



Title: Sustainable Finance for a Zero-Waste Circular Economy in Nairobi County: A Framework for Plastic Solid Waste Quantification, Climate Change Mitigation, and Inclusive Livelihood Transformation

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Abstract

The findings of this study demonstrate that the global increase in plastic solid waste (PSW) has created interconnected environmental, economic, climate, and social challenges, particularly in rapidly urbanizing cities of developing countries. The study developed a Sustainable Finance for Zero-Waste Circular Economy (SF-ZWCE) framework, using global evidence on circular economy, sustainable finance, climate mitigation, and waste management, complemented by empirical evidence from Nairobi County, Kenya. The findings indicate that waste prevention, reuse, repair, source segregation, recycling, composting, anaerobic digestion, and integration of informal waste workers provide greater potential for resource conservation, greenhouse-gas reduction, employment creation, and inclusive economic development than predominantly disposal-oriented systems and Waste-to-Energy incineration. Evidence from Nairobi further shows substantial gaps between plastic waste generation, collection, recovery, financing, and productive reintegration into value chains. The study identifies inadequate financing, infrastructure, governance, data systems, market development, and policy coordination as major barriers to circular transition. The findings further demonstrate that sustainable finance can serve as a transformative mechanism by directing capital toward prevention, material recovery, recycling infrastructure, circular enterprises, climate-aligned technologies, and inclusive livelihood systems. The SF-ZWCE framework advances existing circular-economy approaches by connecting global material-flow challenges with investment decisions, climate outcomes, and livelihood transformation. The study concludes that integrating waste quantification, sustainable finance, and social inclusion can accelerate zero-waste transitions and provide a transferable model for Nairobi and other rapidly urbanizing cities globally.

Keywords: Circular economy; sustainable finance; plastic solid waste; zero waste; climate change mitigation; Nairobi County; recycling; green finance; inclusive livelihoods; sustainable waste management.



1. Introduction

1.1 Global Context of Plastic Waste and the Circular Economy

The findings of this study are situated within a global transition from linear production and consumption systems toward circular and resource-efficient economies. At the global level, rapid population growth, urbanization, industrialization, and changing consumption patterns have increased the generation of municipal solid waste and intensified pressure on natural resources and waste-management systems (Kaza et al., 2018; UNEP, 2024). The conventional linear model of extract–produce–consume–dispose has resulted in substantial material losses, environmental degradation, greenhouse-gas emissions, and increasing demand for virgin resources.

The circular economy has emerged as an alternative model that seeks to maintain the value of products, materials, and resources within the economy for as long as possible through prevention, reuse, repair, refurbishment, remanufacturing, recycling, and recovery (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017). Zero-waste approaches extend these principles by emphasizing prevention and reduction at source, followed by reuse, repair, recycling, composting, and recovery before residual treatment and disposal (Murray et al., 2017; Zaman, 2015).

Global evidence nevertheless indicates that the transition remains incomplete. Plastic production has increased dramatically over recent decades, while only a relatively small proportion of plastics has been recycled. Geyer et al. (2017) estimated that approximately 6.3 billion tonnes of plastic waste had been generated globally by 2015, of which only about 9% had been recycled. More recent evidence indicates that global plastic production and waste generation continue to increase, creating significant environmental and climate pressures (OECD, 2022; UNEP, 2023).

The global evidence therefore establishes that plastic waste is simultaneously an environmental liability and an economic resource. The challenge is not simply to dispose of plastic waste safely but to develop systems capable of retaining its material value while reducing environmental and climate impacts.

1.2 Plastic Waste, Climate Change and Resource Depletion

The findings from the global literature demonstrate that plastic waste is closely connected to climate change because most plastics are produced from fossil-based feedstocks. Greenhouse-gas emissions occur throughout the plastic life cycle, including extraction of fossil resources, production, transportation, processing, and end-of-life treatment (Zheng & Suh, 2019; UNEP, 2021).



Recycling, reuse, repair, and material recovery can reduce demand for virgin materials and thereby reduce some of the energy and emissions associated with primary production. The transition toward circular plastics is consequently relevant not only to waste management but also to climate-change mitigation and resource security.

However, the findings also demonstrate that not all waste-management technologies generate equivalent environmental outcomes. Waste-to-Energy (WtE), for example, can reduce waste volumes and recover energy but may compete with recycling for materials and requires significant infrastructure and financial investment. The environmental performance of WtE depends on waste composition, technology, energy displacement, emissions controls, and the opportunity cost of combusting recyclable materials (Astrup et al., 2015).

This evidence supports a waste hierarchy in which prevention, reuse, repair, and recycling are prioritized before residual treatment and disposal.

1.3 Global Shift toward Sustainable Finance

The global transition toward circularity has increasingly become a financial issue. Circular infrastructure, recycling technologies, reuse systems, resource-recovery enterprises, and sustainable product design require substantial investment. Consequently, sustainable finance has emerged as an important mechanism for directing capital toward activities that generate environmental and social benefits.

International financial institutions and governments have developed green bonds, climate finance, blended finance, impact investment, sustainability-linked lending, and taxonomy-based investment classifications to mobilize capital toward sustainable activities (OECD, 2020; UNEP Finance Initiative, 2023).

The EU Taxonomy represents a significant development in this area because it establishes criteria for identifying environmentally sustainable economic activities, including activities contributing to climate mitigation, climate adaptation, and the transition toward a circular economy (European Commission, 2020).

The global evidence nevertheless indicates that sustainable-finance frameworks often remain more developed in high-income economies than in developing-country cities. Financing barriers remain significant for small and medium-sized circular enterprises, informal waste workers, community-based organizations, and decentralized recycling systems.



This creates a particular challenge for African cities, where circular-economy systems frequently depend on informal workers and small enterprises that have limited access to formal financial services.

1.4 From Global Evidence to the Nairobi Context

The global findings provide the foundation for examining Nairobi County, where rapid urbanization and changing consumption patterns have intensified plastic-waste challenges. Nairobi represents an important case because it combines substantial plastic-waste generation with an active informal recovery sector, emerging material-recovery infrastructure, municipal waste expenditure, and increasing interest in circular-economy development.

The findings of this study indicate that Nairobi generates approximately 500 tonnes of plastic waste per day, while an estimated 70–75% is collected. However, approximately 93% of collected plastics are reported to flow toward landfill pathways (Mwai & Fujiwara, 2025). These findings reveal a substantial gap between waste collection and productive material recovery.

The study's analysis identifies PET, HDPE, LDPE, and PP as important plastic streams with significant recovery potential. The findings therefore indicate that Nairobi's challenge is not simply the absence of recyclable materials. Rather, significant economic value is lost because materials are not consistently separated, sorted, processed, marketed, and reintegrated into productive activities.

The wider municipal waste system reinforces this finding. Nairobi is estimated to generate approximately 3,085 tonnes of municipal solid waste per day, with collection and recovery remaining below total waste generation (UN-Habitat, 2026). Although estimates vary according to methodology and reporting period, the evidence consistently demonstrates a substantial gap between waste generation and resource recovery.

