Circular Economy Policies and Innovations in Africa: Pillars for Achieving Sustainable Development

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Abstract

Africa is the fastest urbanising continent leading to increased consumption of resources and generation of waste. Studies indicate that by 2060, the continent's population will be approximately 2.8 billion. The increase in Africa's population will further increase consumption and production patterns. Therefore, the continent needs to shift from a linear economy to a circular economy that is a more economical and ecologically form of sustainable development. In Africa, a sustainable circular economy will include better-informed harnessing of resources and sound waste management to meet the population's needs and achieve several sustainable development goals (SDGs). This study relied on a desktop research design to gather well-grounded data on African circular economy policies and innovations. Data revealed that several African countries have begun strengthening their governance to initiate circular economy aspects in policies and innovations. For example, African governments empower youth and women groups, particularly from the slums and university scholars, to develop innovations to boost circular economy practices. Similarly, skilled experts are teaming up to form regional organisations like the African Circular Economy Network (ACEN) to promote waste management creativity and

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economic productivity. This paper ascertains that African governments have more opportunities to shift from a linear economy to a circular economy. The continent boasts of many skilled scholars, policymakers, and indigenous communities that can engage in a participatory approach to design effective policies and innovations that integrate circular economy practices that uphold the principles of sustainable development.

Keywords

Circular economy · Cleaner production · Industrial ecology · Sustainable development · Sustainability

4.1 Introduction

Contemporary development models are shifting towards the inclusion of sustainable development goal recommendations in policy and practice. However, the extent to which such propositions are implemented varies in countries and across sectors. To catapult sustainable development, governments must create a socio-economic atmosphere that allows access to technology and spearhead a culture of innovation. It is such initiatives that facilitate sustainable transitions towards a circular economy. Linear economy models focus on waste production, consumption, and generation, and not much effort is put into reducing waste.

On the other hand, a circular economy implies an economic system of production and consumption that targets to create further value from products through sharing, reusing, repairing, refurbishing, and recycling (Geissdoerfer et al. 2017). Such a system aims to ensure a product's extended life cycle and keep waste generation as minimum as possible. The circular economy system also constitutes many initiatives by different sectors to ensure that cumulatively more value is derived from products and efficiency is met across the cycle, from design, through production to consumption, than waste management. An interesting characteristic of a circular economy is that it goes beyond the economy and creates an equilibrium with other domains of development, such as the biophysical environment and society.

Within this framework, the principles of people, planet, and profit are derived to drive the private sector activities and enterprise. One of the critical factors to the success and adoption of a circular economy is embracing technology and innovation, but this should be carefully done to ensure optimal value creation.

4.1.1 Methodology

This study adopted a desk view research design. Desk view research design entails using existing scholarly data to find more information about the research phenomenon in question. This study incorporated peer-reviewed and credible secondary data to acquire more information about African circular economy innovations and

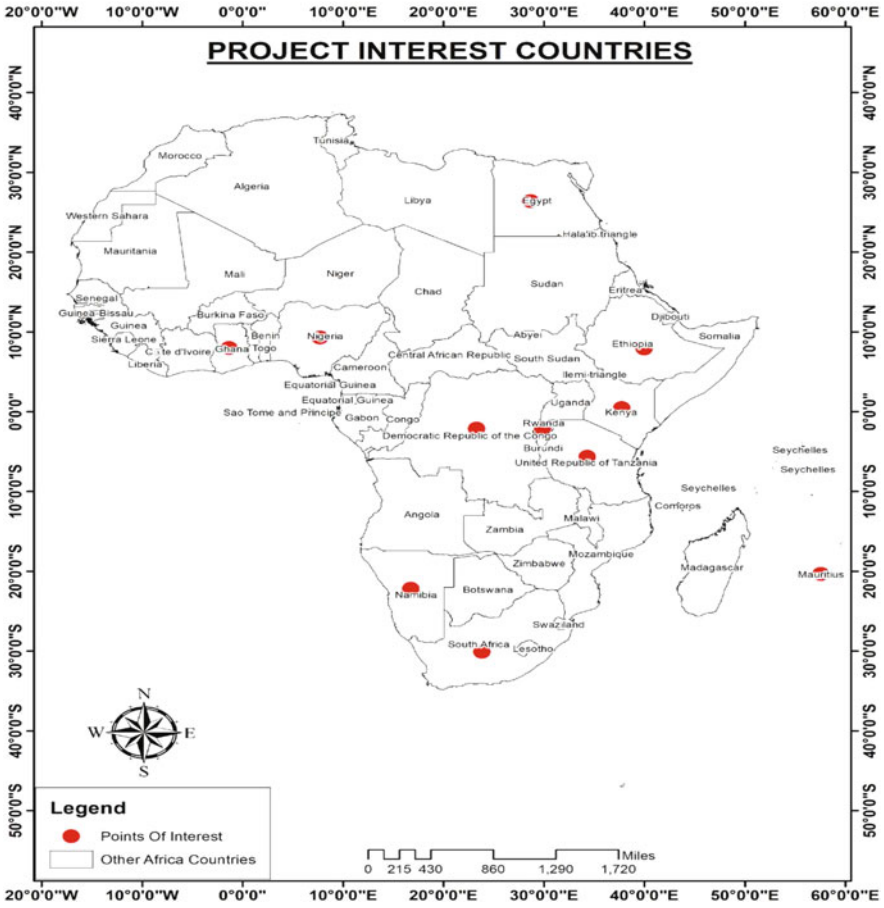

Fig. 4.1 Map of African countries. (Source: Authors)

policies. The secondary data sources were journals, books, periodicals, newspapers, government statistics reports, and credible internet sources. This research study was limited to funding. Thus, utilising a desk view research design was instrumental in cutting the cost as it promotes research using secondary data instead of fieldwork to collect raw information. The study utilised quantitative and qualitative data to provide more information about African circular economy policies and innovations. Figure 4.1 indicates the countries that this study examines. The countries include Kenya, Rwanda, Tanzania, Ethiopia, Mauritius, Egypt, Ghana, Nigeria, the Democratic of Republic of Congo (DRC), Namibia and South Africa.

4.2 Sustainable Development Goals and Circular Economy

In the twenty-first century, the globe began to realise that economic growth will lead to massive environmental risks. Rodríguez-Antón et al. (2022) note that their several earth summits were organised since 1972 with the assistance of the United Nations (UN) to provide space for world leaders to identify pathways for sustainable development. The global concern to stimulate sustainable economic growth led to the production of the Brundtland Report in 1987. The report brought to the limelight the term 'sustainable development' for the first time (Rodríguez-Antón et al. 2022). The Brundtland Report of 1987 underpinned global efforts to rethink economic development practices and policies that champion the reduction of ecological destruction.

In September 2001, the UN mandated the 'Declaration of the Millennium' to protect humanity and promote international relations (Fehling et al. 2013; Rodríguez-Antón et al. 2022). Fehling et al. (2013) pinpoint that the 'Declaration of the Millennium' brought about the Millennium Development Goals (MDGs). The MDGs were a list of common targets for the globe to attain by 2015 voluntarily (Lomazzi et al. 2014). Rodríguez-Antón et al. (2022) highlight that in 2015 the UN approved the 'Agenda for Sustainable Development' that paved the way for the SDGs generation. The SDGs have targeted measures to guide humankind to shit to environmentally-friendly practices. The implementation of the SDGs calls for a participatory approach and collective action that allows various stakeholders to share knowledge resources and actively cooperate in implementing sustainable practices.

One of the measures to assist the global community shift to sustainable practices is responsible consumption and production, specifically circular economy. Sutherland and Kouloumpi (2022) note that aligning circular economy to sustainable development is a transformational shift towards creating liveable spaces. Research indicates that a circular economy is linked to several SDGs such as Goal 6-*clean water and sanitation*, Goal 7-*affordable and clean energy*, Goal 8-*decent work and economic growth*, Goal 12-*responsible production and consumption,* and Goal 15-*life on land* (Schroeder et al. 2019). In addition, Schroeder et al. (2019) point out that a circular economy has the potential to support the achievement of more social SDGs such as SDG 1-*no poverty*, SDG 2-*zero hunger*, SDG 3-*good health and wellbeing*, SDG 5-*gender equality*, and SDG 10-*reduced inequalities*.

