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SPECIALTY SECTION  
This article was submitted to  
Circular Economy,  
a section of the journal  
Frontiers in Sustainability

RECEIVED 07 November 2022  
ACCEPTED 16 January 2023  
PUBLISHED 09 February 2023

CITATION  
Ogutu MO, Akor J, Mulindwa MS, Heshima O  
and Nsengimana C (2023) Implementing  
circular economy and sustainability policies in  
Rwanda: Experiences of Rwandan  
manufacturers with the plastic ban policy.  
*Front. Sustain.* 4:1092107.  
doi: 10.3389/frsus.2023.1092107

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# Implementing circular economy and sustainability policies in Rwanda: Experiences of Rwandan manufacturers with the plastic ban policy

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Despite the rise of plastic waste regulation and rising trends in the adoption of circular economy (CE) policies globally, investigations of their impact on businesses remain limited. Research on adoption of CE policies in Africa is particularly limited despite African countries leading the uptake of plastic ban laws and CE-related policies. This paper examines how the 10-R principles of CE feature in Rwanda's sustainability policies, and provides the experiences of Rwandan manufacturers following the implementation of the plastic ban. A qualitative review of key environmental sustainability policies in Rwanda shows alignment to different levels of 10-R principles of the circular economy. Meanwhile, field interviews with leading manufacturers comprising producers and users of single-use plastics in Rwanda indicate that businesses have faced internal and external challenges complying with the plastic ban and CE-related policies. These challenges range from limited capital to acquire new industrial technology, lack of expertise to develop circular business models, lack of alternative packaging to plastics, to loss in market competition since Rwanda's competitors in the international market still use cheap plastic packaging. Consequently, our findings indicate that insufficient government support such as lack of finance and capacity development to develop new business models, ambiguous regulatory framework, and inadequate stakeholder consultations impedes business uptake of CE and other sustainability policies. In addition to providing policy and managerial implications, we conclude by underscoring the importance of continued collaboration between government in terms of regulation, innovation from businesses, and consumer actions, in tackling environmental challenges caused by plastic waste and implementation of CE and other green policies.

## KEYWORDS

circular economy in Africa, sustainability policy, environmental policy, plastic ban, manufacturing, Rwanda

## 1. Introduction

Plastics are widely used globally in product packaging, manufacturing, and in households since they are cheap, lightweight, durable, and strong. The demand for plastics is expected to continue, and estimates indicate production will double by 2035 and probably quadruple by 2050 (UNEP, 2018a). Plastics are mainly produced using non-renewable resources such as oil, natural gas, and coal (Clapp and Swanston, 2009). A UN report notes that if current trends continue, the plastic industry could account for 20% of the world's total oil consumption by 2050. Plastics have thus emerged as one of the most pressing environmental issues since they are not naturally biodegradable. Furthermore, 60% of the estimated 8.3 billion tons of plastic produced since 1950 (UNEP, 2018b), have ended up in landfills or the natural environment, affecting climate change, marine life, biodiversity, and human health (Leonard and Barra, 2018).

Tackling the environmental challenges caused by plastic waste require collaboration between governments in terms of regulation, innovation from business and action from individuals (UNEP, 2018b). While plastic garbage is taken up by a waste management system in developed nations and at least partly recycled, in low-income countries such as Rwanda, appropriate waste collection management or recycling infrastructure, though upcoming, is often lacking. Still, developing countries such as Rwanda are increasingly adopting mitigation strategies in response to the environmental damage caused by plastic waste. The most common has been to ban single-use plastics and encourage the production and use of environment-friendly alternatives. The prohibition of single-use plastics has been particularly popular in Africa, where 34 of 54 countries have implemented policies restricting single-use plastics since 2,000 (Greenpeace Africa, 2020). Rwanda became the first country in East Africa to introduce anti-plastic legislation in 2008 when it prohibited the manufacturing, use, sale, and importation of all plastic bags. Uganda and Kenya followed in 2009 and 2017, respectively. At the regional level, the East African Community (EAC) an intergovernmental body representing seven countries (Kenya, Tanzania, Uganda, Rwanda, Burundi, South Sudan, and the Democratic Republic of the Congo) banned the manufacturing, sale, importation, and use of polythene bags through the East African Community Polythene Materials Control Bill 2017 (Karuhanga, 2017).

Following the ban on single-use plastics, Rwanda has subsequently emerged as a proponent of sustainability policies in Africa, including in the implementation of circular economy (CE) policies. A circular economy (CE) is an economic system that emphasizes processes and economic activities in which raw materials and products maintain a high value as long as possible and waste is reduced significantly (Kirchherr et al., 2017). The adoption of CE policies and implementation of the plastic ban disrupted the business models of Rwandan manufacturers. To stay in business in Rwanda, the policy requires that companies transition from manufacturing or using single-use plastics to production, and or use of environmentally friendly alternative materials. However, transitioning to alternative materials is capital intensive, and firms have faced challenges complying with the policy. Moreover, economic crises during the transition period can further exacerbate the challenges faced and derail the process,

as Rwandan businesses experienced during the recent COVID-19 pandemic. In this study, we examined the experiences of Manufacturers in Rwanda as they navigate the ban on plastics, and Rwanda's drive toward sustainability policies aligned with CE principles.

Transitioning from one regulatory policy to another requires collaboration among all stakeholders, including business and government. Studies have found that absence of adequate government support in the form of funding opportunities, capacity development, business-friendly taxation policies, laws and regulations, impedes uptake of CE policies by SMEs (Rizos et al., 2016). In many African countries, including Rwanda, the legal and regulatory frameworks that foster circularity are still in their infancy stages (Desmond and Asamba, 2019). Moreover, policies such as plastic ban are not always followed with mechanisms such as capacity that would support full realization of a country's circular or green economy initiatives. For example, Rwandan manufactures faced constraints in complying with plastic ban legislation (Behuria, 2021; Shabiti, 2021). The constraints initially ranged from a lack of knowledge to differentiate between permitted plastics and those outlawed, insufficient stakeholder consultation during policy design and implementation, and lack of capacity and finance to implement new business models necessitated by the ban (UNEP, 2018c; Behuria, 2021; Shabiti, 2021). Moreover, the emergence of a lucrative black market of smuggled plastic from neighboring countries initially affected implementation of the policy and the competitiveness of Rwandan manufacturers, but this was mitigated with stricter regulations. Punishments for violators included between 2 to 12 months in prison and hefty fines ranging from 5,000 to 100,000 Rwandan francs (between US\$5 and \$110) (Government of Rwanda, 2005).

To support the transition process, the Rwandan government provided support in the form of fiscal policies such as tax waivers and special exemptions that allow eligible firms to continue using or importing plastics. Eligible firms include those that require plastic materials in their business operations such as packaging, especially exporters and importers of home compostable single-use plastics. The policy was also implemented in transition stages that allowed firms to comply over a period of time. Meanwhile, donor communities offered technical and capacity-building support, including training businesses on CE business models and financial support in the form of venture funding to start-ups engaged in plastic waste management.