1.5 Primary Empirical Evidence from Nairobi

To move beyond reliance on global and secondary evidence, this study incorporates primary empirical evidence from Nairobi's waste-recovery system. The primary investigation focuses on waste workers and circular-economy enterprises and examines plastic recovery activities, working conditions, income, operating costs, access to equipment, access to finance, market linkages, and relationships with formal recycling systems.

The findings demonstrate that informal waste workers constitute an important component of Nairobi's existing circular economy. Waste pickers, collectors, aggregators, and small recycling



enterprises recover materials that would otherwise enter disposal pathways and connect these materials to downstream markets.

The primary evidence further indicates that waste recovery provides important livelihood opportunities but is constrained by limited access to finance, inadequate equipment, insecure working environments, unstable material markets, and weak institutional integration. These findings reinforce earlier research showing the important contribution of waste pickers and waste dealers to Nairobi's recycling economy (Mwaniki & Mbogua, 2001).

The study's findings therefore challenge approaches that treat informal workers solely as a problem requiring formalization. Instead, they demonstrate that informal workers are existing circular-economy actors and economic assets whose capabilities can be strengthened through targeted investment.

1.6 Findings on Nairobi's Waste-Finance Relationship

The financial analysis undertaken in this study demonstrates that Nairobi already commits significant public resources to waste management. The revised FY2024/25 Nairobi County budget allocated approximately KSh 2.96 billion to solid waste management (Nairobi City County Assembly, 2025).

However, the study finds that financing waste management does not necessarily mean financing circularity. Expenditure on collection, transportation, and disposal can improve sanitation while leaving substantial quantities of valuable materials outside productive economic cycles.

The findings indicate that additional investment is required in source segregation, material-recovery facilities, recycling enterprises, reuse systems, circular supply chains, market development, and worker integration.

The study therefore finds that sustainable-finance decisions should assess investments according to their capacity to produce multiple outcomes, including:

resource recovery + climate mitigation + financial viability + employment + social inclusion.

This finding provides the empirical basis for integrating finance directly into the proposed circular-economy framework.

1.7 Findings from Nairobi Circular-Economy Case Evidence



The study also draws on emerging circular-economy initiatives in Nairobi, including the Korogocho Material Recovery Facility (MRF). The facility represents an emerging model of decentralized sorting, segregation, and material recovery involving Nairobi City County, UN-Habitat, the Italian Agency for Development Cooperation, AVSI Foundation, Miss Koch Kenya, and community-level stakeholders (Italian Agency for Development Cooperation, 2026; UN-Habitat, 2026).

The case findings demonstrate that circular infrastructure can create multiple benefits when material recovery is combined with community participation and livelihood development. However, the study also finds that infrastructure alone does not guarantee circularity.

The performance of such facilities depends on reliable supplies of segregated waste, suitable technologies, skilled workers, stable markets, institutional coordination, and long-term financing.

The case therefore provides empirical support for treating circular infrastructure as an integrated financial, environmental, technological, and social system.

1.8 Research Gap Identified from Global and Nairobi Evidence

The comparison between global evidence and the Nairobi findings reveals an important research gap.

Existing circular-economy models primarily explain how materials and products can remain within productive loops (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017). Material-flow studies quantify the movement and loss of resources. Sustainable-finance frameworks focus on the mobilization and allocation of capital. Informal-sector studies examine employment and livelihood dimensions.

However, these dimensions are rarely integrated into a single investment-oriented framework for an African city.

The Nairobi evidence demonstrates why such integration is necessary. A recyclable plastic does not become circular simply because recycling technology exists. Its recovery requires collection, segregation, workers, equipment, finance, processing capacity, markets, and demand for secondary materials.

Similarly, a financial investment cannot be considered fully sustainable if it produces environmental benefits but creates financially unsustainable enterprises or displaces workers whose livelihoods depend on resource recovery.



The study therefore identifies a need to connect:

Plastic waste quantification → Circular interventions → Sustainable finance → Climate and resource outcomes → Livelihood transformation.

1.9 Novel Contribution of the Study

The principal contribution of this study is the development of the Sustainable Finance for Zero-Waste Circular Economy (SF-ZWCE) framework.

The framework advances existing circular-economy models in several important ways.

First, it transforms plastic-waste quantification into an investment-prioritization mechanism. Waste-flow data are used not merely to establish the scale of pollution but to identify where financial resources can generate the greatest recovery and circularity benefits.

Second, the framework places sustainable finance at the centre of circular-economy implementation. It links different circular activities with appropriate financing mechanisms and recognizes finance as a driver of system transformation rather than simply a supporting input.

Third, the framework incorporates informal waste workers and circular enterprises into the investment architecture. Their labour, knowledge, networks, and recovered materials are recognized as productive components of the circular economy.

Fourth, the framework evaluates investments through an integrated set of outcomes: material circularity, climate mitigation, resource efficiency, financial viability, employment, and social inclusion.

Thus, while conventional circular-economy models largely focus on closing material loops, the SF-ZWCE framework focuses on financing, measuring, and socially embedding those loops.

Its central contribution can therefore be expressed as:

From circular material flows to financially enabled, climate-responsive, and livelihood-inclusive circular transformation.

1.10 Study Objective and Research Questions

The overall objective of the study is to develop an empirically grounded Sustainable Finance for Zero-Waste Circular Economy framework for Nairobi County.



The study is guided by four specific objectives:

To quantify and characterize plastic solid-waste flows in Nairobi County and assess existing recovery and recycling pathways.

To examine sustainable-finance opportunities, investment patterns, and financing constraints affecting the transition toward a zero-waste circular economy.

To assess the climate-mitigation, resource-efficiency, employment, and livelihood outcomes associated with alternative circular-economy interventions.

To develop an integrated SF-ZWCE framework for guiding inclusive and climate-responsive investment in Nairobi County.

The corresponding research questions were

What is the major plastic solid-waste flows, recovery pathways, and material losses in Nairobi County?

What financing mechanisms, investment patterns, and financial barriers influence the transition toward a zero-waste circular economy in Nairobi County?

What environmental, climate-mitigation, employment, and livelihood benefits can be achieved through alternative circular-economy interventions?

How can a Sustainable Finance for Zero-Waste Circular Economy framework integrate waste quantification, sustainable finance, climate mitigation, and inclusive livelihood transformation in Nairobi County?

1.11 Significance of the Study

The findings demonstrate that Nairobi's transition to a Zero-Waste Circular Economy requires a fundamental shift from financing waste disposal toward financing resource recovery, circular enterprises, climate mitigation, and inclusive livelihoods.

The study contributes empirically by connecting global circular-economy evidence with Nairobi-specific plastic-flow statistics, primary evidence from waste workers, municipal financial data, and emerging circular-infrastructure cases. It contributes conceptually by moving beyond existing circular-economy models that focus primarily on material loops and introducing an integrated



framework in which finance, climate outcomes, and livelihoods are treated as core components of circularity.

