

Towards Zero Construction Waste in Coastal Kenya: Exploring Circular Solutions through Policy and Regulatory Pathways

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Abstract

Rapid urbanization, human settlement and industrialization along the coast of Kenya have led to substantial growth in the construction and infrastructure sectors. The resulting intensive resource consumption and extensive waste generation have significantly strained local terrestrial and marine ecosystems. Key waste streams include construction debris, demolition waste, wastewater, plastic waste, dust, chemical residue, and hazardous materials, which pose environmental and health risks and contribute greatly to the current marine litter menace. This paper adopts a life cycle perspective, analysing the entire production-consumption cycle of construction activities through comprehensive value-chain analysis. It applies a mixed methodological approach, entailing a review of existing international, regional, national, and sub-national Sustainable Consumption and Production (SCP) policy frameworks to identify and address critical gaps. Additionally, stakeholder consultations and qualitative assessments are used to identify critical regulatory gaps and inform recommendations. Key results indicate significant gaps in the adequacy of existing policies, policy implementation and regulatory frameworks concerning construction waste management. Recommendations include enhancing recyclability, using environmentally friendly materials, and establishing rigorous waste management strategies. Crucially, the study proposes the development of specific Construction Waste Management Regulations aimed at achieving zero construction waste through an integrated Reduce, Reuse, Recycle/Restore, and Return (RRRR) approach. The paper offers replicable models for sustainable urban development within the broader Western Indian Ocean region.

Keywords

Sustainable Consumption and Production (SCP), Construction Waste, Construction Value Chain, Life Cycle Analysis, Reduce, Reuse, Recycle/Restore, and Return (RRRR)

1. Introduction

Rapid urbanization, human settlement and industrialization along the coast of Kenya have led to substantial growth in the construction and infrastructure sectors. Globally, it is estimated that construction and demolition generate approximately 10,000 metric tons per year, with the larger fraction being concrete, bricks, ceramics, and glass (Rodriguez-Morales, Burciaga-Diaz, Gomez-Zamorano, & Escalante-Garcia, 2024). According to a 2014 report by the Intergovernmental Panel on Climate Change (IPCC), the building and construction sector accounts for 30% of global energy use and a commensurate level of greenhouse gas (GHG) emissions (IPCC, 2022). The resulting intensive resource consumption and extensive waste generation have significantly strained local terrestrial and marine ecosystems (NCA, 2023).

In Kenya, the rapid coastal urban (and largely unregulated) growth and expansion is expected to contribute greatly to burgeoning investments in the construction and infrastructure sectors within the six counties of coastal Kenya, also referred to as *Jumuia ya Kaunti za Pwani* (JKP) (NCA, 2020). These are the counties of Mombasa, Kwale, Kilifi, Tana River, Lamu and Taita Taveta, which were formerly known as the Coast Province (Map 1).

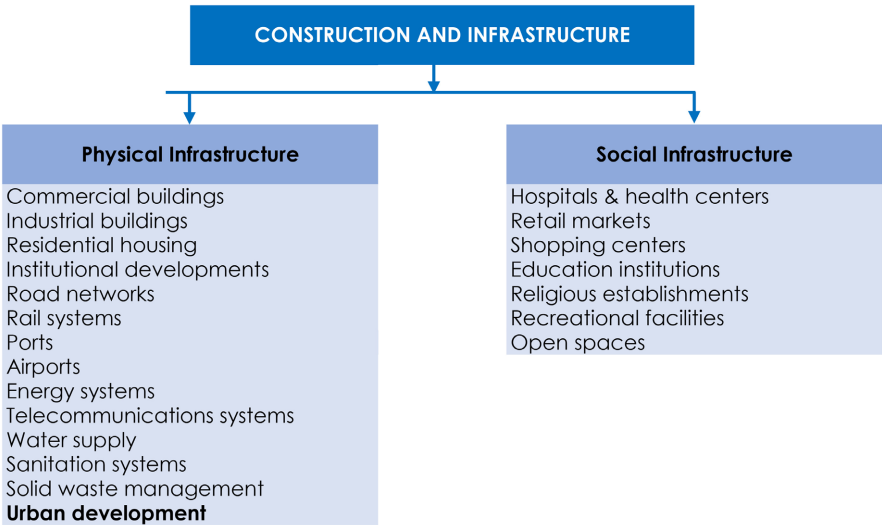
While a variety of construction and infrastructure development projects are distributed along the rural and urban coastal stretch of the JKP region, the *urban development* process takes a huge chunk of both ongoing and anticipated construction and infrastructural development. This sector includes development of *physical infrastructure* (commercial and industrial buildings, residential housing, institutional developments, road networks, rail systems, ports, airports, energy and telecommunications systems, water supply and sanitation systems, and solid waste management systems) as well as *social infrastructure* (hospitals and health centres, retail markets and shopping centres, education institutions, religious establishments, recreational facilities and open spaces), as illustrated in Figure 1 below.

Construction and infrastructure developments are labour-intensive and have high socio-economic impact. They are *large consumers of natural resources* including land, stones and blocks, asbestos, sand, ballast, murram, timber and wood products, water and energy (NCA, 2024). These activities also *generate enormous amounts of wastes*, including waste water, dust and fumes, oils and chemical residues, debris, waste wood, litter, plastic wastes, soil and rocks, and construction and demolition debris, among others.



Note: Source: <https://goblue.co.ke/>.

Map 1. The JKP Economic Bloc.



Note: Source: Author (2025).

Figure 1. Summary of construction and infrastructure projects in the JKP region.

Construction and demolition waste has numerous environmental impacts, including land degradation, landfill depletion, carbon and greenhouse gas emissions, water pollution, high energy consumption and resource depletion (The UN Secretary-General Advisory on Zero Waste, 2024). In the delicate coastal ecosystems, it is important to pay attention to the efficient management of construction and demolition waste, as it plays a crucial role in ensuring sustainable development while at the same time preserving the marine and coastal ecosys-

tems.

