

CORVINUS UNIVERSITY OF BUDAPEST
DOCTORAL SCHOOL OF INTERNATIONAL RELATIONS AND POLITICAL
SCIENCE, WORDL ECONOMY SUBPROGRAM

**THE CHALLENGES AND POTENTIALS OF CIRCULAR
ECONOMY IN SUB-SAHARAN AFRICA**

ANALYSIS OF DRIVERS AND BARRIERS FOR WASTE EXCHANGE AND
UTILIZATION BASED ON FIVE CASE STUDIES

DOCTORAL DISSERTATION

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I. Research Scope and Justification

Introduction

This dissertation investigates sustainable development and green industrialization in Sub-Saharan Africa (SSA) through the lens of circular economy (CE) and industrial symbiosis (IS), focusing on waste and by-product utilization. SSA faces escalating waste generation, rapid population growth, and urbanization, yet waste management research is underrepresented, particularly in primary data collection tailored to local conditions (e.g., waste types, technology, regulations, and social perceptions). This creates a "blind spot" for both research and policy. The study aims to address this gap by generating primary data, developing a research toolkit, and providing policy recommendations to support sustainable waste management practices.

The research is driven by concerning trends: SSA's population is projected to increase 2.5 times by 2050 (UN Population Division, 2019), with municipal solid waste expected to nearly triple (Kazat et al., 2018). By 2100, SSA could become the largest waste producer globally (Hoornweg et al., 2013). In 2016, only 44% of waste was collected in SSA, compared to over 90% in Europe and North America. Industrial output and consumption have surged since 2001 (World Bank, 2025a), exacerbating waste challenges. Additionally, SSA's vulnerability to climate change, as highlighted by the Climate Change Vulnerability Index (Reliefweb, 2020), underscores the need for sustainable waste management to mitigate environmental damage.

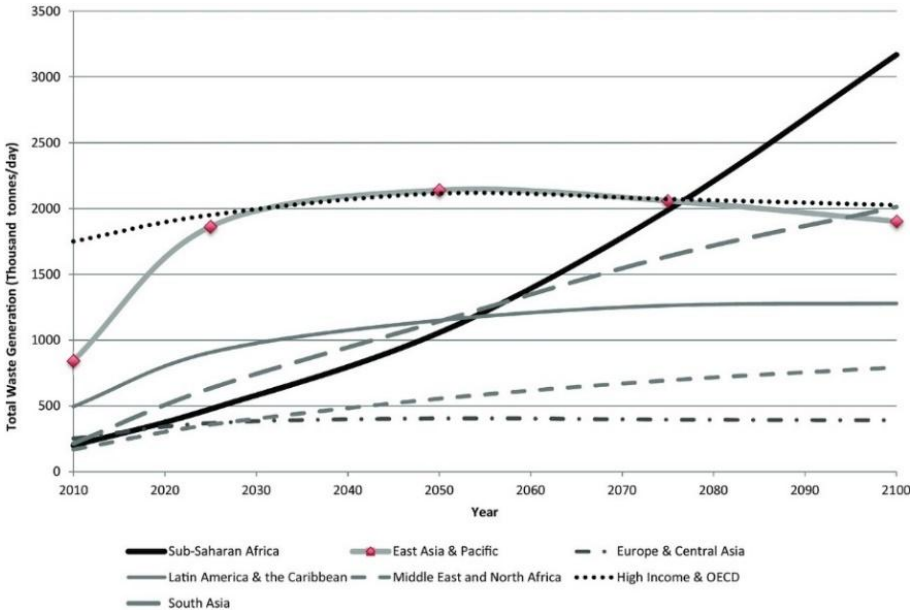


Figure 1. Waste generation by region, 2010–2100 under SSP2 (thousand tonnes/day); Source: Hoornweg et al. 2013

Another critical issue is stagnant productivity. Between 1990 and 2010, labor in SSA shifted from low-productivity agriculture to even lower-productivity service sectors, not manufacturing, leading to negative or minimal productivity growth in countries like Nigeria, Ghana, and Zambia (McMillan et al., 2017). This hinders economic convergence with developed nations. CE, particularly IS, offers a solution by promoting resource efficiency and productivity while addressing environmental concerns.

