Assessment of plastic policies for identification of waste emergence and potential waste reduction in Africa

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Abbreviations

2R	Reduce, Reuse
3R	Reduce, Reuse, Recycle
AfDB	African Development Bank
ASEAN	Association of Southeast Asian Nations
AU	African Union
CPA	Comparative Policy Analysis
EAC	East African Community
ECOWAS	Economic Community of West African States
EoL	End of Life
EPR	Extended Producer Responsibility
EU	European Union
GOC	Government of Canada
GOK	Government of Kenya
HDPE	High Density Polyethene
HS	Harmonized System Codes
IGES	Institute for Global Environmental Strategies
IPA	Integrative Propositional Analysis
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
Kg	Kilograms
LCA	Life Cycle assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LDPE	Low Density Polyethene
MEA	Multilateral Environmental Agreement
MOEF&CC	Ministry of Environment, Forest and Climate Change
MSF	Multiple Streams Framework
MSW	Municipal Solid Waste
Mt	Million Tonnes
NEMA	National Environment Management Authority
NWPP	Non-woven Polypropylene
OECD	Organisation for Economic Co-operation and Development
PE	Polyethene
PP	Polypropylene
PPE	Personal Protective Equipment
plastic waste	Plastic Waste
SADC	Southern African Development Community
SUP	Single Use Plastic
SUPB	Single Use Plastic Bag
UNComtrade	United Nations Comtrade
UNEP	United Nations Environment Programme
UNHABITAT	United Nations Human Settlements Programme
UNIDO	United Nations Industrial Development Organization
WEF	World Economic Forum
WPP	Woven Polypropylene

Executive Summary

Plastic consumption is ubiquitous in human lifestyles. Currently, the consumption and waste generation of plastic in Africa is rated fourth globally after Asia, Europe, and North America (Babayemi et al., 2019) and is expected to increase, where future infrastructure developments may not meet the waste demands (Lebreton and Andrady 2019). Plastic waste is associated with various problems affecting terrestrial and marine ecosystems through the release of chemicals, marine debris, ingestion, and suffocation to living things, urban flooding, and loss of environmental aesthetic value. Primarily, plastic waste is linked to single use plastic (SUP) and short-lived plastic with an average life span of 0.5 years (Geyer et al., 2017). To manage plastic waste African countries have adopted policies to manage plastic consumption within its lifecycle.

The upstream 2R (reduce and reuse) plastic waste prevention policies applied in Africa with single use plastic bags (SUPB) being the most targeted plastic item (UNEP 2018). However, the plastic waste problem persists and is attributed to a lack of monitoring, enforcement, alternatives, smuggling, and lobbying from the plastic industry (Ncube et al., 2021). Plastic waste policies in Africa have not been examined comprehensively beyond subregional exploratory studies, that outline the policy details (Bezerra et al., 2021; Behuria, 2021; Adam et al., 2020). In some instances, Africa and its countries are evaluated with other regions or emerging economies limiting the comparative assessment in the region (Diana et al., 2022). As such, the status of plastic policies in mitigating the plastic waste problem also remains unknown in some African countries. Additionally, scholars question whether policies as currently designed result in plastic waste management, as the problem persists (Adam et al., 2020).

Thus, the objective of this study was to review plastic policies to determine the status of plastic waste reduction in Africa and use the Kenyan SUPB ban as a case study to demonstrate the potential waste reduction and associated current and future environmental outcomes for the improvement of plastic policy development and implementation in Africa.

This research reviewed plastic policy design in Africa using gap analysis and integrative propositional analysis (IPA) models based on a modified codifying scheme from Farrelly et al., 2021 and Diana et al 2022 to determine their impact on plastic waste reduction. The study found that there are 48 active plastic policies in 39 of the 55 countries in Africa. Furthermore, there has been a shift in three countries from SUPB bans to SUP policies to manage more plastic products, and two countries have shifted from SUPB charges to SUPB bans. SUP and packaging policies that define a group of plastic products, loosely the cover products. Four of the nine packaging policies analyzed are SUPB policies by design. The lack of definitions and coherence, and provision of exemptions in policies result in plastic waste traceable from exemptions, in-policy, undefined SUP, out-of-policy SUP, and non-SUP sources. These policy elements should be clearly stated in future policies to achieve successful plastic management.

Secondly, the behavioral aspects of the SUPB ban in Kenya were examined. The aspects considered include consumer consciousness towards the ban, reusable bag usage behavior, and estimation of plastic bag consumption before the ban. Using a questionnaire survey, the results indicate that the ban has favorable support from about 67% of consumers. Behaviorally, ownership of reusable bags tripled to 12 bags per household and up to 82% of consumers purchased new reusable bags when they forgot or brought less bags when shopping resulting in plastic reusable bags as the most owned carrier bags. Moreover, the study estimated the ban potentially eliminates about 6.2 billion bags (138 bags capita^{-1} y^{-1}) from the waste stream.

Finally, due to a lack of baseline data on reuse, lifecycle assessment (LCA) was used to determine reuse and evaluate the SUPB ban and the adopted main alternative, the Non-woven propylene (NWPP) being the most preferred bag by consumers and woven propylene, including future infrastructure scenarios. The study showed that environmental emissions amongst bags were weight dependent. About 50% - 80% of Global warming potential (GWP) and fossil depletion occurred outside the country since Kenya does not produce plastic granulates. The other 16 environmental impact assessed were largely produced in the country with a few considered in and out of the country emissions. With the country's population of 53 million (2021), annual waste generation for SUBP was estimated at 62,907 tonnes. NWPP waste generation ranged from 1,272 tonnes to 13,357 tonnes, and WPP ranged from 2,006 tonnes to 21,060 tonnes for 69-6 reuses annually. The substitution effect in waste reduction ranged from 98% to 67% with incremental usage of bags from 2 bags Capita^{-1} Y^{-1} to 21 bags Capita^{-1} Y^{-1}. This was in the range of mainstream NWPP bag that requires 38 reuses to its 18 environmental impacts, an equivalent of 4 bags Capita^{-1} Y^{-1}.

This study is important by demonstrating the comparative assessment of plastic management policies in Africa and the potential waste reduction with successful reuse for a region that is understudied in waste management. The study is unique by demonstrating how interactions and interrelationships of policy elements result in plastic waste generation in different categories including possible transboundary flows between countries due to variability in policies. Furthermore, it also uncovers citizen preference for plastic reusable bags, a shift from SUPB due to the plastic ban in Kenya. The lack of clarity on reuse, which is a basis of LCA studies increases uncertainty in establishing the environmental benefits of reusable bags.

The study concludes that the design of new policies should consider the shortcomings beyond previous conventional factors such as lack of enforcement, monitoring, and plastic industry influence to enhance plastic waste management. The identification and promotion of alternatives should incorporate alternative material and consumer behavior characteristics such as usage frequency, reusable bag standards, waste, and health factors in policy formulation. Proper usage of reusable bags should be factored into awareness campaigns to lower the environmental burden since consistency in usage is a major factor for the attainment of waste reduction and offsetting their environmental impacts.

Chapter 1. Introduction

1.1. Background

Plastic applications are common in our daily lives as packaging, consumer products, agriculture, clothing, construction, medicine, and transportation media (UNEP, 2018). Plastic was first discovered in the early 20th century for military use. Since then, about 8300 million tonnes (Mt) of virgin plastics had been produced by 2015 (Geyer et al., 2017) and global production and consumption of plastic has increased tremendously since 1950 by a multiple factor of 230 to 460 (Mt) in 2019. This increase is linked to growth in industrialization, urbanization, higher incomes, and population. Moreover, material characteristics of plastic such as cost (cheap), lightweight, degradation resistance, and moldability have increased its viability as a substitute for other products. The unprecedented growth in plastic consumption has also resulted in increased plastic waste generation. Global plastic waste generation was 353 Mt in 2019 compared to 234 Mt in 2000 (OECD 2022).

Plastic waste generation is related to income with Western Europe and North America having the highest consumption rates at an average of 100 kg person^{-1} yr^{-1}, Asia 20 kg person^{-1} yr^{-1}, and Africa 16 kg per person^{-1} yr^{-1}. The annual average plastic consumption per capita in the world is 43 kg. (Babayemi et al 2019). Global plastic waste generation is expected to increase driven by developing countries in Africa and Asia (Lebreton and Andrady, 2019).

Collectively, up to two-thirds of plastic waste is linked to single use plastics (SUPs) and short lived plastics with a life span of less than five years. The waste is dominated by packaging (40%), consumer products (12%) and textiles (11%) (OECD 2022). The problematic nature of plastic waste includes resource and management issues. Up to 90% of plastics are manufactured from virgin fossil feedstock and account for 6% of global oil usage, projected to increase by 20% by 2050 under the current consumption rates. Furthermore, SUP packaging loses 95% of its material value with first use, an equivalent of $80–120 billion annually (WEF 2016). Fig.1.1. below shows only 9% of plastic is effectively recycled, 50% is disposed of in sanitary landfills and 19% is incinerated in the world. While 16% of plastic waste is collected for recycling almost 40% is disposed of. Moreover, 22% of plastic waste is subjected to uncontrolled dumping, open burning, and leakage to both terrestrial and marine environments, a phenomenon that has been christened in recent times as mismanaged plastic (OECD 2022). Specifically, the common polluting SUP items in marine and terrestrial environments are cigarette butts, bags, beverage bottles, wrappers, bottle caps, straws, stirrers, and foam takeaways (Morales-Caselles 2021).

The global south contributes largely to mismanaged plastic due to a lack of waste management infrastructure and imports (Jambeck et al., 2015; OECD 2022). Due to its low value, contamination risks and cheap virgin feedstocks, plastic has the lowest recovery. (Geyer et al., 2017; Ncube et al 2021).

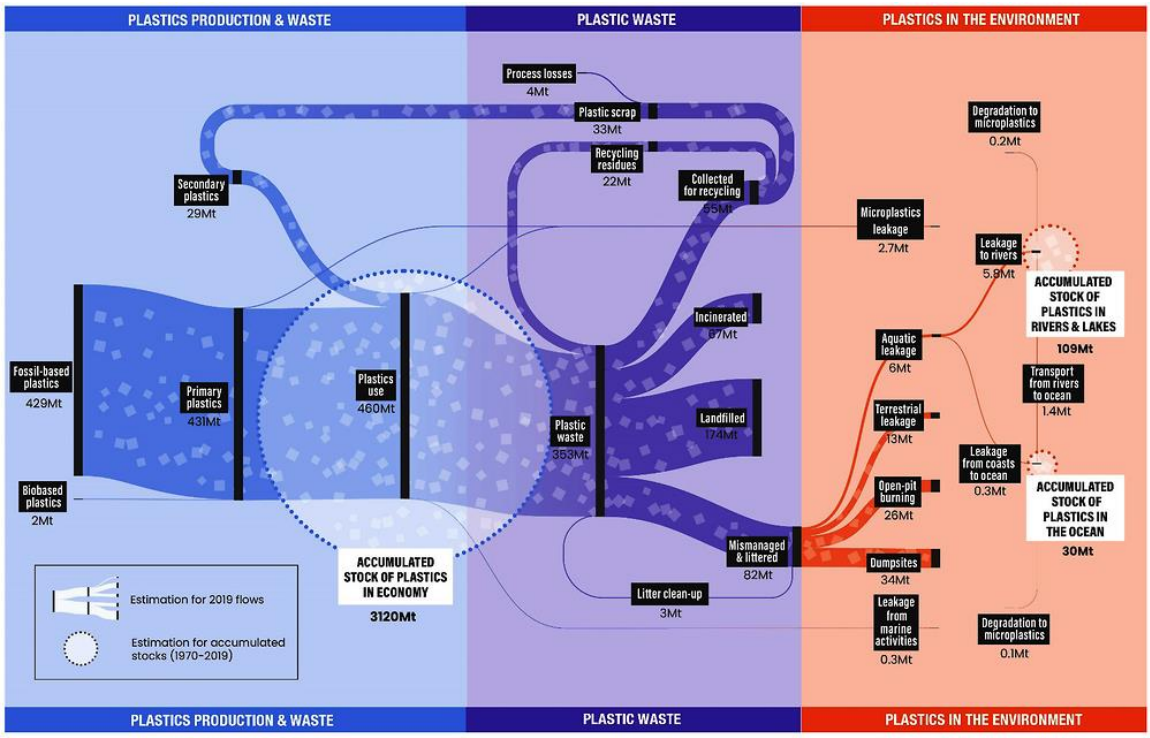


Fig.1.1. Global plastic material flows

(OECD 2022)

1.1.1. Plastic waste management in Africa

Africa has 55 countries with a population of 1.2 billion living in 49 inland and 6 island countries. It is the fastest growing continent by population, urbanization, and economic growth and is projected to have 2.1 billion people by 2050 with two thirds living in urban areas (AfDB. 2022). Most countries are classified as low income or lower middle income countries. The total municipal solid waste generation in Africa is expected to reach 226 Mt in 2025 with current daily waste generation ranging between 0.11-0.78 kg person^{-1} day $^{-1}$. The waste is predominantly organic at 57% followed by plastic at 13% and paper at 9%. Glass and metal are 4% each respectively, and other materials at 13% (Kaza et al., 2018). Presently, the continent is the 4th largest producer of plastic waste together with Latin America after Asia, Europe, and North America. As noted above, the average per capita consumption rate in Africa is 16 kg person^{-1} yr^{-1}. However, this varies by country as countries with stronger GDP consume more plastic consumption ranging between 4.4–24.5 kg person^{-1} yr^{-1} (Babayemi et al 2019).

Whereas plastic consumption and waste generation are low, Africa is the second largest emitter of mismanaged plastic waste after Asia through open burning, open dumping, and littering (Lebreton and Andrady 2019; Adam et al 2020). As noted by Jambeck et al 2015, 4 countries Egypt, South Africa, Algeria, and Morocco rank in the top 20 with mismanaged plastic in the world. Additionally, it is anticipated that possible developments of waste management infrastructure may not meet future demands for plastic in Africa (Lebreton and Andrady 2019).

The dominant End of Life (EoL) processes such as open dumping and open burning are unstainable but widely practiced with 19 of the world's 50 biggest dumpsites found in Africa (UNEP 2018). Plastic waste is mostly dumped with other waste as mixed waste due to minimal segregation. As a result, plastic bags are found all over the space and have been nicknamed the national flower in Kenya, South Africa, and Somaliland (Nielsen et al., 2019). To curb the impacts of plastic pollution countries are applying different approaches to solve the problem by targeting specific or groups of plastic items, problematic plastic, and avoidable plastic (Alpizar et al., 2020). For instance, Kenya adopted a plastic bag ban in 2017 prohibiting the manufacture, use, and import of single use plastic bags (SUPB) for retail packaging.