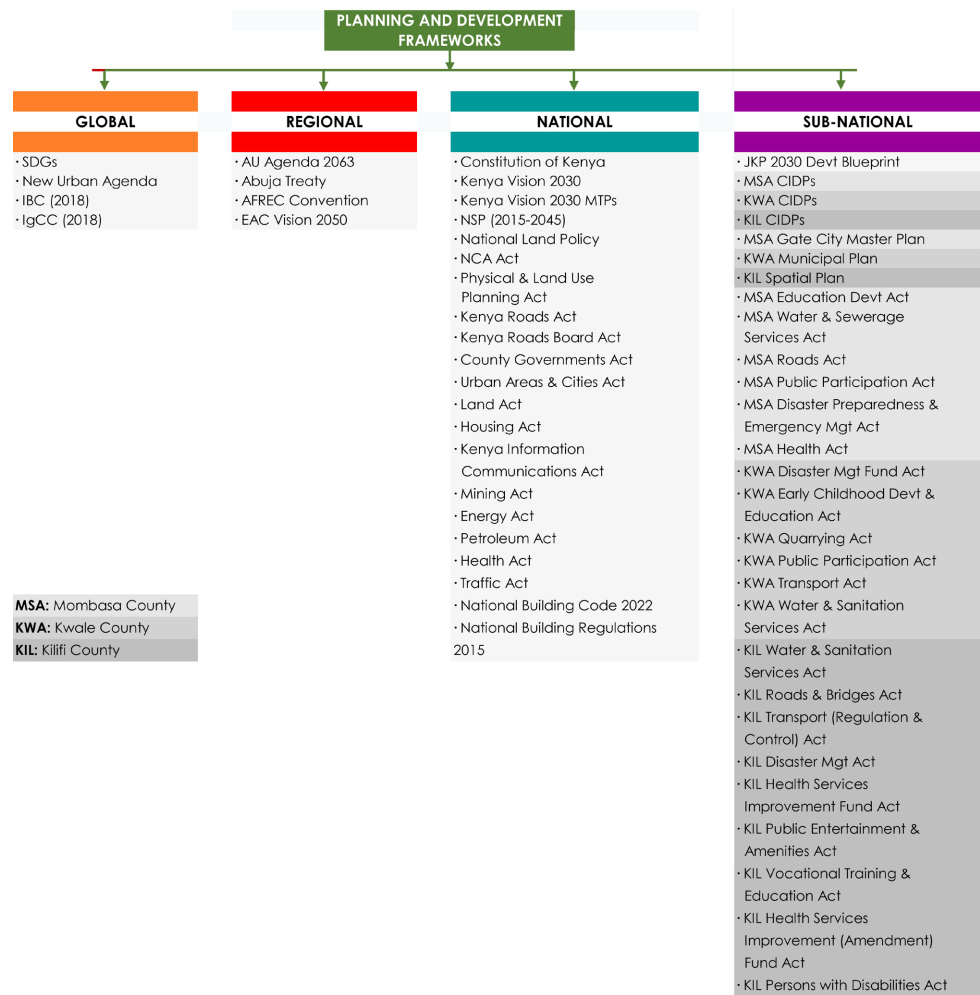
This paper examines the management of construction and demolition waste (CDW) with specific focus on the coast of Kenya. The first section contextualizes the construction and infrastructure in the Kenyan coast, highlighting the proposed regional, national and sub-national development agendas driving the same. The second section highlights the methodology utilised in the study for data collection and data analysis. The third section discusses sustainable construction and production (SCP) with a focus on the management of CDW along the entire construction value chain. It highlights waste generated, waste management practices that promote waste prevention, minimization and recovery strategies. The fourth section discusses the findings from a review of policy and regulatory frameworks governing the management of construction waste, site visits and engagement with key stakeholders. Proposals for reforms are tabled in the fifth section.

1.1. Construction and Infrastructure along Kenya's Coast

Kenya's coastal region exhibits the current global trends of rapid and unprecedented urbanisation. This rapid urban (and largely unregulated) growth and expansion is expected to contribute greatly to burgeoning investments in the construction and infrastructure sectors within the six counties. While a variety of construction and infrastructure development projects are distributed along the rural and urban coastal stretch of the JKP region, the *urban development* process takes a huge chunk of both ongoing and anticipated construction and infrastructural development. The legal and policy frameworks governing the identification of development priorities are presented in **Figure 2** below. Moreover, the coastal counties continue to actively define and refine their local development priorities through their CIDPs, and localised plans such as the Mombasa Gate City Master Plan, the Kwale Municipal Plan (2023-2032) and the Kilifi County Spatial Plan (2021-2030).

According to the Intergovernmental Panel on Climate Change (IPCC), the building and construction sector accounts for 31% of global energy use and 21% of GHG emissions in 2019. The report models different global scenarios for existing buildings and buildings yet to be built and projects a net-zero GHG emissions in 2050 if policy packages, which combine ambitious sufficiency, efficiency, and eco-friendly measures, are effectively implemented (IPCC, 2022). The UN-Habitat proposes interventions to make construction more environmentally friendly. A 2015 UN-Habitat report proposes interventions *inter alia*: the use of energy-efficient sources, use of recyclable material, waste management, use of renewable energy and resilient and low-carbon infrastructure (UN-Habitat, 2015).

The Kenya Building Research Centre (KBRC) has conducted research to build the knowledge base on a sustainable built environment in Kenya. In 2019, the Centre published reports that mapped out the building materials in the coastal region. In Kilifi County, the report reveals that the common building materials



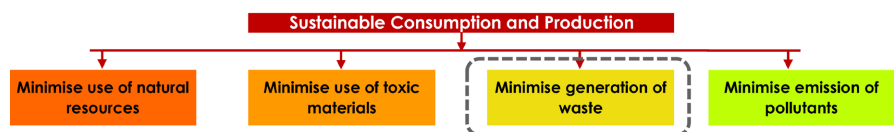
Note: Source: Author (2024).

Figure 2. Summary of planning and development frameworks sampled.

included: ballast, washed sand, palm trees (*makuti*), casuarina trees, brick, *ma-zera* stone, coral blocks, hard core stones and to a minimal extent, interlocking blocks. The report notes that traditional building materials such as *makuti* and coral stones are being replaced by modern materials such as precast products and bricks. The report also addresses and encourages the use of alternative technologies due to the threat of depletion of locally available natural materials. A similar study in Kwale County reveals that common building materials include: pit sand, river sand, white sand, coral stone, *makuti*, hard core and ballast (KBRC, 2019). In Mombasa County, the commonly used materials for building include: balcony balustrades, bricks, building stones, cabro, cement, chips blocks, cinder blocks, coral reef stones, glass, limestone, *makuti*, metal windows, ter-razzo chips and doors. In Mombasa specifically, the report observes that the traditional and modern building materials used within the region have shaped the local architecture of the area and the unique identity for the area (KBRC, 2019).

1.2. Sustainable Consumption and Production (SCP) along the Construction Value Chain

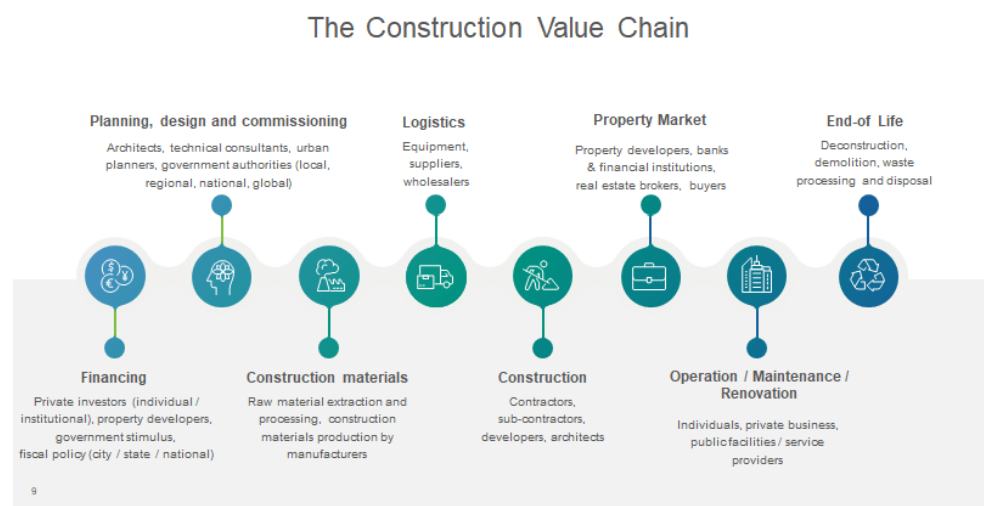
The research project that informed this paper builds on knowledge pertaining to transitions to sustainable consumption and production (SCP) patterns in construction and infrastructure, with a focus on policy and governance. In this regard, it adopted the definition of SCP as “the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations” (UNEP, 2010), as illustrated in **Figure 3** below.