SSA's rapid population growth, urbanization, and shifting consumption patterns toward packaged goods and electronics (Kazat et al., 2018) necessitate a rethinking of waste management, product life cycles, and business models to prevent environmental degradation. CE offers a promising framework, as SSA has unique advantages: a young, labor-rich population suited for labor-intensive CE practices; less entrenched linear production models; and cultural practices of collaboration to manage scarcity (Lemille, 2020). However, the lack of primary data on waste types, technologies, regulations, and social behaviors limits tailored solutions. The dissertation addresses this by providing empirical data and a toolkit for future research.

The dissertation employs exploratory and fundamental research, grounded in qualitative and quantitative data from five case studies in Uganda, Zambia, and Ghana. It focuses on locally generated waste, excluding imported materials.

The central research question (RQ) is:

- *How and why does the utilization of waste and by-product materials have potential and face challenges in Sub-Saharan Africa?*

This is supported by three sub-questions (SQs):

- *SQ1: How are specific waste materials and by-products exchanged, or could be exchanged, between industries to promote CE practices?*
- *SQ2: How and why is the adoption of waste exchange and utilization hindered?*
- *SQ3: How can waste exchange and utilization be facilitated and challenges addressed through policy and practice?*

Research gaps in Sub-Saharan Africa

CE strategies, as outlined by Bocken et al. (2016) and Stahel (2016), aim to slow (e.g., reuse), close (e.g., recycling), and narrow (e.g., reduced material use) resource loops. Industrial symbiosis (IS) is a cornerstone of the circular economy (CE), focusing on the collaborative exchange of waste or by-products between companies to enhance resource

efficiency and reduce environmental impacts. IS, as defined by Neves et al. (2019), fosters B2B synergies where waste becomes a resource, reducing costs (e.g., transport, landfilling) and generating revenue. Unlike post-consumer recycling, IS targets pre-consumer industrial by-products, emphasizing shared infrastructure and services (Lybaek et al., 2020).

IS operates at three levels: micro (in-house or bilateral exchanges), meso (geographically proximate firms, often in eco-industrial parks), and macro (regional or national scales). These concepts frame the literature review, with a focus on their application in Sub-Saharan Africa (SSA) to identify research gaps.

At the micro level, Integrated Farming System (IFS) exemplifies in-house circularity. IFS integrates crop, livestock, and aquaculture waste to enhance productivity and sustainability (FAO, 2001). For instance, crop residues and animal manure are recycled to improve soil fertility, addressing food security amid rising input costs (Chan, 1985). Studies in SSA, such as Agbonlahor et al. (2003) in Nigeria and Singbo and Lansink (2010) in Benin, highlight IFS's role in boosting efficiency and soil health, though empirical research remains limited.

Eco-Industrial Parks (EIPs), a meso-level application, promote material, energy, and water exchanges among co-located firms. The Kalundborg Symbiosis (Denmark) and Shenzhen EIP (China) demonstrate resource efficiency through collaboration (Ehrenfeld and Gertler, 1997; Gao et al., 2019). In SSA, examples include South Africa's Gauteng and Western Cape IS programs (Oguntoye et al., 2019; Ellen MacArthur Foundation, 2020) and Ethiopia's garment sector EIPs (Jensen, 2020). EIPs reduce costs, emissions, and waste but face challenges like high startup costs and regulatory complexity (Behera et al., 2012; Tseng et al., 2021).

Macro-level IS involves regional or national resource exchanges, but research in SSA is sparse. Studies highlight isolated cases, such as Tanzania's sugar industry (Rweyendela and Mwegoha, 2020) and Mauritius's slaughterhouses and recycling (Mauthoor, 2017). Kenya's push for green special economic zones (Khisa and Onyuka, 2018) and Nigeria's industrial park opportunities (Bilyaminu et al., 2024) suggest potential, but broader implementation is limited by data gaps and infrastructure challenges.

Hence, IS and CE offer significant potential for sustainable development in SSA, but their adoption is hindered by limited research and contextual challenges. The dissertation's five case studies aim to address these gaps by exploring CE frameworks, policy, regulation, and waste characterization, providing a foundation for advancing sustainable industrial practices in the region.

