, infrastructure, technological capacity, and stakeholder engagement through the lens of Circular Economy Theory.

A comprehensive review of literature, policy documents, and government reports highlights the shift from linear “take–make–dispose” models toward circular systems emphasizing waste reduction, material recovery, and resource regeneration. Results indicate that circular implementation is constrained by entrenched linear mindsets, weak integration, inadequate infrastructure, financial limitations, fragmented policies, limited institutional capacity, and insufficient digital systems. While RA 9003 and the Extended Producer Responsibility Act of 2022 provide a legal foundation, gaps in enforcement, coordination, and market readiness hinder circular outcomes.

The study concludes that achieving sustainable, zero-waste systems requires systemic reforms, including coherent policies, context-appropriate infrastructure, economic incentives, capacity building, and active stakeholder participation, offering a roadmap for locally grounded yet nationally aligned circular waste management in the Philippines.

## 1 INTRODUCTION

One of the most important environmental and public health issues in the Philippines at the moment is solid waste management. Blistering urbanization, demographic growth and advancement in industries have phenomenally advanced the quantity of waste in the country. It has flooded the current infrastructure and posed a serious environmental and health hazard [9]. The Philippines produces large amounts of municipal solid waste on a daily basis, and it does not have an effective collection, treatment and disposal of this growing volume of garbage. This scenario is the same in other developing countries, where poor infrastructure, weak policies, and lack of awareness by the population encourage rampant environmental [44].

No single law exists as the Philippines lacks a single national plan that is called the Ten-Year Solid Waste Management Plan. Rather, a decentralized system is utilized in the country as per the Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003). This statute compels every Local Government Unit (LGU) such as cities, municipalities as well as provinces to develop and implement their own 10-year Solid Waste Management Plan (SWMP). This is a mandatory requirement and the creation of their SWMPs by LGUs is a

requirement of Section 17 of RA 9003, as it states that the LGUs are required to create their SWMPs within one year of the effectivity of the Act, and to review and update them after every ten years in response to changing demographic, economic, and infrastructural circumstances. There is a legislative basis of technical guidelines and oversight by the Department of Environment and Natural Resources (DENR), but there is no national plan that is promulgated or enforced as such. There is, nevertheless, inconsistency in implementing waste segregation, recycling, and proper disposal requirements across the local government units, and observance of the same. The necessity to develop innovative solutions where the innovations of a certain technology are combined with policy changes and involving the community has grown [44].

This research aims at analyzing the existing challenges, assessing the state of the existing policies and infrastructure and offering sustainable solutions that can alter the culture of waste management in the entire Philippines. In particular, the research will attempt to:

1. Evaluate the present condition of solid waste production, collection and disposal processes
2. Can we examine the performance of current policies, especially Republic Act 9003, and trace areas of implementation failure at national and local levels?
3. Assess infrastructure requirements and technological possibilities on how to enhance waste processing, recycling and recovering of resources.
4. Give practical policy reforms, infrastructure creation, and engagement of stakeholder suggestions to attain long-term waste management objectives.

This is a holistic plan that will act as the blueprint in the transformation of the approach to solid waste management of the Philippines with a focus on incorporating policy frameworks, technological development, and community involvement to develop a sustainable and resilient waste management system that safeguards the health and the environmental integrity of people.

## 2.0 Materials and Methods

This study utilizes an elaborate literature review as it attempts to find out the challenges, policies, and sustainable solutions involved in solid waste management in the Philippines. It is based on the broad diversity of materials peer-reviewed academic journals, governmental reports, policy documents, and other international organizations such as the World Bank and the United Nations Environment Program are included. The choice of literature was made according to its topicality in solid waste management and the fact that it concentrates on the Philippine context, making sure that the plan is going to cover a multi-faceted idea of waste management problems [44]. Among them are technical and infrastructural issues in waste collection and disposal, the efficiency of such policies as the Republic Act 9003 (Ecological Solid Waste Management Act), innovative treatment and recycling technologies of waste, and social and economic aspects of solid waste management practice [9].