The resulting SF-ZWCE framework therefore provides a context-specific basis for guiding public expenditure, private investment, development finance, producer-responsibility financing, and impact investment toward activities capable of producing measurable environmental, climate, economic, and social benefits.

The study ultimately finds that the circular transition in Nairobi should not be understood simply as a shift from landfilling to recycling. It represents a broader transformation from a linear waste-management system to a financially enabled, resource-efficient, climate-responsive, and socially inclusive urban economy.

2. Literature Review

2.1 Evolution of Circular Economy Thinking

The literature reviewed in this study shows that the circular economy has evolved from a predominantly resource-efficiency concept into a broader approach to restructuring production, consumption, and waste systems. Geissdoerfer et al. (2017) conceptualize the circular economy as a regenerative system that seeks to minimize resource inputs and waste through strategies that slow, close, and narrow resource loops. Similarly, the Ellen MacArthur Foundation (2013) emphasizes three principles: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

Although these perspectives are complementary, they differ in emphasis. The Ellen MacArthur Foundation provides a practical and business-oriented model for closing material loops, whereas Geissdoerfer et al. (2017) provide a broader conceptual foundation connecting circularity with sustainability. However, both approaches provide limited guidance on how circular transitions should be financed, particularly in resource-constrained urban settings.

This limitation is important because circularity requires substantial investment in collection systems, sorting infrastructure, recycling technologies, markets, skills, and enterprises. The literature therefore suggests that the transition cannot be achieved through circular design principles alone. It also requires financial mechanisms capable of translating circular objectives into scalable investments.



The present study addresses this gap by treating finance as an integral component of circular-system transformation rather than as an external enabling factor.

2.2 Systems Thinking and Circular Economy Transitions

Systems thinking provides a useful theoretical basis for understanding why isolated waste-management interventions frequently produce limited results. Meadows (2008) demonstrates that sustainability problems emerge from interactions among multiple components of complex systems. From this perspective, waste generation is influenced not only by disposal practices but also by production systems, consumption behaviour, institutional arrangements, market incentives, infrastructure, technology, and finance.

This perspective contrasts with conventional waste-management studies that often examine individual stages of the waste chain, such as collection, recycling, or disposal. While such studies provide useful technical information, they can overlook interactions between different components of the system.

The literature therefore supports an integrated approach, but a significant limitation remains: systems-thinking literature provides relatively little operational guidance on how financial capital should be allocated across interconnected circular interventions.

This study extends systems thinking by linking material flows to financial decisions. It proposes that investment priorities should be determined by examining where interventions can simultaneously improve resource recovery, climate performance, financial viability, and livelihoods.

2.3 Plastic Waste and Global Environmental Impacts

The literature provides substantial evidence that plastic waste has become a global environmental challenge. Geyer et al. (2017) demonstrated the unprecedented scale of global plastic production and waste generation, while Jambeck et al. (2015) established the significant contribution of inadequately managed plastic waste to marine pollution.

UNEP (2021) further emphasizes that plastic pollution is connected to environmental degradation throughout the plastic life cycle, from fossil-resource extraction and manufacturing to disposal and leakage into ecosystems.



However, the literature differs in how it conceptualizes the plastic problem. Some studies emphasize pollution prevention and environmental protection, while circular-economy research emphasizes resource recovery and material value retention. The first perspective primarily treats plastic as an environmental liability, whereas the second views plastic waste as a potentially recoverable economic resource.

The present study combines these perspectives. It treats plastic waste simultaneously as an environmental risk and an economic resource whose recovery can generate climate, economic, and livelihood benefits.

This distinction is particularly important for Nairobi because a significant proportion of plastic waste entering the waste system remains potentially recyclable.

2.4 Waste Management and Climate-Change Mitigation

The literature establishes a strong relationship between waste management and climate change. The World Bank (2018) projects substantial growth in municipal solid-waste generation, particularly in low- and middle-income countries. Landfilling organic materials contributes to methane emissions, while plastic production, transportation, and disposal generate additional greenhouse-gas emissions.

Zheng and Suh (2019) demonstrate the importance of considering emissions across the entire plastic life cycle rather than focusing exclusively on end-of-life management. This life-cycle perspective provides stronger support for prevention, reuse, and recycling than approaches that focus only on disposal.

However, climate-oriented waste studies tend to emphasize emissions reduction, whereas circular-economy studies tend to emphasize resource conservation. These approaches are related but not identical. A technology may reduce the physical volume of waste without maximizing material recovery or minimizing life-cycle emissions.

The literature therefore indicates the need for investment assessment that simultaneously considers carbon reduction and resource circularity. The present study fills this gap by incorporating climate mitigation as one of several criteria for evaluating circular investments.

2.5 Zero-Waste versus Disposal-Oriented Approaches

The literature on zero waste increasingly challenges disposal-oriented waste-management systems. Zero-waste approaches prioritize prevention, reduction, reuse, repair, recycling, composting, and



resource recovery, thereby attempting to minimize residual waste (Zaman, 2015; Murray et al., 2017).

Evidence from different regions indicates that zero-waste strategies can create employment, reduce environmental impacts, and conserve resources (Dias, 2016; Wilson et al., 2006). However, the literature is divided concerning the role of residual treatment technologies, particularly Waste-to-Energy (WtE).

Supporters of WtE argue that it can reduce waste volumes and recover energy from residual materials. Critics argue that incineration can compete with recycling, require significant capital investment, and potentially divert recyclable materials away from higher-value recovery pathways (Astrup et al., 2015).

The critical finding from this debate is that the performance of a waste-management system should not be evaluated solely according to how much waste it removes from the waste stream. It should also be assessed according to material recovery, greenhouse-gas emissions, resource efficiency, employment, financial sustainability, and social outcomes.

The present study adopts this broader evaluation approach and places prevention, reuse, repair, segregation, and recycling above residual treatment within its proposed investment hierarchy.

2.6 Informal Waste Workers and Social Inclusion

A substantial body of literature recognizes the important contribution of informal waste workers to recycling and resource recovery in developing countries. Wilson et al. (2006) demonstrate that informal recyclers can significantly contribute to waste recovery despite operating outside formal institutional structures.

However, the literature reveals two competing perspectives. One perspective views informality primarily as a governance problem requiring formalization. The alternative perspective recognizes informal workers as existing economic actors who provide essential environmental services.

A purely formalization-oriented approach may overlook the knowledge, networks, flexibility, and collection systems already developed by informal workers. Conversely, leaving workers entirely outside formal systems can perpetuate occupational insecurity, low incomes, exploitation, and inadequate social protection.



The literature therefore supports an inclusive integration approach, but it provides limited guidance on how such integration should be incorporated into sustainable-finance frameworks.

The present study fills this gap by treating informal waste workers as productive participants in circular value chains and incorporating employment, income, working conditions, and social inclusion into investment assessment.

2.7 Sustainable Finance and Circular Economy

The literature on sustainable finance has expanded significantly through the development of green bonds, climate finance, blended finance, impact investment, sustainability-linked finance, and environmental taxonomies (OECD, 2020; UNEP Finance Initiative, 2023).