1.1.2. Plastic waste management in Kenya

Kenya is an East African country with a population was 54,027,487 as of 2022. It is a low middle income economy country with a GDP per capita of $ 2,099.3. The GDP growth rate is 4.8%, the population growth rate is 1.9% and the urban population is 29% (World Bank 2023). Waste management is a devolved county function for the local government while the national government oversees overall policy development and enforcement through lead agencies, the Ministry of Environment, and the National Environment Management Authority (NEMA). The per capita waste generation is 0.5 kilograms (Kg). When adjusted for the current population, the annual waste generation is 9.86 Mt as of 2021. Waste composition is about 60 - 70% organic, 20% plastic, 10% paper, and 2% metal. The national waste management strategy follows the 3R (Reduce, Reuse, Recycle) strategy with a preference to reduction and disposal the least preferred (GOK 2019).

Specific to plastic, Kenya imports plastic resins or finished products since the country does not produce virgin plastic (UNIDO 2021). It is estimated that the country consumes about 0.5 Mt of plastic annually. Plastic packaging comprises 0.26 Mt and almost all are dumped as mixed waste (0.212 Mt) while the rest are recycled (0.047 Mt) (Elliott, 2018). In general, the collection rate of plastic waste is 27%. However, up to 92% of plastic waste is mismanaged, and 8% is collected for recycling (IUCN-EA-QUANTIS, 2020). To mitigate the plastic waste problem, the government has continuously attempted to control the consumption of SUPB. As a result, it adopted an SUPB ban on production, distribution, and use with the highest fine in the world of up to $40,000 and 4-year jail term (Behuria 2021). Thus, it is important to update existing data on plastic consumption and waste management and assess the current status of the current policy environment.

1.2. Overall research trends on plastic policy

Globally, there is no legally binding plastic treaty, and the international community is currently working to establish a pact by this year, 2024. The design and structural elements of such a treaty are under debate in different forums including the scientific community. Mirroring the success of the Montreal Protocol, Raubenheimer and McIlgorm (2017) and Kirk (2020) propose the inclusion of various plastic management instruments including production caps, toxicity limits, improved waste management, and EPR management. These points have been emphasized in recent publications, production caps (Bergmann et al. 2022; Dey et al., 2022); chemicals in plastic and their relationship with recycling modes and biodegradable plastic (Wang and Praetorius 2022). There exist plastic management instruments for each lifecycle stage and sudden application may disrupt human lives and economies (Kirk 2020).

Regionally, the EU is the only regional body globally with packaging and plastic specific policies including the Single Use Plastics Directive (2019/904) that placed restrictions effective 2021 on cotton bud sticks, cutlery, straws, stirrers, plates, and food and beverage containers made of expanded polystyrene (European Union, 2018). However, other regional entities have adopted some forms of plastic specific action plans, declarations, or strategy policies. For instance, the Association of Southeast Asian Nations (ASEAN) adopted the Framework of Action on Marine Debris in 2019 (Tsuruta 2021). On the other hand, membership club entities have adopted such strategies. The G7 member countries adopted the G7 Action Plan to Combat Marine Litter in 2015 and subsequently reinforced it in the G7 Ocean Plastics Charter in 2018 recognizing the danger plastic poses to the environment and human health. The G20 member countries adopted the Action Plan on Marine Litter in 2017 and the Osaka Leaders Declaration in 2019 towards marine litter (Tsuruta 2021; Fadeeva and Van Berkel 2021; Olsen et al., 2023). Among these groups, only South Africa belongs to the G20 group of countries.

Specifically, to policy effectiveness, SUPB policies have shown to induce a reduction between 36% - 96% with successful implementation globally (Schnurr et al., 2018). In Africa, South Africa and Botswana reported initial short-lived success in the usage of SUPB while Rwanda indicated reduced plastic imports between 2004 and 2016 due to the 2008 plastic bag ban (Babayemi et al., 2019). The success of policies is undercut by a lack of alternatives, smuggling, and the plastic industry (Muposhi et al., 2022). While SUPB policies including effectiveness have been studied the distinction between carrier bags and barrier (ultrathin) bags is rarely made within the policy studies (Xanthos et. al. 2017; Nielsen et. Al 2018). In this way, some quantitative information is being obtained on Africa as well. However, the effectiveness of policies is limited or undocumented due to a lack of enforcement, monitoring, evaluation, and recent adoption in most African countries (UNEP, 2018; Nyathi and Togo, 2020;).

Recently, scholars have questioned whether plastic policies are designed to succeed in the first place (Adam et al., 2020). Policy design refers to interactions and interrelationships of the building blocks of policy also known as policy elements (de Wee 2021) to achieve coherence such that policy success is dependent on reduced conflict between the elements and with other policies. That is for policy goals, instruments, and implementation strategies to be effective in the reduction of plastic problems within its life cycle. Horizontal coherence assesses conflicts within a policy or between a national policy and other national policies. Vertical coherence assesses such conflicts between national policy and regional or international policies (Ferraro and Failler 2020).

Diana et al. (2022) conducted a content analysis of 291 English based international, national, and subnational jurisdiction based plastic policies, globally. Annual policy adoption was led by high and upper middle income countries followed by low income and lower middle income states. The most adopted policy was regulatory instruments and subsequently economic and information instruments respectively. The study also established that macro-plastics were the most targeted plastic product followed SUPB and microplastic the least.

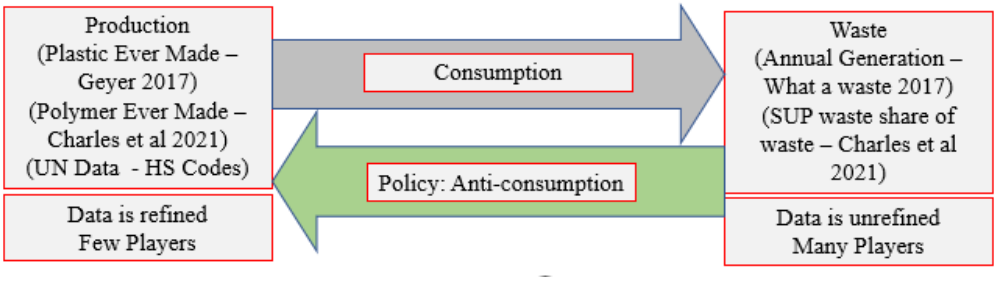
Farrelly et al. (2021), through the purview of full life cycle management of plastic, assessed national and international policies in 10 Pacific island nations. Additionally, the application of different instruments was investigated to identify gaps in the policies. Akenji et al. (2019) conducted a similar study in ASEAN countries, the Republic of Korea, and Japan, identifying multiple gaps as a foundation for a regional policy on top of current voluntary initiatives and SUP policy instruments. Lyon et. al. (2020) reviewed 371 peer reviewed publications and governmental and international organizations' documents on marine plastic pollution from 10 member countries from the ASEAN +3 organization and Japan, The People's Republic of China, and the Republic of Korea highlighting the lack of baseline data on marine debris, impact on the marine environment and community health. UNEP (2019) benchmarked ASEAN member countries' packaging policies against legislations from Japan and the EU and there was an increased existence of MSW and source reduction policies than EPR policies among ASEAN countries.

There is no regional study assessing plastic management instruments within plastic policies in the African region than subregional studies like Western Africa (Adam et al., 2020) Southern Africa (Bezerra et al., 2021); and East Africa (Behuria, 2021). The common variables synthesized from available studies include year of announcement/adoption, policy status (active, under review, or revoked), legal type (law, decree, notice, or directive), policy framework (what it says), type of policy (ban or levy), decision structure for policy adoption, policy drivers and existence of national campaigns (Adam et al., 2020; Bezerra et al., 2021; Nyathi and Togo, 2020). Therefore, there is a need to assess plastic policy designs and coherence in Africa beyond exploratory studies (what a policy says). This

relationship is important in determining the reasons for continued plastic pollution from a policy design perspective by identifying potential sources of waste for strengthening policy instruments.

1.3. Overall research framework

Waste prevention assesses three objectives including waste prevention quantification from a baseline year, environmental impacts, and social aspects of waste prevention (Yano and Sakai 2016). The foundational data for waste prevention, assessment of potential reduction, and prioritization of management areas, are waste generation amounts and composition (Zacho and Mosgaard, 2016). This also forms the basis of policy evaluation as baseline studies for policy adoption and effectiveness for active policies. Waste reduction can be estimated since there are high confidence levels in global aggregate polymer production and plastic product production data and equal linkage to aggregate waste production globally and in some nations (Geyer 2017; Charles et al. 2021; OECD 2022). However, Africa as a study context is often lump summed with other regions such as the Middle East limiting the clarity of results on the region. At the same time, most countries lack refined baseline data on national plastic items production, consumption, and treatment pathways hindering policy reduction assessment as shown in Fig 1.2. (Nakatani et al., 2020). The lack of baseline data makes it difficult to establish actual or potential waste prevention capabilities within a policy.



(Author)

Fig 1.2. Data uncertainties in policy evaluation

1.4. Purpose of the study

Africa produces the least amount of plastic and is the second largest producer of mismanaged plastic in the world. Various 2R (Reduce and Reuse) policies have been adopted by African countries to achieve plastic waste prevention. In the past, plastic policy and persistent policy failure have been attributed to a lack of monitoring, enforcement, and alternatives, smuggling, and lobbying from the plastic industry. However, scholars question whether plastic policies as currently designed can achieve waste reduction. Hence, there is a need to fill this research gap in plastic policy design studies in Africa. Additionally, to demonstrate the real time or potential effectiveness of a plastic policy countries need to establish baseline data for evaluation through actual data collection or estimation from available data points (Matsuda et al., 2018). Using the Kenyan SUPB ban the study estimates plastic bag consumption

before the ban to establish a basis for waste reduction from legally admissible and accessible carrier alternatives.

The study further scrutinizes the environmental impacts and behavioral responses of the SUPB ban in Kenya. This study assesses the reuse potential of reusable bags as a key indicator of the qualitative and quantitative effectiveness of a SUPB ban policy. Additionally, it also looks at the unintended consequences of the ban beyond the three major variables. Thus, through the lenses of quantification of waste difference from a baseline year, assessment of life cycle environmental impacts, and assessment of the social aspects of waste prevention, the overall research objective of this research is to analyze the effect of plastic policies on waste management systems for identification of potential reduction in Africa and Kenya as cases studies through the following specific objectives:

(1) To review qualitatively, the impact of policy design and coherence based on the interactions and interrelationships between plastic policy elements in Africa by establishing the status, scope, trends, variability, and sources of plastic waste for achievement of waste reduction.
(2) To explore the consumer consciousness and behavior of the plastic bag ban in Kenya using a questionnaire survey by evaluating the relationship between socio-economic factors and the perception, reusable bag ownership, usage, and disposal, and baseline SUPB consumption before the ban.
(3) To quantify the SUPB ban policy waste reduction margins in Kenya using baseline data from (2) and environmental outcomes of SUPB and reuse potential of reusable bags using a life cycle assessment.

This study aims to inform stakeholders for improved implementation of plastic waste management strategies in addressing persistent plastic pollution, enforcement challenges, and illegal plastic flows against existing instruments for strengthening the policy design process.

1.5. Structure of thesis

Fig.1.3. below shows the structure of the research flows and the entire thesis. The thesis is organized in five chapters as outlined below:

Chapter 1 introduces the plastic waste management problem at global, Africa, and Kenya levels by highlighting production and consumption, waste generation, and treatment. It provides focus on the purpose of the study problem, and Africa and Kenya as the target study areas with persisting plastic pollution in the face of plastic policies.

Chapter 2 discusses the impact of single-use plastic (SUP) policy designs on plastic waste reduction in Africa by collecting and assessing SUP policies in Africa as of March 2023. The chapter seeks to answer the question of whether plastic policies in Africa as currently designed can achieve waste reduction.

Chapter 3 discusses SUPB policy in Kenya as a case study from Africa. It introduces the evolution of SUPB policy, previous SUPB consumption, and the behavioral response of the introduction SUPB ban in Kenya including the adoption of reusable bags.

Chapter 4 analyzes the waste and environmental outcomes of Kenya's SUPB ban against the mainstream adopted alternative carrier bag. The chapter uses environmental impacts to estimate the reuse potential of bags, waste reduction effect, and outcomes based on future scenarios.

Chapter 5 provides the overall conclusion of the study by summarizing the study background, the key results, and the recommendations towards plastic waste management. Additionally, the study limitations are also indicated as well as areas of future research.

