Assessing Plastic Circular Economy Policies and the Use of Digital Technology in Africa

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ASSESSING PLASTIC CIRCULAR ECONOMY POLICIES AND THE USE OF DIGITAL TECHNOLOGY IN AFRICA

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1   Introduction

The world is confronted with complex and interconnected environmental problems (Kinzig et al., 2013). These problems range from ozone depletion, climate disruption, species declines and extinctions, emerging diseases, antibiotic resistance, persistent organic pollutants, amongst others. Amongst these major challenges is plastic pollution which has been attracting increasing attention lately (Syberg et al., 2021). While extensive studies exist on how to reduce plastic waste (Austin et al., 1993; Ayeleru et al., 2020; Chow et al., 2017; Luo et al., 2022; Rochman et al., 2013), there is a shortage of materials evaluating the effectiveness of numerous initiatives that have been proposed to tackle plastic waste problems. In addition to that, there is a shortage of literature on how these initiatives are relevant to Africa's unique situations and in transforming Africa's plastic "throwaway" economic model. In this chapter, we review some of these regulations within an African circular economic framework and assess how digital innovations can help in reducing plastic waste on the continent.

There has been an increasing interest in the growing prevalence of (micro) plastics in the environment, particularly regarding its effects on marine ecosystems. This increased attention over ocean life has led to the implementation of some strict guidelines and policies, but the efficacy of these regulations remains widely undetermined (da Costa et al., 2020). Similarly, because there is no convention with the sole aim of solving the plastic waste problem (it is always an integral part of other pollution-related regulations), there are no unified and integrated mechanisms regulating and controlling the spread of plastic materials.

To further increase interest in plastic waste problem is the COVID-19 pandemic. Just as most health shocks tend to produce some negative economic outcomes (Alam

& Mahal, 2014), COVID-19 pandemic has been asserted to have also exacerbated the plastic waste challenge as the use of single-use plastic products seemed to have tripled during the pandemic, thereby providing further justification for looking at this topic.

In this development, Africa is not insulated from these challenges, rather Africa equally has a significant role to play in taming environmental degradation. Africa holds a topical position in discussing marine ecosystems because two of the ten top-ranked rivers (Niger and Nile) that transport 88–95% of the global plastic waste load into the sea flow through Africa (Schmidt et al., 2017). It is also projected that the volume of wastes in Sub-Saharan Africa will almost double by 2050, with much of this being plastic (Kaza et al., 2018). Ayeleru et al. (2020) estimates that 17 Mt of plastic waste is annually generated in Africa, hereby calling for urgent attention. It has been said that inaction may result in the number of plastics in the ocean exceeding the number of fish by 2050. According to Ellen MacArthur Foundation, by 2040, the circular economy has the potential to reduce annual plastic inflow into oceans by 80%, which can cut greenhouse emissions by 25%, create about 700,000 net additional jobs and generate over USD 200 bn per year in savings.

From our observation, it is difficult finding specific circular economy legislations or legislations particularly focusing on plastic waste circular economy. It becomes more difficult finding policies that are circular and are aimed at plastic economy. Our observation aligns with Desmond and Asamba (2019) in which they consider one country (Rwanda) out of eight selected countries with circular economy initiatives directly focusing on plastic waste. This has also translated into dearth of systematic studies of circular economy policies in Africa, and there is a massive research gap in identifying the extent and impact of sustainability policies regarding plastic wastes in Africa. In this chapter, we annotate on some international initiatives that were designed to influence plastic waste management on the continent before delving into a case study of policy state in Nigeria.

Review of studies by Cagno et al., (2021) shows that despite the availability of literature on the broad topic of circular economy there is limited studies on digital technologies in the circular economy transition (Cagno et al., 2021). Similarly, researchwise, focus on the plastic circular economy is in its infancy for the most part of Africa (Oyinlola et al., 2022).

In this chapter, we use a mixed method of analysis. We utilise machine learning to undertake text analysis of policy descriptions across Africa. We also undertake a descriptive data analysis of the DITCh Plastic Survey which is akin to Facebook-Yale climate change opinion survey and the WWF–SA study survey (South Africa) to assess people's perception of plastic waste and plastic waste policies in Africa. Our survey includes individual's levels of awareness of plastic waste policies and perceptions of plastic waste policy effectiveness on the continent. Insight from the data is combined with national case studies of two policies in Nigeria.

We find that the conception and drafting of legislation are shallow such that there is incomplete approach to tackling plastics waste problems, there is lack of awareness of the initiatives, exclusion of the informal sector and the existence of enforcement problems such as lack of information on usage and traceability. In our attempt to investigate how digital tools and innovations could enhance policy implementation for reducing plastic waste, we also reviewed the DITCh Plastic digital innovation aggregator, which presents some of the technological start-ups' ideas in Africa. We then propose practical digital technological tools that can enhance plastic circular economy policies in Africa. We find a hollow implementation of circular plastic economy initiatives in Africa, with little evidence of their success (Kweku & Johanna, 2020). We reiterate the relevance of our conclusion for policy (from the text analysis that we conducted), i.e., that African initiatives need to move beyond prohibition into a circular framework (re-use, re-cycle, re-make, etc.).

We support the World Economic Forum (2021b) assertion that governments should set up political, legislative and economic frameworks that can incentivise profitable circular economies by facilitating a digital backbone for Africa and support the claim that digital innovations can generate economies of scale (World Economic Forum, 2021a) for circular plastic economy stakeholders by connecting stakeholders from a wide range of backgrounds, sectors and countries across Africa (Oyinlola et al, 2022) and that digital innovations can be used to aid recycling by efficiently connecting consumers, waste collectors and recyclers; reduce plastic wastes by engaging consumers on ways to cut down resource usage; and aid redesign by optimising processes.