These mechanisms have created opportunities to mobilize private and public capital toward environmental and climate objectives. Nevertheless, the review reveals a conceptual separation between sustainable-finance literature and circular-economy literature.

Circular-economy studies generally focus on what should happen to materials, while sustainable-finance studies focus on where capital should be allocated. Few frameworks explicitly establish a direct relationship between the physical flow of materials and the allocation of financial resources.

This is a significant gap. Without information about material quantities, recovery rates, market values, emissions, and social outcomes, it becomes difficult to determine which circular investments should receive priority.

The present study therefore proposes that plastic-waste quantification should become a basis for investment prioritization, thereby connecting physical resource flows with sustainable-finance decisions.

2.8 Sustainable Finance and African Cities

The literature reveals that financing circular-economy transitions presents particular challenges in African cities. Municipal governments often operate under constrained fiscal conditions, while recycling enterprises and informal operators frequently lack access to affordable credit.

Financial models developed in high-income economies may therefore have limited applicability in African contexts because they often assume stronger institutional capacity, formal enterprises, reliable data, established recycling markets, and greater municipal revenues.



African cities also have distinctive characteristics, including extensive informal employment, rapid urban growth, inadequate infrastructure, and weak integration between formal and informal waste systems. These characteristics require financing approaches that are flexible and capable of supporting small-scale and community-based circular enterprises.

The literature nevertheless contains relatively few empirically grounded frameworks that integrate municipal finance, private investment, informal-sector livelihoods, material flows, and climate objectives within an African urban context.

The present study responds to this limitation through its focus on Nairobi County.

2.9 Nairobi's Plastic Waste and Circular-Economy Evidence

The Nairobi literature provides evidence of substantial waste-generation and recovery challenges but remains fragmented across different research areas. Studies have examined plastic pollution, municipal waste management, informal recycling, environmental impacts, and circular-economy initiatives.

Available evidence indicates that Nairobi generates approximately 500 tonnes of plastic waste per day, while an estimated 70–75% is collected. However, approximately 93% of collected plastic is reported to flow toward landfill pathways (Mwai & Fujiwara, 2025).

This evidence reveals an important distinction between collection and circularity. A waste-management system may achieve relatively high collection rates while still recovering relatively little material value.

The study's empirical evidence from waste workers and circular enterprises further demonstrates that informal actors already recover and trade recyclable materials but face constraints involving finance, equipment, markets, infrastructure, and institutional recognition.

The literature therefore provides evidence of the individual components of Nairobi's circular economy but has not sufficiently connected these components into a financially oriented circular-transition framework.

2.10 Municipal Investment and the Financing Gap

The literature and empirical evidence examined in this study further reveal that Nairobi already allocates substantial public resources to waste management. The revised FY2024/25 Nairobi County budget allocated approximately KSh 2.96 billion to solid waste management (Nairobi City County Assembly, 2025).



However, the critical issue identified is not simply whether money is being spent on waste management, but what type of waste system that expenditure creates.

Investment in collection and disposal can improve immediate sanitation outcomes but may maintain a linear system. Investment in segregation, material recovery, recycling, reuse, and circular enterprises has the potential to create longer-term resource, climate, and economic benefits.

This distinction reveals an important financing gap: waste-management expenditure is not automatically equivalent to circular-economy investment.

The present study therefore proposes that financial expenditure should be assessed according to its ability to move materials upward through the waste hierarchy and generate measurable environmental, economic, climate, and social outcomes.

2.11 Critical Synthesis of the Literature

The critical comparison of the literature identifies four major gaps.

The first gap is conceptual. Circular-economy models explain how materials should remain in productive use but provide limited guidance on how financial resources should be prioritized to achieve this objective.

The second gap is financial. Sustainable-finance literature provides instruments for mobilizing capital but rarely integrates quantified waste flows, recycling potential, and material-value recovery into investment decisions.

The third gap is social. Informal waste-worker literature recognizes their contribution to resource recovery but rarely incorporates their livelihoods and working conditions into the financial evaluation of circular investments.

The fourth gap is climate-related. Waste and climate studies demonstrate the importance of emissions reduction but often evaluate technologies primarily through environmental indicators rather than simultaneously considering material circularity, finance, employment, and social inclusion.

These gaps demonstrate that the existing literature provides important individual components but lacks an integrated framework capable of answering the question:



How can financial capital be strategically allocated to transform quantified plastic waste flows into circular, climate-responsive, financially viable, and socially inclusive economic systems?

2.12 Contribution of the Present Study

The present study addresses these gaps through the Sustainable Finance for Zero-Waste Circular Economy (SF-ZWCE) framework.

The framework advances existing circular-economy models by connecting plastic-waste quantification with investment prioritization, rather than treating waste data simply as descriptive information. It further connects sustainable-finance mechanisms with specific circular interventions, including prevention, reuse, repair, segregation, recycling, and circular enterprise development.

Unlike frameworks that focus primarily on material loops, the SF-ZWCE framework incorporates climate mitigation, financial viability, employment, and livelihood transformation as core measures of investment performance.

The study therefore makes a conceptual shift from:

“How can waste be recycled?”

to:

“How can financial resources be strategically allocated to prevent waste, recover materials, reduce emissions, strengthen circular enterprises, and transform livelihoods?”

The originality of the study consequently lies in integrating material-flow analysis, sustainable finance, climate mitigation, and inclusive livelihoods within one framework designed for Nairobi County and potentially transferable to other rapidly urbanizing African cities.

This approach fills the identified literature gap by moving beyond the conventional circular-economy focus on closing material loops toward a broader model of financing and governing circular transformation.



3. Methodology

3.1 Research Design

The study adopted a mixed-methods research design combining quantitative and qualitative approaches to examine sustainable finance for a zero-waste circular economy in Nairobi County. The mixed-methods approach was appropriate because the study investigated measurable factors such as plastic-waste management, recycling, access to finance, employment, and livelihood outcomes, while also examining qualitative issues including governance, policy implementation, institutional coordination, stakeholder experiences, and barriers to circular-economy development.

The quantitative component involved a structured survey of 250 respondents, while the qualitative component involved policy analysis, institutional-document review, comparative case studies, and interpretation of stakeholder experiences. The study was guided by systems thinking, circular economy theory, and sustainable finance principles.

3.2 Study Area

The study was conducted in Nairobi County, Kenya. Nairobi was selected because of its rapid urbanization, increasing generation of solid and plastic waste, active informal waste-recovery sector, recycling enterprises, and emerging circular-economy initiatives.

According to the 2019 Kenya Population and Housing Census, Nairobi County had a total population of 4,397,073 persons (KNBS, 2019). This figure was used as the reference population for the study.

3.3 Target Population and Sample Size

The target population was the population of Nairobi County, comprising 4,397,073 persons according to the 2019 Kenya Population and Housing Census. However, because the study specifically focused on plastic solid waste, circular economy, sustainable finance, and livelihoods, the primary respondents were individuals with direct involvement in or knowledge of the waste-management and circular-economy system.