Table 1. Research Gaps: Circular Economy and Industrial Symbiosis in SSA, Source: author's construction

| Research Area | Identified Gaps | Case Studies | | | | |
|---------------------------|--|--------------|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| CE Framework | Poor contextual adaptation of CE principles to SSA's informal, low-infrastructure environments | x | x | x | x | x |
| Geographic Focus | Concentration on urban areas; neglect of rural and peri-urban contexts | | x | | x | |
| Industrial Symbiosis (IS) | Sparse research on IS across most SSA countries and sectors | | x | x | x | x |
| Sectoral Coverage | Limited studies beyond traditional industries (e.g., sugar, oil, textiles) | | | x | x | x |
| Network Development | Lack of understanding on how to establish new IS relationships | | | x | | |
| Policy & Regulation | Insufficient analysis of local policies, incentives, and regulatory environments | x | x | x | x | x |
| Waste Characterization | Limited data on industrial waste types, quantities, and usability | x | x | x | x | x |
| Informal Sector | Exclusion of informal actors from CE and IS frameworks | | | x | | x |
| Social Acceptance | Lack of research on cultural attitudes and public perception of waste-based products | x | | x | x | x |
| Long-Term Impact | Few studies assess life-cycle, environmental, or socio-economic impacts of CE and IS initiatives | | x | | x | x |

II. Research Design and Methodology

This dissertation investigates waste exchange and utilization in Sub-Saharan Africa (SSA) through **5 qualitative, exploratory case studies informed by 105 semi-structured interviews**. The methodology is structured around four key elements: (1) research design, (2) theoretical framework and conceptualization, (3) country selection, and (4) case study selection and data collection. Together, these approaches ensure a systematic yet flexible process suitable for exploring a novel field with limited prior research and empirical data.

Research Design: Grounded Theory, Exploratory and Fundamental Research

Given that circular economy and waste utilization research is underdeveloped in SSA, the study employs an exploratory design. This allows the researcher to investigate poorly understood processes without predefined hypotheses. Grounded Theory (GT) provides the methodological foundation by enabling inductive theory-building directly from interview and field data. In parallel, fundamental research guides the study's broader aim of

expanding theoretical and conceptual understanding of industrial symbiosis (IS) in new contexts.

The combination of GT, exploratory inquiry, and fundamental research has precedent in social, environmental, and business studies. Examples include studies of cultural memory (Hussein et al., 2020), sustainability in informal settlements (Soliman et al., 2022), and environmental learning (Smith-Sebasto & Walker, 2010). Business research likewise demonstrates the value of GT for uncovering under-theorized social and organizational processes (e.g., Geiger & Turley, 2003; Goyal et al., 2022).

This integrated approach is particularly suited to SSA, where variables, relationships, and institutional contexts of waste exchange are not yet clearly defined. GT's structured coding process complements exploratory goals while contributing to fundamental theory building, making it an effective tool for both empirical insight and conceptual advancement.

Theoretical Framework and Conceptualization

The study employs Industrial Symbiosis (IS) as its core conceptual lens. IS refers to the exchange and reuse of waste and by-products between industries to achieve environmental and economic benefits. The framework is operationalized through four dimensions:

1. Typology of IS relationships – categorized into internal exchange (within a firm), external exchange (between firms), eco-industrial parks (EIPs), and urban industrial symbiosis, where local governments facilitate exchanges between communities and industries. These levels capture micro, meso, and macro scales of symbiotic interaction.
2. Drivers and barriers – Literature identifies key enablers such as environmental awareness, supportive regulation, stakeholder involvement, and geographic proximity, as well as barriers including weak legislation, lack of knowledge and trust, economic risks, and technological limitations.
3. Policies supporting IS – Both direct and indirect policies (e.g., landfill taxes, waste management frameworks) are considered, with attention to top-down vs. bottom-up and incentive-based vs. regulatory approaches.
4. Economic modelling – Based on Boons et al. (2011) and Bertani et al. (2019), IS relationships are assessed using two “fitness” equations: one for suppliers (balancing processing costs against landfill costs) and one for buyers (comparing waste vs. virgin material costs). These models informed the interview design by highlighting relevant cost categories such as storage, transport, treatment, and subsidies.