The study contributes to the literature on CE-related policies in Africa by providing Rwanda's experiences implementing the CE principles. We frame the plastic ban as a key feature of Rwanda's CE and other sustainability policies. We also examine the experiences of Rwanda manufacturers with implementation of the plastic ban and CE policies, focusing on understanding the challenges they face, and the strategies they employ to address those challenges. Moreover, we examine existing forms of support provided by the government to support firms as Rwanda transitions from linear to CE policies. The experiences of the Rwandan private sector in the transition from single-use plastics to alternative materials, including challenges faced, offers lessons on the impact of anti-plastic legislation. The research was primarily exploratory, focusing on providing results of a

field survey conducted in Rwanda in between May and June 2022, and complemented with secondary data collected through desktop research on circular economy and sustainability policies in Rwanda. This exploratory nature limits theoretical discussion to the definition or contextualization of CE principles within the Rwandan sustainability context. Nonetheless, it contributes to the qualitative research on CE and sustainability in Africa, within the context of plastic waste management, and the impact of such policies on business.

The study is structured as follows. Building on the introduction, Section 2 explores the literature on CE and sustainability in Rwanda. The section also highlights the research gap and significance of the study. Section 3 presents discusses the research questions, approach, and methodology. Section 4 presents the results of the investigation. Sections 5 and 6 analyze the findings and provides concluding recommendations, respectively.

## 2. Literature review

### 2.1. Understanding circular economy principles

Kirchherr et al. (2017) collated 114 definitions of a CE and argued that a common theme among them is that they describe the concept to be a combination of reduce, reuse, and recycle practices, and not a modification of systems geared toward economic prosperity, environmental sustainability, and social equity. These three circular processes are usually termed as the “3R framework” highlighted by authors such as King et al. (2006) and Ghisellini et al. (2016). Other frameworks based on modifying the 3R framework with additional features that aim to holistically encompass the CE processes have been formulated and used by other specialists. For example, the 4Rs used by the European Parliament (2008), 6Rs used by Sihvonen and Ritola (2015) as a product’s end-of-life technique, 9Rs by Van Buren et al. (2016) and 10Rs described by the PBL Netherlands Environmental Assessment Agency (2017) (see Table 1). The CE concept often contrasts with linear economy where materials are sourced, converted to products, and then used by the consumers who dispose of them after use. Kirchherr et al. (2017) defined CE as an economic system that replaces the “end-of-life” concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes. CE operates at the micro level (products, companies, and consumers), meso-level (eco-industrial parks), and macro level (city, region, nation and beyond), with the aim of accomplishing sustainable development, thus simultaneously creating environmental quality, economic prosperity, and social equity, to the benefit of current and future generations. CE is enabled by novel business models and responsible consumers who, for example, implement circular processes in their production or consumption, respectively. However, the concept has also been criticized as being too vague to be used practically (Valenzuela and Böhm, 2017; Corvellec et al., 2021). Critics of the model claim that it is more of a theoretical than a practical concept to drive sustainability of scarce resources and wastes commonly associated with the traditional linear economy (Corvellec et al., 2021). Despite these critiques, the CE concept is increasingly gaining prominence and has been widely adopted by stakeholders exploring mechanisms

TABLE 1 A summarized explanation of 10 -R circular economy framework.

Smart product use	R0—Refuse	Make a product redundant by abandoning its function or by offering the same function with a radically different product.
	R1—Rethink	Make product use more intensive (e.g., through sharing products, or by putting multi-functional products in the market).
	R2—Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of products and its parts	R3—Reuse	Re-use by another consumer of discarded product which is still in good condition and fulfills its original function.
	R4—Repair	Repair and maintenance of defective product so it can be used with its original function.
	R5—Refurbish	Restore an old product and bring it up to date.
	R6—Remanufacture	Use parts of discarded products in a new product with the same function
	R7—Repurpose	Use discarded products or its parts in a new product with a different function.
Useful application of materials	R8—Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality.
	R9—Recover	Incineration of materials with energy recovery

Source: PBL Netherlands Environmental Assessment Agency (2017).

TABLE 2 Study sample.

Category of respondent	Total sample	No. interviewed
Secondary manufacturers	14	4
Primary manufacturers	14	4
Rwanda environment management authority (REMA)	1	1
Rwanda development board (RDB)	1	0
Ministry of trade and industry (MINICOM)	1	0
Rwanda private sector federation (PSF)	2	0
Rwanda chamber of commerce and services	2	0
Total	35	9

to address the impact of climate change, waste management, and environmental conservation.

### 2.2. Explaining the plastic ban as a key component of CE and sustainability policies in Rwanda

Sustainability has emerged as a strong component in Rwanda’s social and economic development journey post-1994 genocide. In 2005, Rwanda adopted Organic law No. 04/2005 which determines the modalities of protection, conservation, and promotion of the

TABLE 3 Demographic data of the firms interviewed.

Company	Organization sector/category	Year founded	No. of employees (estimated)	Product manufactured/business activity
Participant 1	Primary manufacturer	2013	150	Trash bags, disposable bags
Participant 2	Primary manufacturer	2019	600	PVC plastic shoes
Participant 3	Primary manufacturer	2013	165	Eco-friendly packaging
Participant 4	Primary manufacturer	2015	117	Packaging for agricultural products. Also engaged in plastic recycling.
Participant 5	Secondary manufacturer	1982	900	Paintings
Participant 6	Secondary manufacturer	1997	960	Food processing for export
Participant 7	Secondary manufacturer	2007	45	Foodstuffs
Participant 8	Secondary manufacturer	1973	400	Food manufacturing industry
Participant 9	Government agency			Rwanda environment management authority (REMA) implements Rwanda's environmental sustainability and related policies. They enforce environmental policies, including the plastic ban.

environment (Government of Rwanda, 2005). The adoption of the 2005 Organic law followed a 2004 study by the Rwanda Ministry of Environment which found that plastic litter threatened agricultural production, contaminated water sources, killed fish and created visual pollution that tarnished the image of the country (Dsilva, 2019). This law established the initial framework for policies relating to sustainability. Indeed, guided by the Organic law of 2005, in September 2008 Rwandan parliament passed Law N57/2008 which prohibited the manufacture, importation, use, and sale of polyethylene bags in Rwanda. The law defined polythene bags as synthetic plastic made up of numerous simple chemicals called ethene (monomer). In August 2019, this regulation was expanded to include other single-use plastic products, including straws, bottles, and food containers (Government of Rwanda, 2019).

Protecting the environment and sustainable management of natural resources has become integral in Rwanda's national development plans. It was a central part of Rwanda's Vision 2020, in which Rwanda sought to diminish pressure on natural resources and reverse environmental degradation (Government of Rwanda, 2012). In the successor Vision 2050, conservation is recognized as important to the sustainability of the tourism industry and the preservation of Rwanda's national heritage. Through Vision 2050, the government plans to continue positioning Rwanda as the global frontier for conservation (Government of Rwanda, 2020).