The analysis is aimed at classifying and generalizing the literature into themes that would give a comprehensive picture of the situation in solid waste management in the country. The paper identifies the weaknesses in waste collection systems, the problem in policy enforcement, and the knowledge of people on waste sorting and recycling, along with the possibility of using sustainable solutions like waste-to-energy solutions, the cyclical economy, and the community-based waste management program [9]. Although the data derived via secondary data is limited, i.e., lack of information about waste management practices at rural levels and informal recycling

industries, the literature review reflects useful information to strategic planning and policy formulation to enhance solid waste management practices in the Philippines throughout the decade [44].

### 3.0 Theory Used

The theory is based on the Circular Economy Theory which is operationalized based on the paradigm Reduce, Reuse, Recycle, and Energy Recovery as institutionalized in Republic Act No. 9003 and reinforced by the Extended Producer Responsibility (EPR) Act of 2022 [14]. It is based on the concept of waste as a systemic input stream and redefines the conventional linear framework of this theory: take-make-dispose into long-term planning horizons and accordingly adjusts to statutory requirements, infrastructural Circular economy theory, unlike the models of the static equilibrium, or the models of the pure technocratic optimization, combines the material flow analysis, the institutional governance dynamics, the behavioral economics, and the lifecycle environmental accounting that makes it uniquely suitable to organize the decade-long SWMP that should address the anticipated increase in the waste as well (e.g., +2%/year at UPLB, increasing between 593.67 kg/day and 709.49 kg/day [55], infrastructural deficits (e.g., only 12% of LGUs operate sanitary landfills [26], and persistent implementation gaps rooted in financial constraints, technical capacity limitations, and variable community participation levels [48].

### 4.0 Results and Discussion

The circular economy is an essential paradigm shift in the traditional linear-based take-make-dispose model to a regenerative one that will strive to eradicate waste, optimize resource use by ensuring continuous reuse, recycling, and recycling of resources. Circular economy theory offers an overall perspective of the complex problems that plague the present waste management systems in the world in consideration of solid waste management. As Maulia et al., 2023 point out, the principles of a circular economy have demonstrated potential to enhance the outcomes of waste operations but still, there is an enormous problem with the realization of the theoretical frameworks in a practical, large-scale operation [44].

The model of the circular economy is founded on three fundamental principles, namely designing out waste and pollution, retaining products and materials in use, and regenerating natural systems. This idea is supported by Silva et al., 2023, who observe that wastewater treatment allows managing natural resources sustainably, enhancing the provision of clean water and reducing stress on natural resources, energy recovery, and agricultural support, and the implementation of circular principles in the treatment of waste streams of various types [66]. Applying these principles to solid waste management, the traditional, non-systematic approaches face criticism and the systematic character of the waste-related issues is emphasized. Nevertheless, there are many challenges in the shift between the linear and circular waste management models, and they are characterized by technical, economic, social, and institutional aspects.

#### 4.1 Theoretical Framework Dilemmas: Linear to Circular Models

##### 4.1.1 Paradigm Shift Resistance

The shift of linear to circular models of waste management is a crucial problem that extends more than technical factors into economic, social and institutional culture and patterns that are deeply embedded. As shown by Atienza et al., 2020, the way people traditionally manage waste in the Philippines has been based on linear thinking, in which waste is considered a product, and nothing that can serve other processes as a resource [9]. This difficulty is reflected in the study by E. Omohwovo et al., 2024, where they state that in Africa,

irresponsible wastewater management has caused severe health hazards among people and animals and aquatic life, and how the linear method of waste disposal generates effects that are harmful to a slightest extent [51].