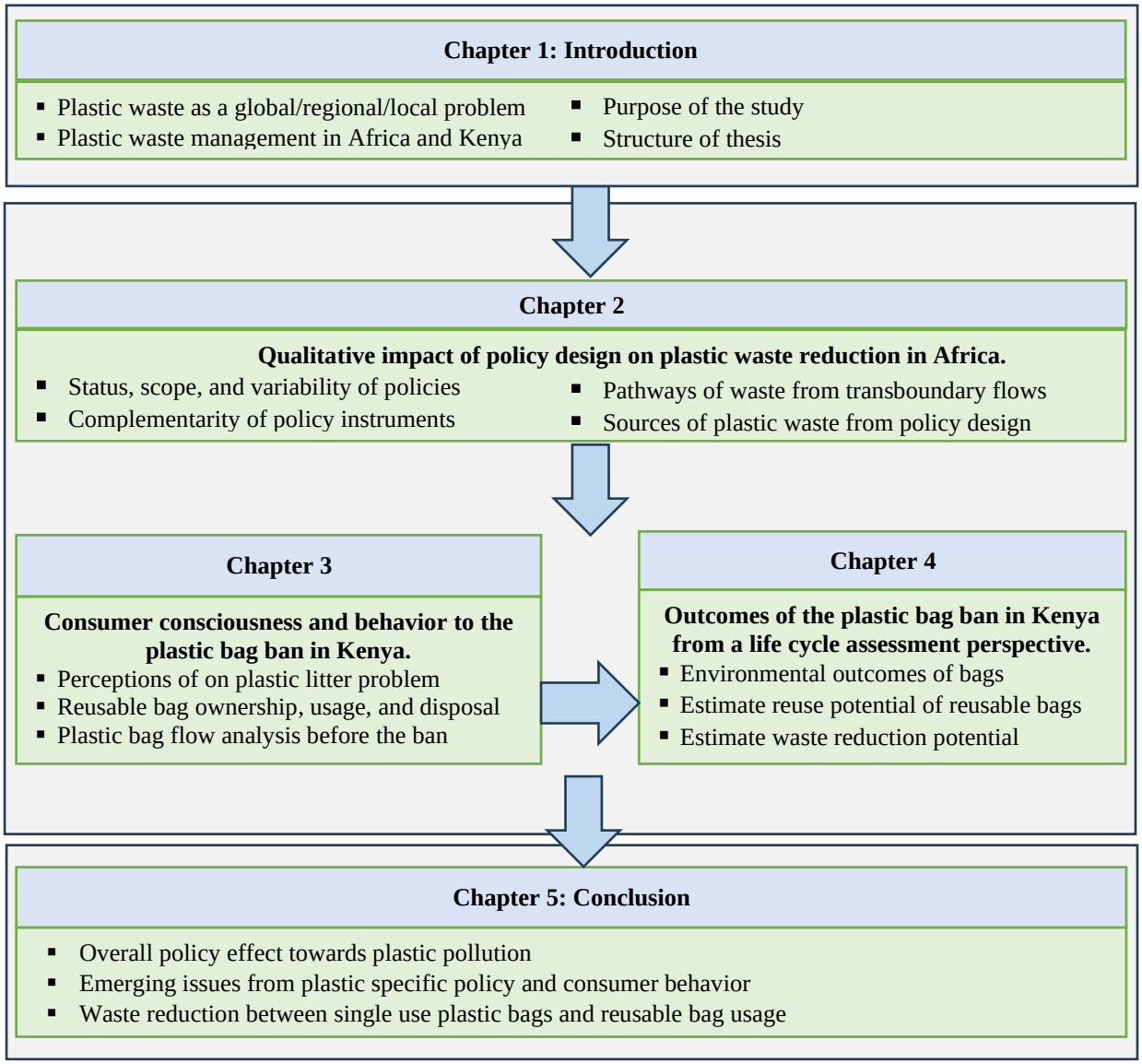


Fig.1.3. Structure of the thesis

Chapter 2. Impact of policy design on plastic waste reduction in Africa

2.1. Introduction

Single-use plastic (SUP) include packaging, consumer and institutional products, and microbeads designed to be used once or within a short span and are an important product group in the plastic pollution issue (Xanthos and Walker, 2017; UNEP 2018; Ncube et al., 2021). About 55% of plastic waste are SUP, mainly packaging (47%) (Geyer et al., 2017; Charles et al., 2021). Plastic waste, especially packaging waste, has the lowest recycling rates due to low market value and contamination risks (Geyer et al., 2017; Ncube et al., 2021). Addressing plastic pollution requires upstream waste prevention and downstream waste recovery measures within the plastic lifecycle.

The average plastic consumption rate in Africa is 16 kg/person/year compared to the global average of 43 kg/person/year and 100 kg/person/year in Western Europe, and North America. Africa and Latin America are the fourth largest producers of plastic waste after Asia, Europe, and North America (Babayemi et al., 2019). However, underdeveloped waste management systems coupled with illegal waste imports make Africa the second largest emitter of mismanaged plastic waste globally. Plastic waste generation is expected to triple by 2060, and even worse, possible infrastructure developments may not meet the rapid plastic waste generation in Africa due to rapid urbanization, population growth, and trade liberalization (Jambeck et al., 2015, Kaza et al., 2018 Lebreton and Andrady, 2019). Furthermore, the surge of plastic waste from personal protective equipment (PPE), takeaway packaging, and overpackaging recently linked to the COVID-19 pandemic outlines uncertainty in plastic waste management (Adyel, 2020; Benson et al., 2021).

Plastic waste including micro and nano plastic have socio-economic and environmental effects in both terrestrial and marine ecosystems (Ayeleru et al., 2020; Muposhi et al., 2022). 2R (Reduce and Reuse) policies address plastic waste prevention at the international, regional, national, and local levels. The adoption and implementation of plastic policies have been studied by various scholars including global drivers such as international pressure due to the transboundary nature of plastic pollution and the international political agenda currently emphasizing the plastic problem (Knoblauch et al., 2018). General national stakeholder interests emphasize the plastic menace and external benefits of environmentalism include improving tourism, sustainable finance, environmental leadership, and health risks (Behuria, 2021). Additionally, the revitalization of livestock farming, and protection of wildlife due from ingestion of plastic litter are lead factors in some African countries (Bezerra et al., 2021).

There is no binding international treaty on plastic pollution at this moment (2023 September), with an agreement set for 2024 under the coordination of the United Nations Environment Program. Regionally, the African Union (AU) has no regional Multilateral Environmental Agreements (MEAs) on plastic pollution except indirectly through other agreements such as “Agenda 2063: The Africa We Want”, “Agreement Establishing the African Continental Free Trade Area”, “Africa Blue Economy

Strategy", "African Union Plastic Pollution Initiative" and "Durban Declaration" (Sadan and De Kock 2021). Among the sub-regional bodies, only the East African Community (EAC) established a regulation, the "East African Community Polyethene Materials Control Bill, 2016" in 2017. The bill proposes to ban SUPB after one year but exempts plastic used for industrial packaging, household goods, and furniture, and endorses sustainable packaging and recycling (EAC 2017). All East African countries have moreover proceeded to establish plastic laws. Studies have established that 10 of the 16 Southern African Development Community (SADC) and 12 of the 16 Economic Community of West African States (ECOWAS) countries have plastic policies (Adam et al., 2020; Bezerra et al., 2021).

Policies adopt regulatory, economic, rights-based, and behavioral instruments to manage plastic. Regulatory approaches apply complete or partial bans that fully or partially limit consumption while economic instruments use taxes or charges at points of sale on products to disincentive usage. Rights-based approaches include extended producer responsibility (EPR) and deposit systems that assign rights and duties to products for management. Lastly, behavioral instruments, target behavior change by creating awareness among populations (Alpizar et al., 2020; Cornago et al., 2021). Regulatory instruments are more dominant in Africa compared to economic instruments in Europe. Asia moderately applies the instruments while in Oceania bans are slightly predominant (UNEP 2018).

Globally, single-use plastic bag (SUPB) policies induce a reduction between 36% - 96% with successful implementation (Schnurr et al., 2018). The most documented case from Ireland applied a US$0.08 SUPB tax in 2002 and reported a 90% reduction, that is, 328 bags/person/year to 14 bags/person/year (Xanthos and Walker, 2017). In Africa, South Africa and Botswana reported initial short-lived success in the usage of SUPB. Nevertheless, the levies were decreased after lobbying from the plastic industry (Dikgang and Visser, 2012). Rwanda's plastic imports under HS Code 3926, "Articles of plastics, and articles of other materials", were reduced from 5000 to 175 tons between 2004 and 2016 due to the 2008 plastic bag ban (Babayemi et al., 2019). Kenya's ban has reported a reduction in SUPB and increased adoption of reusable bags (Omondi and Asari, 2021). The success of policies is undercut by a lack of alternatives, smuggling, and the plastic industry (Muposhi et al., 2022). In this way, some quantitative information is being obtained in Africa as well. However, the effectiveness of plastic policies is limited or undocumented due to a lack of enforcement, monitoring, evaluation, and recent adoption in most African countries (Nyathi and Togo, 2020; UNEP, 2018).

Persisting plastic pollution has resulted in policy design and policy coherence as topical study areas in the European Union (EU), Asia, and the Pacific regions (Akenji et al., 2019; UNEP, 2019; Farrelly et al., 2021;). Policies are made of elements such as title, citation, definitions, exemptions, and fines that interact within its design in a given structural logic (de Wee, 2022). Policy coherence ensures the interactions of policy elements to reduce conflict within the policy and with other policies, to guarantee the success of the policy (Knoblauch et al., 2018; Ferraro and Failler, 2020). Thus, policy

design studies establish the relationship between active policies and recurring plastic pollution. To build and improve on studies on plastic policy, considerations are made to scrutinize SUP policy design in Africa.

Reviews of plastic policies including Africa have been done within the global context to capture the themes above (Xanthos and Walker, 2017; Schnurr et al., 2018; Nielsen et al., 2019; Diana et al., 2020; Knoblauch and Mederake, 2021; Muposhi et al., 2022). In some instances, Africa as a study context is lump summed with the Middle East limiting the clarity of results on the region. Regional studies (Nyathi and Togo, 2020; Deme et al., 2022) and subregional studies, Southern Africa (Bezerra et al., 2021); Western Africa (Adam et al., 2020) and East Africa (Behuria, 2021) have also been conducted. In the process, descriptive and comprehensive databases on plastic policies have been established. Notably, the studies which are exploratory have focused on SUP policies but largely on SUPB policies since they are the most adopted policies. Such documented data include the year of announcement/adoption, policy status (active, under review, or revoked), legal type (law, decree, notice, or directive), type of policy (ban or levy), decision structure for policy adoption, policy summary, policy drivers, national awareness campaigns and effectiveness.

The focus of this paper is thus policy design and coherence than the description existing policies in the literature. The present paper explores the extent to which policies as currently designed influence plastic waste reduction in Africa by assessing the status, trends, and variability of SUP legislations, and potential sources of plastic waste from transboundary flows due to different policies adopted by countries. This study aims to inform policy stakeholders on the problem of persistent plastic pollution, enforcement challenges, and illegal plastic flows against existing instruments for strengthening the policy design process.

2.2. Materials and Methods

Gap analysis assesses the current state of a phenomenon against a reference model, outlining the existing and missing features in a policy for subsequent improvement proposals (Farrelly et al., 2021). This research adopted gap analysis applied in waste policy studies (Tencati et al., 2016; Akenji et al., 2019; Diana et al., 2020; Farrelly et al., 2021). Policy documents were identified and scrutinized based on policy elements by referring to a coding scheme modified from Farrelly et al. (2021) and Diana et al. (2022) as shown in Table 2.1. below. The interaction and logic of policy elements were assessed to strengthen gap analysis that only identifies them. In this regard, integrative propositional analysis (IPA) used in comparative policy analysis was additionally used to supplement gap analysis. IPA considers a policy as a system of interacting and integrated propositions that can be evaluated qualitatively (and quantitatively) based on the policy text. The text evaluation enables the identification of weak logic for policy improvement (Wright and Wallis, 2015; Wallis, 2021; de Wee, 2022; de Wee and Asmah-Andoh, 2022). A step-by-step application of the methodologies is explained below.

2.2.1. Policy identification and selection criteria

The first process involved tabulating national, legally binding plastic policies in Africa from peer-reviewed journals and reports to an Excel list with subtitles including country, title, geography (national or regional), product type, and status (active, under review, or revoked). Policies considered were legislation, notices, and guidelines (Supplementary 2.1). The list was cleaned for duplicity by policy title and years of adoption/implementation. Policies were excluded if they were inactive (under review or revoked), regional (a province only), or national but place specific e.g., national parks only. The policies were subsequently counted by title and classified under SUP policies, packaging policies, and product policies by country (Fig. 2.1.). SUP policies target both packaging and plastic items. Packaging policies target primary and secondary packaging while a product policy targets one specific plastic item.

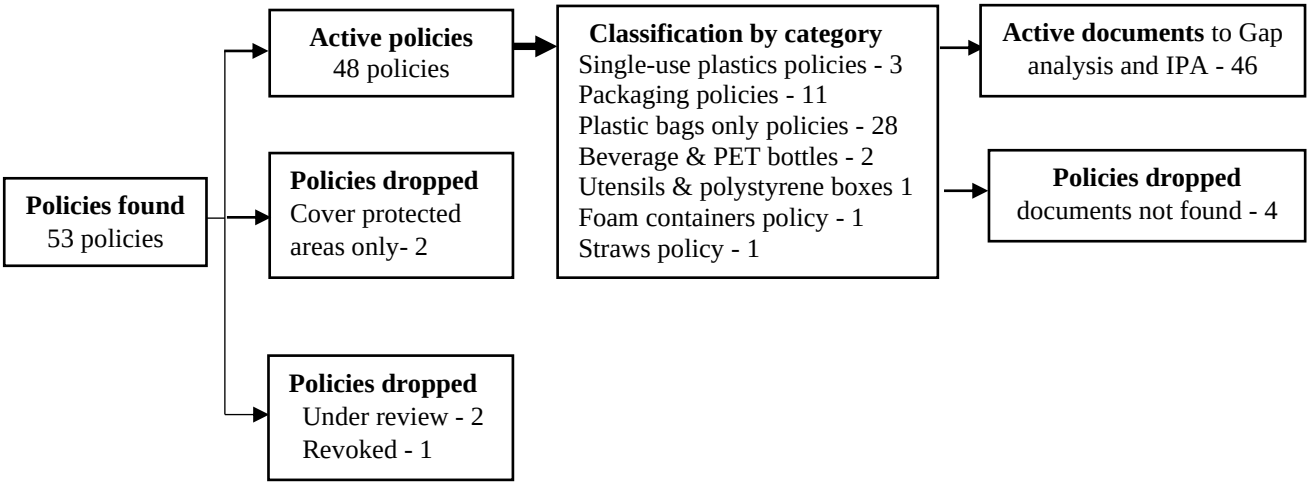


Fig. 2.1. Triage and analysis flow for national plastic policies from harmonized databases

Original (in English) or English-translated versions of policy documents were downloaded from existing inventories developed by the Nicholas Institute for Environmental Policy Solutions, Duke University (Karasik et al., 2022) and the Global Partnership on Plastic Pollution and Marine Litter Digital Platform, (Global Partnership on Marine Litter 2023) or on the internet as of March 2023. These inventory sites update plastic policy data regularly and therefore a new comprehensive search for policy documents was not warranted for this study. When two or more policies in a country existed, the latest policy was analyzed, if the policy text explicitly repealed the old. Otherwise, both policies were included in the study. Text from policies was extracted and coded based on a modified coding scheme from Farrelly et al., 2021 and Diana et al 2022; and copied into an Excel file (supplementary document 2.2). Policy elements were extracted from Mauritius, Senegal, and Rwanda SUP policies (Table 2.1.). Four policy documents could not be found online. Their inclusion in the count was to maintain consistency with published information. However, they were not subjected to gap analysis and IPA.