Country Selection

Three countries were selected based on existing CE/IS activity, researcher’s prior field experience, and accessibility:

- Uganda: Chosen after a field trip in 2021 enabled contacts with institutions such as the Uganda Cleaner Production Centre. The country has multiple CE initiatives and offered strong local support.
- Ghana: Selected due to its high concentration of CE cases (Footprints Africa, 2021), prior experience of the researcher, and institutional connections including the Ghana Cleaner Production Centre.
- Zambia: Added after conference contacts with Copperbelt University researchers, providing access to the mining sector—a critical but underexplored domain for waste utilization.

The choice of anglophone countries also ensured consistency in data collection, given the researcher’s language expertise.

Case Study Selection and Data Collection

Case studies were designed to reflect different IS levels (micro, meso, macro) and cover diverse industrial sectors in SSA. This follows a “most-different cases” design to maximize generalizability.

Table 2. Case studies according to waste exchange level, Source: author's construction

| Level | Form of exchange | Actors | Case studies |
|-------|----------------------------------|--|---------------|
| Micro | Internal exchange | One single company | Cs2, Cs5 |
| | External exchange | Two or more companies | Cs1, Cs2, Cs5 |
| Meso | (Eco) Industrial park | Companies in the industrial park and park management authority | Cs3 |
| | Urban industrial symbiosis | Local community (authority) and companies | Cs5 |
| Macro | Nation-wide industrial symbiosis | Economic sectors | Cs4, Cs5 |

- **Case Study 1 (Uganda, micro-level external exchange):** Seven businesses in plastic recycling, agriculture, carpentry, textiles, and packaging. Focus on economic, environmental, and social impacts.

- **Case Study 2 (Uganda, micro level internal and external exchange, agriculture):** Amelia Agro Africa Ltd., a farm using diverse waste inputs. Two rounds of interviews (2021, 2022) explored IS cost structures and supplier motivations.
- **Case Study 3 (Uganda, meso-level, industrial park):** Kampala Industrial and Business Park. 42 companies and the park authority were interviewed to assess barriers, enablers, and management’s facilitation role.
- **Case Study 4 (Zambia, mining sector, macro-level):** Copperbelt mining waste utilization, focusing on copper slag and tailings. 19 interviews with experts, mining firms, and potential “destination product” companies explored technological, legal, economic, and knowledge aspects.
- **Case Study 5 (Ghana, multi-level):** 23 companies, three recycling firms, and four experts/policy-makers. Data collection spanned 2023–2024, addressing policy, industry perspectives, and waste management strategies.

Data collection: Across all cases, semi-structured interviews were preferred to online surveys due to the need for clarification and probing. Questionnaires were adapted iteratively, reflecting GT’s logic of theory-building. They covered roles in waste exchange (supplier/receiver, user/non-user) and addressed motivations, costs, barriers, and regulatory issues. Interviews were complemented with site visits, observations, and expert discussions. Ethical protocols (informed consent, anonymity, voluntary participation) were followed throughout.

*Table 3. Case studies (CS) and their data collection period, respondent number (RN) and publication status;
 Source: author’s collection*

| CS | Title | Data collection period | RN | Publication status |
|----|---|------------------------|----|--------------------|
| 1 | Waste utilization mini case studies in Uganda | 05.2021 | 7 | Published |
| 2 | The role of agriculture in micro-level waste exchange and utilization in Sub-Saharan-Africa. The case of Amelia Agro Ecological Farm in Uganda | 05-06. 2022 | 9 | Published |
| 3 | Potentials and challenges of waste exchange and utilization in an African industrial park. The case of the Kampala Industrial and Business Park in Uganda | 01-04. 2023 | 43 | Under review |
| 4 | Potentials and challenges of the utilization of mining waste materials. The case of copper mining waste in Zambia | 04.2023 | 19 | Published |
| 5 | Waste utilization potentials and challenges on micro, meso and macro levels in Ghana | 07. 2023 – 04. 2024 | 27 | Under review |

III. Results

Answers to the three Research Sub-Questions

SQ1: How are specific waste materials and by-products exchanged, or could be exchanged, between industries to promote circular economy practices?