Finally, countries have adopted various approaches to stem environmental degradation such as the use of education, persuasion and policies, but judging from the low success level of current efforts, there is the need to review current initiatives particularly in Africa where resource-rich syndrome may impede performance-based ideas, profit-maximisation objectives may hinder sustainability consideration and prominent roles of the informal sector are often ignored in policies. However, before delving into discussing some of the plastic waste policies in Africa, there is the need to briefly discuss key economic concepts relevant to our study.

Section 1 of this chapter presents the general introduction. Section 2 introduces the concept of circular economy. Section 3 focuses on the plastic circular economy policies in Africa. Section 4 presents the descriptive statistics from our survey and looks at the role digital innovation can play in scaling the circular economy in Africa. Section 5 presents the summary and conclusion of the chapter.

2 Concept of Circular Economy

The concept of circular economy has been around for a number of decades (Lacy & Rutqvist, 2016). It is an approach that keeps resources in productive use for

as long as possible. A good analogy often used to explain a circular economy is comparing a river with a lake. A linear economy is depicted to flow like a river where products are created through a series of value-adding activities and upon sales of the product, the property right and the liability for risks and wastes are transferred to the buyer. The owner thereafter decides what happens to old products (discarded, reused or recycled). On the other hand, a circular economy is depicted as a lake where reprocessing of products takes place. It operates as a system where the objective is to maximise a product's value at each point of its life.

The contrast between an "open economy" where input is unlimited and a "closed economy" where resources are bounded was raised in the famous essay of Boulding (2011). Boulding's essay is usually cited as the origin of the concept of "circular economy". The concept introduces required "closing loops" into an open economy by ensuring that products that are at the end of their service life are either reused or turned into other resources, thereby minimising waste (Stahel, 2016). One critical linkage between plastic pollution and a circular economy is the fact that the traditional economic production cycle of "make, use, dispose" is said to have resulted in one-third of plastic wastes not collected or managed globally (MacArthur et al., 2016).

Ellen MacArthur Foundation (EMF) also reiterates that a circular economy is restorative and regenerative by design. It distinguishes between technical and biological cycles and aims at keeping products, components and materials at their highest value always. It is suggested that the transition from linear economy to a circular economy is the biggest revolution in 250 years as it presents a radical rethink of the relationship between customers, markets and natural resources while at the same time presents biggest opportunities (Lacy & Rutqvist, 2016).

Factors driving the circular economy adoption are principally resource constraints, technological developments and socio-economic opportunities (Lacy & Rutqvist, 2016). A study of seven European nations found that transitioning to a circular economy will reduce greenhouse gas emissions of each country by about 70% and grow their workforce by about 4% (Stahel, 2016). Recycling is a well-known element of the circular economy, but there are other elements that are not well-publicised yet. Our focus in this chapter is on how digital technologies can play important roles in scaling Africa's circular economy. When we talk about digital technology, we refer to innovations around cloud, mobile, social, big data analytics, internet of things (IoT), amongst others.

3   Circular Economy Policies in Africa

This segment attends to three key areas. The first part briefly reviews international marine initiatives that may likely have implications on Africa circular plastic economy. The second part of the segment delves deeply into initiatives in Africa that are considered under green economy that may have wider implications on Africa circular plastic economy. The last part looks at the state of national policy

in one of the countries that is recorded to have one of the highest initiatives on green economy in Africa (Nigeria).

3.1   Global Marine Policies and Africa Cross-Border Plastic Initiatives

There are a few international frameworks in operation seeking to attend to plastic waste problems such as the United Nations Convention on the Law of the Sea (UNCLOS) of 1982. The law attempts to regulate every aspect of the sea resources and the use of the ocean (Gagain, 2012). Article 210 of the convention encourages individual states to develop frameworks to prevent, reduce and control pollution of the marine environment. However, as well-intended as the "Constitution for the Oceans" is, it focuses on a wide range of areas, but it did not specifically contain any provisions regarding plastic pollution. It rather considered plastic as all other wastes potentially hazardous for the ocean life (da Costa et al., 2020). The implication of this is a slack domain to directly tackle plastic waste as a core challenge. Similarly, the position of countries such as the United States not to be signatory to the law has reduced the effectiveness of UNCLOS in tackling plastic problems (Bateman, 2007).

A similar intervention, supported by the United States, the "Marine Debris Program" (MDP) specifically designed to curb marine debris was jointly developed by the United Nations Environment Program (UNEP) and the US National Oceanic and Atmospheric Administration (NOAA). The programme aimed at fighting the increasing prevalence of marine litter, but it also has its limitations in application because its functionality depends on the willingness of participating nations. Because of its non-binding nature, we view this as a tame attempt at tackling the challenge of plastic pollution at the global level.

Similarly, a resolution on marine litter and micro plastics was passed during the United Nations Environment Assembly (UNEA) of UNEP in Nairobi (Kenya in 2017), urging all countries to make responsible use of plastic while endeavouring to reduce unnecessary plastic use. UNEA-4 acknowledged the problem of micro plastics, marine plastic litter and the problem of single-use plastic. Various resolutions from UNEA are considered good global initiatives at understanding plastic solutions with the aim of informing global policies. As an extension of this, the African Ministerial Conference on the Environment (AMCEN) in Durban (South Africa 2019) has also passed a declaration emphasising the need to address plastic pollution.

A cross-border initiative involving Rwanda, Nigeria and South Africa announced the African Circular Economy Alliance (ACEA) during COP23 in Bonn as an effort to create inter-governmental corporations. One of their aims was to encourage other African countries to consider implementing similar policies as Nigeria's EPR programme (Desmond & Asamba, 2019). The initiative was also to facilitate knowledge sharing of the empirical applications of circular economy to different sectors of the economy between circular economy professionals in Africa. While the inclusion of the two biggest economies in Africa (Nigeria and

South Africa) in this initiative is significant, the number of countries involved shows one of the challenges of global initiatives (low participation level).