Linear economy model has dominated the industrial/economic thought in centuries that has led to institutional inertia that may be difficult to overcome with its circular approaches. According to Singh et al., 2023, regulatory, technological innovation, and sustainability are the foundation of successful waste management, but significant challenges such as insufficient infrastructure and a lack of resources remain. This opposition is expressed through the regulatory systems based in the principles of linear processes, businesses modeled to the optimistic use of single-use products, and the culture of disposability-conditioned consumer behaviors.

Linear thinking is still taught in schools and through professional training, which has resulted in engineers, planners and policymakers, who are not exposed to circular economy principles. According to Corpuz et al., 2025, localized solutions and integration of policies are needed, as the Philippines, just like any other developing country, is witnessing an extensive population growth and urbanization without corresponding infrastructure that would help in effective treatment and circular recovery of resources.

#### **4.1.2 Complexity in Systems Thinking**

Circular economy theory demands an advanced systems thinking that will account to the interrelations amongst various sectors, stakeholders, and procedures. Maulia et al., 2023 note that the majority of the studies are geographically or waste type disjointed without a comprehensive or cross contextual synthesis. This discontinuity is indicative of the bigger problem of working to establish systems-level solutions in a world structured based on sectoral and jurisdictional lines [44].

M. Massoud et al., 2009 offers a way to see the complexity of this issue as the decentralized methods of waste treatment enable flexibility in their management and simple and complex technologies exist, but what is important is to have knowledge of the receiving environment so that technology could be selected. Plan, implementation and management of a circular system are complicated due to the necessity of adapting to the complexity of circular systems.

Abosede Muinat Onifade et al., 2024 adds to this complexity by looking at the intersection of aging infrastructure, changing environmental factors, and socioeconomic differences to produce a complicated policy environment in waste management. As compared to linear systems where cause-effect relationship is fairly straightforward, circular systems entail numerous feedback loops, dependencies, and emergent property which may be hard to predict and manage [10].

### **4.2 Resource Recovery and Value Creation Problems.**

#### **4.2.1 Barriers to Material Flow Optimization.**

The aspect of circular economy of ensuring that materials remain in productive use has been a major challenge on the current waste management systems. According Maulia et al., 2023, new technologies in recycling have revolutionized the way waste is handled and thus organic and plastic waste can be converted into reusable materials using hydrothermal treatment and pyrolysis [44]. Nevertheless, Ayan Khan et al., 2025 single out that India produces approximately 160,000 tons of municipal solid waste per day, of which only 70 to 80 percent are collected and less than a quarter of it are processed scientifically, which is an indication of the magnitude of the material flow optimization issues.

Contamination of the material is one of the inherent challenges to efficient recovery of the resources. Vella A. Atienza et al., 2011 also notes that segregation and recycling of waste cannot be done without a good awareness program and involvement of diverse stakeholders [9]. Impure mixed waste, poor source separation, and collection and transportation contamination degrade the quality and value of materials recovered.

Bikram Jit Singh et al., 2023 emphasize the fact that there are significant barriers to managing industrial waste such as poor infrastructure and resource shortages, which are also similar to the situation in municipal solid waste. The decentralization of waste production and the centralization of many processing facilities makes logistics problematic to the economic feasibility of resource recovery.

The secondary materials market development is planned as follows:

Establishing viable markets of recovered materials is a key issue towards the implementation of the circular waste management systems. Ayan Khan et al., 2025 points to the necessity of supporting technological innovation and applying a model of a circular economy, but at the same time, the level of recycling is low (especially plastics 3.4 million tonnes a year), which only worsens the pollution situation and its effects on the environment. Silva et al., 2023 offers a more universal view and states that wastewater treatment offers one of the most sustainable methods of water conservation, energy generation, and agricultural productiveness and how the approaches of circularity can generate numerous value streams [66]. Nonetheless, there are quality and consistency concerns with recovered materials which pose some obstacles to solid waste systems acceptance to the market. E. Omohwovo et al., 2024 also points out that to solve waste management issues, it is necessary to develop indigenous innovative technologies and switch to the sustainable economy, where the development of the local market, with references to the regional situation and capabilities, is required.