An in-depth literature analysis reveals that the two variables, circular economy and SDGs, have a significant positive relationship (Valverde and Avilés-Palacios 2021). The two concepts are intertwined as a circular economy positively impacts humanity to transition to healthy living spaces that create an equilibrium between economic, social, and environmental pillars of development. Individuals, companies, and countries are incorporating circular economy practices and SDG recommendations into their practices and operations to have a competitive edge in ecological protection, innovations, and employment creation to boost living standards. Data indicate that Africa lags behind in the industrialisation sector and economic growth than Asia and the Pacific region (Andersen et al. 2021). However,

many African countries have begun implementing and targeting rapid industrialisation policies and practices to spur economic growth (Opoku and Yan 2019).

The massive industrialisation across the continent provides an opportunity to integrate circular economy practices and SDGs' recommendations into policies, strategies, action plans, and operations. The African circular economy is recognised as a vibrant and innovative system providing circular solutions mainly inspired by waste management conditions. Policymakers in the continent discern that intertwining circular economy and SDGs into national development will play a crucial role in attaining broader sustainability goals and objectives (Anderson 2021; Ellen MacArthur Foundation 2021). However, since the continent is still in rapid economic development, there is still a great opportunity for adopting more effective and sustainable practices to create a resilient social and environmental living space.

4.3 Opportunities and Importance of Circular Economy Policies and Innovations

A Circular Economy is an economic model whose main objective is to produce goods and services in a sustainable way by limiting the use of waste and raw materials as well as the production of waste. A circular economy aims to use waste and recycle them into raw material for product remaking and to be used for other purposes. A circular economy applies the principles of a green economy, industrial ecology, and eco-design (Klein et al. 2013).

CE involves reusing/redesigning waste materials to make them longer lasting and reusable. This approach also helps in keeping away waste from landfills and also trying to recover valuable resources. According to Klein et al. (2013), CE is an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes. It is a system that aims to accomplish sustainable development that eventually creates environmental quality, economic prosperity, and social equity to the benefit of current and future generations (Klein et al. 2013).

The CE is a relatively new concept in Africa and will benefit the countries on the continent. This has a promising opportunity for the economic perspective that includes creating job opportunities for the youth. CE will also create environmental opportunities to be practised that promote environmental sustainability (Stubbs 2019). A circular economy is crucial for African countries because of its economic and environmental impacts on the continent. Some African countries have already implemented strategies that are in line with CE by developing a green economy that will feed into it. Examples of these countries are Kenya and South Africa, whose case studies will be discussed below.

4.3.1 Importance of Circular Economy

CE is essential in breaking the linear economy already affecting the planetary boundaries by exceeding it (IRP 2017). CE, however, is based on achieving both environmental and economic benefits. The impact it will have in Africa is predominantly aimed at reducing poverty, environmental pollution, and inequality, which are some of the sustainable development goals. Recent research demonstrates a positive relationship between a circular economy (CE) and achieving some sustainable development goals (Valverde and Avilés-Palacios 2021). Schroder et al. (2019a, b) established a strong relationship between CE and SDGs 6, 7, 8, 12, and 15 and further argued that indirect relationships exist among the other SDGs. For example, the achievement of SDG 6 on the improvement of clean water and sanitation establishes good health and wellbeing (SDG 3). On further examination, we find that achievement of SDG 8 positively impacts SDG 1, 2, 3, 4, and 5.

Despite the progress towards achieving economy-related targets by 2030, the sustainability of cities and communities lags behind (Sutherland and Kouloumpi 2022). The duo advances that "...the circular economy comes in: by circulating resources multiple times, the circular economy tackles issues of scarcity and allows all to access what they need—without overburdening the earth...".

A circular economy has a higher chance of reducing costs and preventing market price fluctuations (Ellen MacArthur Foundation 2013). Through using the five Rs (reduce, refuse, re-use, recycle, repurpose), the same products will be reused to prevent waste, thereby reducing the expenditure of purchase and disposal. This will encourage the stability of products manufactured in African countries. Products can be put in a production cycle to recycling to avoid waste from the industries being released into the environment. These innovations will also create an enabling opportunity for the creation of employment in the continent.

A circular economy will encourage the use of renewable energy since the materials meant for disposal can be used as an alternative source of energy (Ellen MacArthur Foundation 2013). This will also encourage the creation and innovation of new products that can be used as energy sources instead of the natural methods we use, such as wind. Through having several energy sources, fossil fuel use can be reduced, thus cutting down on the amount of pollution in the continent. Having alternative sources of energy will also heavily help in cutting down on overdependence on using charcoal, firewood, and deforestation in the long run.

A circular economy can potentially address poverty reduction in the continent by providing a route to supporting the human development of African countries through the CE 2.0 framework. This will be done by creating employment and designing profitable business models for the continent (Schröder et al. 2020). The innovations that would be encouraged will be a window of opportunities for individuals to develop their self-sufficient way of earning a living and improving their livelihood. Job creation in the continent is essential to reduce the number of unemployed people and reduce the high poverty rates in the continent at large. This will help raise the economic status of the countries.

A circular economy can potentially improve people's livelihoods in developing countries. This can be done by creating more sources of employment opportunities and creating an enabling environment through encouraging innovations (Fernandes 2016). Having more employed people will be beneficial in raising the economic status of the country, reducing poverty levels, reducing crime rates, and also ensuring general economic growth for the continent.

A circular economy will provide a chance for other economic issues such as waste management, disposal of electronic waste, energy needs (including the use of renewable energy), poverty reduction, and job creation (Gower 2016). These issues have been dealt with in a linear manner, thus causing their management to go out of hand. For example, waste management in most African countries usually depends on getting rid of the waste in sanitary landfills or burning. This has proven to have negative impacts such as pollution, loss of aesthetic value, and making land to be unable to be used. CE will provide an opportunity to reduce the amount of waste being thrown away by prolonging the use through recycling, thereby helping solve one of the most important environmental issues, pollution.

4.4 Circular Economy Innovation Policies in Africa

4.4.1 Overview of Circular Economy Policies and Innovations in the Continent

According to Braun and Toth (2020), the circular economy in Africa has been implemented as a restorative process of transforming the traditional approaches of economic production and general consumption into new systems that seek to prioritise environmental conservation goals. As a result, the continent is focusing on adopting circular economy innovations that have proven to create value in different aspects of business operations, with the main considerations of the start-ups and SMEs, attracting investors to support the sustainable development within the region. In the process, leveraging FinTech and sustainable financial support has been observed as a key element towards the continent's circular economy innovation growth (Ghosh 2020). Similar views by Bag et al. (2020) indicated that most African countries seek to intensify their industrialisation while pursuing green growth to improve competitive growth, hence, considering a circular structural change. In the process, the continent perceives the resource supply as a more important incentive than cutting costs. Therefore, the African continent is currently transforming its operational strategies to support a circular economy.

Ramakrishna et al. (2020) noted that implementing a circular economy in Africa faces financial challenges, which creates limitations towards attaining sustainability goals. As a result, there is poor resource planning and utilisation, leading to reduced launching of innovations in the country. Some African countries have failed to attain the circular economy goals because of the capacity variations that affect the process of implementing circular economy practices. Lack of sufficient capacity has also forced some African nations to adopt sub-standard solutions that have long-term

costs. Ghisellini and Ulgiati (2020) noted that the capacity limitations had affected the reliability of the decisions made by the leadership teams because their decision-making process is influenced by the prevailing resource capacity characteristics. However, Schröder et al. (2020) recommended that proper planning provides a key mechanism towards the formulation of solutions that can receive external support, hence, helping the continent attain sustainability.