These included waste collectors, waste pickers, waste aggregators, recyclers, recycling-enterprise workers, community representatives, municipal waste-management personnel, and other relevant stakeholders.

A sample of 250 respondents was selected for the quantitative survey. The sample was considered appropriate for generating empirical evidence on waste-management practices, recycling, financing constraints, employment, livelihoods, and perceptions of sustainable-finance opportunities.

The sample size can be expressed using the Yamane formula:

$$n = \frac{1 + N(e)^2}{2N}$$

where n is the sample size, N is the target population, and e is the acceptable sampling error. Using the Nairobi County population of 4,397,073 and a sample of 250 respondents produces an implied sampling error of approximately 6.32%.

3.4 Sampling Procedure

The study employed stratified and purposive sampling. Stratification ensured representation of different categories of actors within the waste-value chain, while purposive sampling identified respondents with relevant knowledge and experience concerning plastic-waste collection, recovery, recycling, financing, and circular-economy activities.

The approach was particularly important because the study sought evidence from actors directly engaged in the waste system rather than from the general population alone.

3.5 Data Collection

Primary quantitative data were collected from the 250 respondents using a structured questionnaire. The questionnaire examined plastic-waste generation and collection, source separation, recycling and reuse, access to infrastructure and equipment, access to finance, investment constraints, employment and income, market access, climate-related outcomes, and participation in circular-economy activities.

Qualitative evidence was obtained from relevant stakeholders, policy documents, institutional reports, and comparative case studies. The qualitative component provided contextual explanations for the quantitative findings and assisted in identifying institutional and structural barriers affecting Nairobi's circular-economy transition.



3.6 Secondary Data

Secondary data were obtained from peer-reviewed academic journals, government publications, Nairobi County documents, international development reports, institutional databases, and relevant policy frameworks. Major sources included the Kenya National Bureau of Statistics, Nairobi City County, UNEP, World Bank, UN-Habitat, European Commission, and Ellen MacArthur Foundation.

The secondary evidence was used to examine trends in plastic-waste generation, collection, recovery, recycling, climate impacts, sustainable finance, employment, and circular-economy development.

3.7 Quantitative Data Analysis

Quantitative data obtained from the 250 respondents were coded and analyzed using descriptive and inferential statistics. Descriptive statistics included frequencies, percentages, means, and standard deviations.

Inferential analysis was undertaken to examine relationships between the principal study variables. Pearson's product-moment correlation coefficient (r) was used to determine the strength and direction of relationships between variables that met the assumptions for parametric analysis.

The analysis examined relationships between access to sustainable finance and recycling performance, circular-economy participation and livelihood improvement, investment in circular infrastructure and resource recovery, and access to finance and circular-enterprise development.

3.8 Correlation and Significance Testing

Pearson correlation analysis was used to determine whether statistically significant relationships existed among the key variables. Statistical significance was assessed using a two-tailed test at the 5% significance level ($\alpha=0.05$).

The decision rule was that a p-value below 0.05 ($p < 0.05$) indicated a statistically significant relationship, while a p-value equal to or greater than 0.05 ($p \geq 0.05$) indicated that the relationship was not statistically significant.



The results were reported using the correlation coefficient and corresponding p-value. For example:

Access to sustainable finance was positively and significantly associated with recycling performance ($r = [\text{actual value}]$, $p = [\text{actual value}]$).

Similarly:

Participation in circular-economy activities was significantly associated with livelihood improvement ($r = [\text{actual value}]$, $p < 0.05$).

The actual r and p -values must be calculated from the 250 completed questionnaires and should not be fabricated from the sample size.

3.9 Qualitative Data Analysis

Qualitative information was analyzed thematically. The analysis focused on sustainable-finance barriers, governance, infrastructure, informal-sector inclusion, market access, circular-enterprise development, climate mitigation, and livelihood transformation.

The qualitative findings were compared with the quantitative results to identify areas of convergence and divergence. This strengthened interpretation and enabled the study to explain both the statistical relationships and the institutional or socioeconomic factors underlying them.

3.10 Plastic-Waste Flow Analysis

Available Nairobi data were analyzed to establish patterns of plastic-waste generation, collection, segregation, recovery, recycling, and disposal. Major plastic categories were considered in assessing recovery potential and investment priorities.

The analysis used the concept of a circularity gap, referring to the difference between the quantity of plastic entering the waste-management system and the quantity successfully recovered and returned to productive use.

This analysis provided an empirical basis for identifying opportunities for investment in source separation, material-recovery facilities, recycling, reuse, and circular enterprises.

3.11 Financial and Investment Analysis



The study examined existing and potential financing mechanisms for circular-economy development. A distinction was made between conventional waste-management expenditure and investment that directly contributes to circularity.

The analysis considered public finance, green bonds, climate finance, blended finance, concessional lending, impact investment, sustainability-linked finance, producer-responsibility financing, and private-sector investment.

The objective was to determine how financial resources could be directed toward waste prevention, segregation, material recovery, recycling, reuse, circular enterprises, and climate-aligned technologies.

3.12 Livelihood and Informal-Sector Analysis

The study examined the contribution of informal waste workers to Nairobi's circular economy. The survey assessed employment, income, working conditions, access to finance, access to equipment, market opportunities, and participation in material recovery.

Informal waste workers were treated as economic actors within circular-value chains, rather than simply as beneficiaries of formalization programmes. This perspective enabled the study to examine how financial investment could simultaneously improve material recovery and strengthen livelihoods.

3.13 Comparative Case-Study Analysis

International and Nairobi-based case studies were reviewed to identify approaches to zero-waste management, recycling, resource recovery, sustainable finance, informal-sector integration, and climate mitigation.

The cases were compared in terms of financing mechanisms, institutional arrangements, technology, recycling performance, employment, social inclusion, resource recovery, and environmental outcomes. The purpose was to identify lessons that could be adapted to Nairobi while recognizing differences in economic, institutional, and infrastructural conditions.

3.14 Systems Analysis

The quantitative, qualitative, and secondary findings were integrated through a systems-thinking approach. The resulting analytical model connects plastic generation, source separation, collection, sorting, material recovery, recycling and reuse, markets, sustainable finance, climate mitigation, and livelihood transformation.



The model recognizes that these components are interdependent. For example, increased recycling capacity may have limited impact without adequate source separation, reliable material supply, markets, financing, and skilled workers.

3.15 Development of the SF-ZWCE Framework

The final stage involved synthesizing the empirical findings into the Sustainable Finance for Zero-Waste Circular Economy (SF-ZWCE) framework.

The framework integrates plastic-waste quantification, prevention, source separation, resource recovery, recycling, sustainable finance, climate mitigation, circular-enterprise development, employment, and livelihood transformation.

The framework advances conventional circular-economy approaches by explicitly linking material flows to financial investment and social outcomes. It therefore provides a basis for determining not only how plastic waste can be recovered but also where investment should be directed and how the resulting environmental, financial, climate, and livelihood outcomes should be assessed.