Review of these global and regional efforts shows some shortcomings as a limited number of countries participate in most of these initiatives and many of them are non-binding agreements. We are also of the view that their implementations also lack a compliance mechanism making accountability also difficult.

3.2   National Policies in Africa

Policy intervention has been identified as a critical driver of sustainable circular plastic economy (Dijkstra et al., 2020). On the positive side, our review of circular economy policies in Africa shows that there is small evidence of initiatives around climate change and green economy in general. At least, 36 African countries have introduced one form of initiatives or the other (see Figure 14.1, left part). It shows the density of national green economy policies across Africa. Policies by count shows some good representation, as the top economies in Africa in terms of gross domestic products (Nigeria, South Africa and Egypt) lead in terms of policy count while there are only three countries in Africa (Equatorial Guinea, Gibraltar and South Sudan) with no recorded evidence of green economy initiatives. The flip side of it is that they are mostly towards the banning of plastic bags (Kweku & Johanna, 2020).

We reviewed 241 policies or interventions in Africa but only eight fell under National Circular Economy (NCE), i.e., only 3% clearly fell under NCE (Table 14.1).

To highlight these policies, Figure 14.1 (right part) shows distribution of policy across Africa that are classified as "Circular Economy Policy" (Chatham House,
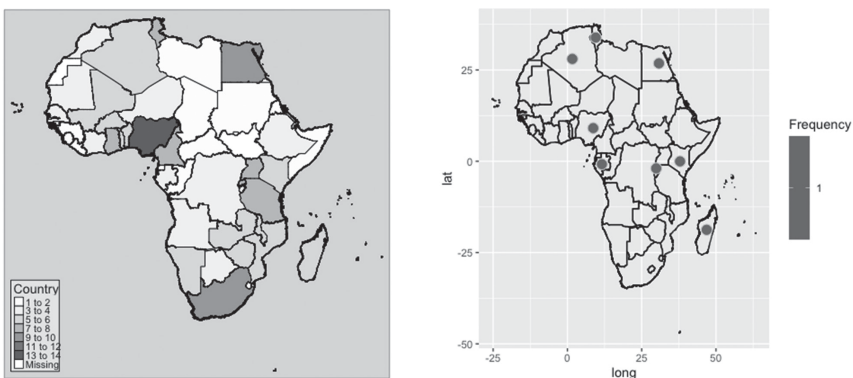
FIGURE 14.1   Density of national green economy policies and number of policy categorised as circular economy policy across Africa

Note: Data Sourced from Chatham House. Summarised data for generating the map 1 is in Appendix 1, map 2 is generated from Table 14.2

TABLE 14.1 Summary of green economy policies by category in Africa

Policy Category	Policy Count	Proportion
Extended Producer Responsibility EPR	26	11%
Fiscal Policy	14	6%
National Circular Economy Policy	8	3%
Product Policy	48	20%
Waste Management and Recycling	145	60%
Total	**241**	

Note: Data sourced from Chatham House database – https://circulareconomy.earth/

TABLE 14.2 Circular economy policies in Africa

Country	Policy Name	Policy Description	Start year
Algeria	National action plan for sustainable production and consumption methods (PNA-MCPD) 2016—2030	The plan has three overarching aims: 1) to integrate sustainable consumption and production patterns into national policies and plans; 2) to ensure energy transition through promotion of energy efficiency and 3) development of renewables and develop a zero-waste economy by 2030. Includes specific actions to accelerate the circular economy transition through greater recycling, improving waste management services, eco-design, and life cycle analysis.	2016
Egypt	National Action Plan for Sustainable Consumption and Production	This action plan aims to support Egypt's development efforts in achieving sustainable consumption and production practices in its key economic sectors, including energy, agriculture, water and waste. Regarding waste management, the action plan advocates for waste prevention, reduction, recycling, re-use and recovery. It also promotes a gradual transition to a green and circular economy as a conceptual framework for policy making. This strategy also highlights steps to be taken to promote a gradual adoption of governmental procurement towards environmentally friendly products and sustainable technologies.	2016
Gabon	Gabon Green Operational Plan	The plan sets the green strategy for Gabon, with the 'aim to increase the level of wealth produced while controlling the footprint ecological effects of human activities'. It specifically mentions the application of circular economy principles in the plan and the promotion of waste recycling channels.	2015

TABLE 14.2 (Continued)

Country	Policy Name	Policy Description	Start year
Kenya	The Green Economy Strategy and Implementation Plan (GESIP) (2016),	Green Economy Strategy and Implementation Plan 2016–2030 is geared towards enabling Kenya to attain a higher economic growth rate consistent with the Vision 2030, which firmly embeds the principles of sustainable development in the overall national growth strategy. This strategy builds on the achievements realised during the implementation of the first Medium Term Plan (MTP I 2008–2012) and on-going implementation of MTP II (2013–2017) for Vision 2030. The strategy aims to shift the attitudes of households and industry towards sustainable consumption and production and sustainability.	2016
Madagascar	Environmental Program for Sustainable Development	The programme has two strategic objectives broken down into six specific objectives; Strategic Objective 1: an effective environmental policy framework, an optimised environmental performance of development actors, and a reliable information system as a decision support device; and Strategic Objective 2: an inventory of natural capital and the benefits generated at a known national level, a network of green infrastructures managed effectively and increasing resilience to risks of disasters, and fair and equitable sharing of the benefits of nature strengthening socio-economic resilience, including objectives around waste valorisation and recycling.	2016
Nigeria	National Policy on the Environment (Revised 2016)	The goal of the National Policy on the Environment is to ensure environmental protection and the conservation of natural resources for sustainable developments. Its strategic objective is to coordinate environmental protection and natural resources conservation for sustainable development. Waste management is an important part of this policy, with a whole Objective focusing on "Waste and Environmental Pollution" and looks at solid waste, household, and industrial waste, wastewater, toxic and hazardous waste, radioactive waste.	2016