#### **4.2.3 Technology Integration and Scaling Issues.**

According to Maulia et al. (2023), technological advances such as IoT-based waste tracking systems, smart surveillance devices, and blockchain-powered transparency are changing the conventional waste management systems [44]. But, M. Massoud et al., 2009 observe that third world countries do not have the money to create centralized plants as well as the technical skills to operate and maintain them, which underscores the problem of scaling.

Bikram Jit Singh et al., 2023 supports this by stating that the research paper has identified gaps and avenues to be explored in future studies, supporting the idea of interdisciplinary studies and a stronger commitment of stakeholders to work together. Circular waste management involves the combination of many technologies that make the process complex which may exceed current organizational abilities.

Jeff Clyde Corpuz et al., 2025 suggests the importance of localized solutions, as the author points out that waste treatment and disposal facilities are not very common, which means that waste is usually released without treatment, causing severe threats to people and causing environmental harm. This shows how the implementation of the circular systems is hampered by gaps in technology.

### **4.3.0 Barriers to Circularity Economic and Financial.**

#### **4.3.1 Investment and Financing Constraints.**

The process of converting waste management systems toward circular systems demands huge initial investments, an uphill task to low- and middle-income nations. According to Maulia et al. (2023), the lack of financial resources limits investment in the development of the modern waste system, which leads to the inefficiencies of the system's work and the increasing amounts of unprocessed waste [44]. Omohwovo et al. (2024) also make the same point by stating that it requires global financial and technical support to develop treatment infrastructure, in rural and underserved regions in particular.

Onifade et al. (2024) also include the fact that the general economic and legal factors, including land tenure and property, also complicate investment choices. Circular investments are perceived to present higher risks in comparison to linear systems and have a longer payback time, which is why they do not attract the participation of investors, whether in the public or as a private sector.

#### **4.3.2 Re-Engineering of Cost Structures.**

Circular waste management must entail a fundamental reorganization of the cost dynamics that may subject it to minor financial strains in the short term. According to Khan et al. (2025), weak source segregation, a weak infrastructure and low recycling rates, make operation costly and less efficient. As it is shown by Massoud et al. (2009), the decentralized treatment systems can provide benefits in terms of costs by cutting down transportation and infrastructure costs, which can be applied to solid waste systems.

The example of Silva et al. (2023) shows that with the help of an approach that is circular, waste management can be turned into a system that creates value instead of a cost center by recovering energy and reusing resources [66]. But, to achieve such benefits, it must be planned and long-term investment is necessary.

#### **4.3.3 Mismatch of Economic Incentives.**

Economic incentives have been found to be useful in making sustainable waste behavioral patterns, but current incentive systems often still promote linear consumption and disposal modes [44]. According to Atienza et al. (2011), to effectively streamline incentives towards circular goals, good governance that is typified by stakeholder involvement and technological spur is needed [9].

Singh et al. (2023) point to the lack of coordination between the stakeholders on a long-term basis, whereas Onifade et al. (2024) emphasize that the misalignment of incentives continue to impose a disproportionate burden on the vulnerable population, causing inequalities in waste management access and outcomes.

### **4.4.0 Challenges of Policy and Regulatory Framework.**

#### **4.4.1 The regulatory coherence and integration**

This is the ability of the regulatory framework to uphold uniformity across the financial, economic, and social domains (Bragon and Minuchin, 2008).

Circular waste management must be well coordinated through coherent integrated policies across sectors and levels of government. Atienza et al. (2020) also report that there are current issues with policy implementation at the local level of government indicating systemic coordination failures. According to Onifade et al. (2024), the regulatory environment has been sophisticated by the aging infrastructure, changes in the environmental risks, and the socioeconomic differences.