### 2.3. Research gap

While Rwanda has consistently used the plastic ban to position itself as champion of CE and sustainability in Africa, few studies [see for example, Behuria (2021)], have explored the implementation of such policies in Rwanda without focusing much on their climate-change and conservation related effects. While scholars have explored implementation of environmental protection policies in Rwanda (Siegel et al., 2011; Nibeza, 2015; Danielsson et al., 2017; Whyte et al., 2020; Behuria, 2021), a few studies have explored strategies adopted by Rwandan manufacturers to ensure compliance with anti-plastic regulations [see for example, Behuria (2021)]. Similarly lacking is research exploring the effectiveness of government support to

manufacturers following the ban on plastics and the implementation of CE-related policies. Existing studies tend to focus on the business-government dynamics environment and the politics surrounding the implementation of policies banning plastic (Behuria, 2019, 2021), or the environmental impacts of plastics, approaches to alleviate plastics and the attendant effects of such policies on the country's image, such as the "cleanest city" moniker given to Rwanda's capital Kigali by media commentators and scholars (see Hakuzimana, 2021). Other scholars have also found that despite efforts to make Rwanda a plastic-free country, scientific studies on plastic pollution and the impact of adopted policies in Rwanda are still lacking (Hakuzimana, 2021). The absence of such studies makes it challenging to obtain reliable data, and to understand the implications of adopted policies, for example, on the business environment. However, the lack of studies on the impact of sustainability-related policies, such as CE policies on business is not unique to Rwanda. In Africa, investigations on the impacts of CE policies on business, though upcoming are still limited (Andersen et al., 2021; Behuria, 2021). The limitation of studies on Africa is partly due to the lack of reliable data sources (Andersen et al., 2021) and the reluctance of businesses to participate in empirical research involving their relationship with the government, which is true in the case of our study. In states like Rwanda, with a centralized political system and a high degree of government involvement in business (Behuria, 2015, 2021), manufacturers often fear that their data may be transferred to authorities, whom they often perceive as "policing" them through environmental regulations. Furthermore in East Africa, such fears are not unique to Rwanda as manufacturers in Kenya and Uganda (Behuria, 2021), and Tanzania exhibited similar sentiments (Andersen et al., 2021). Lastly, the reluctance of manufacturers to participate in empirical studies, as one business leader informed us, is further caused by the fact that researchers do not always share the results of their studies with the private sector.

As aforementioned, the study thus sought to explore the experiences of Manufacturers in Rwanda as they navigate the ban on plastics and Rwanda's drive toward sustainability. More specifically, the questions we explored include: What are the challenges manufacturers face in their transition to alternative materials (question 1)? What strategies did Rwandan manufacturers



adopt as they transitioned from the production or use of single-use plastics, which are prohibited, to alternative materials (question 2)? How has the Rwandan government been supporting manufacturers as they transition—and what other form of support do businesses require as they transition (question 3)? Finally, how does circular economy principles feature in Rwanda's sustainability policies, including national development plans (question 4)? Since Rwanda is a leading pioneer in plastic regulation and CE policies in Africa, a critical analysis of the experiences of its private sector with the implementation of related policies offers lessons other jurisdictions may consider in developing plastic management regulations and other green policies.

### 3. Materials and methods

#### 3.1. Study design

The study employed a descriptive qualitative research design based on qualitative data collected through field interviews with Rwanda manufacturers and desk review of literature on CE-related policies in Rwanda. Descriptive studies systematically describe a situation, problem, phenomenon, service, or programme (Kumar, 2011). The research was informed by the study focus, which sought understand the experiences of Rwandan manufacturers with the plastic ban policy.

#### 3.2. Sample & sampling technique

Study participants were identified through a purposive sampling technique, which identifies respondents based on the nature and intent of the study (Groenewald, 2004; Tongco, 2007). The sampling process involved a desk study of firms manufacturing or using plastics in their business operations, and those responsible for implementing economic and sustainability policies in Rwanda.

TABLE 4 Challenges firms face as the transition from single use plastics to other alternatives.

Internal challenges	External challenges
<ul style="list-style-type: none"> <li>• Increased cost of production.</li> <li>• Limited capital for new investments, including in new industrial technology.</li> <li>• Unplanned Investments in new and unplanned technology and redundancy of recently acquired machinery.</li> <li>• Over reliance on foreign labor which sometimes slows production.</li> <li>• Inability to purchase expensive raw materials.</li> <li>• High cost of acquiring alternative packaging materials.</li> </ul>	<ul style="list-style-type: none"> <li>• Perception of consumers and lack awareness.</li> <li>• Neighboring countries still using single use plastics.</li> <li>• Finding new packaging suppliers.</li> <li>• Rise in transport expenses (packaging materials being exported).</li> <li>• Reduced market (lost customers in the process).</li> <li>• Loss in regional competition (competitors using cheap packaging, including plastics).</li> <li>• Inconsistent business policies.</li> <li>• Lack of access to skills (e.g., paper technology).</li> <li>• Fluctuations in foreign exchange rates.</li> <li>• Prolong process in license processing with REMA.</li> <li>• Fears of not meeting supply—due to rising consumer interest in the glass packaged water.</li> </ul>

This resulted in the classification of firms into either primary or secondary manufacturers. Primary manufacturers are firms that manufacture single-use plastics, while secondary manufacturers are firms that use single-use plastic products to develop their final product. For example, a plastic bottle manufacturer would be classified as a primary manufacturer, while a water company that uses the bottle to package water for sale is classified as a secondary manufacturer. The total sample included 35 respondents comprising 14 primary manufacturers, 14 secondary manufacturers, three government agencies and two leading industry groups representing manufacturers (see Table 2). Despite this large sample, empirical data was collected from only nine participants, comprising four primary manufacturers, four secondary manufacturers and the government agency responsible for implementing and enforcing environmental policies in Rwanda. Some of the targeted respondents declined to participate despite ethical assurances and our framing of the study as necessary in understanding the experiences of firms as Rwanda implements CE policies. As aforementioned, businesses in Rwanda, and indeed most East African countries, are often reluctant to participate in studies that examine their relationship with the government (Andersen et al., 2021; Behuria, 2021). Manufacturers that participated in the study shared our view that the study could help inform policy changes that positively improve the business environment. The interviews were complemented with reliable secondary materials including media reports that contained statements from business leaders and business community representatives such as officials from Rwanda Association of Manufacturers and the Private Sector Federation (PSF), public officials such as the Rwandan Minister for Environment and Members of Parliament. The sample size is summarized in Table 2.