Note: Source: Author (2024) as adapted from UNEP (2010).

Figure 3. Elements of SCP, with a focus on construction waste management.

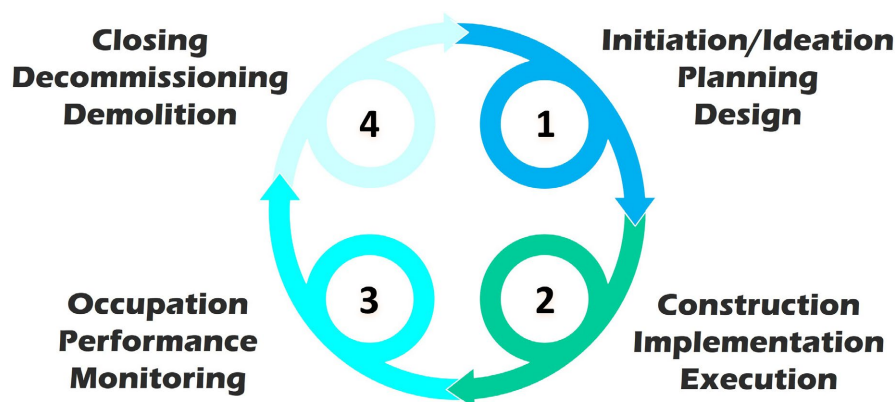
The World Business Council for Sustainable Development (WBCSD) defines a *value chain* as “the full cycle of a product or process, including material sourcing, production, consumption and disposal/recycling processes” (University of Cambridge Institute for Sustainability Leadership, 2024). The International Resource Panel and UNEP describe the construction sequence as Planning, Design, Commissioning, Construction, Maintenance, Refurbishment and End-of-Life (One Planet Network, 2020). The construction value chain, incorporating this sequence and integrating key actors and business processes, is illustrated in **Figure 4** below.



Note: Source: One Planet Network (2020).

Figure 4. Stages of the construction value chain.

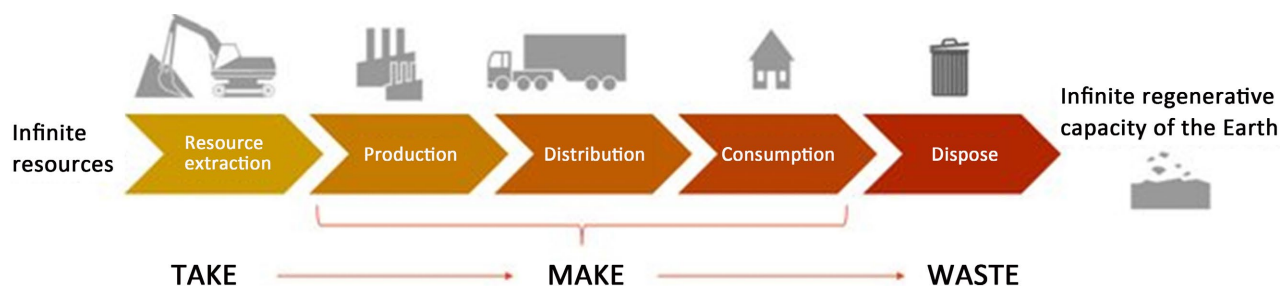
The research takes on the “life cycle approach/perspective” (UNEP, 2010) in its analysis of the production-consumption paradigm in the sector. The application of life cycle thinking “expands the traditional focus on the production site and manufacturing processes and incorporates various aspects over a product’s entire life cycle from cradle to cradle (i.e., from the extraction of resources, through the manufacture and use of the product, to the final processing of the disposed product)” (UNEP, 2010). This research entails undertaking a value chain analysis throughout the whole life cycle of the construction and infrastructure projects (Figure 5) in the JKP region.



Note: Source Author (2025).

Figure 5. Construction and infrastructure project life cycle.

Solid waste can be categorised into Municipal Waste (household waste) and Non-Municipal/Special Waste (which includes industrial waste, agricultural waste, *construction and demolition waste* (CDW), hazardous waste, medical waste and electronic waste (e-waste)) (UNEP, 2024). Waste management methods can be illustrated using the traditional linear economy model (take-make-waste) in Figure 6, or the circular economy model.



Note: Source: <https://www.researchgate.net/publication/323809440>.

Figure 6. The linear economy—the “take, make and waste” approach.

The circular economy model is a model of sustainable consumption and production (SCP) that aims to conserve natural resources and minimise waste by keeping materials in use for as long as possible. One of its configurations is the Reduce,

Reuse, Recycle/Restore, and Return (RRRR) model (Figure 7).



Note: Source: <https://www.txurbansawmill.com/articles/circulareconomy>.

Figure 7. Circular economy production model.

2. Research Methods

In its investigation on how to integrate sustainable consumption and production (SCP) in Kenya's coastal cities and urban areas, the research applied a mixed methodological approach. Firstly, a detailed review of existing international, regional, national, and sub-national SCP policy frameworks was conducted to identify and address critical gaps in the management of construction and demolition waste (CDW). Relevant case studies from both local and international contexts were reviewed to benchmark and validate SCP practices. This process provided comparative insights and highlighted transferable innovations applicable to the JKP context.

Stakeholder consultations and qualitative assessments were used to further identify critical regulatory gaps and inform recommendations. These were focused on three key locations, namely *Mombasa City in Mombasa County*, *Ukunda/Diani in Kwale County*, and *Malindi Municipality in Kilifi County*, using the following criteria:

- *Mombasa City* has the highest urban population in the JKP region and significant levels of pressures from urbanization and economic activities. It is also an economic hub for neighboring counties and characterizes the challenges of sustainable consumption and production in a rapidly urbanizing coastal city.
- *Ukunda/Diani Municipality* in Kwale County is selected due to its increasing

population and urbanization pressures against its pristine natural features that make it a major tourism hotspot. In this regard, the study aims to identify the conflicts between spatial expansion of town centers for tourism.

- *Malindi Municipality* in Kilifi County is selected due to its place as a major tourism hotspot, increasing commercial activities and urban sprawl and informal settlements. Malindi Municipality has fine, long and expansive ocean front beaches that are pristine.

The key stakeholders engaged include the Mombasa County Government, Kilifi County Government, Kwale County Government, *Jumuiya ya Kaunti za Pwani (JKP)* and various National Government and State agencies (such as the Kenya Marine and Fisheries Research Institute—KMFRI, the National Construction Authority—NCA, Kenya Forest Service—KFS and the National Environment Management Authority—NEMA), private sector, civil society and local communities (such as Community Based Environmental Conservation—COBEC, Oceans Alive Trust and South Coast Residents Association—SCRA), technical experts and academic institutions (University of Nairobi—UoN, Jomo Kenyatta University of Agriculture and Technology—JKUAT and Kenyatta University—KU), among others.