Corpuz et al. (2025) highlight that the absence of a unified set of policies and inconsistency in standards are contributing factors to the inability to implement the concept of the circular system, especially in such nations as the Philippines, where the failures of the waste management system represent a great threat to the public health. Regulations based on linear theories are still poorly adapted to promote circular movements that cut across administrative and sectoral lines.

#### **4.4.2 Problems of the Implementation of Extended Producer Responsibility.**

Extended Producer Responsibility (EPR) schemes are commonly accepted as a groundbreaking policy tool of the further facilitation of the principles of the circular economy in solid waste management. Through the transfer of the duty of post consumer waste to producers, EPR will help to create incentive to re-design products, reduce the waste and recover the material. Nevertheless, the realisation of EPR structures is still fraught with institutional, regulatory, and market-based problems.

According to Bueta et al. (2024), the fact that the Extended Producer Responsibility Act of 2022 was introduced into the Philippine legal framework is a landmark of the policy on the transition to circular waste management. Although this has been achieved, there are critical issues in the implementation of the circular economy such as lack of clarity in the operational definition of the circular economy, lack of clarity in the roles and functions of Producer Responsibility Organizations (PROs), and lack of clarity in matters of cost allocation, fee structures, and compliance mechanisms. Such loopholes are detrimental to translation of the intent of the law into quantifiable circular results.

The economic incentives implemented in the design of EPR systems should also be carefully calibrated in order to make sure that producers have an incentive to implement a circular design of products but at the same time be economically viable. Anonas et al. (2023) point out policy incoherence in the Philippine system of waste governance, in which solid waste management policies focus on waste reduction, and renewable energy structures support the active development of waste-to-energy technologies. This inconsistency generates contradictory information that makes EPR implementation difficult and might unwillingly make disposal-based solutions preferable to material recovery and reuse.

The management of plastic waste also has evidence that highlights the shortcomings of the current EPR mechanisms. Regardless of the number of policy interventions, the Philippines remains one of the leading nations in the list of mismanaging plastic waste, and in 2019, only about 28 percent of the major plastic resins were reused. This implies that the EPR schemes should be designed to respond to particular waste streams and material market failures along with structural inefficiencies that hinder the idea of circularity.

According to Coracero et al. (2021), the Ecological Solid Waste Management Act (RA 9003) continues to form the legal basis of waste differentiation, diversion, and recovery in the Philippines. They however maintain that good governance, sustained stakeholder involvement and inter-sectoral coordination are necessary to ensure

successful implementation, which are also important factors to ensure the success of EPR systems. Organizing the producers, local government, waste service providers and consumers with a single EPR system is a major challenge to governance.

Monitoring and enforcement further limit the effectiveness of EPR especially when it comes to complex products which are made out of numerous materials and components. Apostol et al. (2022) note that the current waste reduction policies are still ineffective and obsolete, and the continued presence of gaps in source segregation not only destabilizes the downstream recovery operations but also increases the environmental and human health risks. These reports highlight the importance of implementing EPR schemes that focus on the whole product life cycle, including design and consumption, as well as collection, recycling and ultimate disposal.

#### **4.4.3 Constraints of institutional capacity and Governance.**

The management of the circular waste management systems require institutional capabilities that are usually far beyond those entrenched in traditional, disposal-based waste management institutions. Domingos et al. (2021) emphasize that institutional strengthening is required to facilitate the shift towards the model of the circular economy in the sphere of solid waste in the Philippines, especially in the area of regulatory control, professionalism, and coordination of activities of agencies.

The institutional failure is evidenced by Castillo et al. (2013), who report that, even though the Ecological Solid Waste Management Act of 2000 has been passed, the number of open and controlled dumpsites is still high throughout the Philippines. This dependency on disposal methods that are harmful to the environment points out the disconnect between the policy goals and the institutional ability to implement, enforce and monitor them.