Table 2.1. Modified coding scheme used for policy elements, data capture, and analysis (Farrelly et al., 2021 and Diana et al 2022)

Policy Element	Term	Definition as applied in the research
Title		Policy title as stated in the policy document
Citation		Statement in a policy document introducing what a policy entails
Policy type	Category policy	Policy that covers a family of single-use plastic such as SUP policy or packaging policy
	SUP policy	Policy that covers all single-use plastics including packaging and SUP items.
	Packaging policy	Policy that covers both primary and secondary plastic packaging.
	Product policy	Policy that covers a single plastic product or item made fully or partially from plastic
Instrument		Mechanism to reduce or manage the plastic problem
	Regulatory instrument	Command and control instruments in form of bans
	Total ban	Prohibition on the consumption of all SUP item(s) in all forms and restrictions
	Partial instrument	Prohibition on the consumption of SUP item(s) with certain exemptions or restrictions such as nonbiodegradability, thickness, polymer, and recyclability restrictions.
	Economic instrument	Monetary instruments such as taxes, levies, and charges on SUP items at applied along production chain for producers or consumers at the points of sale.
	Main instrument	Policy mechanism to reduce and manage plastic pollution identified by policy title or citation.
	Supporting instruments	Any other mechanism to reduce or manage plastic pollution mentioned within the policy document.
Interpretation		The definition of terms as used in the policy document and the context of understanding a policy
	Single-use plastic items (SUP Items)	Products include packaging, cutlery (straws, knives, plates, stirrers, etc.), beverage cups, cotton buds, cigarette butts, balloons, balloon sticks, wet wipes, and sanitary items.
	Plastic packaging	Items used for protection, containment, handling, delivery, and presentation of goods from producers to consumers.
	Product definition	Refers to the description of an item, fully or partially made from plastic. Product names were also considered as product definition
	Undefined SUP	SUP that falls under category definition but are unmentioned or unlisted in a policy, hence have unclarified status.
	Primary packaging	Packaging in direct contact with the product, especially from manufacturing and includes bottles, containers, food packaging, food containers, beverage containers (PET bottles), wrappers, and packets.
	Secondary packaging	Packaging used to carry goods from retail centers. Most include carrier bags, and flimsy/barrier bags
	Plastic carrier bags	Bags with or without handles used to carry products from retail centers to a destination by consumers
	Barriers bags	Thin or film bags at retail centers used for packaging, safety and grouping products
	Exemptions	SUP defined and permitted for circulation under the scope other controlled SUP.

2.1.1. Data Analysis

The existence of policy clarification, category/product definitions, listed plastic items, exemptions, main instrument and supporting instruments were considered for gap analysis. The existence was established three ways, tick (✓) for a policy element explicitly mentioned, circle (o) for a policy element inferred. and dash (-) for missing policy elements. Inferred policy elements are elements covered by the policy title but whose status is undefined or unlisted. For instance, when the SUP policy provides a definition to include all SUP and lists SUP items under the policy, it leaves the status of other SUP under the umbrella definition undefined. Policy elements explicitly exempted were marked with an (E).

To demonstrate variability, IPA was performed based on interactions and interrelationships between the policy elements and the main policy instrument. The interactions of elements strengthen or weaken a policy determining whether a policy remains intact and as a result effective or ineffective (Fig.2.2.). The existence of strengthening relationships (+) is derived from citations, full definitions and supporting instruments. Weakening relationships (-) are partial instruments (partial bans and economic instruments), partial definitions and exemptions that enable SUP circulation likely to end up as municipal solid waste (MSW). Fines were not assessed at design level due to the complex nature of inducing deterrence. The output sought from the methodologies were (1) Scope: specific SUP targeted, untargeted, or with unclear status in a policy; (2) Variability: similarities and differences between policies and (3) Sources of plastic waste from general policy designs.

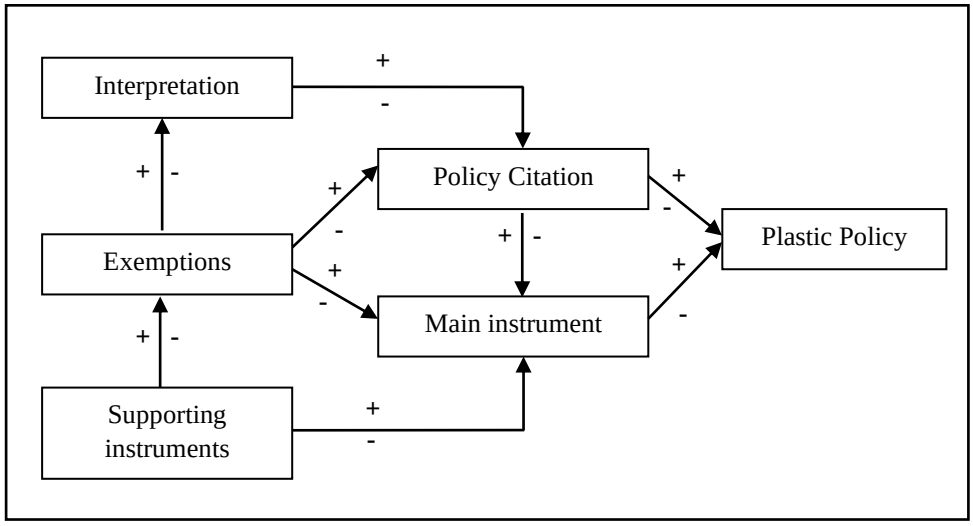


Fig. 2.2. The interactions of policy elements within a plastic policy

2.2. Results and Discussions

2.2.1. Overview of plastic policies in Africa

The triage of existing databases identified 48 active nationwide plastic policies in 39 countries mainly consisting of 3 SUP, 11 packaging, and 28 SUPB policies. Most countries have one policy targeting one plastic product (SUPB). Seychelles has the highest number of policies (5) targeting multiple products. SUP and packaging policies broadly cover multiple products per category and more explicitly when plastic products are mentioned in the policy. The scrutiny for products in the SUP and packaging policies indicates very few countries explicitly list products in their policies. The highest number of explicitly legislated products (8) are in Mauritius and Senegal (Fig. 2.3.). In addition to some category policies, SUPB are cumulatively addressed in all African countries with a policy making it the highly targeted SUP item.

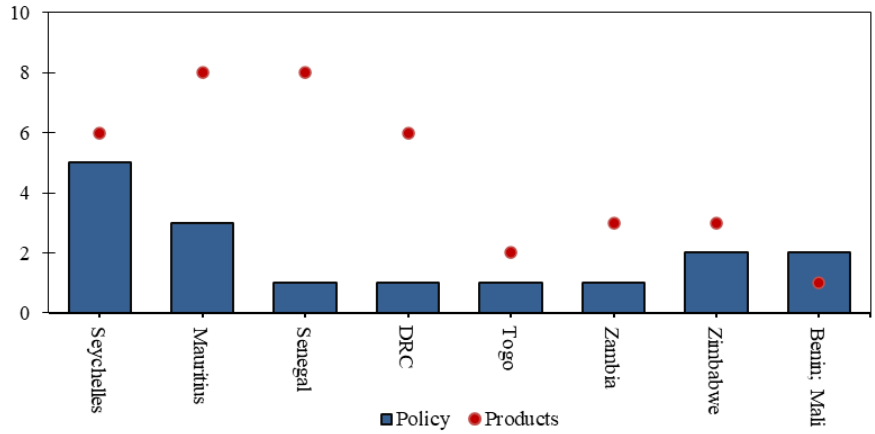


Fig.2.3. Number of policies and corresponding number of plastic products explicitly mentioned in policies by country.

2.2.2. Scope of SUP policies

Two of the three SUP policies in Africa are a transition from SUPB policies. Mauritius adopted the SUP policy in 2020 independent of its bag (2020) and PET bottle (2001) policies. Senegal's 2020 SUP law repealed the 2015 law on flimsy plastic bags while in Rwanda the 2019 SUP law repealed the plastic bag ban of 2008. Mauritius and Rwanda are East African countries however it is difficult to establish if there was any policy diffusion between the countries. Rwanda stands as a beacon of environmental leadership, being the first country in Africa to adopt SUPB ban (Behuria 2021) and subsequently the first to adopt SUP policy. Adam et al (2020) relate Mauritius' SUP policy adoption as driven by the tourism agenda. Senegal a West African country with a coastline employs a total ban on the production and circulation of SUP compared to a ban on non-biodegradable plastic ban in Rwanda and Mauritius.

Senegal and Mauritius provide descriptions of their policies and outline products that fall under them. In both policies, SUP is a product designed to be used once before discarding, Senegal, SUP law (2020), Article 3, and Mauritius SUP law (2020), section 2. This is in line with the widely adopted description of SUP. However, Mauritius explicitly provides provisions for the exemption of primary bag packaging through its bag policy in the First Schedule, part II. The wording in Rwanda's SUP policy, prohibits bags and SUP items. SUP items are defined as disposable items designed to be used once before discarding or recycling, Rwanda SUP law (2020), Article 2.1. This structure introduces limits on SUP management in Rwanda by excluding primary plastic packaging ('SUP items' as opposed to 'SUP'). Here, to some degree, we see Rwanda and Mauritius eventually having the same design by wording and exemptions, respectively (Fig. 2.4b). This design makes Senegal's policy (Figure 2.4a) more cohesive than Rwanda's and Mauritius' because of exemptions. In this case, the major determinant for policy success in the Senegal is the application of downstream supporting instruments.

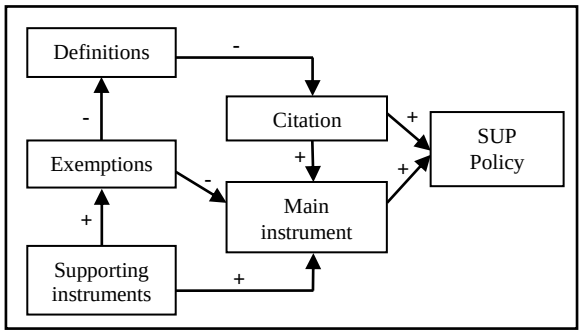


Fig.2.4a. Policy design in Senegal

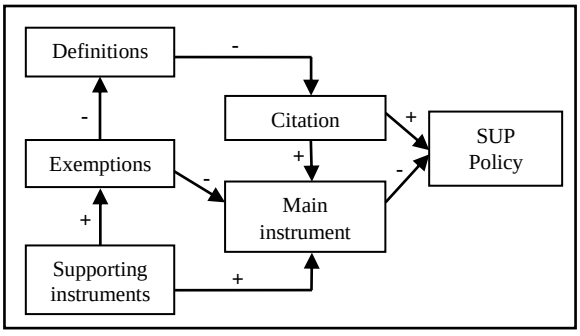


Fig.2.4b. Policy design in Rwanda and Mauritius

2.2.3. Scope of packaging policies

9 of the 11 plastic packaging policies were subjected to scope and variability analysis due to the availability of policy documents. Studies on packaging policies have been overshadowed in literature by SUPB documentation. The earliest packaging policies were adopted in 2001 and 2004 in Mali and Benin, respectively, with the most recent policies adopted in 2018. Policies are predominantly based on partial biodegradability restrictions in these countries. In countries with more than one policy, Mali applies an EPR policy on packaging and a ban on non-biodegradable bags, and in Zimbabwe a thickness ban on plastic packaging and a ban on polystyrene polymer products. Policy mixes in Zambia include an EPR on packaging and a thickness ban on SUPB while in Cameroon a non-biodegradable ban and thickness ban on packaging. Packaging policies like SUP policies have similar uncertainty with the status of primary packaging that is either undefined or exempted. This undefined status creates a grey area in policy enforcement and introduces such plastic into circulation with or without a management plan. However, full exemption of primary packaging in packaging policies creates SUPB policy by design in Burundi, Burkina Faso, Zimbabwe, and Zambia. DRC provides the most comprehensive plastic packaging policy in Africa (Table 2.2).

Table 2.2. Product mapping in SUP, packaging, and multi-policy designs in Africa

					Secondary Packaging		Primary Packaging				Single Use Plastic Items					
Country	Year of Adoption	Policy Instrument	Category/ Product Definition	Policy Coverage	Carrier Bags	Barrier Bags	Beverage & PET Bottles	Containers	Sachets Wrappers	Non – Food Packaging	Beverage Cup	Cutlery	Plates	Straws	Stirrers	Lids
Mauritius	2020	NBB	Yes/Yes	SUP	✓	E	✓	o	o	E	✓	✓	✓	✓	✓	✓
Senegal	2020	Ban	Yes/Yes	SUP	✓	o	o	o	✓	o	✓	✓	✓	✓	✓	✓
Rwanda	2019	NBB	Yes/No	SUP	✓	o	Out of policy				o	o	o	o	o	o
Mali	2001	EPR/NBB	No/No	Packaging	✓	o	o	o	o	o	Out of policy					
Benin	2004	Tax	Yes/Yes	Packaging	✓	o	E	E	E	E						
Zimbabwe	2010	TB/B	Yes/Yes	Packaging /PS	✓	✓	E	E	E	E						
Togo	2011	NBB	No/No	Packaging	✓	o	o	o	✓	o						
Cameroon	2012	NBB/TB	Yes/No	Packaging	✓	✓	o	o	o	o						
Burkina Faso	2014	NBB	Yes/No	Packaging	✓	o	E	E	E	E						
DRC	2018	NBB	No/Yes	Packaging	✓	✓	E	E	✓	✓						
Burundi	2018	NBB	Yes/No	Packaging	✓	o	E	E	E	E						
Zambia	2018	EPR/ TB	Yes/Yes	Packaging	✓	✓	✓	E	E	E						
Seychelles	2013-2020	NBB/EPR	Yes	Multiple products	✓	E	✓	Out of policy			✓	✓	✓	✓		

Acronym meaning: NBB – Nonbiodegradable ban; TB – Thickness bans; B – Ban; EPR – Extended Producer responsibility.
✓- Explicitly mentioned E-Explicitly exempted o-Status undefined

2.3. Scope of product policies

2.3.1. SUPB Policies

SUPB constitutes most product policies, controlled in all African countries with a policy, 28 standalone SUPB and in 11 category policies. By title count, policy designs mostly apply total (12), biodegradability (12), and thickness (7) restrictions with few aspects of charges and mixed instruments. In a few cases, partial restrictions transition to full bans due to previous policy failures (Dikgang and Visser, 2012). Botswana's 2018 ban replaced the 2007 levy while Tanzania's 2019 ban replaced the previous 2016 SUPB ban.