(*Continued*)

TABLE 14.2 (Continued)

Country	Policy Name	Policy Description	Start year
Rwanda	Rwanda National Environment and Climate Change Policy	The National Environment and Climate Change Policy provides strategic direction and responses to the emerging issues and critical challenges in environmental management and climate change adaptation and mitigation. The key issues and challenges identified include high population density, water, air and soil pollution, land degradation, fossil-fuel dependency, high-carbon transport systems, irrational exploitation of natural ecosystems, lack of low-carbon materials for housing and green infrastructure development, inadequate waste treatment for both solid and liquid waste, increase of electronic, hazardous chemicals and materials waste, among others. The policy includes seven policy objectives, of which Policy objective 1: Greening economic transformation includes a specific statement policy statement on promoting the circular economy.	Start year
Tunisia	National Strategy for the Green Economy 2016–2036	The purpose of the national strategy is to explore possibilities of development of current economic activity and new green activities in several areas, including organic farming and eco-tourism, sustainable transport and infrastructure, sustainable buildings and green industries, environmental services, energy efficiency and renewable energy, water conservation and water re-use and integrated waste treatment management. It includes focus areas 1 & 3 linked to the circular economy and waste management; 'cultivate efficiently in the use of natural resources, less polluting and the ocean with sustainable production' and 'waste disposal in an integrated framework in order to improve life by recovering recycled waste and reducing greenhouse gas emissions'.	2016

Note: Policy extracts and categorisation from (Chatham House, 2021)

TABLE 14.3 Countries and number of policy descriptions containing "plastic"

Countries	Policy Counts
Mauritius	5
Mali, Seychelles	4
Benin, Zimbabwe	3
Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Namibia, São Tomé and Príncipe, Senegal, South Africa, Togo, Zambia	2
Algeria, Angola, Botswana, Burundi, Cameroon, Cape Verde, Democratic Republic of the Congo, Djibouti, Egypt, Eritrea, Ethiopia, Gabon, Guinea–Bissau, Kenya, Lesotho, Madagascar, Malawi, Mauritania, Morocco, Mozambique, Niger, Republic of the Congo, Rwanda, Somalia, Sudan, Tanzania, Tunisia, Uganda	1

Note: Data from Chatham House (2021)

TABLE 14.4 Distribution of policies that contained plastic by policy type

Policy Category	Policy Counts
Extended Producer Responsibility EPR	7
Fiscal Policy	9
Product Policy	42
Waste Management and Recycling	9
Total	**67**

Source: Data (Chatham House, 2021)

2021). Eight countries from all African countries recorded one initiative each considered to be circular in nature. The tabular presentation (Table 14.2) presents policies that are considered under circular economy with their descriptions and policy commencement date.

Delving deeper beyond this categorisation into individual policy description, we review the listed 241 policies to ascertain those who at least mentioned "plastic" in their descriptions. We found 67 policies across Africa. Table 14.3 shows countries and number of policies relating to plastics.

In the light of our topic, we reviewed the categorisation of the 67 policies, using the five categories of policies under Chatham House. None of the policies in Africa that at least contained plastic in the description falls under Circular Economy Policy (see Table 14.4).

To further review the 67 policies that contain "plastic" in their description, we undertake text analysis of their descriptions, using machine learning. We tokenise every word used in the description, using Gibss LDA method of topic modelling (Hornik & Grün, 2011). The top 10 topics are built on "bags", "finance", "law", "levy", "plastic", "approving", "decree", "management", "plan" and "presidential"

FIGURE 14.2 Word cloud of words used in plastic-related policies in Africa

Note: R package used for word cloud. Policy description extracted from Chatham House Database

(in descending order). These further validates our earlier realisation that these policies are product based and are rather prohibitive in nature. We further select the most frequently used words in the policies (words with frequency more than 200 in the tokenised document). Figure 14.2 presents the resulting word cloud from the text analysis. The conspicuous topic from the leading terms is "… national law bans packaging bag". These are closely followed by terms such as "prohibiting", "prohibition", "producer", "distribution", amongst others.

Some of our takeaway from these facts are, Africa is positively initiating policies toward green economy, however, only a few leans towards circular economy. Some initiatives are plastic-focussed but none of such is categorised as circular in nature. We state that the intersection between policies that are plastic focussed and policies that are national circular plastic economy is zero in Africa (as at time of this publication). The relevance of our conclusion for policy from the text analysis is that African initiatives need to move beyond prohibition into a circular framework (re-use, re-cycle, re-make, etc.).

3.3   State of National Plastic Policies: A Case of Nigeria

This segment presents our national-level case studies. We have briefly discussed international and continental efforts at tackling plastic waste problems above, but for a more succinct scenario analysis, we review the two main initiatives relating to plastics wastes management in Nigeria. Our choice of Nigeria is based on the

high level of plastic wastes the country generates (Ajani & Kunlere, 2019), fact that it currently has more green economy initiatives more than any other country in Africa (see Appendix 1). In addition, the country's policies and regulations are close to what other African countries (Rwanda, Kenya, Gambia, Ghana, South Africa and Morocco) have formulated. Insights from this review are then combined with our Africa–wide survey to generalise the state of plastic waste policies.