Resistance from the top country leadership creates a barrier towards the execution of sustainable goals in the market (Ramakrishna et al. 2020). Some African leaders lack sufficient understanding about the need and impacts of adopting circular economy practices, hence, leading to reduced support of the efforts in place. Some national leaders expected to support the circular economy initiatives have underlying personal interests that affect the general effectiveness of policy formulation and the implementation exercise. However, Ghosh (2020) argued that lack of support has mostly emanated from the overreliance of the African economy on the extractive industry, which is the key point of transformation before the achieving of the circular economy within the area. As a result, the industry provides a source of income to most citizens and the country in general through employing most skills within the nation (Schröder et al. 2020). In the process, efforts to adopt new strategies in support of the circular economy implementations that counter the lucrativeness of the extractive industries often lead to resistance. Therefore, the overreliance on this sector leads to increased resistance from the citizens, political leadership, human rights groups, and other beneficiaries of the companies, which creates a barrier towards the execution of the desirable circular economy factors within African countries.

Tudor and Dutra (2020) stated that the adoption of circular economic innovations has aided to open up better development avenues in host African states, confining to sustainable characteristics of resilience and resourcefulness, thus, leading Africa to a prosperous, equitable, and flourishing circular economic continent. The solutions provided with the circular economy help to improve efficiency, create time-saving models, and increase the general productivity of industries while at the same time improving resource sustainability. Conversely, Imoniana et al. (2021) argued that the African continent stands a better chance to utilise this innovation due to its low economic footprint. The diversity of natural resource capital and potential infrastructural adaptability make this region better in advancing this innovation.

Pizzi et al. (2020) revealed that since circular economic innovation was launched in the continent, there has been significant economic growth, job creation, and other sustainable environmental outcomes. The expansion of use and research on this innovation in the continent has further promoted the preservation of production capacity of critical resources, shaping existing investment policies, and improved employability in the informal economic sector (Imoniana et al. 2021). Ghisellini and Ulgiati (2020) also confirmed that circular economy provides both long-term and short-term benefits towards enhancing the continent's well-being both directly and indirectly, hence, improving the general living standards of the people and the resource sustainability for economic improvement. Therefore, a circular economic

trend has transformed the existing economic patterns in the continent by creating new jobs through the sustainable use of available natural resources.

According to Skrinjaric (2020), the common circular economy policy implementation approach is the mapping of the existing initiatives into the circular system and the execution of the strategies to transform the economy. In the process, the future skills and jobs are mapped to sustainability to ensure that the continental operational activities make both direct and indirect contributions towards supporting the desired circular economy goals. Braun and Toth (2020) added that the effectiveness in the coordination of the regional and national leadership provides suitable mechanisms for supporting the adoption of the strategies of a circular economy.

Contrarily, Ghisellini and Ulgiati (2020) noted that considering the fact that the strategies adopted within the continent towards the supporting circular economy are voluntary and not compulsory, there is a high likelihood that the initiatives cannot be prioritised appropriately to support the goals. Similarly, the central played by the national leaders towards the implementation of the circular economy policies has affected the general effectiveness of the policies, leading to an increased chance of influence of political forces that increase the challenges of attaining the set goals (Braun and Toth 2020). Politics and lobbying practices are influential and affect the reliability and trueness of the sustainability decisions made by the country. Therefore, the implementation of sustainable practices through policy formulation provides a better and improved way of attaining the circular economy goals.

4.4.2 Various Continental Blueprints Like Agenda 2063, Trade Agreement, and National Circular Economy-Related Policies

Research indicates that Africa is the fastest urbanising continent in the world. The continent will have over four billion people by 2100. A significant number of the population will reside in urban areas. The continent will also experience a huge physical and landscape transformation due to the construction of major industrial plants, transportation networks, and housing to drive economic and social growth. Several governments recognise that there is an urgent need to enact circular economy policies to achieve urban sustainability. African governments are ratifying Multilateral Environmental Agreements (MEAs) such as the United Nations Paris Agreement and sustainable development goals (SDGs) to formulate national circular economy policies (Andersen et al. 2021). African governments with circular economy policies also aim to initiate smart green technologies to address severe environmental challenges like climate change and unsustainable waste management. This research discusses circular economy policies from Ethiopia, Ghana, Rwanda, Namibia, Nigeria, South Africa, and Kenya.

4.4.2.1 Agenda 2063: The Africa We Want

Africa's Agenda 2063 is a major blueprint that guides the continent to initiate sustainable economic growth and inclusivity (African Union Commission 2015). Agenda 2063 demonstrates the Pan-African unity of nations to collaborate in

achieving sustainable economic development, freedom, and inclusion of all women, youth, and other vulnerable groups in development projects. The primary purpose of creating Agenda 2063 was to help nations cope with global economic activities in the post-colonialism era, which was the main advocacy of the Organization of African Unity (OAU) before transforming into the African Union (AU). Agenda 2063 was also created as a result of frustrations and a lack of sustainable economic and social initiatives in the continent compared to other developed areas like Europe, North America, and Parts of Asia. Over the years, some of the countries in the region have been relying on *foreign* aid, either food or monetary. Agenda 2063 will play a significant role in helping countries to become dependent rather than relying on foreign aid and innovations.

Therefore, Agenda 2063 aims to transform the continent into a global sustainable economic and prosperous social region within 100 years after the formation of the OAU (African Union Commission, 2015). The blueprint's vision is "to become an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the international arena" (African Union Commission 2015). The blueprint was adopted in 2015 during the 24th African head of states and AU leaders' assembly in Addis Ababa. However, the first advocacy for the formulation of a continental blueprint was first discussed with the head of government and AU representatives in 2013. The AU is tasked with monitoring and guiding African nations with the implementation of Agenda 2063.

Agenda 2063 will play a significant role in promoting circular economy activities and aspirations (African Union Commission 2015). One of the aspirations of the blueprint is a creation of a prosperous continent that incorporates sustainable development. The aspiration's main goals are transforming economies, adopting modern agricultural technologies, promoting blue economy, enhancing the health of the citizens, and educating and training citizens to develop scientific-technological innovations. In goal number one on the transformation of economies, Agenda 2063 guides African countries to empower industries to adopt circular economy innovations that transform waste into a raw input for the production of other products (African Union Commission 2015). African industries are encouraged to invest in research and development to create a chance for workers to develop new technologies to manage solid waste and wastewater treatment. The transformation of economy goals creates a chance for manufacturing and industrialisation plants in the continent to adopt cleaner production and industrial ecology ventures to reduce carbon emissions and industrial effluents that threaten aquatic ecosystems. Solid waste recycling and wastewater treatment also play a critical role in strengthening the economic growth of the region. Circular economic activities such as recycling waste and innovations create employment opportunities for citizens, improving their living standards.

The adoption of modern agricultural technologies goal of Agenda 2063 creates a platform for African governments to transform their crop production strategies (African Union Commission 2015). The goal requires governments to empower their citizens in developing agricultural technologies that reduce ecological damages. Agricultural activities must display a harmonious relationship with nature

through activities such as reducing air pollution from farm inputs like insecticides and herbicides. Farmers must also maximise using organic waste to create manure rather than relying on inorganic fertilisers that cause harm to soil microbes and reduce soil quality. The adoption of modern technologies allows governments and farmers to engage in sustainable waste management using circular economy strategies.

The promotion of the blue economy goal promotes African governments to ratify Agenda 2063 and initiate activities such as a waste collection of plastic bottles and papers that are increasing in oceans (African Union Commission 2015). Agenda 2063 recognises the blue economy as a major economic factor that must be sustainably managed to enhance the survival of aquatic organisms to boost food security and protect coastal areas from extremes of climate change, such as coastal flooding.