3.16 Validity, Reliability and Triangulation

The validity and reliability of the study were strengthened through the use of multiple data sources and methodological approaches. Evidence from the 250 respondents was triangulated with policy documents, institutional reports, waste-flow statistics, academic literature, and comparative case studies.

The mixed-methods approach enabled the study to compare statistical evidence with qualitative experiences and secondary information, thereby improving the credibility and contextual interpretation of the findings.

3.17 Ethical Considerations

Participation in the study was voluntary, and respondents were informed about the purpose of the research. Confidentiality and anonymity were maintained throughout data collection, analysis, and reporting.

Particular attention was given to informal waste workers because information relating to income, employment conditions, and financial circumstances can be sensitive. The study therefore emphasized their contribution to resource recovery while recognizing the socioeconomic challenges associated with informal employment.



3.18 Methodological Contribution

The methodology combines mixed-methods research, a 250-respondent primary survey, correlation and p-value analysis, plastic-waste-flow assessment, financial analysis, qualitative evidence, policy analysis, comparative case studies, and systems modelling.

This integrated approach provides an empirical basis for examining relationships between sustainable finance, recycling, resource recovery, climate mitigation, employment, and livelihood outcomes. It also supports the development of the SF-ZWCE framework as an evidence-based model for financing and implementing a zero-waste circular economy in Nairobi County.

FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study on sustainable finance for a Zero-Waste Circular Economy (ZWCE) in Nairobi County. The findings are based on the mixed-methods approach adopted in the study, including primary data obtained from 250 respondents and evidence from academic literature, policy documents, government publications, institutional reports, and international case studies. The discussion focuses on plastic solid-waste management, sustainable finance, circular-economy practices, climate-change mitigation, employment and livelihoods, informal-sector inclusion, governance, and advocacy.

The findings demonstrate that Nairobi's waste challenge is not simply a problem of collection and disposal. It is a systemic challenge involving production and consumption patterns, inadequate infrastructure, limited financing, weak material markets, institutional fragmentation, and socioeconomic exclusion. The results therefore support an integrated approach in which sustainable finance is used to accelerate waste prevention, resource recovery, climate mitigation, enterprise development, and inclusive livelihoods.

4.2 Plastic Solid-Waste Management in Nairobi

The findings indicate that plastic solid waste remains a significant environmental and economic challenge in Nairobi County. Population growth, urbanization, changing consumption patterns, and increasing use of packaged goods have increased pressure on the existing waste-management system. This is consistent with global evidence showing that municipal solid-waste generation is increasing rapidly, particularly in low- and middle-income countries (Kaza et al., 2018).

The study further finds that the challenge is not only the volume of plastic generated but also the limited proportion that is separated, recovered, reused, or recycled. When recyclable plastics are



mixed with organic and other waste, contamination increases and the economic value of recovered materials decreases. Consequently, Nairobi loses both environmental benefits and potential economic value.

The findings support the argument that plastic waste should increasingly be understood as a secondary resource rather than simply as waste. This interpretation is consistent with circular-economy theory, which emphasizes retaining products and materials in productive use for as long as possible (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017).

4.3 Waste Prevention and Source Separation

The findings demonstrate that waste prevention represents the most effective point of intervention in the waste hierarchy. Preventing unnecessary plastic consumption reduces the demand for virgin materials and avoids environmental impacts associated with production, transportation, and disposal.

Source separation was also identified as a critical condition for successful recycling. Separation at household, institutional, commercial, and market levels improves material quality and reduces contamination. This finding is consistent with zero-waste approaches that prioritize prevention and recovery rather than disposal (Zaman, 2015).

For Nairobi County, this means that investment in recycling infrastructure should be accompanied by investment in source separation. Constructing recycling facilities without establishing reliable supplies of segregated materials could result in underutilized infrastructure and financial losses.

4.4 Sustainable Finance and Circular-Economy Investment

The findings indicate that inadequate access to finance remains a major constraint to circular-economy development. Small and medium-sized circular enterprises frequently lack collateral, formal financial histories, predictable cash flows, and the administrative capacity required to access conventional lending.



The findings further reveal a potential financial-exclusion risk within sustainable finance. Financial institutions may prefer large formal enterprises because they are perceived as less risky. Consequently, informal recyclers, community-based organizations, youth enterprises, women-led enterprises, and micro-enterprises may remain excluded despite their contribution to resource recovery.

The study therefore finds that Nairobi requires diversified financial instruments, including blended finance, concessional loans, credit guarantees, equipment leasing, revolving funds, impact investment, and targeted grants. Blended finance is particularly relevant because public and development capital can reduce risks and mobilize private investment into sectors perceived as financially uncertain.

This finding supports the broader sustainable-finance literature, which emphasizes the importance of mobilizing private capital toward environmental and social objectives while managing investment risks (OECD, 2020).

4.5 Sustainable Finance and Climate Mitigation

The findings demonstrate that circular-economy investment can contribute directly and indirectly to climate-change mitigation. Waste prevention reduces emissions associated with resource extraction and manufacturing, while recycling reduces demand for virgin materials. Similarly, diverting organic waste from disposal through composting and anaerobic digestion can reduce methane emissions.

The climate benefits of circularity therefore extend beyond the waste sector itself. Material efficiency and recycling can reduce emissions throughout the product life cycle. This finding is consistent with international evidence demonstrating the strong relationship between resource efficiency, circularity, and climate mitigation (Intergovernmental Panel on Climate Change [IPCC], 2022).

The study therefore recommends that circular-finance projects in Nairobi incorporate measurable climate indicators, including greenhouse-gas emissions avoided, waste diverted from disposal, materials recovered, and virgin materials displaced.

4.6 Informal Waste Workers and Livelihood Transformation

The findings establish that informal waste workers are important participants in Nairobi's existing circular economy. Their collection, sorting, aggregation, and trading activities contribute to resource recovery and provide income-generating opportunities.



However, the findings also identify major socioeconomic challenges, including insecure employment, inadequate occupational health and safety, limited access to finance, unstable markets, and weak representation in formal decision-making.

The study finds that formalization presents both opportunities and risks. A regulatory approach based mainly on licensing and enforcement could exclude vulnerable workers. In contrast, an inclusive approach that provides legal recognition, training, protective equipment, access to finance, social protection, and participation in municipal contracts can improve both livelihoods and recycling performance.

This finding supports the literature demonstrating that informal waste workers make important contributions to recycling in developing countries and should be integrated into rather than displaced by formal waste-management systems (Wilson et al., 2006; Dias, 2016).

4.7 Employment and Local Economic Development

The findings indicate that circular-economy activities can create employment across collection, sorting, repair, reuse, recycling, processing, logistics, and marketing. This presents an important opportunity for Nairobi because circular activities can contribute to employment creation while simultaneously addressing environmental problems.

However, the study finds that the number of jobs alone is not an adequate measure of success. Circular-economy employment should also be assessed in terms of income security, occupational safety, skills development, social protection, gender inclusion, and career progression.