Thirty five policy documents were subjected to scope and variability analysis due to the availability of text. SUPB include both carrier and barrier bags. In the absence of a product definition, the status of barrier bags remains undefined in the policy. Total and partial restrictions indicate a fair distribution of such undefined status with barrier bags totally restricted in only three countries (Table 2.3.). This is attributable to a necessity function where barrier bags serve the sachet economy, a market in developing countries where manufactured consumer products are primarily bought in small quantities repacked in bags rather than bottles or jars (Adam et al., 2020; Omondi and Asari, 2021). SUPB policy cohesion is achieved in three countries. Thirty two countries require additional policy mechanisms to manage either carrier or barrier bags flow downstream due to partial restrictions, exemptions, or undefined status on barrier bags.

Table 2.3. Types of main policy instruments applied to SUPB

Restriction Scope	Instrument	Country
Ban on carrier and barrier bags	Total ban	Kenya, Mauritania, Tanzania, Congo
	Non-biodegradable ban	Cameroon, DRC, Eritrea
	Thickness ban	Zambia, Zimbabwe, Ethiopia, Madagascar, Uganda, Tunisia
Ban on carrier bag with barrier bag status undefined	Total ban	Senegal
	Non-biodegradable ban	Rwanda, Togo, Burundi, Burkina Faso, Côte d'Ivoire, Gabon
	Thickness ban	Mali
Ban on carrier bag with exemption on barrier bags	Total ban	Mauritius, Botswana, Cape Verde, Gambia, Morocco, Seychelles
	Non-biodegradable ban	São Tomé and Príncipe,
	Thickness ban	Malawi
Ban on plastic bag imports	Non-biodegradable ban	Djibouti
Charge on carrier and barrier bags		South Africa (Also applies a thickness ban)
Charge on carrier bags only		Benin, Algeria, Mozambique, Lesotho

2.3.2. Multiple products policies: The case of Seychelles

Seychelles has five policies on multiple product policies, a non-biodegradable ban on SUPB (2017), utensils and polystyrene boxes (2017) and takeout straws (2019), and a PVC label ban on beverage bottles (1994) and a levy on PET bottles (2020). Utensils are defined as forks, spoons, knives, plates, bowls, cups, and trays. The multiple products policy employed by Seychelles triggers design concerns about whether SUP is better managed wholly or at the product level. In SUP and packaging policies, some products are undefined weakening their management. Product policies provide a one-on-one management plan as a solution. Additionally, product policies provide a fine print of exemptions. Seychelles straws law section 2.1 provides an exemption for prepacked beverage or product with straws. Plastic waste monitoring programs provide products likely to become waste, informing recent SUP policies (Ocean Conservancy, 2018). Thus, countries should establish plastic waste generation patterns for policy development since it is tedious to design each policy per product.

2.4. Complementarity of policy instruments

Policy classification is majorly derived from policy titles setting the main policy instrument in publications. Policy designs complement main instruments with supporting instruments for the downstream management of plastics especially due to exemptions, other sources of plastic pollution, or traceability. These supporting instruments mainly include extended producer responsibility (EPR) and related mechanisms such as source registration, source labeling, source reporting, recycling, and product designs. It is important to emphasize that EPR can stand alone as a main instrument. About 30 SUP policies in 29 countries reported supporting instruments in varying degrees depending on the

design, the highest being seven instruments in Senegal. This concentration of supporting instruments is found in SUP and packaging policies due to undefined plastics and increased exemptions (Table 2.4).

Beyond waste prevention, there is the prominence of source registration, a requirement for producers allowed to use and release SUP into the environment to get approval from relevant government agencies. Source labeling, printing producer information on SUP and reporting the amounts of SUP released into the market were noted in some category policies. This enhances traceability by ensuring exempted plastic are traceable. Policy designers take cognizance of shortcomings in eliminating plastic, designing measures to manage any source of plastic waste. Awareness creation is however not captured in most policies but in Cape Verde, Sao Tome and Principe, and Madagascar. According to ten Brink et al. (2016), the adoption of ban and charges are rarely successful in isolation without continuous public education on plastic pollution. Similar variations in complementarity are available in the EU, Asia, and Pacific (Tencati et al., 2016; UNEP 2019; Farrelly et al., 2021). Notably, ASEAN countries have more policies on plastic waste imports (Akenji et al., 2019) compared to the two countries in Africa. The complementarity of instruments is important in policy cohesiveness since it seals sources of plastic waste. However, such policy designs push the burden of policy effectiveness to enforcement.

Complementarity of plastic management instruments in category and packaging policies in one hand and product policies on the other differs due to number of products involved and allowed to circulate. Japan has multiple policies to curb plastic pollution. For instance, the Containers and Packaging Recycling Law (CPRL) to the recovery of plastic packaging waste has realized a PET bottle collection rate of 93% with a recycling rate of 85.8% (Plastic Atlas 2022). The Plastic Resource Circulation Strategy, 3Rs (reduce, reuse, and recycle) + Renewables plans to reduce on SUP waste generation, improve plastic waste management and encourage adoption of paper and bioplastic alongside ambitious quantifiable targets (Ando et al., 2023). Additionally, a $0.05 SUPB charge was adopted in 2020 banning the free issue of plastic bags at retail centers (Seo and Kudo 2022). The charge is slightly higher compared to $0.03 SUPB charge in South Africa adopted in 2003 (Dikgang et al., 2022). The status of SUPB charges and taxes as well packaging management instruments remain undocumented in Africa. Moreover, Benin, Algeria and Lesotho apply production or environmental levies while in Mozambique a ban on free issue without stipulated charge is applied.

Table 2.4. Supporting policy instrument mix by country in Africa

			Supporting instruments in plastic policies in Africa												
Country	Policy Type	Main Instrument	Charge	EPR	Source Registration	Source Labelling	Source Reporting	Recycling	Product Design	Overpackaging	Polymer Restrictions	Degradability Restrictions	Awareness	Imports	Comment
Mauritius	SUP	NBB	-	-	✓	-	-	-	-	-	-	-	-	-	-
	Bags	NBB	-	-	✓	✓	-	-	-	-	-	-	-	-	Oxo -ban
	PET Bottle	EPR	-	-	✓	-	✓	-	-	-	-	-	-	-	-
Senegal	SUP	Ban	-	✓	✓	✓	✓	✓	✓	-	-	-	-	-	Waste import ban
Rwanda	SUP	NBB	-	✓	✓	-	-	✓	-	-	-	✓	-	✓	-
Togo	Packaging	NBB	-	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
Benin	Packaging	Tax	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bags	Ban	-	✓	-	-	-	✓	-	-	-	-	-	-	-
Cameroon	Packaging	NBB/TB		✓	✓	✓	-	-	-	-	-	-	-	-	-
DRC	Packaging	NBB	-	✓	✓	-	-	-	-	-	-	-	-	-	-
Burundi	Packaging	NBB	-	✓	✓	-	-	-	-	-	-	-	-	-	-
Burkina Faso	Packaging	NBB	-	-	✓	-	-	-	-	-	-	-	-	-	-
Zimbabwe	Packaging	TB		✓	-	✓	✓	-	✓	-	-	-	-	-	-
	Polystyrene	Ban	-	✓	-	-	-	-	-	-	✓	-	-	-	-
Mali	Packaging	EPR	-		✓	✓	✓	-	✓	✓	-	-	-	-	-
	Bags	NBB	-	-	-	-	-	-	-	-	-	-	-	-	-
Zambia	Packaging	EPR/ TB	-	-	✓	-	-	-	-	-	-	-	-	-	-
Seychelles	Bags	NBB	-	-	✓	-	-	-	-	-	-	-	-	-	-
	Utensil & PS boxes	NBB	-	-	✓	-	-	-	-	-	-	-	-	-	-
	Straws	NBB	-	-	-	-	-	-	-	-	-	-	-	-	-
	PET bottle	EPR	-	-	-	-	-	-	-	-	-	-	-	-	-
	Beverage Container	EPR	-	-	-	-	-	-	✓	-	-	-	-	-	-
Algeria	Bags	Tax	-	-	-	-	-	-	-	-	-	-	-	-	-
Botswana	Bags	Ban	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape Verde	Bags	NBB	-	✓	✓	✓	-	-	-	-	-	-	✓	-	Reduction Targets
Côte d'Ivoire	Bags	NBB	-	✓	-	-	-	-	-	-	-	-	-	-	-
Djibouti	Bags	-	-	-	-	-	-	-	-	-	-	-	-	Ban	-
Republic of the Congo	Bags	Ban	-	-	✓	-	-	-	-	-	-	-	-	-	Food only/ Oxo -ban
Ethiopia	Bags	TB	-	-	✓	-	-	-	-	-	-	-	-	-	Biodegradability labels
Eritrea	Bags	NBB/TB	-	-	-	-	-	-	-	-	-	-	-	-	-
Gabon	Bags	NRB	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambia	Bags	Ban	-	✓	-	-	-	-	-	-	-	-	-	-	-
Kenya	Bags	Ban	-	-	-	-	-	-	-	-	-	-	-	-	-
Lesotho	Bags	Tax	-	-	-	-	-	-	-	-	-	-	-	-	-
Madagascar	Bags	TB	-	-	-	✓	-	-	-	-	-	-	✓	-	-
Malawi	Bags	TB	-	-	-	✓	-	-	-	-	-	-	-	-	-
Mauritania	Bags	Ban	-	-	-	-	-	-	-	-	-	-	-	-	-
Morocco	Bags	Ban	-	-	-	✓	-	-	-	-	-	-	-	-	-
Mozambique	Bags	TB	Charge	-	✓	✓	-	-	-	-	-	-	-	-	-
South Africa	Bags	TB	Charge	-	-	-	-	-	-	-	-	-	-	-	-
Uganda	Bags	TB	-	✓	-	✓	-	✓	-	-	-	-	-	-	-
Tanzania	Bags	Ban	-	✓	-	-	-	-	-	-	-	-	-	-	-
Tunisia	Bags	TB	-	-	-	✓	-	-	-	-	-	-	-		Oxo- ban
São Tomé & Príncipe	Bags	NBB	-	-	-	-	-	-	-	-	-	-	✓	-	-

Key: Ban – Ban applicable to restrictions; NBB – Non-biodegradable ban; TB – Thickness bans; NRB - Non-recyclable ban; Oxo – Oxo degradable plastic

2.5. Qualitative implication of status, scope, and variability of waste prevention

2.5.1. Policy instrument sources

This paper divides MSW plastic waste as either SUP or non-SUP waste. Regulatory instruments like total SUP bans completely cover the defined SUP whereby no plastic waste is expected with successful enforcement. Partial restrictions based on biodegradability, thickness, or recyclability enable approved consumption like economic instruments that induce anti-consumption through rational behavior. These pathways enable plastic circulation and therefore the existence of some waste (Table 2.3. and Table 2.4.). The application of EPR anchors on additional costs associated with plastic waste management to incentivize both prevention and efficiency in recovery (Cornago et al., 2021). Thickness restrictions while targeting waste prevention also seek to improve the reuse and recyclability of plastic at the end of life (Li and Wang, 2021). Partial instruments, therefore, define in-policy sources of SUP waste, plastic products that are likely to become waste after consumption such as a 30 or more microns thick bag or biodegradable bag.

2.5.2. Policy scope sources

Policy scope is the policy definition and the listed products in the policy. SUP policies cover a broad band of plastics and have a higher potential for waste prevention. At the same time, incomplete product definitions and listings introduce regulatory uncertainty of the unlisted SUP items which increase in SUP and packaging policies. That is, whether they are subject to management even though they fall under the family of SUP definition but are not listed for management (Table 2.3. and Table 2.4). DRC, Zimbabwe, and Zambia are the only African countries that provide clear packaging policy guidance on primary packaging. Considerations of policy instruments and scope dynamics give rise to out-of-policy sources of SUP waste that include SUP not considered by a category or product policy. Additionally, unclear policy definitions give rise to undefined sources of SUP waste.

2.5.3. Exemption related sources

Policies explicitly provide exemptions for various reasons. Primary packaging is exempted explicitly (Mauritius, Burkina Faso, etc.) or by different wordings such as trade and manufacturing (Benin); packaging perishables (Cape Verde), and repacked foods (Seychelles). There are also industry exemptions such as agriculture, medical, pharmaceutical, military, scientific experiments, education, and construction. While these exemptions might lead to waste generation the management of the waste streams ideally should be independent of MSW. plastic waste management thus requires the improvement of other sectoral waste management categories. The other exemption reasons include hygiene (DRC, Burkina Faso, Congo) and food safety (Senegal). Waste management also receives preference under exemptions in some countries as garbage bags. Exemptions result in exemption-related sources of SUP waste.

2.5.4. Transboundary flows and sources

The possible transboundary flows are based on different policy applications among neighboring nations. This avails SUP in some nations while instigating their management in others. The possible flows include three levels: flows from countries without plastic policies to countries with plastic policies, flows from countries with partial restrictions such as thickness ban on SUPB to countries with total restrictions such as total ban on SUPB (same product flows), and flows from countries with lower tier policy such as plastic bag policy only, where unregulated SUP move to a higher tier SUP policy environment (Fig. 2.5.). Transboundary flows require international or regional dialogue to harmonize policies to reduce plastic consumption. SUP policies have only been adopted in countries with small populations.