Agenda 2063s goal of enhancing the health of the citizens advocates for sustainable management of ecological resources to create a conducive living environment with clean water, air, and smart green technologies. The goal encourages the implementation of renewable energy such as wind power, solar energy, and the generation of electricity from tidal waves. The goal also encourages the use of organic waste to generate biofuel to boost lightning and harmful elimination sources of energy like charcoal that emit carbon dioxide. In most urban areas in the continent, like in Mukuru slums and Kibera, there has been the establishment of biofuel generation plants to manage organic waste collected within Nairobi City. The goal of enhancing the health of the citizens is also promoted through wastewater treatment. After treating wastewater, clean water is piped back to households to help them access water for domestic use and promote hygienic conditions. Agenda 2063 goal of education and training of citizens to develop scientific-technological innovations empowers people to develop new initiatives to manage solid waste, wastewater, and promote the transformation of urban areas into ecocities.

4.4.2.2 Climate Resilient Green Economy Policy in Ethiopia

Climate Resilient Green Economy (CRGE) is the main circular economy policy in Ethiopia (Albagoury 2020). CRGE was initiated in November 2011 and aimed to transform the country's traditional linear economy into a circular economy. The ministry of environment in Ethiopia is tasked with implementing CRGE (Albagoury 2020). The primary purpose of CRGE is to reduce the effects of extreme climate change through the adoption of renewable energy. Thus, by the end of 2025, which is the end of implementing CRGE, Ethiopia will be a middle-income economy with higher resilience to climate change impacts and reduce emissions of GHGs. The CRGE draws support from three major national documentations, the Climate Resilience Strategy for Agriculture, Ethiopia's Programme of Adaptation to Climate Change (EPACC), and the Green Economy Strategy ("Ethiopia's Climate Resilient," n.d.).

The CRGE is built on four main circular economy strategies. The first pillar is the protection of forest reserves which act as carbon stocks and aesthetic value. Ethiopian government aims to reduce overexploitation of forest resources by encouraging industries to use alternative raw materials such as using plastic waste to make

fencing poles. CRGE also encourages industries and citizens to a mixture of timber waste such as sawdust and cow dung to produce briquettes (Barbre 2013). The policy also plays a significant role in using organic waste from coffee which is a major cash crop in Ethiopia, to produce biofuels to reduce the cutting of trees to make charcoal or firewood.

The second pillar of CRGE is an improvement of agricultural activities such as livestock keeping and crop production ("Ethiopia's Climate Resilient," n.d.). This second pillar aims to ensure that agricultural activities in Ethiopia have lower GHG emissions. The ministry of environment in Ethiopia recognises that agricultural transformation is a major factor towards achieving a green economy ("Ethiopia's Climate Resilient," n.d.). Thus, the government will empower large-scale and small-scale farmers to make organic waste from biodegradable farm waste to reduce the use of inorganic chemicals like insecticides, herbicides, and fungicides that cause air pollution and emission of aerosols that deplete the ozone layer, causing an increase of temperature.

Expansion of renewable energy production is the third pillar of CRGE. CRGE advocates for the efficient utilisation of resources to achieve environmental, social, and economic growth. CRGE policies create a platform for Ethiopia to initiate renewable energy initiatives such as generating power from waste in Koshe dumpsite. The policy empowers waste collectors in Addis Ababa and other major urban centres in the country to collect waste and transport it to Koshe dumpsite for power generation ("Ethiopia's Climate Resilient," n.d.). Thus, instead of disposing of waste in landfills and other open dumpsites, it is widely used as raw input for the generation of renewable power.

The fourth pillar is the adoption and promotion of smart and green technologies in the transportation sector, industrial plants, and construction of housing structures ("Ethiopia's Climate Resilient," n.d.). CRGE policy ensures that Ethiopia initiates strategies to replace the use of fossil fuels in automobiles, industries, and construction. One of the major achievements due to circular economy policy in Ethiopia is the production of the first locally assembled electric car (Tekle 2020). The first electric car was due to collaboration between a renowned Ethiopian athlete, Haile Gebreselassie, and South Korean motor company Hyundai. CRGE aims to initiate several innovations to achieve sustainability in the transportation sector, industries, and housing.

4.4.2.3 Plastic Bag Law 57 in Rwanda

The Plastic Bag Law 57 of 2008 is the major circular economy-related policy (Danielsson 2017). The law prohibits the manufacture, sale, and use of plastic bags. The Rwandan government recognises environmental conservation and protection as a major priority to achieve economic and ecological sustainability. Article 22 of Rwanda's Constitution states that citizens have the right to reside in a hygienic environment. Rwanda was the first country in the East African Community (EAC) to ban the use of single-use plastic bags (Mugisha 2020). Individuals with a higher stock of plastic bags were given 3 months to sell their products. Plastic Bag Law

57 of 2008 prohibits the use of plastic straws, containers, plastic packaging materials, and plastic cutlery.

Plastic Bag Law 57 of 2008 also applies to foreign visitors prohibiting the importation of plastic bags into the country. Plastic bags are confiscated at various entry points such as airports for recycling. The Plastic Bag Law 57 of 2008 allows companies like Ecoplastic in Rwanda to collect confiscated plastic bags and plastic waste such as bottles and use them to produce construction materials. According to Tasamba (2020), in Rwanda, there are various waste recycling plants that transform plastic waste into tiles and roofing materials. Existing plastic waste in Rwanda is also transformed into fibres to make clothing.

4.4.2.4 Green Economic Coalition Dialogue (2011)-Related Circular Policy in Namibia

The Green Economic Coalition Dialogue in Namibia was initiated in 2011 to help the country transform into a circular economy (Desmond and Asamba 2019). The dialogues were supported by Deutsche Gesellschaft (GIZ). Namibia's ministry of labour and social welfare is tasked with the implementation of the policy by creating practical activities from the dialogues. The primary purpose of the Green Economic Coalition Dialogue is reducing industrial waste, enhancing recycling, and initiating renewable energy projects (Desmond and Asamba 2019). The Namibian government, through the Green Economic Coalition Dialogue, offers loans to individuals and companies to initiate renewable energy technologies (GIZ 2013). The loan is commonly referred to as the Solar Revolving Fund. The Green Economic Coalition Dialogue promotes Community Based Natural Resource Management in Namibia, allowing the production of renewable energy from biomass such as the Jatropha plant and bioethanol-containing materials (GIZ 2013). The promotion of renewable energy production by the Green Economic Coalition Dialogue plays a significant role in reducing disposable waste and maintaining the aesthetic value of the ecological surroundings. The Green Economic Coalition Dialogue also creates a chance for industrial plants to reduce harnessing of raw materials and use waste materials as a substitute for raw inputs.

4.4.2.5 National Environmental Management Act (1998) in South Africa

The National Environmental Management Act (1998) was adopted in 1998 by the South African government. The National Environmental Management Act is abbreviated as NEMA, which promotes the enforcement of section 24 of the country's constitution. The ministry of environment in South Africa is tasked with the implementation of NEMA. NEMA's primary objective is reducing waste pollution and enhancing sustainable utilisation of ecological resources (Desmond and Asamba 2019). NEMA promotes the implementation of 3R programs of waste management, recycling, reusing, and reduction. For example, NEMA promotes recycling initiatives such as using old plastic bottles to establish small urban agricultural crops to boost food security in unplanned settlements. South Africa's NEMA also empowers the creation of state agencies such as the National Environmental Advisory Forum and the Committee for Environmental Coordination under

sections three and seven, respectively (FAO n.d.). The state agencies play a significant role in enforcing environmental initiatives to reduce waste. NEMA also creates a platform for the creation of public-private partnerships to engage in informed decision-making about waste reduction initiatives in industries and urban areas.