Consequently, sustainable-finance projects should incorporate decent-work indicators alongside environmental and financial indicators.

4.8 Waste-to-Energy and Investment Trade-Offs

The findings identify significant environmental, financial, and circularity trade-offs associated with Waste-to-Energy incineration. Although incineration can reduce the physical volume of waste and generate energy, it generally requires substantial capital investment, reliable waste supply, advanced emission-control systems, and long-term operational commitments.

The study identifies technological lock-in as a particularly important risk. Long-term contractual commitments requiring continuous quantities of waste may create incentives to maintain waste generation and disposal volumes, potentially conflicting with waste-prevention and recycling objectives.



This finding is consistent with concerns raised in the circular-economy literature regarding technologies that recover energy while destroying potentially recoverable materials. Therefore, the study recommends that any WtE proposal be subjected to full life-cycle assessment, financial-risk analysis, climate assessment, and circularity assessment before receiving green or sustainable finance.

4.9 Governance and Political-Economy Constraints

The findings demonstrate that Nairobi's circular-economy transition is influenced by political, institutional, and economic interests. Waste management involves county authorities, national government institutions, private contractors, producers, recyclers, waste workers, communities, and investors.

These actors do not necessarily have identical interests. For example, investments that reduce waste generation could affect established waste-disposal revenue structures. Similarly, fragmented institutional responsibilities can create uncertainty concerning regulation, financing, enforcement, and accountability.

The study therefore finds that financial reform must be accompanied by governance reform. Nairobi County should strengthen coordination among relevant government institutions and establish mechanisms for stakeholder participation, transparency, accountability, and performance monitoring.

4.10 Advocacy for a Zero-Waste Circular Economy

The findings demonstrate that advocacy is an essential component of the transition to a Zero-Waste Circular Economy. Technical investment and financial mechanisms alone are unlikely to achieve systemic change if policymakers, producers, financial institutions, communities, and waste workers do not understand or support the transition.

At the county level, advocacy should promote public awareness of waste prevention, household source separation, responsible consumption, reuse, and recycling. Community-based organizations, schools, universities, faith-based organizations, civil-society organizations, and media institutions can support behavioral change by communicating the environmental and economic value of recovered materials.

Policy advocacy should focus on strengthening extended producer responsibility, improving enforcement of waste-separation requirements, supporting circular enterprises, protecting waste-worker livelihoods, and ensuring that public investment is consistent with zero-waste objectives.



Financial-sector advocacy should encourage banks, pension funds, development-finance institutions, and impact investors to recognize circular enterprises as legitimate investment opportunities. Advocacy should also promote financing criteria that prevent green finance from supporting projects that undermine waste prevention or material recovery.

The findings therefore suggest that advocacy should operate at three interconnected levels: community advocacy, policy advocacy, and financial advocacy. Community advocacy can change behavior; policy advocacy can improve institutional frameworks; and financial advocacy can redirect capital toward sustainable investments.

4.11 Data and Monitoring Constraints

The findings reveal limitations in the availability of reliable and disaggregated waste-flow data. Information concerning plastic generation, collection, recovery, recycling, disposal, financial investment, and employment remains fragmented.

The survey of 250 respondents provides important primary evidence, but the study recognizes that the sample does not represent every resident or waste-sector actor in Nairobi. Self-reported responses may also be affected by recall and response bias.

The study therefore recommends the development of a Nairobi Circular Economy Data and Measurement, Reporting and Verification system. Such a system should integrate administrative records, physical waste audits, material-flow analysis, geospatial information, recycling records, financial data, and employment statistics.

4.12 Correlation Findings

The study employed Pearson's correlation analysis to examine relationships among sustainable finance, circular-economy participation, recycling, resource recovery, and livelihood outcomes. Statistical significance was assessed at the 5% level.

The final results should report the correlation coefficient and corresponding p-value generated from the 250 completed questionnaires. For example:

Access to sustainable finance was positively associated with recycling performance ($r = [\text{insert actual value}]$, $p = [\text{insert actual value}]$).

Where $p < .05$, the relationship should be interpreted as statistically significant. Where $p \geq .05$, the relationship should be interpreted as statistically non-significant.



The actual correlation coefficients and p-values should be calculated from the study dataset and not estimated. This is particularly important for maintaining the statistical integrity of the findings.

4.13 Contribution of the Study

The findings indicate that the principal contribution of this study is the integration of four dimensions that are often addressed separately: plastic-waste management, sustainable finance, climate mitigation, and inclusive livelihoods.

Existing circular-economy frameworks generally emphasize resource efficiency and material loops, while sustainable-finance frameworks frequently focus on investment classification, risk, and environmental performance. The present study advances these approaches by explicitly linking material flows to financing mechanisms, climate outcomes, employment, and social inclusion.

The SF-ZWCE framework therefore provides a more comprehensive basis for assessing circular-economy investments in Nairobi and other African cities.

CONCLUSIONS, ADVOCACY AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions, advocacy implications, recommendations, limitations, and areas for future research arising from the study. The conclusions are based on the empirical findings from 250 respondents and the supporting qualitative and secondary evidence.

5.2 Conclusions

The study concludes that Nairobi County has significant potential to transition toward a Zero-Waste Circular Economy, but this transition requires a fundamental shift from collection and disposal toward prevention, resource recovery, circular production, and sustainable consumption.

The findings demonstrate that plastic waste represents both an environmental challenge and an economic opportunity. When appropriately separated and recovered, plastic can become a secondary raw material that supports recycling enterprises, employment, and local value chains.

The study further concludes that sustainable finance is a critical enabling mechanism. However, conventional finance is insufficient because many circular enterprises and informal waste workers



do not satisfy traditional lending requirements. Sustainable-finance systems must therefore include financial instruments that address the specific risks and financing needs of small and informal actors.

The study also concludes that circular-economy interventions should be evaluated according to their environmental, climate, financial, and social outcomes. Investments that reduce waste but create financial exclusion or undermine livelihoods should not automatically be regarded as sustainable.

The findings further demonstrate that waste prevention, reuse, repair, source separation, recycling, composting, anaerobic digestion, and inclusive resource recovery should receive investment priority over disposal-oriented approaches.

5.3 Advocacy Implications

The study concludes that advocacy should be institutionalized as part of Nairobi's circular-economy transition rather than treated as a supplementary activity.

Community advocacy should promote waste prevention, source separation, reuse, responsible consumption, and recycling. Public education should communicate the economic value of recovered materials and demonstrate the practical benefits of household and institutional waste separation.

Policy advocacy should promote stronger implementation of extended producer responsibility, improved waste-sector governance, inclusive integration of informal waste workers, transparent waste contracts, and investment decisions consistent with the waste hierarchy.

Financial advocacy should encourage financial institutions and investors to recognize circular enterprises as viable investment opportunities. It should also promote green-finance criteria that prioritize measurable material recovery, emissions reduction, employment creation, and social inclusion.

5.4 Nairobi Circular Economy Finance Facility

Nairobi City County should establish a Circular Economy Finance Facility to mobilize and coordinate capital for circular-economy investments.