Table 4. Waste and by-product materials and their exchanges across various industries based on the 5 case studies; Source: author's construction

| Waste Material/By-product | Use/Exchange |
|---|--|
| Water hyacinth | Used to create biodegradable products like trays and packaging, reducing plastic use. |
| Sawdust | Used to produce briquettes and compost, replacing charcoal. |
| Bagasse | Used for composting, animal feed, mulch, and improving soil fertility. |
| Slaughterhouse by-products (blood, off-cuts) | Used for composting and animal feed. |
| Boiler ash (carbon-rich) | Used to maintain soil fertility or as a soil conditioner. |
| Plastic waste | Recycled into products like tiles and bricks, reducing plastic pollution. |
| Banana stems | Fiber extracted for weaving, and remaining material used for organic fertilizers and briquettes. |
| Food waste | Processed to feed black soldier flies that produce animal feed, oil, and fertilizer. |
| Rice husk | Used for chicken bedding, fodder, or compost production. |
| Fish waste | Used as compost or fertilizer to improve soil health. |
| Brewery by-products (spent grain, spent yeast) | Used for animal feed or compost. |
| Distillery spent wash | Used as liquid fertilizer, enhancing soil moisture and mineral content. |
| Palm kernel expeller | Used as high-protein animal feed, especially for pigs. |
| Tea processing by-products (tea dust, winnowings) | Used for composting or livestock feed. |
| Paper and cardboard | Reused or recycled for packaging materials. |

| | |
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| Metal scrap | Recycled or used in metal fabrication. |
| Organic materials (food processing, agriculture) | Used for composting or energy recovery. |
| Used chemicals | Reused in industries requiring similar chemical inputs. |
| Dust and ash | Used in construction or as filler materials. |
| Non-hazardous sewage | Treated and reused in industrial or agricultural applications. |
| Molten slag | Used in construction or cement production. |
| Firewood | Reused for energy generation or heating. |
| Copper slag | Reprocessed for blended cement, road pavement, abrasives, and roofing granules. |
| Copper mine tailings | Used in concrete, tiles, and glass production. |
| Waste rock | Reused for construction, especially road building. |
| Overburden | Reused for backfilling or land reclamation projects. |

SQ2: How and why is the adoption of waste exchange and utilization hindered?

Table 5. Detected barriers for waste exchange and utilization based on the 5 case studies; Source: author's construction

| Case studies | Key Barriers |
|---|---|
| Case study 1 (General) | Limited access to affordable, reliable machinery and technology |
| | Competition from cheaper imported alternatives, such as plastic products |
| | Low consumer demand for organic and alternative products |
| | High R&D costs, particularly for small businesses |
| | Logistical issues and inadequate infrastructure for waste collection |
| | Lack of skilled local labor for manufacturing and machinery repair |
| | Economic sustainability challenges, reliance on grants or donations |
| | Unclear government policies and regulatory challenges |
| Case study 2 (Industrial Waste Utilization in Agriculture) | High costs of transportation, storage, and handling, making waste utilization unfeasible |
| | Poor enforcement of environmental regulations |
| | Lack of waste collection, processing, and redistribution infrastructure |
| | Labor-intensive recycling practices raise concerns about economic sustainability |
| Case study 3 (Waste Usage in an Industrial Park) | High sourcing costs, material competition, and uncertainty about cost-effectiveness of waste vs. virgin materials |
| | Technological barriers and concerns over maintaining product quality |
| | Regulatory and organizational issues, including weak monitoring of compliance |
| | Knowledge gaps and lack of awareness about the value of waste |

| | |
|---|--|
| | Reluctance to change established production processes |
| Case study 4 (Using Mining Sector Waste) | Lack of knowledge about alternative uses for mining waste (e.g., copper slag, mine tailings) |
| | Toxicity and high treatment costs for mining waste |
| | Unclear value of mineral content in waste materials |
| | Ownership and legal barriers preventing access to mining waste for alternative uses |
| Case study 5 (General) | Resource competition and rising costs (material, transportation, treatment) |
| | Low-quality or mixed waste, complicating recycling |
| | Lack of certification for waste-derived products (e.g., biochar) |
| | Inadequate waste management infrastructure |
| | Underfunded informal sector hindering integration into formal recycling systems |
| | Lack of financial incentives and regulatory frameworks to support recycling and waste exchange |
| Resistance to change, funding issues, and inefficient equipment in Micro, Small, and Medium Enterprises (MSMEs) | |

SQ3: How can waste exchange and utilization be facilitated and the challenges effectively addressed through policy and practice?