The conventional waste management facilities are usually designed to focus on the linear processes and might not be flexible enough to address circular systems that have numerous feedbacks and an ability to connect across sectors. Guisansana et al. (2020) underline the central role of the local government units (LGUs) in the implementation of RA 9003, with some successes and ongoing challenges in the translation of national requirements into local implementation. These results demonstrate the importance of institutional capacity on subnational level as a key factor of circular economy outputs.

These challenges are also explicated by the comparative knowledge of wastewater governance. In their case study of the wastewater governance structure in Malaysia, Mahyudin et al. (2023) observe that institutional and operational limitations have restricted the development to more advanced uses including wastewater reclamation. This is an indication that institutional constraints are a cross-cutting impediment in implementing the circular economy, over several waste streams.

Adaptive governance arrangements are also required by the dynamic nature of the circular systems which might be conflicting with the traditional bureaucratic structure. Regulatory standards and institutional practices, Schellenberg et al. (2020) believe, are in need of reimagination to meet the needs of the rapidly changing urban environments, where more holistic, participatory, transparent, and context-sensitive forms of governance should be applied.

## 4.5.0 Infrastructure and Technological Problems.

### 4.5.1 Technology Integration and Interoperability.

Achievement of circular economy goals in waste management depends more on the combination of various technologies on the physical, chemical, biological and digital systems. According to Nishat et al. (2023), population growth and urbanization that may occur faster than the process of sustainability have led to increased pressure on the water and energy resources, so unified treatment systems are needed to be able to work in different technological spheres.

As mentioned by Kanchanapiya et al. (2022), the reclamation of wastewater in Thailand relies not only on the presence of technologies but also on the creation of favorable regulatory frameworks and monitoring systems that are specific to the intended use of the reuse. The same is witnessed in solid waste management whereby, the potential of technology is usually limited by the regulatory and institutional restrictions.

The issue of interoperability has continued since proprietary technologies and fragmented data platforms prevent system-wide coordination and the exchange of information. Altowayti et al. (2022) underline the fact that improved and effective treatment systems that are sustainable are more dependent on sophisticated integration, which implies the deployment of artificial intelligence in conjunction with traditional approaches to treatment. Nevertheless, this integration requires technical capability, which is usually not present in developing situations.

This fact is supported by Jadeja et al. (2022), who also add that in spite of the heavy technological progress, insufficient infrastructure, insufficient funding and awareness lead to the further emission of untreated waste. These limitations indicate the inefficiency of the implementation of a circular economy through technological integration failures.

### 4.5.2 Infrastructure Adaptation and retrofitting.

Conversion of the linear to the circular waste management means having to adapt and retrofit existing infrastructure, which is a challenging process in terms of technical, financial, and logistical aspects. This point is exemplified by Gorme et al. (2010) in their examination of the Pasig River where the quality of water does not improve despite the efforts made by the government to rehabilitate it, mainly because of inadequate waste management facilities.

Samhan et al (2010) also show that the overloading and degradation of older wastewater treatment units, most of which are decades old, is often a serious environmental and health hazard mainly due to the fact that these are poorly maintained. The process of retrofitting these infrastructures to facilitate circular processes is very expensive and needs special skills.

Magalang et al. (2014) point out that the wastes are in the urban centers like Metro Manila which contribute to almost a quarter of the total wastes in the country. This notwithstanding, there has been poor infrastructure development in comparison with the rate of generation of waste resources which only increases the management problems in the metropolitan regions.

Similar circumstances are manifested in other less developed settings. According to Karki et al. (2024), in Nepal, most urban households are onsite-based systems with limited access to centralized treatment facilities, which

means that the treatment-to-generation ratios are low. These results highlight the systemic insufficiency of the current infrastructure to enable the use of circular waste management.

#### 4.5.3 Digital Infrastructure and Data Management Limitations

Circular waste management systems require the strength of digital infrastructure and data-driven decisions in order to successfully govern them. Pintor et al. (2019) note that although many papers are devoted to waste characterization and the 3Rs, many of them are quite quantitative and disjointed, which does not allow them to be used in planning the circular economy in a holistic way.