4.4.2.6 Extended Producer Responsibility Programme (2013) in Nigeria

Desmond and Asamba (2019) note that the main and most efficient circular economy policy in Nigeria is the Extended Producer Responsibility Programme of 2013. The policy is governed and enforced by the National Environmental Standards and Regulations Enforcement Agency. The primary goal of the policy is to reduce industrial effluents, waste and promote recycling (Desmond and Asamba 2019). Nigeria has been facing an increased generation of Electric and electronic waste that has harmful substances that pose health and safety risks to humans, fauna, and flora (Woggsborg and Schröder 2018). The Extended Producer Responsibility Programme in Nigeria allows producers of e-waste to showcase financial of physical responsibility in managing the waste after the consumption stage. Nigeria's Extended Producer Responsibility Programme creates a platform for e-waste producers to recycle used materials to create new materials and reduce improper disposal of hazardous substances in the environment. Producers of e-waste in Nigeria have recycling targets that must be met to promote circular economy activities. The Extended Producer Responsibility Programme allows e-waste producers in Nigeria to meet the recycling fees and other taxes to eliminate the accumulation of waste in the environment (Woggsborg and Schröder 2018). Thus, the Extended Producer Responsibility Programme promotes healthy living due to the elimination and reduction of harmful e-waste in living spaces.

4.4.2.7 Egypt Vision 2030

Egypt's Vision 2030 is also referred to as the sustainable development strategy (SDS). The policy framework was adopted in February 2016 with the aim of guiding the country to achieve sustainable development (Egypt Economic Development Conference 2015). Egypt Vision 2030 focuses on improving the environmental, social, and economic dimensions. The enactment of the policy was due to motivation from ancient Egyptian civilisation to engage in effective planning of future developments. One of the focal areas of Egypt's Vision 2030 is an investment in reliable renewable energy (Egypt Economic Development Conference 2015). The policy advocates for the use of plastic waste and organic waste to generate electricity. The ability to use waste as raw inputs in the power-generating plant will play a significant role in reducing the accumulation of waste in urban areas and vital ecological resources like the River Nile. Egypt Vision 2030 also empowers the national and regional administrations to invest in wastewater treatment and reuse (Egypt Economic Development Conference 2015). Treating wastewater and providing it back to the citizens as clean water will address water shortage issues that the country faces which hinder the achievement of an ideal hygienic condition in some unplanned settlements like in Ezbet El Haggana slums.

4.4.2.8 Maurice Ile Durable (MID) Sustainable and Circular Economy Concept in Mauritius

Mauritius launched the MID in 2008 with the purpose of guiding the country to achieve sustainable development through circular economy initiatives (Ministry of Environment and Sustainable Development 2013). The MID promotes a reduction and sustainable harnessing of natural resources to reduce extinction and overexploitation. Mauritius also utilises MID to empower citizens to create smart green technologies to tackle waste challenges (Teeluck et al. 2013). One of the major goals of MID is sound environmental management through investment in renewable energy and the elimination of fossil fuels. The concept advocates for the use of biomass waste generated from its urban areas to generate electricity and reduce carbon emissions from fossil fuels. The promotion of environmental goals leads to a significant reduction of the country's ecological footprint due to overexploitation of scarce natural resources. MID advocates for the use of waste materials to be used as raw materials in the production of products to reduce overexploitation of natural resources (Ministry of Environment and Sustainable Development 2013). Mauritius' MID aims to help the country achieve zero waste generation as it will be utilised to make products and generate electricity. The MID also promotes the polluter pays principle, forcing individuals and companies that generate waste to meet the cost of collection and cleaning the environment (Teeluck et al. 2013). Thus, a significant number of individuals and companies in Mauritius undertake recycling measures to avoid paying fines or subjecting their workers to environmental clean-ups due to improper waste disposal.

4.4.2.9 Kenya Circular Economy-Related Policies

Solid waste management has always been a challenge in Kenya. In Nairobi, dumpsites like Dandora are being used for disposal while most waste is disposed of illegally or burnt. These dumpsites are unsanitary, unplanned, and not operated on systematically. This eventually has led to air, water, and soil pollution, thereby causing health and environmental problems (Soezer 2016). Some recycling companies have started recycling plastics into building materials, furniture, and other artefacts (Koech and Munene 2020). This has created a method of reusing plastics that harm the environment and also coming up with a sustainable method of maintaining it through using it as a building material. As a result, this has helped the economy by improving the living standards of the citizens through job creation opportunities. It is also environmentally beneficial since it reduces the pollution of plastic waste (Desmond and Asamba 2019).

E-waste is among the fastest-growing waste in Kenya and the world. This is due to the importation of cheap phones from Asian countries that do not last for long (Desmond and Asamba 2019). E-waste is a serious threat due to its components which include a mix of plastics, chemicals, heavy metals, and radioactive elements, which can be harmful to human health and the environment if not properly handled. Circular economy innovations will also create an opportunity for the proper collection, disposal, and recycling of e-waste. It also provides for improved legal and administrative co-ordination of the diverse sectoral initiatives in the management of

e-waste as a waste stream in order to improve the national capacity for the management of e-waste (National Environment Management Authority 2017).

Vision 2030-Kenya

Kenya's Vision 2030 is a blueprint to guide the implementation of sustainable development projects (Government of the Republic of Kenya 2007). The blueprint aims to transform the Kenyan economy into a global competitor in economic, social, and environmental innovations as well as achieving high life quality. Vision 2030 promotes the implementation of environmental-friendly industries that maximises ecological conservation, social and economic growth. The blueprint also advocates for inclusivity of public sectors, private entities, and citizens in engaging in sustainable development projects that focus on renewable energy, conservation of blue economy, and shift to sustainable consumption and production patterns (Government of the Republic of Kenya 2007).

The social pillar of Kenya's Vision 2030 that promotes economic empowerment and investment of people is a major step in initiating circular economy practices. The primary purpose of the social pillar is to improve the citizens' life quality to promote a clean and secure living setting. The social pillars create a platform for citizens to receive training on water and sanitation, environment, health, urbanisation, and gender inclusivity (Government of the Republic of Kenya 2007). The training occurs in Technical, Vocational Education, and Training (TVET) learning institutions. In the TVETS, leaners are trained to innovate practical activities to transform waste such as sawdust, scrap metals, and greywater into raw inputs for processing other usable products. In Kenya, TVETs are devolved to ensure there are circular innovations in every county and create a chance for a vast number of citizens to join the training.

Kenya's Vision 2030 also has an economic pillar that aims to achieve economic growth of 10% per year and maintain the rate until 2030 (Government of the Republic of Kenya 2007). Economic pillars allow the country to initiate circular economy practices such as empowering Community-Based Organisations (CBOs), women, youth, and vulnerable groups to engage in transforming plastic waste into horticultural crops trays, clothing fibres, building materials, and decorations (Government of the Republic of Kenya 2007). The ability of the CBOs and vulnerable groups to engage in income-generating activities boosts the Kenyan GDP as people can afford monetary resources to improve their living conditions. Waste recycling and transformation also play a significant role in reducing unemployment rates in the country and provide revenues to the government to kick-start development projects. Thus, the economic pillar of Vision 2030 allows the investment of circular economic activities to increase the disposable income of the citizens and boost economic growth.

Vision 2030 also presents the enablers and macro pillar that is cantered on constructing world-class infrastructural developments (Government of the Republic of Kenya 2007). The pillar will allow the construction of nine wastewater treatment facilities and nine solid waste collection and recycling plants in most Arid and Semi-Arid Lands (ASALs). Wastewater and solid plants will reduce the country's

ecological footprint of generating and disposing of waste in the environment. The enablers and macro pillars also promote rain harvesting to improve water availability to the citizens.

Nationally Appropriate Mitigation Action (NAMA): Circular Economy Municipal Solid Waste Management Approach for Urban Areas-Kenya

This policy is commonly referred to as NAMA, whose primary purpose is to promote sustainable development, and reduce environmental and carbon footprints (Ministry of Environment and Natural Resources n.d.). NAMA policies incorporate technologies, financial resources, and private and public partnerships to invest in sustainable development practices. The Kenyan government implements NAMA regulations and recommendations through the United Nations Development Programme (UNDP). NAMA plays a critical role in promoting the waste value chain. The two main objectives of NAMA are the establishment of waste recycling infrastructures and partnerships between the public and private sectors to maximise waste recycling. Public and private partnerships will involve collaborations between the National Environment Management Authority (NEMA), Kenya Bureau of Standards (KEBS), Energy and Petroleum Regulatory Authority (EPRA), county governments, CBOs, waste collectors, and Non-Governmental Organizations (NGOs) (Ministry of Environment and Natural Resources n.d.).