Policy makers both at the National Government and County Government levels were actively through targeted/key informant interviews, focused group discussions (FGDs), cross-sectoral forums (such as the Annual Kenya Institute of Planners (KIP) Convention in November 2021), and dissemination forums (such as the University of Nairobi's 1st International Blue Circular Economy Conference in October 2025), and other engagements. The FGD sessions facilitated a collective reflection on existing Sustainable Consumption and Production (SCP) practices, challenges, and policy integration gaps. The FGDs served as a platform for participatory validation of observed trends and identification of practical entry points for intervention.

Detailed individual interviews were held with National Government officials stationed in the sampled counties. These interviews captured institutional perspectives, implementation bottlenecks, and coordination dynamics between national and county levels. The one-on-one format ensured confidentiality and depth of insight on policy, regulatory, and resource alignment issues.

The team engaged informally with local community members in markets, beaches, and public spaces. These interactions offered grassroots-level perspectives, surfacing lived experiences and cultural dimensions that may not emerge in formal interviews.

Direct observational research was carried out focusing on environmental and waste management systems. Key aspects observed included: existing environmental management practices, levels of food loss and inefficiencies along the value chain, waste sorting practices at the source, physical and operational conditions of dumpsites and landfill areas. These observations offered ground-truthing of both documented practices and stakeholder claims.

Secondary data, including national policy documents, international guide-

lines, and published scientific literature, were systematically reviewed to extract and compare best practices. This informed both triangulation and validation of field findings.

A data validation process to ensure the accuracy and reliability of proposed interventions and recommendations arising from the initial field studies was undertaken from March-May 2025 by seeking further engagement with key informants in the JKP region.

3. Key Findings

The regulatory framework relating to waste management promotes waste prevention, minimization and recovery strategies, as opposed to final disposal (Jorge-Ortiz, Braulio-Gonzalo, & Bovea, 2023). In Kenya, solid waste management operations are a devolved function, and are the responsibility of the relevant County governments. The National Government plays the role of policy development and regulatory oversight in the waste sector, as guided by the *Environmental Management and Coordination Act (EMCA)*, 1999 and the *Sustainable Waste Management Act (SWMA)*, 2022. The potential national, regional and county construction projects, as well as private actor projects anticipated along Kenya's coastal areas call for a robust solid waste management and governance system that can absorb the anticipated construction and infrastructure waste in the region.

The *National Environment Management Authority (NEMA)* is established under the **Environmental Coordination and Management Act (EMCA)**, 1999¹ and is assigned the leading role in the implementation of all Government policies relating to the environment, with an additional mandate for the general supervision and coordination of all matters relating to the environment (The Environmental Management and Coordination Act, 1999 (Cap 387))². NEMA defines construction waste as waste that is generated as a result of new construction works, remodelling or demolition (NEMA, 2014). The scope of construction is defined under EMCA to include activities involving erection, alteration, repair, dismantling, demolition, structural maintenance, painting, mowing, land-clearing, earth-moving, landscaping, grading, excavating, alteration of equipment, and the structural installation of construction components and materials in any form or for any purpose that includes any work in connection with the construction³. Waste that is generated from construction thus includes debris, steel, timber, iron sheets, tiles, ceramics and hazardous waste such as asbestos, among others (The Environmental Management and Coordination Act, 1999 (Cap 387))⁴.

EMCA periodically develops and updates its regulations to not only reinforce existing laws but also introduce more stringent measures to ensure sustainable

¹Environmental Management and Coordination Act, s7(1).

²Environmental Management and Coordination Act, s9(1).

³Section 3 Environment Management and Co-ordination Act 1999.

⁴Ibid.

environmental management. The **Environmental Management and Coordination (Waste Management) Regulations, 2024** regulate the handling, storage, transportation, segregation and destruction of waste. They introduce the *life cycle approach* in the handling of waste by recommending the adoption of cleaner production methods that conserve raw materials and energy, reduce toxic emissions and wastes, identify and eliminate potential negative impacts of the product, enable recovery and reuse of the product where possible, and the incorporation of environmental concerns in the design and disposal of a product. The regulations restrict the disposal of hazardous waste on a public highway, street, road and recreational area or in any public place except in a designated waste receptacle. They further recommend the introduction and maintenance of a *national waste information system* for recording, collecting management and analysis of waste data and information.

The **Environmental Management and Coordination (Water Quality) Regulations, 2024** set standards for wastewater management and water quality across various uses, including drinking, industrial, agricultural, and recreational purposes. They hold polluters accountable for preventing water pollution and require them to bear the costs of remediation in case of contamination. The **Environmental Management and Coordination (Air Quality) Regulations, 2024** are updated regulations that aim to prevent, control, and abate air pollution. They introduce stricter emission standards and monitoring requirements, ensuring that entities responsible for air pollution are liable for mitigation and compliance costs.

The Sustainable Waste Management Act (SWMA), 2022 establishes the legal and institutional framework for the sustainable management of solid waste in Kenya. Its objectives include health improvement, reduction of air, land, fresh water and marine pollution, promotion of circular economy practices, as well as creating an enabling environment for activities of waste management, recycling and recovery⁵. In its definition of the term “waste” the Act clearly identifies the following categories of waste: *municipal waste, domestic waste, waste from agriculture, construction waste, commercial waste, waste from horticulture, aquaculture and forestry, medical waste, chemical waste, hazardous waste, toxic waste, industrial waste, pesticides, e-waste and toxic substances*.

SWMA obligates every producer of solid waste to bear extended producer responsibility (EPR), with an aim to reduce pollution and environmental impacts of the products they introduce into the Kenyan market, and the waste arising from these products (The Sustainable Waste Management Act (Cap 387C))⁶. The **Sustainable Waste Management (Extended Producer Responsibility) Regulations, 2024** mandate producers to take responsibility for the entire lifecycle of their products, especially post-consumer waste. This includes obligations for collection, recycling, and environmentally sound disposal, thereby internalizing the environ-

⁵Section 3 Sustainable Waste Management Act 2022.

⁶Section 13 Sustainable Waste Management Act 2022.

mental costs associated with their products. This EPR responsibility can be fulfilled individually, or through a compliance scheme.

EPR in this case extends to producers of construction materials. Construction activities involve the use of manufactured materials and natural resources that are not manufactured, but extracted from the natural environment. It is hard to trace primary producers or sources of natural or extractive building materials such as stones, sand and timber. EPR as contextualized by the SWMA may not be fully applicable in the construction waste management realm. A more nuanced approach entailing *extended developer responsibility (EDR)* may be appropriate.

SWMA further mandates county governments to establish materials recovery facilities for the sorting, segregation, composting and recycling of solid waste. It is to be expected that construction waste should be taken to landfills as a last resort, and instead should be reduced at source, re-purposed for recycling or re-use within the construction and infrastructure value chain. Moreover, in an attempt to mainstream solid waste management, the Act advocates for the integration of waste management into schools' curricula.