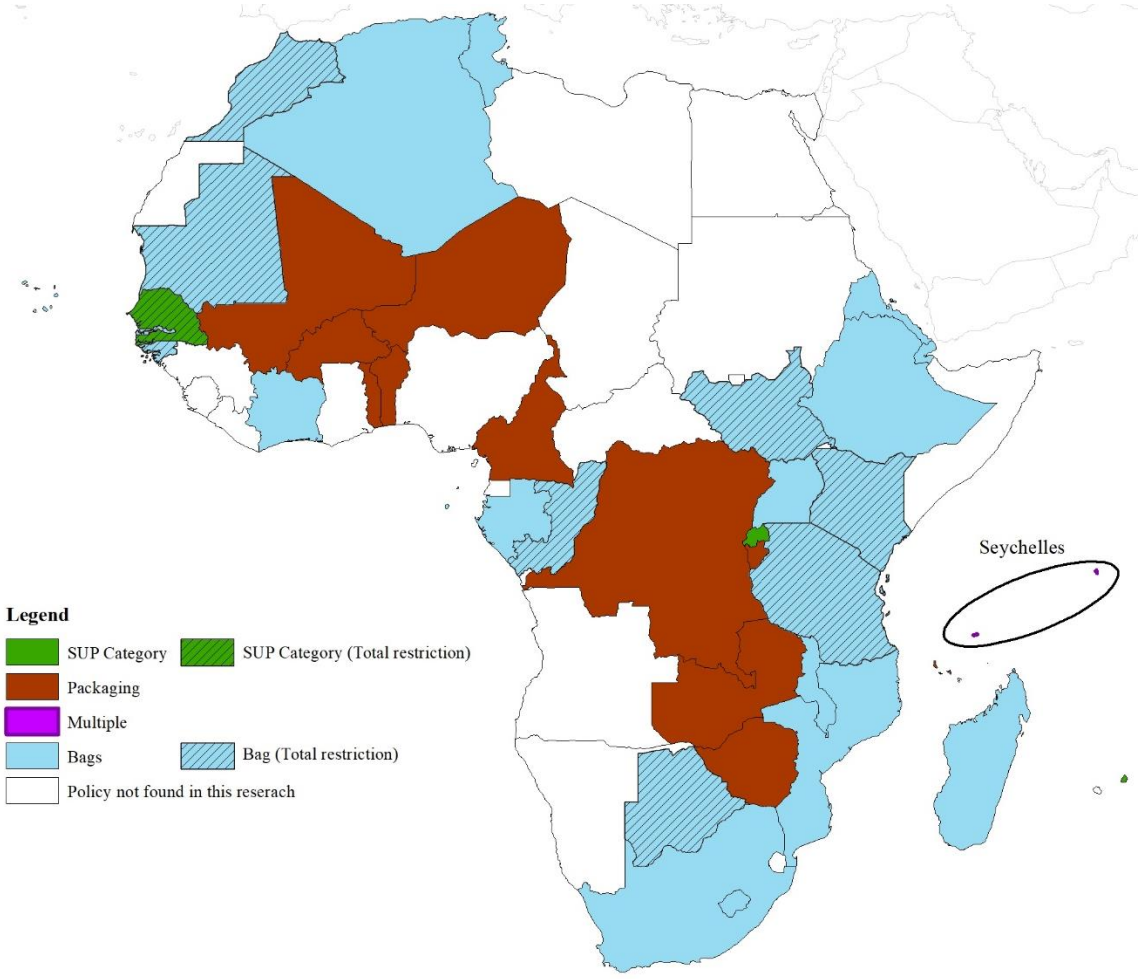


Fig. 2.5. Map showing the spatial distribution of policies by type in Africa

2.6. Conclusions

SUPB (28) policies are the most dominant type even though packaging policies (11) have existed since 2001. SUP (3) policies are more recent and target the management of more plastic products. Most policy (18) designs are anchored on nonbiodegradability restrictions alluding to bio-based plastic as an alternative to conventional plastic. Category and product definitions and exemptions define SUP and packaging policy designs. Where such definitions are inadequate, exemptions availed and partial instruments applied, SUP circulation occurs resulting in less cohesive policies. Thus, sources of plastic waste can be mapped from policy design before implementation from partial instruments, policy scope, exemptions, and transboundary sources. Product policies provide a more targeted management focus but exhibit the limitations above in a diminished form. The design models anticipating plastic circulation beyond waste prevention apply supporting instruments (30) mainly EPR-based instruments to enhance traceability and recovery.

For potential increased adoption of SUP policy in African countries, the management of primary packaging and highlighted potential sources of plastic waste should be addressed. Additional research is necessary to map actual plastic consumption and littering to inform the policy design targets. Future research is also needed on vertical policy coherence to assess the effectiveness of plastic policies with other national and international policies.

Chapter 3. A study on consumer consciousness and behavior to the plastic bag ban in Kenya

3.1. Introduction

Management of plastic waste focuses on plastic packaging due to its short lifespan. Approximately, of 146 million metric tons of plastic packaging produced in 2015, 141 million metric tons ended up as waste (Geyer et al., 2017). The dominance of plastic is due to replacement of traditional packaging materials. Plastic waste problems include marine debris, urban flooding, photodegradation, existence in food chain and visual nuisance. Additionally, plastic waste can entangle, suffocate or be consumed leading to death of terrestrial and marine organisms (Synthia, 2015; Lange et al., 2018; UNEP, 2018; Smith et al., 2018 Koelmans et al., 2019]. Single use plastics (SUP) contribute to resource wastage. Almost 95% of material value is lost with single use through landfilling, mismanagement and recycling loses (EU 2018). In both land and ocean, plastic bags, polyethylene terephthalate (PET) bottles and food wrappers are the most discarded (PWMI 2016). Unless measures are taken to limit usage of plastic packaging, consumption is expected to increase.

Various mechanisms are applied to control plastic products and waste at global, regional, national, and local levels. These mechanisms target all SUPs or specific items such as plastic bags or microbeads. At the national level, bans, levies, or a combination of both are mostly applied. Plastic bans vary in characteristic such as point of application (retail centers), material (degradable vs non-degradable) or level (primary vs secondary packaging). Charges or levies are applied to retailers, suppliers, and consumers. About 127 countries had established a form of national law on plastic bags as of 2018 (UNEP 2018; UNEP 2018b). Global assessment of the policies in about 60 countries indicate 70% have no or limited data on impacts while 30% have recorded reduced plastic bag usage or a cleaner environment (UNEP 2018b). There is lack of consensus on the most effective plastic bag policy. Thus, there is need for more research to establish the impact of policies adopted to control plastic pollution.

The push against plastic pollution in Kenya is influenced by the undeveloped waste management system coupled with illegal and informal dumping. Environmental, economic and health problems highlighted above are also driving factors (Lange et al., 2018). Successful adoption of the plastic bag ban took 14 years after proposals and advisories on various policies (Table 3.1) failed due to lack of enforcement, resistance from traders and manufacturers, different lead agencies and poor stakeholder involvement (Kiprop 2017; NEMA 2019).

Table 3.1: Evolution Plastic Bag Policies

Year	Policy Title and Measures	Enforcing Agency
2003	10 Point Action Plan: Measures - thickness bans, taxes and recycling.	KAM and NEMA
2005	Selection, Design and Implementation of Economic Instruments in the Solid Waste Management Sector in Kenya The Case of Plastic Bags: Measures - Thickness bans, education, voluntary schemes, levies and recycling	UNEP
2006	Comprehensive Plastic Waste Management Strategy for Nairobi: Measures - education, recycling, buy back schemes and reuse.	KNCPC*
2007	Budget Statement: Excise duty tax for plastic bags below 30 microns thickness.	Ministry of Finance
2007	Vision 2030: Measure - Plastic Bags Regulation Initiative, taxes.	Ministry of Planning
2011	Banning plastic bags below 60 microns.	NEMA and KEBS
2017	Gazette notice 2334 and 2356 of 2017. Measure: Ban on use, manufacture and imports on plastic bags for retail packaging.	**NEMA In Force**
2019	Public Notice. Measure: Ban manufacture, import, supply, distribution and use of non-woven plastic bags.	NEMA and KEBS Suspended by court

*Kenya National Cleaner Production Centre (KNCPC)

Plastic bag ban in Kenya is a partial ban that prohibits the use of SUP bags for retail or household packaging. That is, bags used to carry goods from retail centers including very light and transparent bags. The ban has the following characteristics:

1. It is a subsidiary law as gazette notices No. 2334 and 2356 enforceable under the Environment Management and Coordination Act (1999) and the Constitution of Kenya 2010.
2. The ban was published on 28th February 2017 and took effect on 28th August 2017 after a grace period of 6 months.
3. It disallows all manufacturing, importation, distribution, and use of single use plastic bags for retail or secondary packaging therein clarified as (1) Carrier bags with handle and with or without gussets and (2) Flat bags without handles and with or without gussets.
4. The SUP ban allows fines of about $20,000 - $40,000 or 1-4 year prison terms or both.
5. Key exemptions include primary packaging, duty free bags, wrapping films and waste bags if labelled by industry name and certified by the National Environment Management Authority (NEMA) (NEMA 2019).

The recommended alternatives carriers are plastic based reusable bags, cotton bags, paper bags, jute bags, canvas bags and 100% biodegradable bags. Moreover, additional policy enforcement of the ban has been sought to improve effectiveness of this policy. These include an advisory to ban reusable plastic based bags pending approval of standards due to influx of poor quality non-woven Polypropylene (PP) bags and the Plastic Bags Control and Management Regulations 2018 (to be adopted) (NEMA 2019).

The success of plastic bag policies depends on enforcement, alternatives, stakeholder support and time (UNEP 2018b) Bans are expected to introduce a complete reduction of plastic bag consumption. However, past research reviewed have indicated that the effectiveness of bans is not amicably documented. For example. despite a total ban, plastic bag usage in India is estimated to be 40% (MOEF 2019). Regionally, Rwanda enacted a total ban in 2008. However, the compliance or influx of illegal bags are not clarified. In other countries such as Botswana and South Africa introduction of plastic bag levies resulted in a 50% reduction. However, the charges were lowered after industry lobbying and carrier bag consumption increased (Dikgang and Visser 2012; Dikgang et al., 2012; Jospeh et al. 2016). In Europe where plastic charges are popular, countries like Ireland with the most successful policy reported a 90% reduction in consumption of SUP plastics. Charges must however be adjusted from time to time to prevent a surge in consumption as experienced in Ireland (Thomas et al., 2016). Without reliable comparative data, establishing the most effective mechanism for reducing consumption or pro-environmental behavior is seen as a major challenge.

In this view, this study explored the impact of the plastic bag ban among residents in Kenya to improve implementation. The perception towards the SUP ban, environmental awareness, behavior in usage of reusable bags and the previous plastic bag product flow are discussed.

National or regional baseline consumption is important in evaluation of the effectiveness of policies. Monthly plastic bag consumption in 2005 was estimated at 24 million bags, an annual projection of 300 million bags. Supermarkets issued a third of the bags. The remaining two thirds were used by the informal retail sector (UNEP 2005). The same statistic was fronted when the ban was introduced in 2017 (NEMA 2019). With national populations, being 36.05 million in 2005 and 45 million in 2017, annual per capita consumption ($capita^{-1}y^{-1}$) in both years were 8.3 bags $capita^{-1}y^{-1}$ and 6.7 bags $capita^{-1}y^{-1}$ respectively. This probably understates the plastic bag issue.

Alternatively, KNCPC (Kenya National Cleaner Production Centre) in 2006 noted that 49,022 tonnes per year (ty^{-1}) were used to produce plastic carrier bags. Production is distributed equally for very light bags (under 15 microns) and carrier bags (15-50 microns). Assuming the average weight of a bag is 8.6 g, annual production was 2.9 billion plastic carrier bags and per capita consumption 77 bags $capita^{-1}y^{-1}$ (UNEP 2005; KNPC 2005). Regionally, only South Africa reported an aggregate consumption of about 8 billion bags in 2002 (Wilson and Smit 2002). Statistics about other countries in Africa are limited. The second estimation is a favorable figure to envision the plastic bag problem. Due to poor solid waste collection plastic bags waste remained in the environment which is called national flower in South Africa and white pollution in China (Zhu 2011; Knoublauch et al., 2018). It is estimated that 8 million tonnes of waste are generated in the country per year. The average generation per capita is 0.5 kg per day. By material composition, plastic waste makes 20% of the total volume (MOEF 2019). Therefore, this study also tried to estimate numbers of plastic bags consumed before the ban to evaluate plastic policies in controlling littering and pollution.

3.2. Materials and Methods

3.2.1. Questionnaire Survey and Analysis

Data was collected through a questionnaire survey. The questionnaire (Supplementary document 3.1) was divided into eight sections that included demographic characteristics, shopping patterns, previous plastic bag reception based on a guide showing plastic bag pictures, previous plastic bag usage after reception, reusable bag usage, attitudes towards the ban, knowledge about bioplastics and usage of plastic products. Most questionnaire constructs were adopted from previous studies and modified to Kenyan context (Sharp et al., 2010). Due to space restrictions only, key results are discussed.

The survey was conducted in March 2019 in Nairobi (Capital City) and a rural town in western Kenya. Responses captured household level consumption habits. High, middle, and low urban residential segments were considered. In rural area, people living in villages and rural market center were surveyed. Respondents were identified through convenience sampling under guidance of research assistants from each residential segment. Identification markers for respondents were household size and availability of household head or 18+ years olds with knowledge on household consumption.

Raw survey data was entered into an excel spreadsheet for analysis that mainly involved descriptive statistics for means and percentages for support and perception towards the ban and ownership and disposal of reusable bags. The spreadsheet was imported to STATA 13 software to perform tests for significance and association for perception and emerging behavior due to the ban Bivariate analysis was performed between each demographic characteristic and support responses to the ban. Chi-square tests for association were applied in analysis of behavior and response behavior.

The sample size and weakness of face to face questionnaire survey such as exaggeration or failure to recall are some of the limitations. Respondents had to recall certain aspects of the use of SUP bags, eighteen months since the ban adoption. Additional research is thus required to improve generalizations.

3.2.2. Estimation of Previous Plastic Bag Consumption

Plastic bag consumption before the ban was calculated by harmonizing household consumption to a weekly basis based on shopping frequency and number of bags received per shopping trip. Shopping patterns were assigned weekly frequencies as follows: Once a day = 5, Several times a day = 10, 2-3 times a week = 2.5, Once a week = 1 and Once a month = 0.25. Afterwards, the number of bags per person per week was calculated based on the household size. Subsequently, the average number of bags consumed per person per week was calculated by location, by retail center and type of bag. Annual after use of plastic bags were calculated by multiplying reception at household level per week by location to 52 weeks. To calculate the total national number, urban and rural populations were adopted as 16,245,000 and 29,127,000 respectively (KNBS 2018). The 2019 population census data was not used because data by location was not public.

3.3. Results and Discussions

3.3.1. Demographic Profile of the Sample

Table 3.2. shows demographic characteristics of the sample and national population. The survey had 90 urban and 60 rural respondents, an aggregate of 150 respondents. Each respondent represented a single household. There were more female (64%) than male respondents. Most of the respondents (80%) were below the age of 40 with half being under 18-29 years. The household size ranges with 1-2 people were 33%, 3-4 people were 41%, 5-6 people were 23% and more than 7 people 3%. Most of the respondents had household income levels concentrated between 0 to Kshs 40,000. The differences between national and sample percentages are influenced by location and sample sizes.