Instead of completely disposing of waste in landfills and collection waste, NAMA plans to help Kenyan authorities to divert 90% of waste to the recycling facilities (Ministry of Environment and Natural Resources n.d.). NAMA policies and recommendations also aim to help the country to set up several waste recycling plants in urban areas to reduce littering and discharge of effluents into the environment. In the solid waste and wastewater treatment facilities, there is the production of organic fertilisers from the organic waste. The implementation of NAMA allows the establishment of small-scale and medium-scale recycling industries within Nairobi that helps to reduce the amount of waste disposal.

NAMA recommendations draw support from multilateral environmental agreements such as the Paris Climate Agreement to help Kenya reduce emissions of GHGs and initiate climate change mitigation measures. Kenya is a signatory to the United Nations Framework Convention on Climate Change. Thus, NAMA creates a platform for Kenya to shift to use generation of power from waste to reduce the use of fossil fuels that accelerates global warming and climate change.

4.5 Case Studies on Circular Economy Innovations

4.5.1 The Case Studies of Circular Economy in Africa Using Eastern and Central Africa, Southern Africa, West Africa, and Northern Africa

Over the years, African countries have been lagging behind industrial and economic growth (Andersen et al. 2021). Research indicates that between 2008 and 2011, the percentage of average job opportunities in African industries was 12.48% compared to Asia's at 22.48% (Andersen et al. 2021). However, in the recent past, there has been an increase in economic growth and industrialisation in the continent. Several African countries are facing a massive transformation in the agricultural sector, housing, and urbanisation. African governments and the AU are ratifying international multilateral environmental agreements such as the Paris Climate Agreement, the United Nations Convention on Biological Diversity (UNCBD), Basel Convention, and Agenda 21 of Rio Summits to develop practical activities to manage waste from rapid economic and industrial growth. Therefore, several African countries have initiated circular innovations to reduce disposable waste. This paper discusses examples of circular innovations from Eastern and Central Africa, Southern Africa, West Africa, and Northern Africa.

4.5.1.1 Mazzi Can in Tanzania

Mazzi Can is a high-quality plastic container that helps farmers in Tanzania store and transport milk (Becon 2016). A significant number of farmers in Tanzania use plastic bottles to transport milk to processing plants and customers. The use of plastic bottles presents an unhygienic condition of handling milk that increases the number of harmful microbes in milk. Using plastic bottles to transport milk also leads to the manufacture of single-use plastic packing materials to meet the high demand. Thus, the Tanzanian government, through a collaboration of Global Good Company and Bill and Melinda Gates Foundation, launched the Mazzi Can (Becon 2016). The Mazzi Can is a 10-l food-grade plastic material with a desirable opening to ensure easier packaging of milk and reduce the production of single-use plastic bottles used in milk transportation as shown in Fig. 4.2. Farmers in Tanzania supply milk to processing and buying centres using Mazzi Can and receive the container for reuse later. Yohannes (n.d.) highlights that Tanzanian researcher's highlight that the Mazzi Can plays a critical role in reducing harmful microbes in milk by over 76% and reduction of plastic bottle waste generation.

4.5.1.2 Construction Materials in Kenya

EcoPost is a private entity in Kenya that specialises in recycling plastic waste to produce construction materials (Koech and Munene 2020). The construction materials produced include plastic lumber used in fencing as shown in Fig. 4.3, among others such as tiles, plastic tables, and landscaping tools. EcoPost's plastic lumber is made of 100% recycled plastic waste. The company produces plastic

Fig. 4.2 Mazzi Can. (Source: Becon 2016)

Fig. 4.3 Fencing posts produced by EcoPost. (Source: EcoPost)

lumber posts of various colours such as black, brown, and grey, and a length of 15 ft. EcoPost states that there are no chemicals used in the production of plastic lumber.

EcoPost purchases plastic waste from various garbage collectors, women and youth recycling groups, learning institutions and collects plastic waste from major areas within Nairobi City County (Ronoh 2014). The company receives monetary and technical support from organisations like Coca-Cola, Bank of Africa, Safaricom Foundation, World Wildlife Fund (WWF), Bid Network, and Ocean Exchange. The construction materials made from plastic lumber are sold to Kenya Urban Roads Authority (KURA), Kenya Copyright Board, Pelican Signs, London Distillers and Urbanis Africa. EcoPost states that the production of construction materials has

reduced deforestation of close to 250 acres of forests and diverted over one million kilograms of plastic waste from landfills to a recycling plant (Ronoh 2014).

4.5.1.3 Organic Waste Briquettes in the Democratic Republic of Congo (DRC)

The DRC continues to face rapid deforestation as people harvest trees for export and commercial activities (Sow et al. 2020). Local communities that reside near forest reserves illegally cut trees to extract firewood leading to the loss of endemic flora species. Sow et al. (2020) note that deforestation in DRC is threatening the existence of Bukavu and Kahuzi Biega Park. The continual use of charcoal and firewood is also causing an increase in respiratory diseases in the country. A private investor from DRC, Murhula Zigabe, has initiated a circular economy initiative of producing organic briquettes as alternatives to charcoal and firewood (Sow et al. 2020).

Zigabe's company, Briquette du Kivu, collects organic waste from banana peels, corn and beans remain, and sugarcane bagasse from households. Briquette du Kivu collects between 300 and 400 kg in a week from households and streets (Lauvergnier 2018). Once the waste is dried, it is subjected to a carbonised furnace for combustion to generate powdery substances. The powdery substance is then mixed with water to create a paste that dries to briquettes as shown in Fig. 4.4. Briduette du Kivu sells their products at a lower price of 50 Congolese francs to attract customers and reduce the usage of charcoal that drives deforestation and a high prevalence of respiratory illnesses (Lauvergnier 2018).

4.5.1.4 Organic Fertiliser Production in South Africa

South Africa produces large quantities of biomass from its vast agricultural activities (Batidzirai et al. 2016). The amount of biomass generated in South Africa has a

Fig. 4.4 Organic waste briquette making in the DRC. (Source: Lauvergnier 2018)

higher ability to support the generation of power and fertilisers. The country is developing a Bioenergy Atlas to increase investment in fertiliser production and energy generation from organic waste (Batidzirai et al. 2016). Increased investment in organic waste will reduce the production of inorganic fertilisers in South Africa that presents environmental problems such as soil leaching. South Africa is regarded as one of the major producers of inorganic fertilisers in the continent, with other countries like Nigeria, Libya, Tunisia, Algeria, and Morocco (AGRA 2019). The country aims to transform to the production of organic fertilisers that do not present adverse environmental and health consequences.

South Africa utilises food waste, animal manure, and other organic materials to produce fertilisers (Kido 2011). Kido (2011) states that the country has been using organic waste to produce fertilisers since 1969. Two per cent of organic waste from Cape Town and 15% of organic waste from Johannesburg are diverted to organic fertiliser processing industries (Kido 2011). The use of organic waste plays a significant role in reducing improper disposable of waste in most urban areas in South Africa. Using organic waste to produce fertilisers to produce reduces bad odour and helps to maintain the aesthetic value of ecological resources in the country. Organic waste also plays a critical role in the conservation of soil microbes that are used in the composition of organic waste (Ayilara et al. 2020). Several insects such as house flies, black soldier flies, and crickets are also mainly used to transform organic waste into organic fertilisers. Local municipalities in South Africa train farmers to avoid the slush and burn procedure of clearing farms but rather use vegetation to create organic fertilisers. The use of organic waste has been vital in improving the country's food security as there are high crop yields due to quality soils (Ayilara et al. 2020). Organic fertilisers promote an increase of soil nutrients, aeration, and maintenance of soil PH to increase crop production.