The National Construction Authority (NCA) is established under the **National Construction Authority Act No. 41 of 2011** and is mandated to oversee the construction industry and coordinate its development. The NCA is mandated to prescribe and enforce a Building Code in the construction sector⁷. The **National Building Code, 2024** is a subsidiary legislation developed under the NCA Act with the aim to promote order and safety in construction work. It does this through the provision of standards for the design, construction, operation, inspection and maintenance of buildings, as well as standards for design, building materials, products, elements, systems and building services. It addresses the issue of construction waste on construction sites by indicating that waste material should be expeditiously removed from construction sites. The Code alludes to the re-use of construction materials by stating that “used materials can only be used on construction works if the material meets the performance requirements of the corresponding relevant standard issued under **the Standards Act (CAP 496)**”. While the Building Code contemplates standardization of used materials in order for them to be repurposed, the practicality of standardizing used construction materials presents a practical and regulatory challenge.

In providing for refuse disposal on site, the National Building Code alludes to the provision of a single refuse container and chute⁸. This is a missed opportunity for the segregation of waste for the purposes of recovery and possible re-use. Similarly, with reference to demolition works, no reference is made to the recovery of construction materials, but rather the provision of a chute for removal of materials (Then National Building Code, 2024)⁹.

⁷Section 5 National Construction Authority Act.

⁸National Building Code 2024, s346, s347 and s349.

⁹National Building Code 2024, s457.

The National Construction Authority (NCA) launched the **Construction and Demolition Waste (CDW) Management Strategy: 2023-2028** in November 2024 at the 12th World Urban Forum held in Cairo, Egypt. It is anchored in the Kenya National Solid Waste Management Strategy, 2014. The Strategy recommends improving the quality of recycling and recovery of existing construction and demolition waste streams to increase the demand for secondary construction raw materials. The Strategy identifies the stakeholders involved in construction and demolition waste (CDW) Management as upstream (generators and CDW control), midstream (recyclers of CDW) and downstream (recycled CDW users). It further identifies several strategic priority areas, including the review and revision of CDW management policies and regulations at the National and County levels, raising awareness and capacity building, as well as improving CDW Management infrastructure.

The Standards Act (CAP 496) establishes the *Kenya Bureau of Standards (KEBS)*¹⁰, whose mandate includes the testing of commodities and any material or substance from or with which and the manner in which they may be manufactured, produced, processed or treated¹¹. KEBS has developed Standards for natural and factory-made construction materials such as cement, reinforcement steel, structural steel, natural aggregates for concrete, natural building stones, stabilised soil blocks, concrete, concrete masonry units, expanded polystyrene (EPS), clay roofing tiles, concrete roofing tiles and burnt clay bricks. Beyond this, KEBS has undertaken the preparation standards for alternative construction materials, focussing on affordable materials. Some of the standards developed include those for plastic composite paving blocks and plastic composite roofing tiles.

Locally manufactured products complying to set KEBS standards are awarded the Standardisation Mark, while imported products are awarded the Importation Standardisation Mark. The Diamond Mark of Excellence (D-Mark) is a voluntary product certification awarded to manufacturers (local and abroad) who have demonstrated a high degree of excellence in product manufacturing and quality. There are, however, no explicit standards for the end-of-life management of these (construction) materials, creating a loophole in ensuring their safe disposal.

The management of construction waste is further buttressed under the **International Green Construction Code, 2018 (IGCC)**. Although this is not a binding document, it urges for the designing of provisions that promote safe and sustainable construction in an integrated fashion with the International Construction Code (ICC) Family of Codes. The IGCC provides minimum requirements to safeguard the environment, public health and safety to minimize the negative impacts of the built environment to natural resources. The Code addresses among others water efficiency, energy efficiency, planting trees on site and site waste management.

¹⁰The Standards Act, s3.

¹¹The Standards Act, s4 (1a).

Regulation 5.3.8.1 recommends that land clearing debris, rock and soil should be diverted from disposal by composting, recycling or reusing. On wastewater management, the Code under Regulation 6.3.6 prescribes reusing water, including the use of reverse osmosis for water treatment.

In the JKP region, some coastal counties have established and enacted solid waste management legislation through formal Acts. **The Kilifi County Solid Waste Management Act, 2019** makes provision for the management of solid waste in Kilifi County. It categorises solid waste into *municipal waste, market waste, construction and demolition waste, industrial solid waste, agricultural waste, biomedical or clinical waste, hazardous waste, e-waste, plastic waste, junk waste* and leaves room for emerging waste types¹². It allows for material recovery¹³, and encourages public and private sector participation in solid waste management efforts, offering mechanisms for how different players can participate¹⁴.

The Tana River County Solid Waste Management Act, 2022 provides for solid waste disposal and establishes the institutional framework for the management of solid waste in Tana River County. It supports an integrated Reduce, Reuse, Recycle/Restore, and Return (RRRR) approach to solid waste management through advocating for the reduction of waste generated¹⁵. Where waste is generated, it provides for re-use, recycling and recovery (in an environmentally sound manner) and safe treatment before disposal¹⁶. It further pledges to put into place measures to ensure safe dumping of solid waste¹⁷. This Act does not offer any classification of solid waste into different categories.

The Mombasa County Solid Waste Management Act, 2021 provides for the collection, treatment, transportation and disposal of solid waste in Mombasa County. It recommends the separation of waste¹⁸ and prohibits the burning of solid waste¹⁹. The Mombasa County Solid Waste Management (Amendment) Act, 2023 tasks the County Government of Mombasa with the responsibility to provide central collection centres for materials that can be recycled, the establishment of waste management infrastructure to promote source segregation, collection, reuse, and set up for materials recovery, as well as the maintenance of data on waste management activities²⁰.

There is a *lack of official waste data* for Kenya, and the JKP region as a whole. There are inadequate indicators for total waste collected, the categorisation of waste generated and collected, and the share of collected waste deposited in controlled landfills.

There is a gap in *solid waste categorisation*. Within the current framework, the

¹²Kilifi County Solid Waste Management Act, s10(2).

¹³Kilifi County Solid Waste Management Act, s9.

¹⁴Kilifi County Solid Waste Management Act, s6(2).

¹⁵Tana River County Solid Waste Management Act, s5(a).

¹⁶Tana River County Solid Waste Management Act, s5(b) and s12(1).

¹⁷Tana River County Solid Waste Management Act, s7(2).