Table 3.2. Sample Characteristics

Category	Characteristic	Sample %	National %	Source
Location[a]	Urban	60	44	KNBS
	Rural	40	56	2018]
Gender	Male	36	48	FSD
	Female	64	52	2016[b]
	Single	27	-	NA
Marital Status	Married	65	-	
	Divorced	7	-	
Age	18-29	51	40	FSD
	30-39	30	24	2016
	40-49	11	16	
	50+	8	20	
Household Size	1-2 people	33	32	FSD
	3-4 people	41	31	2016
	5-6 people	23	23	
	7+ people	3	15	
Education Level	None	-	14	FSD
	Primary	19	46	2016
	High School	39	29	
	College/University	37	11	
	Masters+	4		
Occupation	Agriculture/Farmer	12	32.2	FSD
	Self Employed	43	18.4	2016
	Government Official	7	12.3	
	Enterprise Employee	13		
	Casual laborer	7	18.8	
	Unemployed	15	16.3	
	Other	3	2	
Household Income	Less than 10,000	29	(Less than 15,000) -75.4	FSD
	10,000 – 24,999	31	(15,001-30,000) - 14.9	2016
	25,000 – 39,999	23	(30,001+) 9.8	
	40,000 – 54,999	9		
	54,999+	7		
Shopping Responsibility	Myself	77		
	Family member	27		

[a] Represents number of households by location

[b] Captures data of persons aged 16 years and above only.
Exchange rate in 2019: 1 US Dollar = 102 Kenya Shillings

3.4. Effect of the Ban on Consciousness

3.4.1. Support for the Ban

Fig. 3.1. shows support towards the plastic bag ban by demographic characteristics. On aggregate 67% of the respondents supported the ban, 18% did not while 15% were neutral. Demographically, income and location showed distinctive trends with high income and urbanites showing more support for the ban. Only location (urban or rural) showed a significant relationship for support of the ban (X^2 = 14.29, p=0.001) . This implies positive reception of the ban by citizens.

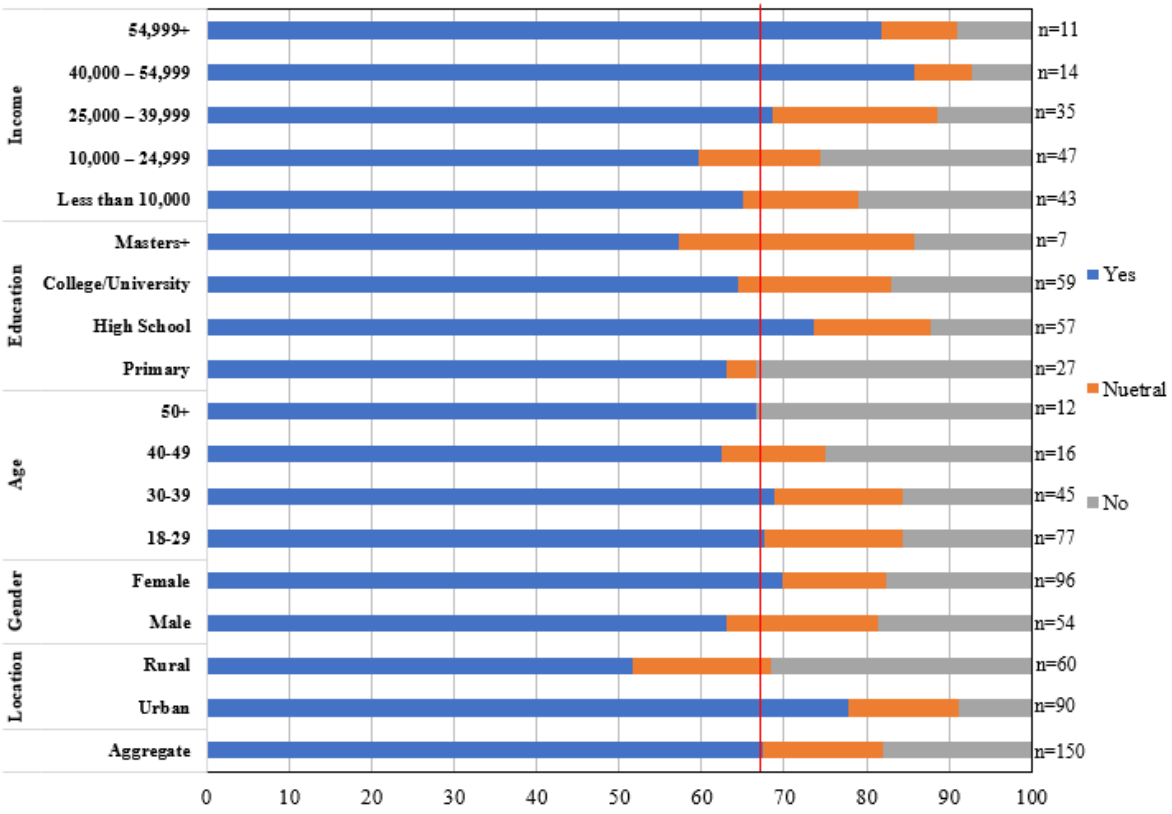


Fig 3.1. Support towards the plastic bag ban by demographic characteristics (%)

Table 3.3. shows comparison of support towards the ban by location in different timelines. NEMA assessments show 80% compliance to the ban (NEMA 2019). A separate study in Nairobi (May 2018) established a 10% change in self-reported responses whereby respondents stating their position on support before and after adoption of the plastic bag ban. Support for the ban increased from 75% to 86.8% while opposition decreased from 19% to 8% (Enge 2018). The increase in "not sure" responses in the current study could relate to enhanced enforcement and media campaign by NEMA in March 2019, the same period as data collection.

Table 3.3. Comparison of support towards the ban in Nairobi in different timelines

Area	Study Period	Response			
		Sample	Yes (%)	No (%)	Not sure (%)
Urban (Enge 2018)	May 2018 pre –ban perception	196	75	19.4	5.6
	post – ban perception	196	86.8	8.1	5.1
Urban[a]	March 2019	90	78	9	13
Rural		60	52	32	17
Aggregate		150	67[b]	18[b]	15

[a] This study

[b] Category and sub category percentages may not average out due to differences in sample sizes.

3.4.2. Perceptions of the Ban on Plastic Litter Problem

Fig. 3.2. shows the effect of the ban on their awareness of waste management and plastic pollution. Based on this, 65% of the respondents chose yes, 19% remained neutral while 17% said no. The key differences by location were agreeing to improved awareness at 73% and 57% in urban and rural responses, respectively. Respondents disagreeing were 10% in urban areas and 23% in rural areas. The dipartites between urban and rural responses could imply increase visibility of urban waste that is more problematic or increased monitoring and media penetration in urban than rural areas. A different study found 68% of urban respondents agreed the ban had increased their awareness to environment issues against 10% that disagreed (Enge 2018).

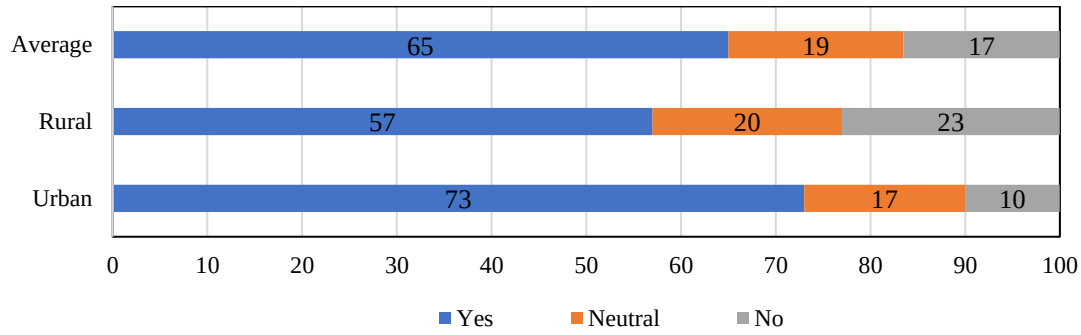


Fig. 3.2. Has the ban improved your awareness on waste management and plastic pollution? (%) (n=150)

3.5. Effect of the Ban on Behavior

3.5.1. Reusable Bag Ownership

Fig. 3.3. shows average reusable bag owned by type per household. Respondents owned an average of 4.32 bags per household before the ban. The ownership tripled to 12 bags per household after the ban. By material, plastic based bags were the most owned at an average of 7.7 bags, followed by cotton, locally fabricated and other material per household after the ban. This indicates preference for modern carrier bags.

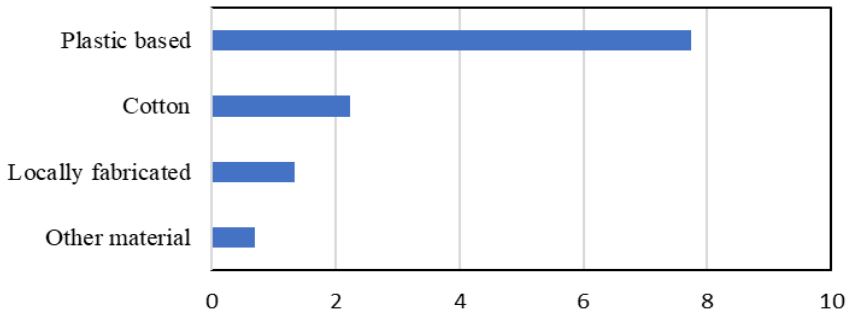


Fig. 3.3. Average reusable bag owned by type per household (n=150)

Fig. 3.4. shows the average reusable bag owned by monthly income per household. Ownership during the post ban period by location indicate that urban residents owned more bags at an average of 7.20 bags than rural respondents, 4.80 bags per household. Urban respondents also owned more bags by each material category compared to rural respondents. The association between income and ownership showed that the number of bags owned per household increased with reduced income. The respondents in the lower income groups possessed more bags due to daily purchase of commodities in small quantities unlike high income groups with the ability to make bulk purchases.

Different studies in Kenya have also established dominance of plastic based reusable bags. In Nairobi city, an author showed respondents preference order as non-woven PP bags 65%, cloth bag 5.6%, handbag/bag pack/sisal bag 6.7%, box/carton/crate/basket 7.8% and another bag 11.8%. Average consumption of non-woven PP bags was 3.6 bags per week (Enge 2018). A 2019 study in Rongai rural Kenya, established usage was as follows: non-woven PP 50%, cloth 23%, canvas 16%; grass basket 8% and sisal basket 4% (Koros 2019) This indicates that plastic based reusable bags are replacing SUP bags as shopping carriers.

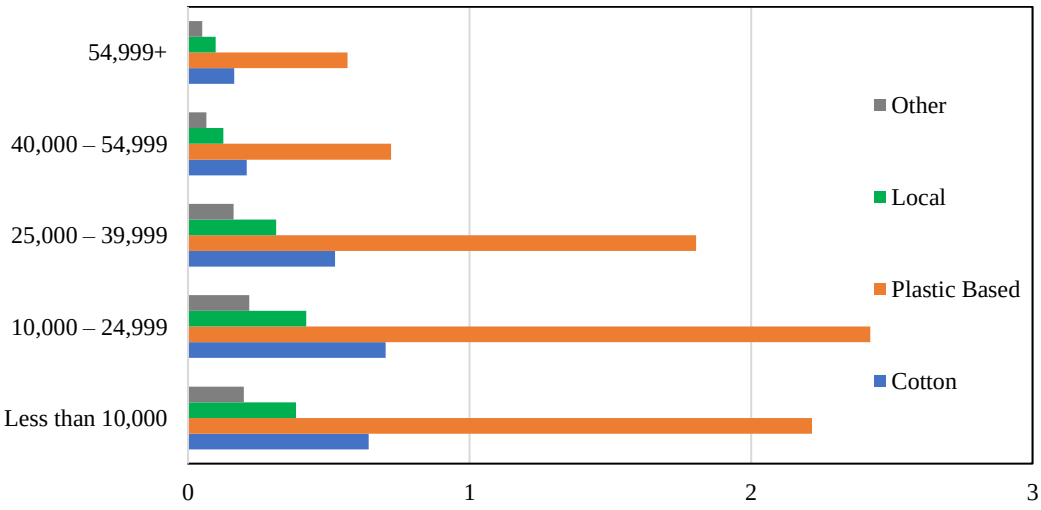


Fig. 3.4. The average reusable bag owned by monthly income per household (n=150)
Monetary unit, Kenya Shilling (KES)

3.5.2. Reusable Bag Usage in Shopping

About 49% of the respondents normally take reusable bags, 21% buy new reusable bags on each shopping trip while 30% sometimes take their own or buy new reusable bags when shopping (Fig. 3.5.). There was a 7% margin for respondents who rarely forgot to bring their own bags or brought less number of bags. More than half the sample sometimes forget or bring less bags when shopping (Fig. 3.6. and Fig. 3.7.). When the respondents forgot or brought less bags, a majority (82%) bought new reusable bags when shopping, 11% carried items by hand while the rest (7%) chose other modes (Fig. 3.8.).

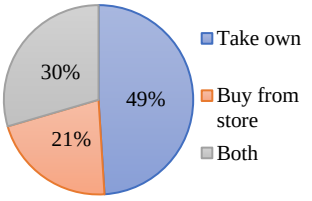


Fig.3.5. Normal behavior when shopping (n=150)

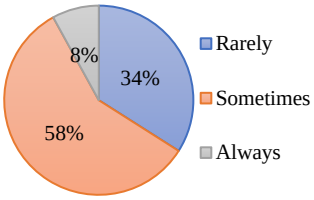


Fig.3.6. Forgetting own reusable bags (n=150)

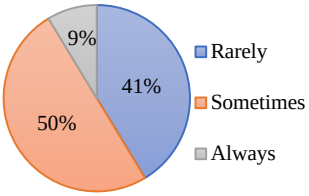


Fig.3.**7.** Bring less reusable bags (n=150)

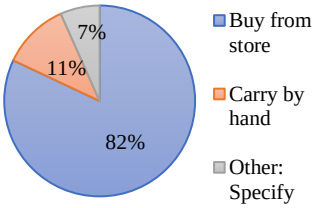


Fig.3.8 Response to forgetting / bringing less reusable bags (n=150)

An association was tested between forgetting or bringing less bags and the response behavior at retail centers. Responses from "both" category were dropped since it is not stable behavior. The association between forgetting to bring reusable bags and bringing less bags while shopping was statistically insignificant to action. This could imply acquisition of new reusable bags by the study sample is inconsistent behavior an indicator that consumers are still adjusting to the plastic bag ban. Reuse systems should maintain continuous awareness creation and better alternative carrier designs.