3.3.1 Plastic Bags Prohibition Bill

The Nigerian National Assembly passed the Plastic Bags Prohibition Bill in May 2019. The bill prohibits the use, manufacture and importation of plastic bags for commercial and household packaging. The bill provides that any retailer that provides customers with plastic bags at a point of sale is guilty of an offence. Likewise, a person who manufactures plastic bags for reselling is equally guilty, just as someone who imports plastic bags either as a carryout bag or for resale. For individual offenders, it proposed a penalty of a fine of not more than N500,000 (Five Hundred Thousand Naira or $1,400 USD), or a prison term not exceeding three years, or both. For corporate offenders, companies shall be liable to a fine of not more than N5,000,000 (Five Million Naira or $14,000 USD).

Despite the passage of the bill by the House of Representatives, the Nigerian Senate is yet to pass the bill into law, and it has not been assented into law by the President, but we still find it useful to review the initiative as part of transforming Nigeria to a circular economy.

The policy is not situated within a goal- or mission–oriented policy framework as it looks more like a statement of prohibitions and corresponding penalties unlike in the UK where the plastic waste policy of taxing users is linked to a 25–year environmental plan. When a policy is not mission–oriented, it does not only stand the chance of fading away in the short run, but it also makes appraising its effectiveness difficult.

The outright ban of plastic bags itself without inculcating other market-based instruments (e.g., plastic taxes, subsidy and incentives) provides a good basis for policy failure. This one-way approach which is similar to plastic ban in Kenya, Rwanda, Gambia and Morocco is shallow, as it does not address other viable plastic management options. A system approach would need to include aspects of recyclability and reusability if the continent is to veer towards circular plastic economy.

3.3.2 Nigeria Extended Producers Responsibility Programme

Germany introduced a policy called "Verpackungsverordnung" in 1991, a legislation to avoid packaging waste. Other countries such as Australia, Belgium and France followed suit before the European Union (EU) introduced the EU Packaging Waste Directive in 1994 which set established collection and recycling

targets for EU Member States. It also established requirements for packaging-design across the EU; however, the directive did not require producers to bear waste collection and recycling costs then (Ajani & Kunlere, 2019). Nigeria launched its Extended Producer Responsibility (EPR) programme in 2014 through the National Environmental Standards and Regulations Enforcement Agency (NESREA). The programme makes manufacturers in Nigeria responsible for the management of their post-consumer products.

The policy requires producers to ensure that wastes arising from the use of their products are safely managed through effective monitoring of the entire lifecycle of their products. Individuals and organisations who buy or use products that are at the end of the useful life cycle are also required to safely dispose of them through legal and appropriate means (e.g., use collection centres managed by accredited collectors). The guidelines permit producers who are unable to effectively manage their products' end-of-life wastes to utilise third-party agents (network of collectors and dismantlers and recyclers known as Producer Responsibility Organizations – PROs) to help them oversee the process (Ajani & Kunlere, 2019). This initiative is considered more extensive than the recently proposed plastic legislation as it required businesses with significant waste outputs to have an EPR plan and such a plan must align with the National Environmental Regulations applied to the sector the company belongs to before it is approved by NESREA.

The programme is considered a more comprehensive model that seeks to optimise the benefits of recycling (Woggsborg & Schröder, 2018), but the first fundamental issue when discussing the circular plastic economy in Africa is that, like most other initiatives, this programme is not plastic waste focussed, even though it covered packaging materials such as aluminium, glass, metals, paper and plastics. Secondly, while it has the implication of affecting product design, it offers little in the area of reusability. In general, reviews of the programme in Nigeria also show that the initiative remains largely unknown, and it is often misconstrued by the public, misapplied and underutilised by businesses while its implementation across Nigeria is recorded to continue facing various challenges (Ajani & Kunlere, 2019).

Reviews of this initiative also show that there is poor public participation because many citizens do not understand the benefits nor their roles in the implementation (Ajani & Kunlere, 2019). The initiative also has poor enforcement mechanisms as defaulting companies can easily evade sanctions. There is also a case of insufficient collection centres, and its implementation has been limited to mostly large cities of Lagos, Abuja and Port-Harcourt. These reasons amongst others coupled with poor funding for the implementation of the policy have weakened the likely effectiveness of plastic waste management. We will however consider how digital tools may come to play in solving some of these problems.

4   Descriptive Statistics and Discussions

We utilise both secondary data source (Chatham Database) and primary data source (DITCh Plastic Survey) in this chapter. Our earlier analysis of policies across Africa made use of the secondary data. This segment utilises the primary data. The DITCh data contained responses from 33 entities (17 organisations, 16 other stakeholders that are not digital innovators) and over 1,500 households surveyed (using trained field officers) across five countries in Africa (Kenya, Namibia, Nigeria, Rwanda and Zambia). The survey assesses the level of technological readiness and different digital tools adopted for accelerating the transition to a circular economy in Sub-Saharan Africa. The insight from this segment is used to align existing policy with public perception as a step in suggesting the role digital technologies can play in alleviating these challenges.

We investigate the efficiency of waste management on the continent and about 24% of respondents in the survey clearly see the waste management on the continent as ineffective while about 43% see the waste management on the continent to be either effective or very effective. About 58% believe that the government is not doing enough. This fact further confirms the earlier assertion that there is little evidence on policy success rates (Kweku & Johanna, 2020).

To assess the accuracy of public perception regarding the effectiveness of existing policies, we review the publics' awareness of laws on plastic management. About 82% of respondents are unaware of laws on plastic waste. This is a major insight from the survey as lack of awareness stands out as one of the reasons plastic waste policies remain ineffective in Africa. We then assess the law enforcement confidence of those who claim to be aware of plastic waste laws in their country and found that about 50% of them do not have confidence in the law enforcement. This is considered a reflection of in-built weaknesses in the policies and lack of faith in enforcement agencies. This outcome aligns with Ajani and Kunlere (2019) assertion that the most comprehensive initiative in Nigeria (for instance) remains largely misconstrued by the public, misapplied and underutilised by businesses (Ajani & Kunlere, 2019).