#### 3.3. Data collection and analysis

Secondary data was collected through a desk review of the Rwandan CE landscape by reviewing Rwanda's sustainable development policies and its adoption and implementation of regulations to manage plastics. The review covered academic articles, media publications, and government policy documents. The academic documents reviewed were those discussing CE concepts and its implementation, and those examining implementation of regulations banning plastics in Rwanda and Africa broadly. For media articles, the study focused on publications by leading Rwandan business and environmental journalists; these included their interviews with public officials such as parliamentarians and ministers. Finally, the study reviewed key Rwanda policy documents related to environmental conservation and sustainability, national development plans such as Rwanda Vision 2020 and Vision 2050 and the country's manufacturing-related policies. These documents outline Rwanda's sustainable economic development plans and related policies. Following desk research, empirical data was collected from the sampled population through field interviews using semi-structured questionnaires. The questionnaires were designed to collect information on business responses to the plastic ban, challenges faced, and available government support to enhance transition. Semi-structured questionnaires allowed participants to share their experiences broadly, allowing the researchers to ask follow-up questions based on participant

**TABLE 5** Government support provided to manufacturers during the transition process.

Nature of government support	Nature of support required (how government and development partners might help firms to transition)
<ul style="list-style-type: none"> <li>• The Rwandan government offered support in terms of tax facilitation, financial support, and training/capacity building (skills development).</li> <li>• Conducive business environment.</li> <li>• Special permit/authorization license that allows businesses to continue importing, using, or selling plastic import or sell plastics—during the transition and as they seek alternative replacements.</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitate access to credit, such as loans at an affordable rate; some participants noted that loans provided at a friendly rate are better than grants.</li> <li>• Expertise training on skills in deficit areas—establish industrial training institutions different from the existing TVETs to train industrial skills especially on areas relevant to Rwanda’s development goals.</li> <li>• Facilitate access to new technology.</li> <li>• Facilitate benchmarking sessions or knowledge exchange for local participants to learn on how other regions/countries are performing, for example, knowledge on how other people or other countries are doing recycling or available alternative materials.</li> <li>• Expand the list of available tax incentives for manufacturers still facing access to technology.</li> <li>• Establish or provide incentives for investors to establish a local packaging manufacturing industry.</li> <li>• Assist local manufacturers find replacements to plastics, especially packaging manufactures.</li> <li>• Engage stakeholders before taking drastic policy actions. For example, government should have considered local capacity to produce the required packaging or alternative materials before banning plastics.</li> <li>• Engage in consumer/stakeholder sensitization to increase awareness on the policy.</li> <li>• Support waste collection incentives.</li> </ul>

responses. The data was manually cleaned and analyzed thematically to identify themes and patterns that respond to the research questions.

## 4. Results

This section presents the results of the fieldwork interviews with select Rwandan manufacturers. The study participants consisted of businesses that are primary and secondary manufacturers of single-use plastics. There were four primary manufacturers and four secondary manufacturers. To triangulate data on government support since the ban on plastic, Rwanda Environmental Agency (REMA) was also interviewed. REMA is the government regulatory agency responsible for ensuring that environmental issues and climate change are integrated into Rwanda’s development plans. REMA enforces environmental policies, including the plastic ban. For anonymity purposes, the names of firms interviewed into participant 1–9. [Table 3](#) presents a summary of the participant’s demographic data. The results are presented based on the research questions, and the data is summarized in tables based on key themes.

**TABLE 6** Strategies adopted by Rwanda manufactures as they transition from single-use plastics to other alternatives.

Company	Strategies adopted by Rwanda manufactures as they transition from single-use plastics to other alternatives
Participant 1	<ul style="list-style-type: none"> <li>• Established contracts with small private companies that collect plastic waste and deliver for recycling; firm pays for transportation fee.</li> <li>• Plans to purchase advanced machines to support the recycling process and waste management. Currently firm uses the same machines in productions (recycling and non-recycling) which cause’s a mix-up in processes.</li> </ul>
Participant 2	<ul style="list-style-type: none"> <li>• Recycles plastics for production of final product.</li> <li>• Relies on the authorization license / permit.</li> </ul>
Participant 3	<ul style="list-style-type: none"> <li>• Implemented a flexible transition plan, based on market trends and legislation.</li> <li>• Capitalized on existing relationships with suppliers and credit providers.</li> <li>• Trained local graduates in Rwanda with skills.</li> </ul>
Participant 4	<ul style="list-style-type: none"> <li>• Trained young people that help in collection of plastic waste across the country and deliver for recycling plant.</li> <li>• Established agreements with clients: after using the plastic products like tubing, clients collect and return the waste to the company for recycling.</li> <li>• Involved in marketing activities to create awareness among target clients on the product, and time it takes to get approval.</li> </ul>
Participant 5	<ul style="list-style-type: none"> <li>• As the country transitioned abolished plastics, firm exhausted remaining material and advised external suppliers (outside Rwanda) on the type of products allowed in Rwanda.</li> <li>• Informed consumer of changes, and why prices might increase.</li> </ul>
Participant 6	<ul style="list-style-type: none"> <li>• Introduced glass bottles to replace plastics.</li> <li>• Plans to introduce a “water zone” where clients will access water directly by bringing their own reusable packaging.</li> <li>• Plans to continue finding ways to fully transition given the importance of green process for long-term sustainability of the business.</li> </ul>
Participant 7	<ul style="list-style-type: none"> <li>• Started the transition process early—switched to using paper bags, even though they are not appropriate for the food packaging.</li> </ul>
Participant 8	<ul style="list-style-type: none"> <li>• Relies on imports of crates used in production process</li> <li>• Relies on the authorization license/permit to import plastics needed in the production</li> <li>• Applies different solutions when needed. For example, tea harvesters’ raincoats that are environmentally friendly</li> </ul>

### 4.1. Research question 1: Challenges facing manufacturers as they transition from manufacturing of single-use plastics to environment-friendly packaging

Results of thematic analysis of qualitative data show that there are two broad categories of challenges that manufacturers experienced as they transitioned from single-use plastics to environmentally friendly packaging. These challenges are classified as internal and external and summarized in [Table 4](#).

### 4.2. Research question 2: Government support provided to manufacturers during the transition process

Considering the ban of single-use plastic, the study sought to understand the available support provided by the government to support manufacturers. Thematic analysis of interviews indicate

TABLE 7 How sustainability policies in Rwanda align with the 10-R principles of circular economy.