The facility should combine county resources with national climate-finance mechanisms, development-finance institutions, commercial banks, producer-responsibility organizations, private investors, and impact-investment funds.

It should provide blended finance, concessional loans, credit guarantees, equipment leasing, working-capital facilities, and targeted grants. Funding decisions should prioritize projects demonstrating measurable improvements in waste prevention, recycling, climate mitigation, employment, and livelihoods.

5.5 Strengthening Extended Producer Responsibility

The implementation of Extended Producer Responsibility should be strengthened as a major financing mechanism for plastic-waste management.

Producer contributions should support collection, source separation, recycling infrastructure, public awareness, data systems, and inclusion of waste workers. Transparency should be required to demonstrate the amount of financing mobilized and the environmental and social outcomes achieved.

5.6 Inclusive Formalization of Waste Workers

Nairobi County should implement an inclusive waste-worker integration programme. Waste workers should have access to registration, cooperative development, occupational safety, training, social protection, financial services, and appropriate collection and recovery contracts.

Formalization should be designed to expand opportunities rather than eliminate existing livelihoods. Waste-worker cooperatives should be linked to Nairobi City County, recycling companies, producer-responsibility organizations, and financial institutions.

5.7 Investment in Decentralized Circular Infrastructure

The findings support investment in decentralized material-recovery facilities located close to major waste-generation areas. These facilities should support source separation, sorting, aggregation, and preparation of materials for recycling.

Investment should also support repair centers, reuse systems, composting facilities, anaerobic-digestion facilities, and community-based resource-recovery enterprises.



5.8 Sustainable-Finance Investment Criteria

Financial institutions should develop circular-economy investment criteria that assess environmental, climate, financial, and social outcomes.

A project should be considered sustainable where it demonstrates measurable contributions to waste prevention, material recovery, greenhouse-gas reduction, employment, livelihood improvement, and resource efficiency.

Projects that create significant circularity risks should undergo enhanced due diligence before receiving green financing.

5.9 Governance Reform

Nairobi City County should establish a multi-stakeholder circular-economy governance platform involving county government, national agencies, producers, financial institutions, recycling enterprises, waste-worker organizations, communities, universities, and civil-society organizations.

The platform should coordinate policy implementation, investment planning, data collection, stakeholder participation, monitoring, and accountability.

The county should also strengthen transparency in waste-management procurement and contractual arrangements to reduce opportunities for conflicts of interest and ensure that public investment supports long-term circularity objectives.

5.10 Circular Economy Data and Monitoring

Nairobi City County should establish a centralized Circular Economy Data and Measurement, Reporting and Verification platform.

The platform should monitor plastic-waste generation, collection, recovery, recycling, disposal, financial investment, employment, gender participation, greenhouse-gas emissions, and livelihood outcomes.

Reliable data will enable policymakers and investors to assess performance and direct resources toward interventions that demonstrate measurable results.



5.11 Partnerships

Implementation should involve partnerships between Nairobi City County, national government agencies, financial institutions, recycling enterprises, producer-responsibility organizations, waste-worker cooperatives, universities, research institutions, development partners, civil-society organizations, and communities.

Universities and research institutions can provide technical expertise in material-flow analysis, life-cycle assessment, climate accounting, financial modelling, and impact evaluation.

5.12 Implications for African Cities

Although the study focuses on Nairobi City County, its findings have broader implications for rapidly urbanizing African cities. Many African cities face similar challenges involving rapid waste generation, limited infrastructure, informal employment, restricted municipal finances, and inadequate recycling markets.

The SF-ZWCE framework provides a potential model for integrating sustainable finance with circularity, climate action, and livelihood development. However, implementation should be adapted to local institutional, economic, and social conditions.

5.13 Limitations of the Study

The study has several limitations. First, the primary survey was limited to 250 respondents and therefore cannot represent every resident or waste-sector actor in Nairobi County. Second, some information was self-reported and may therefore be subject to recall or response bias.

Third, reliable waste-flow and financial data remain limited and fragmented. Fourth, some of the comparative evidence is derived from international experiences that may not be directly transferable to Nairobi because of differences in institutional capacity, infrastructure, markets, and economic conditions.

The findings should therefore be interpreted within the scope of these limitations.

5.14 Recommendations for Future Research

Future research should undertake detailed plastic material-flow assessments across Nairobi's sub-counties and major waste-generating sectors. Longitudinal research should assess the financial and livelihood impacts of circular-economy interventions over time.



Further research should compare the life-cycle environmental and financial performance of recycling, reuse, composting, anaerobic digestion, and Waste-to-Energy systems under Nairobi-specific conditions.

Research should also investigate the development of an African Sustainable Finance Taxonomy for Circular Economy Investments, incorporating environmental, social, climate, and financial criteria appropriate to African cities.

5.15 Overall Conclusion

The study concludes that sustainable finance can play a transformative role in Nairobi's transition toward a Zero-Waste Circular Economy when financial resources are deliberately aligned with waste prevention, resource recovery, climate mitigation, employment, and inclusive livelihoods.

The proposed Sustainable Finance for Zero-Waste Circular Economy framework advances existing approaches by bringing together plastic-waste quantification, circular material flows, sustainable-finance instruments, climate outcomes, and livelihood transformation.

The study finds that the most appropriate pathway for Nairobi is not continued dependence on disposal but a progressive hierarchy of prevention, reuse, repair, source separation, recycling, biological recovery, and responsible residual management.

The transition will require not only capital but also governance reform, advocacy, reliable data, market development, producer responsibility, and meaningful participation of informal waste workers.

Nairobi County therefore has an opportunity to reposition waste as a source of economic value, employment, climate action, and social transformation. A finance-enabled and inclusive circular-economy strategy could strengthen Nairobi's environmental resilience while providing a replicable model for other African cities.

References

- Dias, S. M. (2016). Waste pickers and cities. *Environment and Urbanization*, 28(2), 375–390. <https://doi.org/10.1177/0956247816657302>
- Ellen MacArthur Foundation. (2013). *Towards the circular economy: Economic and business rationale for an accelerated transition*. Ellen MacArthur Foundation.



Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy—A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change*. Cambridge University Press. <https://doi.org/10.1017/9781009157926>

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. <https://doi.org/10.1126/science.1260352>

Kaza, S., Yao, L. C., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. World Bank. <https://doi.org/10.1596/978-1-4648-1329-0>

Organisation for Economic Co-operation and Development. (2020). *OECD business and finance policy papers: Sustainable finance definitions and taxonomies*. OECD Publishing.

United Nations Environment Programme. (2021). *From pollution to solution: A global assessment of marine litter and plastic pollution*. United Nations Environment Programme.

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International*, 30(4), 797–808. <https://doi.org/10.1016/j.habitatint.2005.09.005>

Zaman, A. U. (2015). A comprehensive review of the development of zero waste management: Lessons learned and guidelines. *Journal of Cleaner Production*, 91, 12–25. <https://doi.org/10.1016/j.jclepro.2014.12.013>