To facilitate an informed policy, we inquire about how some factors may encourage respondents to engage in sustainable plastic waste management. Over 90% of respondents (62.72% – very useful and 28.49% useful) are of the view that political instruments such as legislation will encourage them to engage in sustainable plastic waste management. Assessing how likely plastic waste tax may work, only about 11% are very confident on plastic waste tax and an additional 30% just confident. About 33% are not confident that the imposition of plastic waste tax can influence their waste management habits. This brings to fore the limit of prohibitive tax or use of penalties to drive plastic sustainable behaviour in Africa. This is closely related to our conclusion from text analysis of policy descriptions across Africa.

On the use of economic payments or incentives, about 85% see this as a viable option that can encourage them to engage in sustainable plastic waste management

while less than 5% found economic payment as not useful at all. This brings to fore a policy niche often missing in African efforts despite evidence from countries such as India that financial incentives could be effective. Similarly, about 78% of respondents are of the view that they will be encouraged to sustainably manage their plastics waste if they see their friends and family doing it (social influence) while only less than 5% consider it as a not useful approach. This insight provides opportunity to further investigate how social ties and connectedness can be used to drive plastic circular economy in Africa. There are recent evidence that social connectedness can be used to foster positive adjustment behaviour (Turki et al., 2018).

We find that better publicity and awareness will likely be a good strategy to achieve better plastic waste management as over 72% (27.48% – very useful and 45.32% – useful) are of the view that awareness of environmental risks or dangers associated with plastic waste will encourage them to act sustainably. We also find that fair pricing of bottles will be an effective approach as only less than 3% of respondents found it not useful at all and 48.76% of respondents are willing to take their plastic wastes to a collection centre.

We do recognise that every aspect of digital technology (cloud, big data, IoT, blockchain, AI, robotics, GIS, ARvr, websites, 5G, MobileApp, amongst others) has a role to play in managing plastic waste pollution in Africa, but we focus more on mobile solution and websites because of the insight from our data. Only about 25% gave adverse responses to understanding of mobile applications (13.9% never heard of it before and 11.39% are poor at using it), 67.37% are above good (good and excellent) while 7.34% were neutral. Respondents' understanding of website technology is similar to mobile applications. On the other hand, 67.83% gave adverse responses to understanding of AI while only 4.07% are excellent at the use of it, 69.82% gave adverse responses to understanding of Geographic Information System (GIS) while only 3.09% are excellent at using it, 72.97% gave adverse responses to their understanding of blockchain technology while only 2.12% have excellent understanding of the technology. The trend is similar for robotics, cloud (serverless), ARvr and 5G. The fact also that over 74% of respondents claim to have smartphones gives us a further justification to focus on mobile solutions. These results incline us more towards digital-technology-driven solution for Africa.

Presented in Table 14.5 is the respondents ranking of barriers to their adoption of digital tools/technology in plastic waste management (beginning with 1 as the

TABLE 14.5 Summary statistics of respondents ranking of their barriers to adopt digital tools

	Between 1 and 3	*Between 4 and 5*
Technical barrier	70.10%	29.90%
Economic barrier	74.13%	25.87%
Political barrier	74.46%	25.54%
Socio-cultural barrier	71.01%	28.99%

most significant barrier and 5 as the least significant). The overall image is a high barrier to digital tools adoption.

This sub-segment presents general discussion following insights from the descriptive statistics. It highlights major challenges that have been responsible for ineffective or weak plastic waste policies in Africa and proposes practical ways digital technology can mitigate some of the challenges.

Exclusion of the informal sector – The starting point when we discuss transitioning to a circular economy is always effective waste management. In the case of Africa, the conventional framework for recycling and waste management will lead to suboptimal outcomes if the activities of the informal recycling sector are not brought into the equation (Wilson et al., 2006). An effective policy for Africa will need to integrate plastic waste recycling activities of waste pickers and scavengers (informal recycling sector) into the national plan. Findings show that waste scavengers can be formally integrated into the recycling process. This has been demonstrated to be economically viable (Adeyemi et al., 2001). In that vein, similar technology used in AgriTech can achieve this outcome. Digital technologies have enabled crowd farming in Africa such as Farm Crowdy in Lagos, Thrive Agric in Ghana, and Complete farmer in Ghana and same can be modified to suit informal waste collectors in Africa. It is an aggregation platform that can serve any other sector. Good evidence is the activity of "Mr Green Africa" which is integrating informal waste collectors into the recycling cycle in Kenya.

Awareness problem – (EdTech comes to play). Solutions similar to ones used in EdTech can help in improving masses' awareness of plastic waste policies and in educating them in plastics circular economy. Experience from Fintech shows financial literacy can be enhanced using mobile- and web-based educational platforms. This EdTech can be adopted and extended to educate on plastics wastes' impacts and increase awareness of existing policies. When it comes to educating the masses, Takacycle (Tanzania) is one example that uses waste collection and recycling infrastructure to teach and incentivise people on capturing values from their waste while OkwuEco (Nigeria) is using image recognition to educate households about recycling and linking them to waste merchants.

Enforcement problem (Traceability + Blockchain) – Enforcement of any law becomes almost impossible under asymmetric information (incomplete information). Traceability is however possible with digital tools of instilling barcodes that link every plastic packaging to its manufacturer. This enables monitoring and to appropriately enforce penalties for plastic packaging not properly reused or recycled. Similar tools have been used in tracing and confirming the genuineness of drugs in Africa (Kenya and Nigeria). The simple tool will also facilitate a recycling economy where scavengers are paid for recovered plastic and the subject plastic manufacturer is debited for the recovery activities. This particular tool will also tackle one of the main problems often cited in literature as a challenge to a plastic circular economy, i.e., lack of information on plastic usage.