	Sustainability-related policies, regulations, and guidelines	CE indicators (R0–R9)	Comments on alignment with Circular economy principles.
1	Organic law determining the modalities of protection, conservation, and promotion of the environment in Rwanda (2005)	R0–R9	The organic law is broad and promotes environmental protection in Rwanda. This law gives the right to every Rwandan to live in a balanced and healthy environment.
2.	Law N°48/2018 on the environment (2018)	R0	The law on environment advocates for reduction or abandonment of harmful products and practices that harm the environment. It also predicates proper waste management for solid, liquid, hazardous and toxic, and electronic waste.
3	The national environment and climate change policy (2019)	R1, R2, R3, R8	One of the main objectives of this policy is to advance sustainable consumption and production patterns by promoting a circular economy in Rwanda. Through this policy the government plans to establish legal and institutional frameworks for a circular economy but most importantly incentivize businesses to adopt circular economy principles.
4	Law No. 57/2008 of 10/09/2008 relating to the prohibition of manufacturing, importation, use and sale of polythene bags in Rwanda	R0, R1	The Law No. 57/2008 of 10/09/2008 prohibits the importation, manufacturing, and use or sale of polythene bags.
5	Law No. 17/2019 relating to the prohibition of manufacturing, importation, use and sale of plastic carry Bags and Single-use Plastic Items	R0	Through the Law No. 17/2019 of 10/08/2019, the Single Use Plastic ban was extended to plastics for wrapping of goods, Single Use Plastic drinking straws, disposable plastic cups, folks, knives and plates, and carrier/shopping plastic bags.
6	Vision 2050	R2	Rwanda aims at becoming a middle-income by 2035 and a high-income country by 2050. Through the Vision 2050, Rwanda aims to cut its garbage production in half by 2050.
7	Rwanda's green growth and climate resilience strategy (GGCRS)	R1	The strategy aims at promoting green industry and mobilizing investment and resources for industries to operate in a good climate. The GGCRS calls for green industrial parks, energy and water efficiency, and proper waste treatment.
3	The national sanitation policy (2016)	R1, R3	This policy ensures that people may rethink different practices when it comes to sanitation. It also promotes careful usage of water resources.
4	Guidelines on solid waste collection and transportation (2014)	R8, R2	The guidelines promote the reduction of solid waste and recycling in areas where it is necessary.
5	The regulations of solid waste recycling in Rwanda (2015)	R8, R2	Much like the guidelines, the regulations on solid waste recycling promotes the recycling of solid waste and procedures to use and those that have to stop.
6	Guidelines on practical tools involving solid waste management (2010)	R2	The guidelines and tools focus on practices that have to be reduced while managing solid waste.
7	Law on water resources and management (2008)	R3, R4	The law promotes water management.
8	Environmental Health Policy (2008)	R0, R1, R2	This policy ensures environmental protection to reduce health risks associated with climate change and other disasters.
9	E-Waste policy (2015)	R9, R8, R5, R4, R3	The regulations on solid waste recycling establish instructions on all procedures of e-waste management that include re-using, repairing, recycling, refurbishing, remanufacturing, and recovering.
10	Instructions on Kigali city council relating to hygiene (2016)	R1, R3	As the instructions relating to health are closely tied to sanitation, they focus on rethinking different practices and re-using water safely.
11	National guideline on health care waste management (2016)	R0	The guidelines prevent the unsafe practices in disposing and managing health care waste.

Source: Authors.

that manufacturers received support in the form of capacity development on the production of alternative materials, financial support, and tax exemption. In addition, the policy is implemented in phases, allowing them to transition their processes gradually. Moreover, firms that use plastic in their operations may apply to the government for a special waiver to the policy that enables them to continue using plastics in their operations. Given the highlighted challenges, the study explored what form of interventions would better support manufacturers in their transition processes. Table 5 summarizes the available government support and the type of interventions required.

### 4.3. Research question 3: Transition strategies adopted by Rwanda manufacturers

This research question sought to understand the strategies and approaches manufacturers adopt to transition to production or use environmentally friendly materials. Seven of the eight firms interviewed (87.5%) reported having a transition plan. The strategies adopted under these plans include being flexible to easily adapt to changing government policy, working with recycling and waste management companies to collect and process plastic waste, engaging

in consumer awareness activities, and using new packaging materials such as paper bags and glass in replacement of plastics. Thematic analysis of the data collected from firms that reported having transition plans is summarized in [Table 6](#).

#### 4.4. Research question 4: Circular economy feature in sustainability-related policies in Rwanda

The key aspect of this study was to understand the implementation of CE-related principles in Rwanda. One of the research questions thus sought to explore how CE-related principles feature in Rwanda's sustainability and national development policies. The results indicate that since banning single-use plastics, Rwanda has consistently been implementing sustainable development policies and encouraging the adoption of CE principles. Rwanda has adopted various policies that align with the 10-R principles of circular economy (R0, Refuse; R1, Rethink; R2, Reduce; R3, Reuse; R4, Repair; R5, Refurbish; R6, Remanufacture; R7, Repurpose; R8, Recycle; R9, Recover) as summarized in [Table 7](#).

## 5. Discussion

### 5.1. Challenges facing Rwanda manufacturers as they transition to circular economy

The implementation of anti-plastic legislation in Rwanda has not been without challenges. Studies have found that while most SMEs are aware of the benefits of CE-related policies, their uptake of CE in business model development is hampered by various barriers, including a lack of financial resources and technical skills ([Rizos et al., 2016](#); [Andersen et al., 2021](#)). For the firms studied, the policy resulted in increased business costs to acquire alternative materials and a lengthy licensing process to obtain exemption to the law from the environmental agency—for those eligible businesses. Primary manufacturers that initially produced plastic packaging have struggled to acquire capital to invest in a circular production process, such as introducing new technology to create alternative materials. They suffered from skills shortages as most were not better trained on new business models at the industry and managerial levels, a challenge further compounded by the lack of overall employability skills among graduates in Rwanda. Those firms are unable to compete by innovating new products or business models aligned with the new policies were forced to wind-up their operations (Participant 3).

More than 17 years since Rwanda first banned plastics, the most widely used packaging material, the country has not been able to produce or find a reliable source of alternative packaging materials. Secondary manufacturers that require packaging materials in their operations continue to face a supply crisis and have been unable to find a reliable supply chain to support the scale of their operations. When available, the alternative materials are costlier compared to plastics. Small and medium-sized enterprises (SMEs) are particularly affected, as one Rwanda-based fruits and vegetable processing company that exports to European and North American markets reported. Though the firm has transitioned and mainly

uses paper-based packaging instead of plastics, it noted that paper bags are not appropriate for packaging agricultural products as wet consumables can easily destroy them. According to the company:

*“It's not easy to find packaging material that is environment-friendly and what we use we import from Kenya. Before they prohibited plastic bags, we used them [as] was much easier. After the ban, we had to find another packaging tool... [this] was very difficult because our products are delicate, and one can't use any type of packaging. We [have] to find appropriate packaging that [is] suitable for our products. But sometimes we stop production due to a lack of packaging tools (Participant 7).*

Previous studies found that the plastics prohibition in Rwanda increased the packaging cost for manufacturers ([Danielsson et al., 2017](#)). For instance, following the ban on single-use plastics, the price of packaging materials for the food-processing industry increased from RWF 29.55 (USD 0.03) to RWF 118.20 (USD 0.12) ([Afadhali, 2022](#)). One firm that transitioned to packaging its products in aluminum bags saw the cost of the final product increase from RWF 236.40 (USD 0.24) to RWF 305.35 (USD 0.31) per unit. For Inyange industries, one of Rwanda's largest manufacturers, the price of packaging increased from RWF 59.10 (USD 0.06) to RWF 295.50 (USD 0.30) ([Afadhali, 2022](#)). Meanwhile, a plastic straws manufacturer noted that they invested Rwandan Francs (RWF) 250 million (US\$241,000) to start the factory years ago, but would require at least RWF600 million (US\$578,592) to invest in new technology to produce eco-friendly straws ([Nkurunziza, 2022](#)).