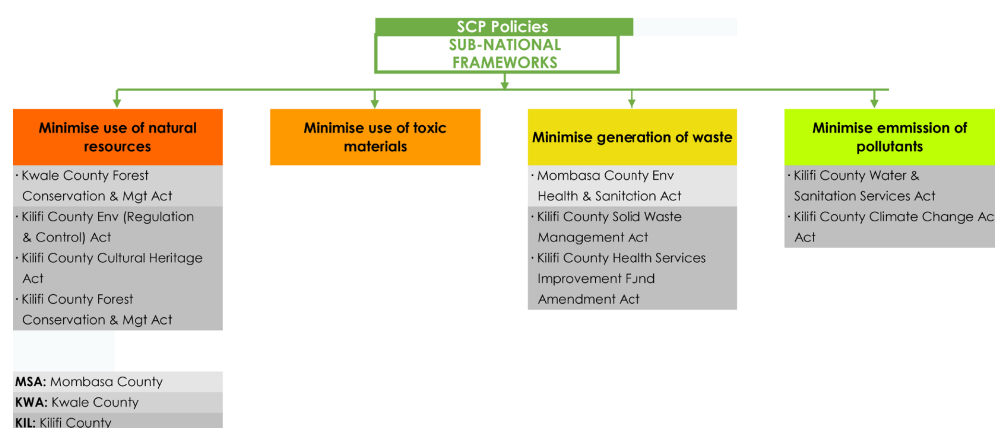
¹⁸Mombasa County Solid Waste Management Act, s12.

¹⁹Mombasa County Solid Waste Management Act, s17.

²⁰Mombasa County Solid Waste Management (Amendment) Act, s4A.

recognition of construction and demolition waste as a waste category is sometimes overlooked. Where construction and demolition waste is recognised and defined, this is only done at the construction and demolition phase, and does not factor waste generated at all stages along the construction life cycle/value chain.

There is an existing a national policy, legal and regulatory framework governing solid waste management in Kenya which includes the Environmental Management and Coordination Act (EMCA), the Sustainable Waste Management Act (SWMA) and the National Building Code, 2024. However, at county level, some counties in the JKP region are lagging behind in this area (**Figure 8**). *Three out of six counties* in the JKP region (Kwale, Lamu and Taita Taveta) *do not have a legislative framework on solid waste management* to date.

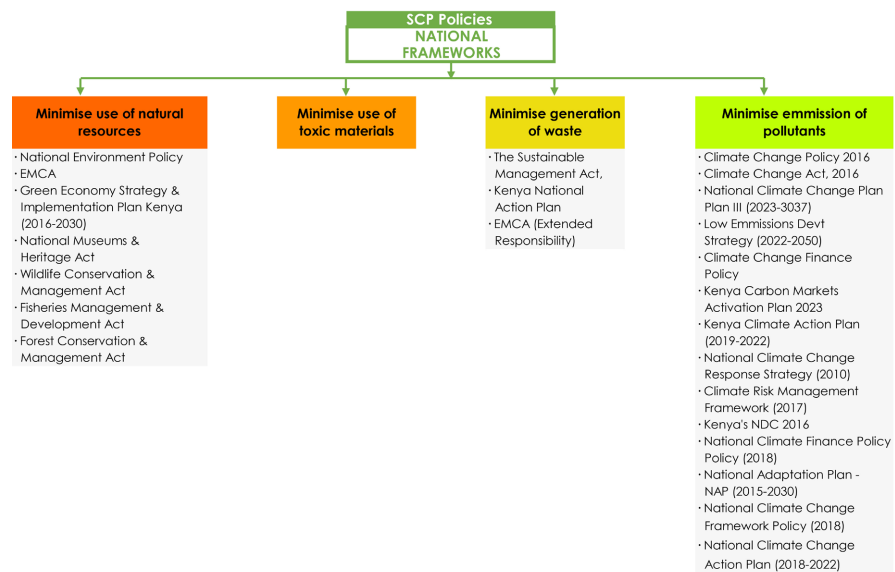


Note: Source: Author (2024).

Figure 8. Analysis of sampled sub-national frameworks addressing different elements of sustainable consumption and production (SCP).

The *existing policy, legal and regulatory framework* for construction waste management is *disjointed*, and riddled with overlapping mandates of the responsible agencies. There are numerous laws, regulations, regulatory authorities and overlapping mandates. This leads to a lack of efficient and effective oversight and enforcement (**Figure 9**).

The construction industry utilizes a mixture of manufactured materials and natural materials such as sand, stones and timber. The natural materials are not necessarily sourced from registered producers and manufacturers. With this peculiarity, the essence of EPR may be lost because of the question of producers' identity of personhood. It is therefore important to have regulations specific to construction for extended developer responsibility (EDR). Manufactured goods properly fit within the framework of EPR. However, natural/extractives or raw materials for construction require a different framework because they are not encompassed in the EPR framework. Having a framework that covers EDR in the context of developers would cover for the raw materials that are not necessarily within the realm of produced goods.



Note: Source: Author (2025).

Figure 9. Analysis of sampled national frameworks addressing different elements of sustainable consumption and production (SCP).



Note: Source: Author (2024).

Figure 10. Open dumping at the Mwakirunge dumpsite, Mombasa County.

Much of municipal waste in sub-Saharan is uncontrolled²¹. Controlled waste is waste that is “collected, and then either disposed of in a controlled facility”. Uncontrolled waste, on the other hand, is waste that is “not collected, and so by necessity dumped in the open by the waste generator, or collected and then dumped and burned at its final destination” (UNEP, 2024). While *solid waste data* in Kenya’s coastal cities is not readily available, it is clearly observable that waste production/generation clearly outpaces waste management interventions. It was observed that the prevalent instruments of waste management along Kenya’s coastal

²¹UNEP, *Global Waste Management Outlook 2024: Beyond an Age of Waste*: (n2) 22.

cities currently follow the *linear economy (take-make-waste) model*, characterized by open dumping. There are designated county dumpsites in several locations receiving an aggregation of both Municipal and Non-Municipal Waste that includes construction and demolition waste (**Figure 10** and **Figure 11**).



Note: Source: Author (2024).

Figure 11. Burning of waste at Mwakirunge dumpsite, Mombasa County.



Note: Source: Author (2025).

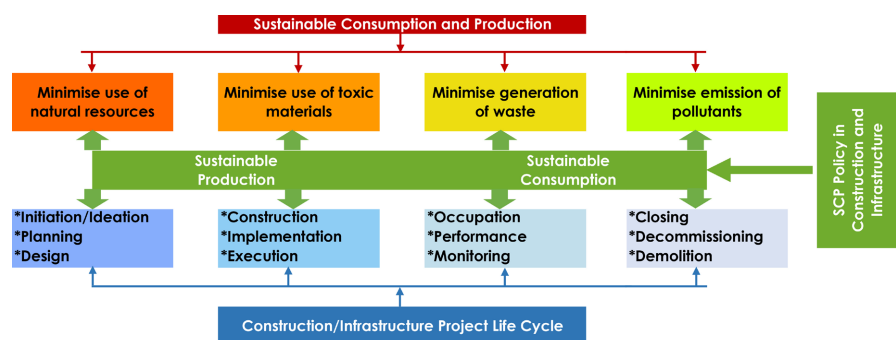
Figure 12. Open dumping of construction waste by the highway, Kilifi County.