Table 6. Detected mechanisms and potential solutions for waste exchange and utilization based on the 5 case studies; Source: author's construction

| Mechanism/Solution | Description |
|------------------------------------|--|
| Affordable and durable machinery | Develop machinery locally or through partnerships to reduce equipment costs. |
| Awareness and education | Raise awareness about the environmental and economic benefits of waste utilization through education and government campaigns. |
| Government incentives | Offer tax breaks, grants, and clear waste management policies to support businesses. |
| Business collaboration | Encourage businesses to collaborate by sharing resources, infrastructure, and technologies to improve efficiency and reduce costs. |
| Efficient waste collection systems | Set up waste collection systems to ensure a steady supply of materials for processing. |
| Access to finance | Provide micro-financing or impact investment to support business scaling and innovation. |
| Capacity building | Implement training programs for workers and entrepreneurs in waste processing, machinery maintenance, and sustainable practices. |

| | |
|--|---|
| Expanding markets for waste-derived products | Explore export opportunities and increase market demand for sustainable products to ensure financial sustainability. |
| Economic incentives (subsidies, tax breaks) | Offer financial benefits like subsidies or tax incentives for companies engaging in waste reuse or recycling. |
| Strengthening regulations | Create regulations to discourage inefficient waste disposal and incentivize recycling and waste reuse practices. |
| Industry-farm partnerships and networks | Facilitate collaborations between industries and farms for waste access, and encourage intermediary involvement to address logistical challenges. |
| Investment in research and technology | Fund R&D to improve waste processing methods and create valuable products like fertilizers or animal feeds. |
| Automation and reducing labour intensity | Introduce automation in processes like composting and feeding systems to reduce labour costs and improve economic sustainability. |
| "Waste-to-value" mindset | Promote the idea that waste is a valuable resource, not a burden, to encourage more sustainable practices. |
| Centralized waste exchange platform | Create an online platform for companies to list available waste materials for exchange, facilitating the matching of suppliers and users. |
| Waste collection and sorting facility | Set up centralized facilities to process waste materials, ensuring consistent quality and reducing logistical challenges. |
| Stakeholder collaboration | Facilitate networking and cooperation between businesses, waste collectors, and middlemen to improve waste exchange efficiency. |
| Technological support | Invest in R&D to develop technologies for better waste processing and reuse. |
| Strengthening regulatory frameworks | Develop clear policy guidelines and regulations that promote waste utilization and ensure compliance with circular economy principles. |
| Monitoring and support mechanisms | Implement systems to track waste exchanges, compliance, and provide data for improving practices. |
| "Materials-as-service" economic model | Explore leasing models for mining materials, allowing mining companies to track and manage materials more effectively. |
| Public awareness campaigns | Raise awareness about the environmental and economic benefits of waste-derived products to change public perception and increase acceptance. |
| Clear regulatory frameworks for recycling | Introduce and enforce regulations that support recycling practices, such as mandatory recycling quotas and sustainability standards. |
| Market demand for recycled products | Create standards and market access initiatives for recycled products, enhancing consumer confidence in recycled goods. |
| Collaboration and partnerships (PPP) | Foster collaboration between industries, waste users, and suppliers to streamline waste exchange and scale recycling infrastructure. |

| | |
|--|--|
| Training and technical support for MSMEs | Offer training programs for MSMEs to help them adopt cleaner production techniques and more efficient waste use practices. |
|--|--|

Conclusions: Answers to the Research Question

The utilization of waste and by-product materials in Sub-Saharan Africa (SSA) presents both significant opportunities and persistent challenges for advancing the circular economy. On the positive side, sustainability and resource efficiency remain strong drivers, with businesses repurposing plastics, organics, and industrial by-products to reduce pollution and conserve resources. Examples include Hya Bioplastics, which converts water hyacinth into biodegradable products, and the Kampala Industrial and Business Park, where firms exchange materials like plastics and metals through industrial symbiosis (IS). Expanding IS research into sectors such as textiles, sugar, and oil refining could extend these benefits.