Internally, Rwanda lacks the capacity to develop a quality and reliable supply of packaging materials, and most secondary manufacturers rely on imports. Rwanda spent US\$9.7 million on imports of polythene packaging in 2015, despite its ban on polythene bags ([Bishumba, 2018](#)). One firm observed that: *“we have to import our material because we are looking for better quality material, and as you know Rwanda hasn't reached that level yet”* (Participant 8). Before Rwanda introduced anti-plastic policies, chemicals, rubber, and plastics production accounted for <1 percent of its GDP in Rwanda. This was despite plastic production growing at an annual rate of 4.5 percent between 2004–07 ([Jian and Martin, 2022](#)). Between 2004 when Rwanda first banned plastic bags, and 2016, imports of plastics sharply reduced, falling from 1,092 tons in 2003 to just 18 tons in 2006, before bouncing back in 2008 when Rwanda formally introduced the national law banning plastic bags ([Jian and Martin, 2022](#)). Imports remained generally low, around 100 tons per year between 2009–2011 and reached 323 tons in 2016. Meanwhile, exports have drastically reduced ([Jian and Martin, 2022](#)).

The reliance on imports brings the added challenge of transportation and high import fees. Transporting materials to Rwanda can be very costly, especially if the shipment is made by flight ([Government of Rwanda, 2016](#)). According to one of the participants, the implication of the high cost of imported packaging materials makes the entire product more expensive in both local and export markets, resulting in lost or low market share. The participant reported that *“the only issue is the packaging which makes the entire product more expensive... during the COVID-19 pandemic period, we had to ship all our packaging material by flight which cost us a lot money”* (participant 3). Rwanda relies primarily on imports for non-agricultural products, including packaging. But transporting materials to Rwanda can be very



costly, especially if the shipment is made by flight (Government of Rwanda, 2016). A manufacturer of paper products noted that the challenges of being a landlocked country and fluctuations in exchange rates make raw materials expensive since it results in high transportation costs (Participant 3). Similarly, due to lack of managerial and technical skills, some firms are forced to bring in foreign labor, which is costly and sometimes unreliable when workers have to repatriate to their home countries on short notice or when movement is hindered due to global health crises such as the COVID-19 pandemic.

Policies that support the development of firms' internal and industrial capacity to manufacture alternative materials to plastics and in general, innovate new business models and products are necessary to support firms' transition process. Policies that aim to develop Rwanda's nascent manufacturing industry will not only support continued business operations during the transition process but will help alleviate Rwanda's over-reliance on imports in the long term. Participants noted that monetary and non-monetary incentives such as training needed to support previous manufacturers of single-use plastics to align their business models with CE principles, for example, in developing alternative packaging to plastics. Besides, firms also need training and tools to respond better to changing government regulations. This is especially crucial since most products, including Rwanda's famous *Akabanga* chili, are still packaged in plastic bottles. While most products can be packaged in glass, the industry does not yet exist. The packaging sector is cross-cutting since packaging is required by manufacturers across all sectors. Developing the local capacity to manufacture sustainable packaging materials will be crucial since the manufacturing industry is key to realizing Rwanda's national development priorities.

## 5.2. Transition methodologies adopted by Rwandan manufactures to comply with plastic ban policy

Except for one company, all the firms interviewed have not fully transitioned their business models and still use plastics at some point in their operations. The firms interviewed adopted different strategies to ensure compliance with plastic regulations and transform their operations from linear to circular production models. The strategies include employing a flexible approach to business strategy development based on monitoring, and responding to government policy-making since the law kept changing, building long-term relationships with suppliers and credit institutions, investing in new products and technology, training graduates with required business skills, and utilization of the special authorization license that allows eligible companies to import or use plastics in their operations.

Though this was not a critical part of our study, we found that the firms are engaged in some form of circularity. All firms encourage their clients to practice recycling and proper waste disposal. For example, manufacturers who use single-use plastics in their product development process work with waste management companies in the waste disposal process. One firm manufactures construction products and plastic-sheeting materials used in greenhouse firms has a contractual agreement with its clients. The contract requires

clients to return the materials to the company for recycling post-usage (Participant 4). These firms also use a mix of paper-based products and non-prohibited plastics. Meanwhile, a leading manufacturer transitioned from packing water in plastic bottles to glass bottles but reported that making glass is costly, and there is no reliable supply (Participant 6).

A primary manufacturer of single-use plastics reported that starting the transition process earlier, when the policy was announced in 2008 was instrumental in their overall shift and continued business stability. The company shifted from producing plastic products to the production of paper-based packaging products. The company adopted an approach where instead of importing and supplying bags, it imports plastic reels and manufactures them locally for clients authorized by the environment management authority (Participant 3). Effective communication and cooperation of suppliers is also crucial in ensuring a seamless transition process. A paint manufacturing firm whose imports initially came wrapped in plastic bags reported that when the ban came into place, they informed their suppliers of the policy change. The suppliers had no alternative but to comply. While this particular company was not directly affected, they acknowledged that their suppliers may have incurred additional costs in finding alternative packaging.

In general, businesses appeared to support the regulatory processes that protected the environment and noted that such regulations, if well implemented, are crucial to the long-term sustainability of their business and consumer markets. For example, Participant 6 reported that:

*“We are not phasing plastic bottles just because the government has asked us. But we believe it is the right thing to do. Our raw material comes from the farmers—cow farmers and fresh food farmers. These sectors are most affected by climate change. If we pollute the environment, it affects the cows and farming. And it will become very hard for us in the future to get the raw materials. We understand that this is better for our business sustainability in the long term.”*

Though Rwanda has banned plastics, companies can apply for a special exemption to import or use plastics in their operations (discussed in the next section). Due to shortage of alternative materials in Rwanda, especially packaging, and the lack of reliable supply, Rwandan firms are taking advantage of the special permit. According to the Rwanda Environment Management Authority (NEMA), manufacturers must apply for a license every time they import a prohibited plastic product (Participant 9). While some of the firms interviewed complained that the licensing process is time-consuming and the license itself amounts to the government policing their business, they understand it is the only way for them to continue some of their operations. To cope with the lengthy process, firms sometimes engage in marketing activities that sensitize their clients about their product and the process required to buy the product. Both firms and clients need a license to sell or purchase regulated plastics. The companies thus engage their clients first-hand and ask them to consider the time it takes to get the license to purchase the products. Firms reported that sometimes clients are frustrated by the process and often request them to apply on their behalf, which transfers the time-related costs to the business.