In Kenya's coastal cities and urban areas, it is also observed that the uptake for *the management of construction and demolition waste as a separate waste stream* has not been adopted. Out of the waste that is generated from construction and demolition, some of the waste ends up in landfills, while the rest remains as waste

(Rodriguez-Morales, Burciaga-Diaz, Gomez-Zamorano, & Escalante-Garcia, 2024). The Building Code only prescribes that where there is excessive debris in a construction and waste, the NCA will issue a written notice for the removal of the waste (The National Building Code, 2024)²². Notably, the regulations do not prescribe designated disposal sites for the disposal of construction waste (NEMA, 2014). Construction waste is freely mixed with municipal waste destined for open dumpsites, burnt, or illegally deposited in open fields, by the roadside (Figure 12) or along waterways. This does not augur well for the growth of the Blue Economy, as it leads to land, air, and water pollution, adversely affects human and animal health, exacerbates flooding, acts as a deterrent to tourism, and finds its way to the ocean as marine litter and debris.

With regard to management of waste from a circular economy perspective, there ought to be legal and economic incentives as more decisive drivers of responsible construction waste management (Figure 13).

There is *poor implementation and enforcement* of existing waste management policies, laws and regulations. Illegal waste management practices are tolerated with few or no legal repercussions, despite clear guidelines for waste management in the relevant frameworks.



Note: Source: Author (2025).

Figure 13. Conceptual framework for ensuring SCP in construction and infrastructure projects.

There is evidence of *weak enforcement mechanisms* for existing waste management regulations, such as hazardous waste management is wanting. The management of biomedical waste (produced during the operations phase of the construction life cycle) is regulated by a robust legal and regulatory framework. Key legislation governing the sector include the Constitution of Kenya 2010, the Sustainable Waste Management Act, the Public Health Act, the Environmental Coordination and Management Act (EMCA), the Food, Drugs and Chemical Substances Act and the Occupational Safety and Health Act (Ministry of Health, 2024). The handling and disposal of biomedical waste is guided by the National Guidelines for Safe Management of Health Care Waste, the Environmental Man-

²²Rule 54, National Building Code 2024.

agement and Coordination (Air Quality) Regulations, the Environmental Management and Coordination (Management and Control of Plastic Packaging Materials) Regulations, the Environmental Management and Coordination (Management of Toxic and Hazardous Chemicals and Materials) Regulations, and the Environmental Management and Coordination (Controlled Substances) Regulations (Ministry of Health, 2024).

Enforcement of construction waste management is disjointed, and is spread across different sectors, leading to *regulatory overlaps*. The National Construction Authority (NCA), as the construction industry regulator, deals with the policy framework on construction and related areas, and has been mandated to enforce the same. In line with this overarching mandate, NCA has developed the National Construction Research Agenda (NaCRA) that guides research on environmentally efficient construction practices, and the Construction and Demolition Waste (CDW) Management Strategy: 2023-2028. Despite this, the Authority still lacks a mandate to address waste management generated from the construction industry. The mandate to address the management of solid waste (including construction waste) is domiciled in the National Environmental Management Authority (NEMA) and respective county governments.

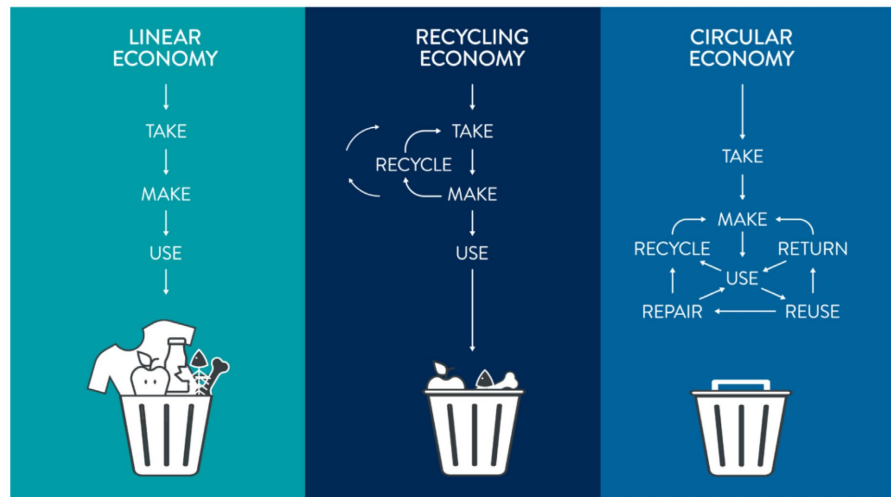
Furthermore, the NCA lacks the mandate to enforce regulations on environmentally friendly construction practices such as the adoption of green building materials. The contractors and clients have the discretion to decide the material to be used in construction. That regulatory mandate on construction materials is domiciled with the Kenya Bureau of Standards (KEBS). Further fragmentation is evidenced by the lack of harmonisation of national government policies, laws and regulations with those stipulated in the County Solid Waste Management Acts.

4. Conclusion and Recommendations

As construction activities continue to rise in coastal Kenya, so does the generation of waste, placing increased pressure on landfills, natural resources, and the environment. The coastal region is particularly vulnerable to climate change impacts, such as rising sea levels and increased temperatures. This thus necessitates the urgent adoption of sustainable building practices to mitigate environmental harm in key sectors, including construction. The construction cycle goes through different phases such as adoption of strategies such as on-site segregation, recycling, reuse of materials, and proper disposal practices, the environmental footprint of construction can be significantly reduced.

The focus of this research is *to minimise the generation of solid waste in the construction and infrastructure sector in Kenya's coastal cities and urban areas*, mainly through proposed interventions in the coastal counties' development plans, urban planning, legislation, regulatory frameworks, investments and policy decisions. The current policy, legal and regulatory framework on waste management is steering the JKP region to a recycling economy, away from the current status quo where a huge chunk of construction waste still ends up in dumping sites and landfills. There is therefore an urgent need to accelerate construction waste management

in Kenya's coastal counties into a fully circular economy that is as close to *zero waste* as possible. **Figure 14** illustrates a clear pathway of progression from a linear to a circular economy, in which the Institute of Electronic and Electrical Engineers (IEEE) recommends the re-imagining of waste as a source of secondary raw materials, achieved by employing measures that include re-use, recycling and repair (IEEE Europe, 2024).



Note: Source:

<https://itcc.ieee.org/blog/a-circular-economy-moving-from-supply-and-value-chains-to-networks/>.

Figure 14. Sustainable waste management: from linear economy to circular economy.

On construction waste, policy options could consider better regulation and enhanced recyclability of construction materials and environmental friendliness of construction materials. How will contractors handle construction and demolition waste? Should there be extended developer responsibility (EDR) along the lines of extended producer responsibility (EPR) as contemplated in the Sustainable Waste Management Act 2022 and the Regulations thereunder? Will they segregate waste, and do they have good waste management strategies? Should there be more regulated and structured markets for off take and up take of construction waste complete with standards? Would the country ultimately move towards zero construction waste as a desired policy objective, and how would this be measured? Perhaps by reference to actual data on construction waste generated, whether and how it is segregated at source or at re-use, levels of material recovery, re-use and final disposal, and ultimately a determination of their environmental footprint. Of course, construction waste, being a specific waste stream that is typically tied to construction and infrastructure developments, remains generally so throughout its life cycle, and is fairly easily distinguishable from operational wastes, including domestic waste, biomedical and electronic waste, which are subject to different but complementary regulatory systems.