We also find a more recent application of blockchain technology for smart contracts as an important tool to improve plastic waste policy in Africa. Chidepatil et al., (2020) in their projects (using blockchain smart contracts, AI and multi-sensor data–fusion) presented efforts at segregating plastics based on the plastics' types. This is claimed to be able to efficiently segregate commingled plastics and can result in all actors (segregators, recyclers and manufactures) being able to share data, plan their supply chain, execute purchase orders and further increase the use of recycled plastic feedstock (Chidepatil et al., 2020).

Product redesign which includes reviewing inputs in production and final packaging of products also has a role in transforming Africa to a plastic circular economy but while that will pivot around engineering reviews, big data from digital technology makes engineering redesign easier and cheaper than before. Chidepatil et al. (2020) address how they are able to help manufacturers get reliable information about the availability, quantity and quality of recycled feedstock using advanced blockchain and AI technologies. This was achieved by calibrating and deriving different grades for different recycled polymers. Manufacturers will then be able to assess the suitability of recycled polymers for various applications (Chidepatil et al., 2020).

The combined utilisation of big data, social media data and machine learning (AI) will help to leverage on the social factor (as observed from our survey) to enhance sustainability habits of Africans. The Social Connectedness Index (Facebook and WhatsApp) presents massive data opportunities to utilise network and social connectedness across nations to influence plastic circular economy adoption while data from Twitter can be used to model strength of a network at the individual levels, thereby providing optimal policy targets. Machine learning can be used to demographically classify individuals on social networks (Ajala et al., 2021), such that plastics control initiatives can be appropriately channelled to key actors.

Big data and mobile applications can facilitate a new redistribution model such that products are used to their full potential as users can co-use instead of owning them personally. This can equally originate from a firm managing physical flow of resources better by making use of big data analytics to assess customers' consumption patterns, behaviour to forecast demand. Wireless intelligent technology can also be integrated into the production line.

Advising on policies itself, emphasis should be placed on internalisation of external costs, where companies that control for emissions and pollution are rewarded. Considering the weakness of a linear economy also, the principle of stewardship should be underscored instead of ownership and its right to destroy. Similarly, policies should be extended beyond punitive laws to the use of economic instruments such as the use of incentives and taxes. A business approach justification can be made from eTrash2cash in Nigeria which is already using web, mobile apps and SMS to exchange wastes for direct cash. Economic incentives currently lacking on the continent's regulation can leverage these technologies.

This is similar to what Eco-Post is doing in Kenya. Fundamental change from outright ownership to leasing will increase reusability (a case of Michelin model). This will promote the product as a service.

Generally, we see a need for structural changes to current policies to experience better adoption of digital innovations for circular plastic economy (Berg et al., 2018). We are of the view that digital innovations can be used to create a well-informed cohort of innovators to promote diffusion of circular plastic economy (Kolade et al., 2022). It can also be used to build a more collaborative multi-sectoral community that can advance plastic circular economy in Africa. Digital technologies can generate economies of scale for circular plastic economy stakeholders by connecting stakeholders from a wide range of backgrounds, sectors and countries across Africa. It can also help to create markets for recycled parts (Oyinlola et al., 2022). In the area of policy, it can aid in implementing EPR regulations and in addressing regulatory barriers.

As part of our contribution to plastic circular economy in Africa, we re-echo World Economic Forum assertion that governments should set up political, legislative and economic frameworks that can incentivise profitable circular economies. We then specifically recommend that African countries should formulate policies facilitating digital backbone at national levels (World Economic Forum, 2021b). This is expected to create competing digital circular business models. This will enable small and medium enterprises (SMEs) to participate in circular economy against the current trend where large multinational companies are leading the drive. This backbone will enable interoperability of many-to-many against the one-to-one interoperability often experienced in the linear economy. We are of the view that it will enable SMEs to scale their innovations. Its potential to reduce cost and risk when it comes to circular economy will help the circular plastic economy. Such a backbone will allow data sharing and standardisation. We find confidence in this suggestion drawing inference from Mojaloop (an open-source software), designed to provide a reference model for payment interoperability. This has already been adopted by some national governments (e.g., Rwanda) with the hope that the interoperability will help in overcoming barriers that have slowed the spread of digital financial services across Africa.

4.1 Evidence of Emerging Digital Tools in Africa Plastic Economy Ecosystem

While policy has a significant part to play in driving the plastic circular economy, we are witnessing a massive role played by digital innovation in improving material efficiency. Primary discourse of circular economy revolves around large corporations because of their perceived capabilities to both conceptualise and lead transformation to circular economy (Schröder et al., 2019). However, we are of the view that African reality such as, the presence of large informal sector, significant

role of government in the economy and the profit-maximisation inclination of large businesses, will demand a slightly different approach to scaling the circular economy in Africa.

We briefly present evidence of the possibility of digital technology, playing a role in addressing plastic waste problems in Africa. We showcase some selected tech start-up ideas focusing on plastic waste problems in Africa (Table 14.6). We map their business ideas to different areas of the plastic circular economy action areas. The three broad action areas often discussed in creating a plastic circular economy are "eliminate, innovate and circulate". The actions are on eliminating all unnecessary plastics, ensuring reusability, recyclability and composability of plastics and to continuously circulate plastic to keep them out of the environment.

5   Summary and Conclusion

The concept of "circular economy" presents a beneficial loop of continuous material recycling without the adverse effects of new production on the environment; however, recycling is only one and of a lower order in the hierarchy of reducing plastic waste impacts (Allwood, 2014). Other policies that reduce demand and increase re-use of products are strategies with equally great potentials to transform Africa into a circular economy. While large multinational companies such as Michelin might be leading adopters of the circular plastic economy globally, the African experience will need to rely on tech start-ups in Africa. The result from our survey shows how difficult it may be for companies in Africa to fully adopt the multinationals model, but tech start-ups have the opportunity to capitalise on this and redefine the business model within the continent. They have access to enabling digital technologies to scale this new business model and they can develop capacities to create circular advantages from product design to production and profitable regeneration.