4.5.1.5 Waste Mobile Applications in Ghana

Ghana is experiencing rapid circular economy innovations to manage waste. In the country, there are several mobile phone applications that have been created and implemented to help individuals and organisations acquire waste management services. One of the mobile phone applications that are used to address waste in Ghana is *Jumeni* (Takouleu 2019). *Jumeni* mobile app is owned and operated by Jumeni Technologies. Jumeni mobile app helps households to pay for waste collection services using mobile banking technologies. The mobile app is compatible with several mobile phone models to create a platform for many Ghanaians to utilise in paying for waste collection services (Takouleu 2019). Jumeni also has a wide database of several waste collectors and recycling plants that help people to request their services to collect waste in their households. Jumeni also guides the waste collectors on key areas that require emergency waste collection to reduce the loss of aesthetic value of the ecological resources in the locality. The mobile applications create a chance for households to rate the services of the waste collectors to ensure that they perform their roles effectively. According to (Takouleu 2019), Jumeni is currently operating in Tema and Kaneshie municipalities.

The other mobile phone applications that are aiding sustainable management of waste in Ghana are CleanApp Ghana and COLIBA (Jackson 2016: Magoum 2020). The CleanApp Ghana was created and launched by Ghana Statistical Service (GSS) in November 2020 (Magoum 2020). GSS receives support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to operate the mobile application. The CleanApp Ghana allows the collection of waste on time for recycling. COLIBA is Ivory Coast-based but was launched in Ghana in February 2016 (Jackson 2016). COLIBA helps households to separate waste into plastics, metal, and organic for easier recycling. The mobile app allows households to receive a notification on planned waste collection dates or request waste collection services. Households that recycle waste through COLIBA receive points that they can redeem to purchase food, airtime, and other basic materials.

4.5.1.6 Hello Tractor Mobile App in Nigeria

Hello Tractor is a renowned technological firm that specialises in agricultural innovations (Goodier 2018). The company launched its mobile application, Hello tractor, to connect farmers to tractor services using the Internet of Things (IoT). Hello tractor was founded in Nigeria and operates in several African and Asian countries. Mobile applications play a critical role in helping farmers in Northern Nigeria to access mechanised farming practices that boost crop production (Otufodunrin n.d.). Research indicates that Africa has less than 50 tractors per 100 km^2 of agricultural land (Otufodunrin n.d.).

Hello Tractor reduces agricultural waste as weeds and other biomass materials in the farmland are ploughed with soils to boost organic content and fertility. Mixing organic content with soils reduces the use of inorganic fertilisers that cause soil leaching and air pollution, causing health complications to humans and fauna. Hello tractor allows providing a booking system that allows farmers to book and schedule tractor services. Farmers receive SMS notifications on planned data they will receive the services. Therefore, Hello tractor has been playing a major role in reducing agricultural waste in Northern Nigeria.

4.6 Barriers That Hinder Circular Economy in Africa

Agyemang et al. (2019) identified the unpredictable labour market and the high unemployment rate in Africa in their efforts towards the adoption of a circular economy. According to Akinade et al. (2020), the African continent is committed to the adoption of circular business models, especially in its future planning. The development of infrastructure and resource use is performed with the focus on the future to improve sustainability and minimal ecological footprint. Similar views by De-Jesus and Mendonça (2018) indicated that Africa has embraced a circular economy with the objective of ensuring affordability of its implemented projects and high-level eco-friendliness, hence, contributing towards the improving productivity of the critical natural capital. In the same way, the focus on improving job availability to the Millions of Africans has driven countries to consider the adoption

of sustainable approaches that engage the informal economy. However, the high rate of unemployment has led to comprise of unsustainable practices in some private and public institutions, hindering circular economy growth in Africa.

Kerdlap et al. (2019) noted the variations in institutional capacity to implement the circular economy strategies, as the main contributor towards the underdevelopment and the high fragmentation levels within the private sector. The heavy investment required by the growing economy to improve their infrastructure and the general urbanisation is associated with heavy financial burdens that are difficult to main. Similarly, De-Oliveira et al. (2019) established that the active informal economy lying beyond market interventions takes a huge portion within Africa, making it challenging to implement the appropriate circular economy approaches. Kinnunen and Kaksonen (2019) found that the priorities of African countries have led to struggles towards growing sustainability in the area without sufficient investment into the key sustainable areas of recycling, repairing, and reusing the raw materials within the industry. Consequently, most regional trade policies and the various investment programs have faced the challenges of actual investment into sustainable practices due to insufficient capacity. Therefore, the implementation of programs to support the successful integration of green economy practices in Africa must focus upon the establishment of systems to support institutional capacity, which acts as a platform for the execution of sustainable plans. However, De-Oliveira et al. (2019) that empowerment and general institutional capacity building play a critical role in supporting the African circular economy but are associated with huge financial requirements that act as a barrier to the process.

The lack of sufficient national support and willingness to adopt change by African leaders is lowering the rate of adoption of a circular economy. De-Jesus and Mendonça (2018) identified World Economic Forum as one of the institutions on the frontline towards transforming Africa's circular economy with the main goal for delivering economic growth, creation of job opportunities, and the protection of the environment. The institution advocates for the project implementations that can deliver the highest value of the resources and ensure reusability is attained. Generally, WEF is playing a critical part in transforming Africa into a circular economy to deliver jobs for youths, overall economic growth, along positive environmental outcomes. However, Ki et al. (2020) revealed that Africa's chances to shift into circular economic patterns are higher as opposed to other continents where the vast infrastructure was put up without projecting on the next life cycles. The continent has good potential of moving into a circular economic model because its ecological footprint is still low (De-Oliveira et al. 2019). The introduction of a circular economy in the continent has assisted in preserving the production capacity of the critical natural resources, expansion of employment capacity in the informal economy, and inspiring proper investment policies in the region. Despite the fact that the envisioned positive impacts of WEF, Kinnunen and Kaksonen (2019) confirmed that most leadership teams of the African countries are providing sufficient support, leading to reduced adoption of a circular economy.

According to Berg et al. (2018), Africa has received financial and other forms of support to foster a circular economy but faced the challenge of poor planning and

resource utilisation. The adoption of circular economy in Africa materialised after the launching of the African Circular Economic Alliance (ACEA) in 2017 when the Rwandan government spearheaded the partnership with WEF (Charles et al. 2019). The primary goal of constituting the ACEA was to carry out policy research and promote high-impact circular economic-related projects; this alliance has more than ten member states from the continent, co-chaired by environment state ministers from South Africa, Rwanda, and Nigeria (Ghisellini et al. 2016). The launching of ACEA has attracted a multi-donor trust funding from global investors with an initial donation of about $4 million, where funding of circular economic projects and entrepreneurs from member states is enforced through the African Circular Economic Support Program (ACESP) (Ghisellini et al. 2016). Owolabi explained that adopting a circular economy in Africa has assisted most member countries to utilise their resources to the highest value and recycle waste materials to useful products, hence, yielding the maximum value out of them. However, despite the benefits and support for circular economy received from donors, poor planning and misappropriation of funds remain some of the key challenges towards the implementation process.

Agyemang et al. (2019) noted that with the high reliance of the developing economy on the extractive industries, there are many forms of resistance from the public and private sector on adopting the circular models that affect the value chains and the secondary material use. Resistance has negative impacts on the success of the circular economy models since lack of support reduces their speed of implementation and increases the chances of failure within the economy. Schroder et al. (2019a, b) added that the specific interests of people and the general stakeholders' attitudes have affected the process of adopting a circular economy within Africa. However, Charles et al. (2019) argued that the determination and interest of the national leadership among the individual African countries affect their level of success in the integration of circular economy since they can formulate policies and guidelines to support the adoption of the models. Therefore, the ability of the government to manage the specific industry interests that deter the implementation of the circular economy increases the chances of success in the execution process.

Gazzola et al. (2020) identified the capacity and the financial constraints as the challenges of the main elements facing circular economy implantation in Africa. The institutional capacity has limited the efforts to establish and enforce the appropriate regulations and standards for circular activities. As a result, some countries have failed to adopt string governance frameworks, leading to risks of installation of cheap and limited-quality technological systems and equipment. The design and implementation of substandard projects within different sectors of the developing countries in Africa have led to increased chances of compromise to the expected standards of the circular economy.