Economic incentives (e.g., tax breaks, grants, subsidies) and technological innovations also stimulate adoption. Initiatives such as ProTeen’s insect-based food waste recycling system highlight the role of research and development in creating value from waste. Collaborative models—including cross-sector partnerships (e.g., Amelia Agro Ltd.’s use of bagasse in farming) and public–private partnerships—further strengthen waste exchange. At the societal level, rising awareness of environmental and economic benefits is fostering demand for sustainable products and shifting consumer attitudes toward waste-derived goods.

Despite these drivers, numerous barriers hinder large-scale adoption. Economic constraints—including high costs of transportation, storage, and technology, along with limited financing for MSMEs—make waste utilization difficult, particularly for smaller firms. Logistical and infrastructural challenges, such as weak waste collection and poor transport networks, further restrict opportunities. Regulatory gaps—including weak enforcement, unclear waste ownership laws, and limited policies for mining waste—create additional disincentives. Technological and knowledge limitations also prevent firms from effectively processing complex or hazardous waste streams. Beyond technical issues, resistance to change, competition from cheaper imports, and the absence of certification systems undermine trust in waste-derived products.

To unlock the potential of waste utilization in SSA, future efforts must focus on strengthening regulatory frameworks, improving infrastructure, enhancing access to finance, and building technical expertise. Equally, research should address gaps in IS networks, waste stream valorization, and certification standards to increase trust and adoption. By overcoming these barriers, SSA can advance industrial symbiosis, scale circular economy practices, and move toward more sustainable and inclusive development.

Policy Recommendations

Develop Affordable and Durable Machinery

- Invest in local production or partnerships for cost-effective, durable waste processing equipment.
- Lowers barriers for small businesses and boosts efficiency. Provide Government Incentives
- Offer tax breaks, grants, and subsidies for businesses adopting recycling and waste utilization.
- Encourages transition to sustainable practices.

Foster Business Collaboration

- Create platforms/networks for industries, farms, and businesses to share waste, resources, and infrastructure.
- Reduces costs and drives innovation.

Strengthen Waste Collection & Sorting Systems

- Build efficient collection, sorting, and centralized exchange platforms (e.g., in KIBP).
- Ensures reliable supply of reusable materials.

Promote Awareness & Education

- Launch public campaigns to shift mindsets toward “waste-to-value.”
- Builds consumer trust and market demand for recycled products.

Support Research & Technological Innovation

- Increase R&D in waste processing for sectors like mining, agriculture, and manufacturing.
- Focus on safe, cost-effective solutions for complex and hazardous waste.

Strengthen Regulatory Frameworks

- Enforce clear rules: recycling quotas, use of recycled materials, and penalties for poor disposal.
- Provide sector-specific policies, especially for mining and agriculture.

Explore New Economic Models

- Implement “materials-as-service” models to encourage material sharing instead of hoarding.

- Promotes circular flows and reduces waste accumulation.

Support MSMEs with Finance & Training

- Provide micro-financing, low-interest loans, and technical assistance.
- Helps smaller businesses adopt cleaner, more efficient production.

Integrate the Informal Sector

- Invest in infrastructure, tools, and training for informal waste workers.
- Formal integration improves efficiency and scale of recycling.

Monitor & Support Waste Exchange Systems

- Track progress of waste exchanges, enforce compliance, and recognize top performers with certifications.
- Encourages best practices and boosts marketability.

Develop Clear Mining Waste Policies

- Set thresholds for repurposing mining waste (e.g., slag, tailings) into construction or road use.
- Reduces environmental risks and adds economic value.

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Under review

Buda, G. (forthcoming). The Promise and Challenges of Circular Economy in Ghana's Transition to a Green Economy

- Under review at Humanities and Social Sciences Communications (Springer Nature)

Buda, G. (forthcoming). Potentials and Challenges of Sustainability, Cleaner Production and Industrial Symbiosis in Uganda's Leading Industrial Park

- Under review at Sustainable Futures (Elsevier)