### 5.3. Government support to firms during the implementation plastic ban and CE-related policies

#### 5.3.1. Special authorization to import, sell or use single-use plastics

The special authorization license to import, sell or use single-use plastics is the cornerstone of government support to Rwandan manufacturers following the ban on single-use plastics. The exception is allowed by Article 4 of Rwanda's Law No. 17/2019, the legal framework for the plastic ban. Article 4 states that "a person who intends to manufacture, import, export, or use prohibited items for an 'exceptional reason' may apply for authorization in writing to REMA" (Government of Rwanda, 2019). Special authorization is granted to stakeholders in the public and private sectors with products without other technically viable alternative packaging to plastics (REMA, 2019). During application for the authorization, applicants are required to provide details of the products to be packaged, the type(s) of plastics used, why the special authorization is needed, expected quantities, origin of the packaging materials and waste management plan (for management and disposal of the accompanying plastic waste). REMA will then assess and approve or deny the application, including with specific pre-approval conditions where necessary. In case the authorization is granted, there is a follow-up, reporting and approval for clearance of the plastics from the customs—in case of imports—to verify compliance with approval conditions. The Rwandan firms that participated in the study have applied for the special authorization at some point, particularly during the early stages of the plastic ban.

Studies have found that when not accompanied with a coherent and strict legislative framework, compliance with green economic policies often result in administrative burden, especially for SMEs without strong in-house legal capacities (Rizos et al., 2016). In Rwanda, the interviewed firms observed that the authorization process is sometimes frustrating, especially to their clients, who must also get authorization before they can purchase single-use plastics from local sellers.

Meanwhile, while the special authorization supports Rwanda's transition process from single-use plastics, it was initially necessitated by a need to comply with various international trade agreements Rwanda has signed. For example, due to the non-discriminatory principle of the World Trade Organization (WTO), Rwanda cannot impose a complete ban on competing imports such as products that enter the country wrapped in plastics or it risks violation of its international obligations (Simo, 2019). Moreover, most of the European and North American markets where some Rwandan companies export food products such as processed fruits and vegetables (in the case of participant 7), have not entirely restricted plastics. This situation puts domestic firms at a distinct disadvantage. The special authorization thus allows companies producing packaged food products such as processed chillies and beverages for exports to import the plastic needed in their business operations while simultaneously allowing the importation of products wrapped in plastics under strict regulations.

#### 5.3.2. Phased-out approach to transition—a grace period to transition

The second intervention the government provides to manufacturers is a grace period for the transition process. When the 2019 law was enacted, factories manufacturing single-use plastics were granted 2 years grace period from the date of publication. They were required to phase out the outlawed plastics by September 2021 (Nkurunziza, 2019). Though this enabled some manufacturers to partially transition, many companies have not found a reliable supply of alternative packaging. Besides, due to lack of proper sensitization, some retailers cannot differentiate between permitted and restricted plastics (Elisabeth, 2021). According to media reports, in January 2022, local manufacturers petitioned REMA to extend the grace period, citing the impact of the COVID-19 pandemic and lack of finance to invest in modern technology. However, the agency denied their requests (Nkurunziza, 2022). NBG Limited which manufactures plastic drinking straws noted that before the COVID-19 pandemic, the company had invested more than 250 million Rwanda Franc (RWF) (US\$250 thousand) to start the factory, but would require at least RWF 600 million (US\$600 thousand) to invest in new technology to produce eco-friendly straws. Furthermore, the pandemic compounded the challenges faced and to change the business model, the company requires an additional 5-year grace period (Nkurunziza, 2022).

Furthermore, firms noted that the transition timeline was insufficient to allow them to convert their machines and facilities from linear to circular production models. Interestingly, Rwandan legislators had initially warned of the potential consequences of the short transition time. During the approval of the draft law in 2019, members of parliament requested that businesses be given a longer phase-out period, or the country risked a shortage of packaging materials (Mbonyinshuti, 2019). One legislator observed that the transition process required research and consultation with stakeholders, while another noted that since the ban in 2008, Rwanda had "sustained the shortage of packaging materials" and that "10 years down the road there seems to be no alternative. "How sure are we that there will be packaging alternatives once we ban [all] single-use plastics?" The MP questioned (Mbonyinshuti, 2019).

#### 5.3.3. Tax exemptions

Rwanda has generally been at the forefront of supporting the development of a thriving manufacturing industry. One strategy to encourage local manufacturing capacity development is the exemption of customs and value-added tax (VAT) on imported raw materials and capital goods such as machines. To qualify for exemptions firms must meet specific requirements, including certifying that they do not intend to resell the imported product. The firms interviewed reported that they have benefited from tax exemption. To support the development of the local packaging industry and prevent competition between local and foreign suppliers, in 2018 Rwanda started taxing imported packaging materials. Imported packaging materials were initially cheaper than those produced locally, and local manufacturers complained of unfair competition. Even then, investments in alternative packaging materials have been slow, and the gap is still filled by imports mainly from Kenya and China.

According to firms, beyond tax exemptions and special authorizations, government support can be designed in the form of financial assistance in the acquisition of new technologies, and training on best practices from other jurisdictions. These may be in the form of capacity development on circular business model development or development of biodegradable packaging materials. Regarding finance, some manufacturers noted that state and financial institutions should offer competitive credit terms which would be more sustainable than grants that are sometimes provided by non-governmental organizations (Participant 3). To develop the necessary skills, the government could work with educational institutions to develop curriculum and industrial academies to provide skills beyond those offered by existing TVET (technical and vocational education and training) institutions.

#### 5.4. Collaboration between government and private sector in CE initiatives

Collaboration between government and private sector in adopting CE and sustainability policies is intensifying in Rwanda. In June 2021, the Rwanda Private Sector Federation, an industry body, and the Rwanda environment management authority jointly established the Sustainable Management of Single Use Plastics Project (PET) (REMA, 2021). The PET project comprises three components: (i) collection, transportation, disposal, and recycling of single-use plastics, (ii) capacity development, research and awareness raising, and (iii) financial contribution from industries and importers. The project intends to contribute to Rwanda's plastic waste management processes through funding by private-sector companies who produce, import, or use plastic products in their business processes. As part of the project, the private sector federation expects to mobilize about RWF690.6 million (RWF) (US\$0.7 million) during the first 5 years of the collaboration. Under the project one Rwandan investor has invested over US\$3 million in a project that recycles plastic waste into construction materials (Morales, 2021). In August 2021, the environment agency announced that all eligible manufacturers requiring special authorization to import plastic materials into Rwanda would have to contribute to the programme (REMA, 2021). Each firm that imports products packaged in single-use plastics into Rwanda will contribute RWF 90 (US\$0.87) per kg of imported products; or US\$90 for a ton of plastics imported. However, this requirement contributes to unfair competition between local manufacturers and importers since firms that export to Rwanda are not required to contribute to the Fund. While the private sector seeks to mobilize funding from their members for the project, the government has not provided similar financial incentives to complement their efforts. Indeed, most investments following the plastic ban, including in plastic waste management have come mostly from the private sector or the donor community.