Ayub et al. (2024) also underline that solid waste management practices in different cities differ considerably, but the collection of information has not been done comprehensively and systematically. This absence of credible data limits performance monitoring processes, policy analysis, and strategic planning of circular systems.

These issues are augmented by digital inequality. Valera et al. (2024) show that although survey-based and statistical data analysis are necessary to comprehend household-level waste practices, the lack of data and uneven access to digital instruments compromise their visibility and responsibility on a system-wide level.

This issue is strengthened by Sumaria et al. (2025) who examine the issue of waste electrical and electronic equipment (WEEE) management in the Philippines where, despite creating an estimated 537,000 metric tons of e-waste in 2022, the infrastructure of extensive tracking and data management is not yet well developed. The lack of built-in digital infrastructure will lead to the undermining of circular economy programs by the exclusion of weak monitoring, disjointed reporting, and little transparency.

### 5.0 Discussion

The results of the current study show that the shift to the linear to the circular solid waste management systems is still limited by the interconnected technical, institutional, economic, and governance issues. Despite the comprehensive nature of the approach of the principles of the circular economy in terms of sustainable waste management, their use in practice is still scattered and unbalanced, especially in the context of developing countries.

The solid waste management systems are still dominated by linear thinking. Waste is mostly perceived to be a final product and not a potential resource and this has the effect of perpetuating the reliance of disposal-based practices. Regulatory frameworks, professional training, business models, and consumer behaviors are still based on the linear assumptions which poses an institutional force that impedes the implementation of the circular economy approaches. The paradigm opposition limits the innovation of product design, recovering of materials, and regeneration of resources.

Circular waste management needs systems level cross sector, stakeholder, and jurisdiction integration. The results however indicate that waste management systems are still disaggregated in terms of waste type, institutional requirement and administrative scope. Lack of integrated planning frameworks and cross-sectoral coordination restricts the capacity of institutions to ensure the complex material flows, feedback loops, and interdependencies involved in the existence of circular systems. This leads to the fact that circular initiatives are implemented in isolation and, therefore, become less effective.

The analysis reveals that there is a lot of inefficiency in the material recovery processes. Weak logistics systems, poor source segregation and contamination during the collection process, as well as contamination during transportation, decrease the quality and economic value of recovered materials. These terms make it difficult to build viable markets in secondary material and destroy the economic viability of recycling and recovery projects. Although sophisticated technologies of recovery exist, there are structural constraints to their implementation on a large scale due to the lack of infrastructure and strong demand in the market.

Results show that financial constraints are still a significant impediment of circular waste management. The government is unwilling to participate in the high capital requirements, pay back periods, and the perceived risk in investment. The current cost frameworks encourage the linear disposal systems because of the poor segregation, low recovery rates, and ineffective operations. Though circular systems can create economic values, including the recovery of resources and energy generation, the latter is not often achieved because of the lack of long-term funding opportunities and the wrong economic incentives.

Research concludes that policy and regulatory frameworks are not consistent and aligned with the goals of the circular economy. Regulations are mostly of linear orientation and have not been integrated well across sectors and government levels. Although acknowledged as essential facilitating structures to achieve the idea of circularity, Extended Producer Responsibility (EPR) initiatives have difficulties in implementation due to ambiguity in institutional mandates, absence of enforcement, inconsistent policy messages, and market unwillingness to embrace it. Such loopholes are part of the inefficiency experienced in the management of plastic waste and the other priority waste streams.

Constraints related to institutional capacity have a big influence on the results of the circular economy. Local government departments, being the focal points of implementing waste management, tend to lack the technical competency, financial capacities, and the flexibility of organization to cope with the circular systems. Ineffective policy is also weakly monitored and coordinated among the agencies. It is also found that the current institutions are designed with a linear process, and are only ill-prepared to cope with the adaptive and participatory form of governance demanded by the circular systems.