Many countries have adopted national and international policies targeting plastic pollution, but substantial numbers of people, firms and organisations will still need to alter their existing behaviours if global plastic pollution is to be curbed. Evidence has shown that education and persuasion alone are insufficient to achieve this outcome, therefore making government policies imperative (Kinzig et al., 2013). As Stahel (2016) suggested, there is the need for governments and regulators to adopt policies that will promote a circular economy at the industry level, including the use of taxation. Likewise, innovations to pave the way for further advancement in splitting up molecules to re-cycle atoms should be supported by the government.

We do recognise that a circular economy will be beneficial to all stakeholders, but many organisations in Africa are not currently built to capitalise on circular advantage. The transformation from a linear to a circular economy will require not only an environmental but also a social and economic restructuring of

TABLE 14.6 Mapping of selected tech start–ups in Africa to plastic circular economy areas

	Eliminating unnecessary plastics	*Recycling used plastics*	*Ensuring reusability of plastics*
Recycle Bot (Zambia)		Mobile device used across the whole value chain	
Africa– Waste – Veolia (Côte d'Ivoire)	Users are able to indicate the amount of waste they would like to remove		
Capture Solutions (Nigeria)	Digitisation of processes (IoT Devices).	Value addition (finished and semi-finished goods)	Geotagging of activities for material traceability. Community based training
Chanja Datti (Nigeria)		Online based recycling company (consumers are rewarded for recycling)	
Coliba (Côte d'Ivoire)	Platform to request pick up of plastic wastes		
Ecofuture (Nigeria)	Collects recyclable plastic wastes using mobile app and SMS		
Kaltani (Nigeria)	Collect and sort plastic	Recycle plastic waste	Wash plastic waste
Recuplast (Senegal)	Website based collection of plastic waste		
Salubata (Nigeria)			Online store selling modular shoes made from recycled plastic
SOSO Care (Nigeria)		Provide health insurance where recyclables are premium	
Dispose Green (Ghana)		Apps that connect people to a wide network of waste collectors	
EasyWaste (Ghana)		Operate recycling centres	
Takacycle (Tanzania)			Educating people on how to capture value from their waste.
Wastezon (Rwanda)			Selling of wastes using an app
	App/Website based waste pick up		
WasteBazaar (Nigeria), RecycleGarb (Nigeria), GreenHill Recycling (Nigeria), MIRA (Ghana), ComeRecycle (Nigeria), Eazy Waste (Ghana), Zonku Technology (Uganda), Yo-Waste (Uganda), Wrapp (South Africa), Virdismart (Kenya), Vicfold recyclers (Nigeria), Scrapays (Nigeria), Reveal Uno (Ghana).			

Note: Data extracted from DITCh Innovation Aggregator Website – (Last assessed on October 31, 2021)

production and consumption patterns. Our first proposition was how to integrate the informal sector into the circular economy? Digital tools can be used to bring together the activities of the informal recycling sector. To increase cooperation among nations, data banks and blockchain technology that facilitate traceability of plastic wastes to their source producers/countries will significantly help not only in formulating better plastics waste policy, it will enhance enforcement.

Our conclusions align with da Costa's (2018) position that four major reasons can explain why current efforts at transforming the plastic economy have yielded limited success. That there is insufficient regulatory scope while for existing regulations, there is lack of implementation and enforcement. Also, there is insufficient states' participation in regional initiatives (poor international cooperation) coupled with inexistence of sufficient data on the prevalence of marine plastic waste in the environment.

We reiterated that some start-ups within the African tech ecosystem are already incubating businesses that can improve plastic waste policies on the continent such as EasyWaste which has been serving as a data hub for reporting collection of waste and recycling data. They also assert to be helping policymakers formulate good waste management policy and bring plastic scavengers from the informal sector. WeCyclers is also using an app to store the number of collected recyclables from various locations while Virdismart uses automated waste collection and management, making use of a Smart Bin that rewards customers.

This chapter has added to literature in two ways. Firstly, it reviewed initiatives in Africa that were intended to affect circular plastic economy on the continent and undertook a country plastic circular economy review of Nigeria (Nigeria Plastic Regulation Bills and the Extended Producers Responsibility Programme), thereby adding to the limited literature on plastic policies in Africa. Secondly, it highlighted digital technological tools and how the tools can be used to enhance Circular Economy Policy effectiveness in Africa and presented some current efforts been made by start-ups in Africa to attend to plastic waste challenges.

Appendix 1

Country	Policy Count
Nigeria	14
South Africa	10
Egypt	9
Mauritius	9
Ghana	8
Tanzania	8
Tunisia	8

Country	Policy Count
Uganda	8
Cameroon	7
Rwanda	7
Seychelles	7
Algeria	6
Benin	6
Cape Verde	6
Madagascar	6
Mozambique	6
Namibia	6
Togo	6
Zimbabwe	6
Burkina Faso	5
Kenya	5
Malawi	5
Mali	5
Zambia	5
Angola	4
Botswana	4
Burundi	4
Côte d'Ivoire	4
Democratic Republic of the Congo	4
Djibouti	4
Gambia	4
Niger	4
São Tomé and Príncipe	4
Senegal	4
Ethiopia	3
Gabon	3
Mauritania	3
Morocco	3
Comoros	2
Guinea	2
Libya	2
Republic of the Congo	2
Sierra Leone	2
Somalia	2
Sudan	2
Central African Republic	1
Chad	1
Eritrea	1
Eswatini (formerly Swaziland)	1
Guinea-Bissau	1
Lesotho	1
Liberia	1

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