According to the Sustainable Waste Management Act, the developer of a construction project qualifies as a “waste generator”. This means that they have duties under contracts to ensure compliance. The idea of extended developer liability doesn’t just lie with the immediate waste-handler (e.g., a contractor), but flows back to the promoter/developer/owner. Contractually, developers must ensure that contractors/subcontractors are bound to comply with waste-management obligations, and indemnities/flow-downs may be required. The idea of extended developer liability is that the developer (or their contractor) must segregate waste, use licensed waste-service providers, and keep records of waste movement and disposal. If waste is poorly managed, the developer may face remediation costs, reputational damage, regulatory enforcement and even tort claims. In an extended developer responsibility model, developers and their allies such as contractors and suppliers would assume primary responsibility for construction waste generated by their activities or projects throughout their life cycle, and particularly in the construction, repair and refurbishment, and demolition phases. Some of the required waste management duties or responsibilities of developers as duty bearers would include data and record-keeping of wastes generated, segregation measures at source or re-use or final disposal, as well as measures taken to either re-purpose or re-use own generated construction waste, trade in or safe disposal of waste. Others would include reporting obligations to regulators, as well as licensing/permit requirements. The enforcement authority would invariably be the National Construction Authority (NCA) in partnership with the National Environment Management Authority (NEMA), with corresponding enforcement mechanisms at the county level.

In the context of the push towards zero construction waste, some recommendations include the following:

- There should be more concerted use of environmental selection criteria for construction materials, including sustainability of the material supply chain and material recyclability at the end of building lifetime, in order to reduce waste at source.
- Government in consultation with stakeholders should develop Construction Waste Management Regulations to manage construction, demolition and maintenance wastes generated by the construction and infrastructure sector, incorporating the tenets of RRRR—reduce, reuse, recycle, return, etc. These could include waste-to-energy regulations.
- Developers and contractors should be obliged under a regulatory framework of extended developer responsibility (EDR) to take responsibility for construction waste from source to final disposal.
- The regulatory framework for construction waste should also include the establishment of a regulated market for construction waste, including appropriate standards for various categories of waste materials, off-take and up-take systems, designated storage places, transportation and uses such as construction, back-filling and paving of roads, among others.

- There should be deliberate efforts towards application of smarter technologies in construction and infrastructure developments, including those that use less water, sand, stones, energy, and other materials, thus ultimately producing less waste. In this regard, the sector should adopt Green Building Initiatives that promote the use of sustainable materials and energy-efficient designs, and include implementation of green certification systems like LEED or BREEAM for new constructions. A Green City Index for the JKP region that is adaptive to the conditions peculiar to the WIO region would be transformative.
- Under the policy and regulatory framework for construction waste management, government should develop and provide incentive schemes to discourage single-use wood products such as formwork, scaffolding, props, etc., which end up as waste and are often re-purposed as firewood, which is an unclean source of energy, especially in urban areas.

In order to enhance the move towards zero construction waste, through RRRR (Reduce, Reuse, Recycle/Restore and Return), the Utilisation of Life *Cycle Assessment* as a tool to evaluate and address all waste generated across the whole life cycle of construction and infrastructure projects is highly recommended.

At the **planning and design phase**, the following specific recommendations are presented:

- Develop a ***Construction Materials Research Policy*** to boost top plug into NCA's National Construction Research Agenda (NaCRA). It will encourage research into the reconfiguration and design of construction materials for durability, the re-use of construction waste for new projects, construction technology for modular construction, and reduce the proliferation of toxic construction materials in the JKP region.
- There is a need to invest in *research and development (R&D)* and *data analytics* in the sector. A proposed ***Regional Construction Materials and Construction Waste Data Repository*** will enable the use of smart technologies and digital platforms for transparency in sharing building materials data, tracking resource use, and promoting transparency in sustainable construction waste management practices in the JKP region.
- Develop a ***Construction Waste Data Management Policy*** to manage construction waste data. It should clearly define *solid waste management targets* for the construction and infrastructure sector in the JKP region as a baseline for all subsequent RRRR (Reduce, Reuse, Recycle/Restore, Return) interventions. It should also set out clear timelines and reporting guidelines for their implementation.
- As the industry regulator, the National Construction Authority (NCA) should develop ***Construction Waste Management Guidelines*** to manage construction, maintenance, demolition and other categories of waste generated by the construction and infrastructure sector. These shall take a multi-sectoral and multi-institutional approach.

At the **construction phase**, the following specific recommendations are provided below:

- Develop ***Modular Construction Guidelines*** that will decrease waste, enhance resource efficiency, and enable faster, cleaner construction and deconstruction. These should be piloted in the affordable/adequate housing initiatives defined in Kenya Vision 2030, JKP Vision 2030, and the CIDPs.
- Implement ***Environmental Footprint Materials Certification Systems*** for construction materials such as Environmental Product Declarations (EPDs) and PEP eco-passport.

At the **occupation/performance phase**, the following specific recommendations for the development and implementation of ***Materials Certification Systems*** and ***Construction Waste Management Guidelines*** are recommended.

At the **demolition/decommissioning phase**, the following specific recommendations are provided below:

- Development of ***Resource Conservation and Recovery Regulations*** to guide the recovery of waste produced along the construction and infrastructure life cycle. This will guide the identification of certain waste construction materials that can be recovered and re-purposed as raw materials for new building projects.
- Develop and enforce a ***Bio-based and Recycled Materials Strategy*** that will encourage construction using bamboo, recycled plastic, and locally sourced materials, reducing reliance on virgin resources and promoting circular economy. It will also stimulate research and development (R&D) in the area of construction materials.
- Provide ***incentive schemes*** to discourage single-use of construction materials, such as wood products for formwork, scaffolding, props, etc.

In addition to the interventions at national government level outlined above, county governments in the JKP region should enact laws, *incentivise investment in*, and *provide space for* urban infrastructure that supports zero construction waste, through the following RRRR interventions:

- ❖ Modular building manufacturing plants (*Reduce*).
- ❖ Establish regulated Construction Waste Markets (*Reuse*).
- ❖ Construction materials recovery plants (*Recycle/Restore*).
- ❖ Waste-to-energy (WTE) facilities (*Return*).

Author Contributions

All three authors contributed collaboratively to the conception, development, and completion of this work. Dr. Momanyi acted as the principal investigator and provided overall supervision and coordination of the research project. He contributed to securing research funding, literature review, primary data collection, and supported the interpretation of the findings. He critically reviewed and revised the manuscript to ensure substantive intellectual contribution, and approved the final manuscript prior to submission. Ms. Wambiri was responsible for the devel-

opment of the research framework and formulation of the research objectives. She participated in literature review, field data collection, as well as data interpretation and analysis, and was responsible for the collection, organization, and analysis of the relevant data pertaining to policy and regulatory documents. Ms. Muchogu provided technical support in refining the research methodology to ensure its suitability and relevance to the construction and infrastructure sector. She participated in literature review, field data collection, as well as data interpretation and analysis, with particular emphasis on circular economy principles, policy instruments, and regulatory pathways within the construction sector. She wrote the first draft of the manuscript and generated all tables and figures presented in the paper. All authors have reviewed and approved the final manuscript and accept collective responsibility for the integrity and accuracy of all aspects of the work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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