Similarly, De-Jesus and Mendonça (2018) noted that the limited access to finance by most African countries is a key challenge towards their execution of circular economy activities. With the huge financial implication involved in shifting the infrastructure, industry processes, and priorities for creativity and innovation, the lack of budgetary support affects their general success. Availability of funding

increases the success of the circular economy approaches and the general adoption level of the best practices. In contrast, Fontana et al. (2021) argued that the appropriateness of the circular economy project implementation plan is the key determinant to the success access of funds because attractive solutions always win sponsors and investors into African countries. Therefore, the accessibility to the funds improves the implementation process of the circular economy through financing the required activities.

The recommendations of Cecchin et al. (2020) indicate that the increased accessibility to the right technological solutions can increase the effectiveness of the circular economy models in Africa. Some technologies such as satellite-based Global Positioning System (GPS), Internet of Things (IoT), Artificial Intelligence (AI), and block chain technologies have contributed towards the transformation of different countries to promote compliance. As a result, with the utilisation of technologies, organisations can conduct different business activities with regard to environmental protection and sustainability factors. However, Gazzola et al. (2020) argued that despite the rise and access to the best global tech solutions, the technological, infrastructural platforms are still ineffective in most parts of the country. The unavailability of the internet in some parts of Africa limits the adoption of technology for supporting the circular economy.

According to Fontana et al. (2021), the circular economy and smart building designs have helped Africa to increase its ability to maintain buildings with efficient services throughout the lifespan. The connectivity, intelligent machines, embedded sensors, and data analytics systems provide efficiency and cost-saving, hence, improving the benefits of a circular economy. Ki et al. (2020) noted that reuse, resell, repair, refurbish, and remanufacturing are the key circular economy practices that are being applied in resource utilisation within Africa. In the process, the circular supplies of the raw materials must be supplied to enhance the renewability, recyclability, and biodegradeability of the inputs. Similarly, Fontana et al. (2021) noted that the circularity of the natural resources in Africa is essential for sustainability and the general supply within their economy, hence, helping to reduce emissions, create jobs, and strengthen the national energy securities. However, Fontana et al. (2021) noted that resource recovery should be the key consideration in Africa through the formulation of technological business models that support innovations for recovery and the reuse of the resources. Consequently, a circular economy will enhance the maximisation of economic value and the elimination of material leakages. Agyemang et al. (2019) identified the extension of the product lifecycle of the products as important in ensuring economic re-use through upgrades, re-market, remanufacture, and repairs. Therefore, the adoption of diverse strategies with the main goals of ensuring that the resources are efficiently used helps to improve the circular in Africa.

Ki et al. (2020) stated that insufficient and ineffective sharing platforms across Africa have reduced their ability to create connections and interactions for the improvement of resource sharing towards building a circular economy. Essentially, the products and assets that provide low ownership rates foster productivity and create value for both the nations in general through improved logistical processes.

Similarly, Cecchin et al. (2020) stated that the shared platforms facilitate the product as service models that allow customers to lease or make pay-for-use arrangements that promote a buy-to-own economy. As a result, companies can manage to reduce the operational costs and upfront requirements for the acquiring of the resources for the company use. Reduced operational and maintenance cost allows recapturing of the residual value, which motivates the companies to make indirect support for the circular economy (Fontana et al. 2021). Therefore, the lack of sufficient sharing systems within Africa has reduced the ability of nations to interact, hence, reducing the effectiveness of the implementation of a circular economy.

The high people population in Africa has created limitations towards the implementation of a circular economy. According to Fontana et al. (2021), the United Nations Population Fund (UNPF) estimated that there are over 200 million people in Africa below 25 years, this number is predicted to double by 2045, and if this happens, the adequate demographic ground will be set for fast-growing economy provided the available economic resources are well utilised to create enough job opportunities. Ki et al. (2020) showed that an environmental protection agency from the United States estimated that recycling about 10,000 tons of used products can create six times more jobs than the original use; reusing and repair can create even more opportunities to be occupied by the anticipated population growth. Besides creating employment opportunities, Gazzola et al. (2020) identified that circular economy has also played a significant role in aiding sustainable economic development across Africa, with more relevant research being pursued. For this reason, the circular economy has revived the recycling industry in the continent, which has reduced wastes and created more jobs for growing populations (Fontana et al. 2021). A circular economy can create new livelihood opportunities for disadvantaged groups to stay in a clean environment, with the reduced flow of plastic waste into the marine atmosphere.

4.7 Recommendations

This study recommends the following recommendations:

- Embracing CE in solid waste management requires deliberate efforts in integrating the managers/stakeholders together to close the loop where wastes become raw materials for another activity.
- African countries' financial support to medium-scale and small-scale enterprises that specialise in various circular economy initiatives like waste recycling, among others
- Enactment of adequate circular economies for each sector such as agricultural, transportation, manufacturing, and educational training to ensure effective implementation of circular economy practices.
- Effective enforcement of circular economy policies and initiatives through legal authorities such as policing units to ensure an increased shift from a linear economy to a circular economy.

- Incorporation of circular economy ideas into learning institutions' training curriculum to create increased awareness on the importance of waste generation, renewable energy, and environmental-friendly agricultural practices.
- Increased investment in Information, Communication, and Technologies (ICT) to create increased wireless connectivity and wider utilisation of smart technologies to promote crowdsourcing of skilled experts to initiate circular economy innovations.
- Increased purchase of products from circular economy practices by governments to create an active market to attract increased investments.

4.8 Conclusion

CE has been used in Africa for several years. The main countries in Africa that are driving CE are Nigeria, South Africa, Rwanda, Ethiopia, Tanzania, DRC, Mauritius, Egypt, Namibia, Ghana, and Kenya. A significant number of African countries are facing increasing urbanisation. Research indicates that most cities in the continent will transition to megacities. Increased urbanisation will lead to a significant increase in waste generation. Thus, most African countries have recognised the need to shift from linear economy to circular economy to promote environmental, economic, and social pillars of sustainability. A circular economy will help African countries to reduce their carbon and ecological footprints due to the use of waste as a substitute for raw materials and reduced dependence on fossil fuels. Networks such as the African Circular Economy Alliance (development of national and local government policy) and the Africa Circular Economy Network (strategic application in business) working in collaboration will be able to facilitate this transition process. Several African countries have started initiatives to strengthen their political system to enact circular economy policies. Some countries are also updating their existing sustainable policies to incorporate circular economy aspects. Regional organisations like the African Development Bank (AFDB), African Union (AU), and international organisations like the United Nations, World Bank, UNEP, UNIDO, UNDP, and GIZ are helping African countries to ratify their circular economy-related practices into practical innovations.

Circular economy innovations in Africa include the use of organic waste to generate fertilisers in countries like South Africa. Organic fertilisers play a significant role in reducing the use of inorganic agricultural inputs that cause soil leaching, soil contamination, and air pollution. The use of organic waste reduces the amount of waste that is disposed at landfills and dumpsites that cause environmental challenges such as increased methane emissions that accelerate ozone depletion. The other circular innovation in African countries like Ghana and Nigeria is the use of mobile applications to manage waste. Mobile applications help people to request waste collection services from waste collectors and waste recycling plants. The mobile applications are compatible with several mobile phone models to ensure that a significant number of people use the technologies. In Kenya, there is the use of plastic waste to produce construction materials like poles. Plastic construction

materials are durable and reduce littering of the environment with plastic bottles. In African countries like DRC, there are small-scale circular economy initiatives like the production of briquettes from organic waste. Organic briquettes help to reduce deforestation that is threatening forest reserves. In Tanzania, there is the utilisation of Mazzi Can to reduce the generation of single-use plastic bottles for milk transportation. In conclusion, African countries will enhance the achievement of their Sustainable Development Goals by fully embracing Circular Economy policies and innovations.

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