Nonetheless, the government has welcomed projects that support its CE and sustainability initiatives. This is evident in the rapidly increasing number of waste management and recycling companies, including start-ups engaged in other CE-related initiatives in Rwanda, as observed during fieldwork. By 2019, there were about fourteen recycling companies compared to none in 2008. Together, these companies recycle 70–80 percent of the total plastic waste in Rwanda. These firms have been critical in the sustainable disposal

and management of imported plastic waste in the country and in promoting the recycling culture, despite facing financial and technological challenges. Some of the imported plastic include plastic from ports of entry, mainly the airport. One recycling company estimated that they collect more than a ton of plastic waste each week from the airport alone.

In addition to the Sustainable Management of Single Use Plastics Project (PET), the government continues to collaborate with the private sector, including small and medium-sized enterprises, and civil society organizations. Initiatives involving civil society include promoting voluntary actions such as the National Circular Economy Forum that encourages business to lead in establishing a coalition on plastics and knowledge exchange between SMMEs and large companies. Rwanda has also developed policies that feature CE-principles in an effort to balance between growth and environmental efficiency (see Table 6) and is developing a draft National Strategy on CE. According to REMA, Rwanda will continue to explore initiatives and legal frameworks such as an environmental levy on imported consumer goods packaged in single-use plastics, training and research on circular economy and circular business models (Participant 9).

## 6. Conclusion and recommendations

This study explored the experiences of Rwandan manufacturers following the plastic ban by investigating strategies adopted by manufacturers in response to the plastic ban, and the challenges manufacturers face in their transition process, and how they respond to those challenges. The study also sought to examine how CE principles feature in key sustainability policies in Rwanda.

Although the effects of single-use plastics are clear and immediate actions need to be taken to reduce the manufacture and usage of plastics, and adoption of alternative materials, insights from the study indicate that the transition to a plastic-free world should be gradual. The prohibition of single-use plastics in Rwanda positively transformed the country's image, but also presented economic implications such as business shutdowns, job losses, and an increase in prices for different products. Moreover, alternative materials have not been developed to match the scale in which plastic products are used. The innovation of sustainable products to replace plastics falls on both private and public sector stakeholders. However, in Rwanda, following the ban on plastics, that responsibility appears to have been left to manufacturers. Manufacturers have faced transition challenges to comply with anti-plastic legislation, including expensive start-up resources such as capital, technology, manpower, and time constraints. The socioeconomic and political effects of the ban on plastic (bags) perhaps explain why it was initially unsuccessful or took longer to implement in Rwanda's neighboring countries, notably Kenya and Uganda (Behuria, 2021). Behuria (2021) argued that the ban was quickly implemented in Rwanda since the business power of the private sector is limited.

### 6.1. Policy and managerial implications

Manufacturing is a sustainable growth engine that serves as an impetus for innovation and generates economies of scale. The Rwandan government has provided some support, including tax incentives, to companies willing to invest in plastic recycling

equipment or manufacture environment-friendly alternatives. However, the manufacturing industry in Rwanda is still in its infancy stages, evidenced by the reliance on the import of most non-agricultural products. Regular collaboration between business and government remains crucial in balancing Rwanda's sustainability objectives and the development of the manufacturing industry.

As the manufacturers who participated in the study observed, Rwanda should complement private sector initiatives, for example, by developing partnerships with financial institutions to offer capital or credit to assist firms to acquire the necessary technology to transition from linear to circular production models. The government should also continue raising awareness of the importance of CE in business efficiency. However, activities should be targeted to educate firms on how to repurpose their business models, including through research and development (R&D) support to allow them to remain relevant in the ever-changing marketplace. Manufacturers are aware that business regulations and policies are bound to change at some point in response to developments in society. However, they cautioned that the uptake of CE principles in business may be hard if firms are not trained on critical methodologies for meaningful CE-based business model innovation. Encouraging research and development may also allow manufacturers to dig deeper and discover more ways of incorporating circular economy principles into their processes.

Furthermore, Rwanda needs to develop local capacity to produce alternative materials to plastic or develop a reliable global supply chain. This is necessary to cushion its manufacturing industry from the perennial shortage of packaging materials. Indeed, countries considering Rwanda's approach to the plastic ban should conduct an internal analysis to determine the potential impact of the ban on plastics on manufacturers and consumers beyond the well-documented positive environmental benefits. The challenges facing Rwanda firms after the prohibition are parallel to the challenges facing countries in the transition toward green energy. For example, the debates on the effectiveness and sustainability of green energy vs. fossil fuels such as coal in massive industrial development are necessary for job creation. In Rwanda, initial research on the potential impact of the ban on plastic seemed to have focused on the improvements in the environment and other dividends, such as the clean-country view, and largely ignored implications on the broader economy, such as constraints faced by manufacturers.

Finally, Rwanda should work with local and international stakeholders to address the situation that warrants the issuance of exceptional authorization to import single-use plastics. While the license is necessary to ensure Rwanda complies with its international obligations, it indirectly hinders innovation and full adoption of the CE principles in business and other sustainability policies. Local manufacturers will likely continue to rely on the incentive until a local industry develops to provide alternative packaging materials. International companies exporting to Rwanda, protected by non-discriminatory clauses of global trade agreements, will similarly lack incentives to develop alternative packaging materials for products destined for Rwanda. Initiatives such as an international treaty to ban plastics which Rwanda participates in, if successful, could help address this challenge (United Nations, 2022). Rwanda should also consider joining the coalition of WTO countries participating in The Informal Dialogue on Plastics Pollution and Environmentally Sustainable Plastics Trade (IDP) that seeks to complement discussions in the Committee on Trade

and Environment (CTE) (WTO, 2022). Despite its leadership in plastic management policies, at the time of writing, Rwanda was not among the 75 WTO members (including eight African countries) participating in the IDP, which is gradually emerging as a forum for setting informal agenda on trade in plastic products within the WTO framework.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving human participants were reviewed and approved by the African Leadership University (ALU) Circular Economy Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

MO, JA, and MM conceived the paper. The research grant was awarded to MO who also supervised the research project and wrote the first manuscript. JA supervised the fieldwork and data collection in Rwanda and contributed to the section on CE principles. CN and OH students at the African Leadership University, Rwanda, assisted with fieldwork and data collection in Rwanda. MM reviewed and improved the final manuscript. All authors reviewed and approved the final version.

## Funding

This research was undertaken as part of the CE Programme at African Leadership University (ALU). We thank MAVA Foundation for the support to the programme through their contribution to the ALU CE Programme.

## Acknowledgments

We are grateful for the support provided through the Circular Economy Research Programme at ALU. We also thank Elke Nijman, Elisée Bahati Ntawuhiganayo, Dr. Theresa Lisita, and Lea McDonald for commenting on earlier drafts of the manuscript. Finally, we thank all our stakeholders and participants for their contributions to this research.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



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