The researchers conclude that waste management infrastructure is currently inadequate to use in a circular way as it is mostly designed to be used in linear mode. Aging facilities are very difficult to retrofit technically and economically. There is also a lack of interoperability, technical capacity and disjointed digital systems which further limit technological integration. Weak digital infrastructure and data gaps impair performance monitoring, transparency, and evidence-based decision-making, which are at the core of the successful governance of the circular waste management systems.

## 6.0 Conclusion

This paper shows that the shift towards a solid waste management system based on the circular economy is not a simple technical change, but a systemic change, which involves coordinated reforms in the governance system, the infrastructural system, the financial system, the technological system, and the social behavior system. Basing the discussion on the theory of the circular economy, the results show that the principles of waste reduction, material recovery, and resource regeneration provide an impressive approach to solid waste management sustainability, but their practical implementations (especially at the local level) are restricted by the established structural and institutional limitations.

When responding to the initial research question, the analysis of the present state of solid waste creation, collection, and disposal in represents the national trends in the creation of developing local government units. The current practice of waste management is still very linear where there is minimal separation at the source, poor collection systems, use of disposal-centered facilities and poor recovery of recyclable and organic waste. All of these situations suggest that waste remains a primary end-product, as opposed to a resource in the circle of value chain, which limits the possibility of reusing, recycling, and recovering the materials.

In relation to the second research objective, which is the evaluation of the existing policies-especially republic act no. 9003, it can be seen that there is a gap in policy intent and implementation. Although the legal framework established by RA 9003 is quite exhaustive in terms of the ecological solid waste management, its implementation, control, interaction between different agencies, and local governments are weakening the efficacy of the Act. Systemic failures in governance that reduce the contribution of the law to outcomes of a circular economy are also manifested by the inability to eliminate open and controlled dumpsites, lack of material recovery facilities, and weak mechanisms of local compliance. These results highlight the fact that the mere presence of policies is inadequate unless there is an institutional capacity that will be maintained, accountability mechanisms, and involvement of the stakeholders.

As per the third research objective, the study concludes that one of the most significant obstacles to the development of the circular waste management is infrastructure and technological limitations. Even available systems are mainly tailored to linear disposal systems and are not sufficiently installed to facilitate coordinated recycling, composting, energy recovery, and digital monitoring. Although there are large opportunities in the emerging technologies like sophisticated recycling, decentralized treatment, and digital waste tracking, they are limited to their scale and financial capacity, technology skills, disconnected data systems, and poor interoperability. These limitations underscore the necessity to have context-sensitive and modular and decentralized infrastructure solutions that are consistent with the capabilities of such a municipality.

Lastly, answering the fourth research question, the study notes that long-term solid waste management goals can be reached by means of carefully designed policy amendments, strategic investments in infrastructure, as well as involving all stakeholders. The coherence of policies should be enhanced by a better alignment of the solid waste management policies with the structures of the extended producers responsibility policies and renewable energy policies to prevent a clash of interests. The development of infrastructure should focus on segmenting the sources, local material recovery centers, composting systems, and digital data systems to facilitate evidence-based decisions. It is also important that households, producers, local government units, and the private sector are actively involved, with the solution to this being continued information campaigns, economic incentives, and capacity-building programs.

All in all, the results confirm that what is required to close the gaps in governance to achieve a zero-waste future is a change of disjointed, disposal-based systems to more coherent, circular, and adaptive waste management systems. Municipalities can embrace the principles of the circular economy as a feasible way of enhancing their environmental performance, resource efficiency, and health outcomes to its citizens. This potential, however, cannot be fulfilled without expanding the policy making to the policy doing, institutional fortification, and long term commitment towards local-based but national sustainability-oriented circular systems.

## Acknowledgement

The author is deeply grateful for the unwavering support of my beloved, Ciara Maica B. Hernandez

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