3.5.3. Disposal Timelines for Reusable Bags

Fig. 3.9. shows disposal timelines of reusable bags. Plastic based and cotton bags are mostly disposed of within a short time frame. About 44% and 48% of the respondents disposed of them within 1-3 months respectively. Up to 85% of the respondents disposed plastic based bags in one year compared to 65% for cotton bags. The most durable bags were locally fabricated or made from other materials (Fig 3.9.). Disposal timelines in the current study does not factor usage frequency and stock. However, there is need for education to improve reusability.

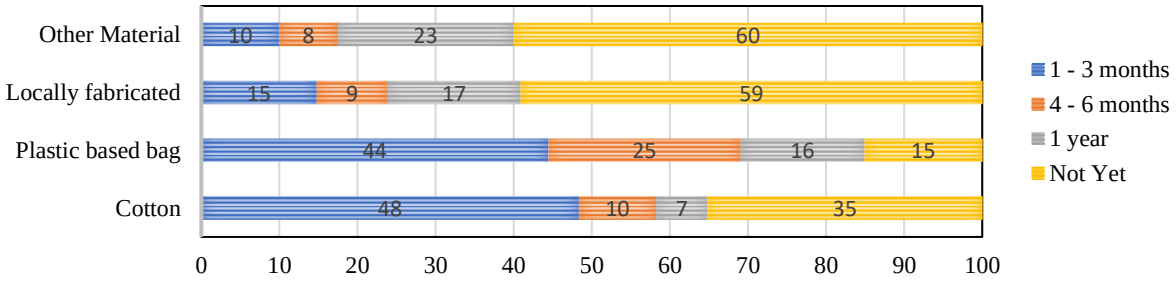


Fig. 3.9. Disposal timelines of reusable bags (%) (n=150)

Regarding the burden of reusable bags, there are several LCA studies to establish minimum usage frequency. And some reported that it's not easy to use reusable bags ecologically. For example, the environmental burden of single use HDPE bags is reported to be lower than that of reusable plastic bags (Bisinella et al., 2018). Plastic based reusable bags should be used between 35-84 times depending on polymer type. Non -woven PP bags common in Kenya should be used 52 times as per a Danish study (Bisinella et al., 2018) .Consumers do not use reusable bags for the required number of times to obtain optimal environmental performance (Kimmel et al., 2014). However, in most of these cases, littering and its effect on biodiversity is not factored. In principle to waste hierarchy, waste prevention should not only reduce waste volumes but also lower the environmental burden. Reusable bags have lower littering potential compared to SUP bags hence is a good indicator for a clean environment. Thus, there is need for education to improve not only reusability but also proper disposal methods.

3.6. Plastic Bag Flow Analysis Before the Ban

Source: Google Images 2019

Fig. 3.10. Examples of banned single-use plastic bags included in the study

From the questionnaire survey, the main sources of SUP carrier bags (Fig. 3.10) in urban and rural areas were local shops, green grocers, open air market and supermarkets with a range of 4.1 –0.6 bags capita^{-1} wk^{-1} The reception of plastic bags in rural area was lower than urban area from all retailers (Table 3.4.). Thus, the average SUP reception before the ban of plastic carrier bags excluding thin clear bags were 11.7 bags capita^{-1} wk^{-1} and 9.4 bags capita^{-1} wk^{-1} in urban and rural areas respectively. By type, both areas showed similar trends. The small black bag and big black bag were dominant while branded supermarket and big colored bag sparingly issued (Table 3.5.). Previous consumption of thin clear bags was included since it is included within the scope of the ban. Thin bag urban consumption per capita was 8.8 bags capita^{-1} wk^{-1} and rural consumption 9.0 bags capita^{-1} wk^{-1}. Therefore, the aggregate SUP bag consumption before the ban was 20.5 bags capita^{-1} wk^{-1} and 18.4 bags capita^{-1} wk^{-1} in urban and rural areas respectively. The slight variations in plastic bag consumption are attributable to higher income and shopping frequencies in urban than rural areas.

Table 3.4. Source of bags issued by retail centers before the ban (capita^{-1} wk^{-1})

Retail Center	**Urban**	**Rural**
Local Shop	4.1	3.7
Green Grocer	3.1	2.0
Open Air Market	2.7	3.1
Supermarket	1.6	0.6
Departmental Store	0.1	0.0
Online Shopping	0.1	0.0
Total	11.7	9.4

Table 3.5. Bags issued by type before the ban (capita^{-1} wk^{-1})

Retail Center	**Urban**	**Rural**
Small Black Bag	5.0	4.9
Big Black Bag	4.0	3.2
Big Colored Bag	1.7	0.9
Branded Supermarket Bag	1.0	0.4
Thin clear Bag	8.8	9.0
Total	20.5	18.4

Estimation of previous annual SUP per capita consumption assumes consistent shopping behavior all year (52 weeks). The annual per capita for SUP carrier bags (excluding thin clear bags) was 533 bags. Annual consumption in urban and rural areas were 608 bags capita^{-1} y^{-1} and 491 bags capita^{-1} y^{-1} respectively. South Africa had 170 bags capita^{-1} y^{-1} as of 2002. Estimations for countries without data in the EU were 466 bags capita^{-1} y^{-1} in 2012 (Sherrington et al., 2012). Jordan has the highest estimate at 500 bags capita^{-1} y^{-1} in 2015 (Saidan 2017).

The overshoot In the Kenyan context reflects weakness of self-reported measures. Additionally, the effect of small economy “kadogo economy” and un-distinctiveness of local retail centers can be factored. The kadogo (Swahili word for small) or sachet economy is supported by small daily purchases made by majority of the labor force on wage based renumeration. Un-distinctiveness of local retail

centers indicates prevalence of retail centers located at the same place especially in middle and low income residential areas and rural areas.

On a national scale, annual usage of plastic bags after reception indicates 1.5 billion SUP bags were reused for shopping while 1.7 billion bags kept in the house. The overall annual stock is thus 3.2 billion bags. Stock is the consideration of bags kept in the house whether used or unused. 0.8 billion bags were used as waste bags while 2.3 billion bags discarded as waste. Due to poor solid waste management systems and low recyclability of plastic bags, plastic bags as garbage were estimated as the sum of plastic bags reused as waste bags and discarded as waste. Based on these aggregate outflow figures, the annual plastic bag reception per capita for the country was estimated to be 138 bags capita^{-1} y^{-1}. Annual plastic bag reception per capita was 160 bags capita^{-1} y^{-1} in urban areas and 125 bags capita^{-1} y^{-1} in the rural area (Fig. 3.11. and Fig. 3.12.).

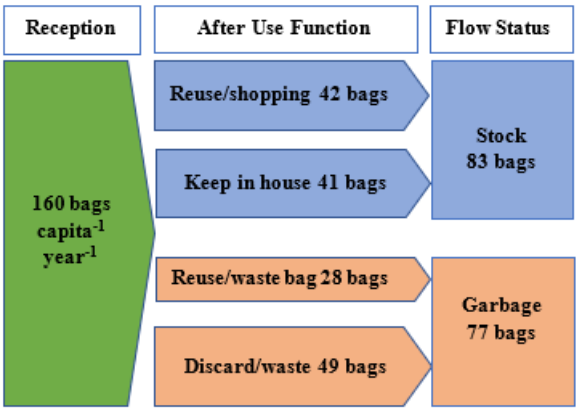


Fig. 3.11. Urban plastic bag flow capita^{-1} y^{-1} before the ban

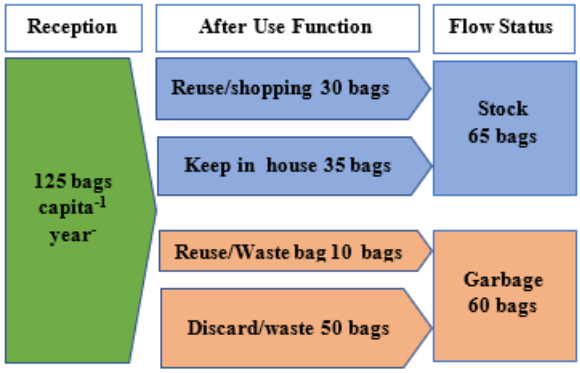


Fig. 3.12. Rural plastic bag flow capita^{-1} y^{-1} before the ban

Table 3.6. shows comparison of plastic bag consumption per capita before the ban based on previous and current studies in Kenya and South Africa. In 2018, plastic packaging industry report estimated an annual plastic production at 517,000 tonnes (Eunomia 2018). Based on estimated carrier bag production proportion (12.5%) (KNPC 2005), average weight of a bag and total population, 7.5 billion bags were produced that year. This resulted in an annual per capita consumption to 165 carrier bags. As it is, previous plastic consumption in Kenya can be derived from four data sets as shown below (Table 3.5.). Data on consumption of plastic products including bags is important in evaluating the impact of plastic policies. The current ban potentially reduces consumption of 6.2 billion SUP carrier bags.

Table 3.6. Plastic bag consumption per capita before the ban

Source	Methodology	Annual Consumption	Consumption per Capita Per Year	Comment
UNEP 2005[14]	Industry Interview	0.3 billion bags[a]	8 bags Pop 2005: 36.05m pple	Understatement
KNCPC 2006[15]	Annual tonnage divided by weight of a bag and total population	2.9 billion bags	77 bags Pop 2006: 37.05m pple	Moderate estimation[b]
Eunomia 2018[33]	Annual tonnage divided by weight of a bag and total population	7.5 billion bags	165 bags Pop 2016: 45.37m pple	Recent industry data[b]
This study (2019)	Estimation by after use numbers using questionnaire survey	6.2 billion bags	138 bags Pop 2016: 45.37m pple	Current Survey Results
Wilson & Smit, 2002[17]	Annual tonnage divided by weight of a bag and total population	8 billion bags	170 bags Pop 2006: 47.03m pple	Consumption in South Africa

[a] Same statistics used as annual plastic bag released into the environment by NEMA – Kenya in 2017
[b] 12.5% of total material is used to produce single use plastic carrier bags (15 – 50 microns)

3.7. Conclusion

The increasing adoption of plastic control policies globally requires assessments on effectiveness. Perceptions of the impacts however differ between urban and rural areas. Urban consumers are more conscious and aware about cleanliness related to plastic bags than rural environment. Such views are likely to influence the intent to use SUP bags or shift to alternatives. Ownership of reusable bags increased three times in the study after the ban. Three environmental factors of consideration are usage, stocking, and disposal of bags. The frequency of usage is important in offsetting the environmental burden of reusable bags. Though frequency is not determined in the study, it was established that about half of the consumers attempt to consistently carry reusable bags when shopping. This reduces purchases of new bags even though most consumers resort to this option when they forget or bring less. At the same time, it is noted that most reusable bags are disposed of in a year. Nevertheless, proper usage of reusable bags can reduce the SUP bag litter problem hence a clean environment by up to 6.2 billion carrier bags. Thus, awareness creation amongst stakeholders is important for such plastic policies.

Additionally, adequate scenarios analysis is necessary to ascertain the baseline problem and review existing alternatives. Anti-plastic waste movements already see shifts to cover all single use plastics such as Rwanda (2019) and EU (2021). Further research on reusable bags such as multiple uses, quality standards and load on waste management is required to inform awareness creation programs. In most cases, plastic based reusable bags replace single use plastic bags. The quality and trends of usage of reusable bags can reverse anticipated environmental goals if the bags are not promoted for multiple use.

Chapter 4. Waste and environmental outcomes of the plastic bag ban in Kenya from a life cycle assessment perspective.

4.1. Introduction

Waste management is a major challenge in developing countries even though plastic waste receives major attention worldwide coming close to climate change in the hierarchy of environmental problems. Annually, about 460 million tonnes (Mt) of plastic are produced with 353 million tonnes becoming waste mainly from single use plastic (SUPs) and short lived plastics. It is projected that plastic consumption will triple by 2060 due to an increase in population, industrialization, urbanization, and income levels (OECD 2022). Moreover, the waste load will outstrip infrastructural development capabilities in developing countries in Africa and Asia (Geyer et al., 2017; Lebreton and Andrady, 2019; Borrelle et al., 2022). SUPs and short lived plastic are a focus of various voluntary and involuntary management instruments (Borg et al. 2022). The consumption and waste generation of single use plastic bags (SUPBs) has soared globally due to their versatility as a carrier or grocery, barrier, and flat bags becoming the face of plastic pollution and being nicknamed the national flower in Kenya, South Africa, and Somaliland (Nielsen et al., 2019; Ncube et al., 2021).

Globally, SUPB has the highest number of policy management instruments among plastic items (Knoblauch et al., 2018). Plastic policies provide solutions to curbing the plastic problem through various regulatory, economic, and rights based interventions (Xanthos and Walker, 2017; Schnurr et al., 2018; Adam et al., 2020; Bezerra et al., 2021; Diana et al., 2022). At the 2R level (Reduce & Reuse), the expected result from policies is waste prevention, a term used synonymously with waste reduction and waste minimization (Zacho and Mosgaard, 2016). Yano & Sakai (2016), note that waste prevention is the quantitative reduction in the amounts of waste produced and qualitative reduction (contamination) of risks of waste. Reuse is an aspect of waste prevention that includes the usage of a product multiple times for the same purpose in its original form (Zacho and Mosgaard, 2016). Successful reuse results in waste reduction and is characterized as substitution effect, waste reduction by volume due to replaced consumption of a product. On the contrary, failure results in a rebound effect due to improper usage of reusables since waste volume increases. The rebound effect can also be realized if gains in substitution result in the consumption of other products resulting in an increase in waste volumes (Tasaki and Yamakawa 2009).

The sustainability of reusable products is subject to proper usage, moreover, reusable carrier bags are perceived to be environmentally friendly and hence dubbed eco bags, an aspect that holds after associated environmental impacts have been offset (Hicks, 2023). Limited reuse leads to the consumption of more reusable bags resulting in a higher environmental impact (Civancik-Uslu et al., 2019). The lack of baseline studies and refined data in developing countries on waste and policy

evaluations limits realizations of waste reduction benefits or policy potential on that regard to the waste management systems (Jehangir et al., 2022).

Waste management systems in Kenya are underdeveloped with limited collection, and treatment, a function of counties (local governments). Counties have designated dumping sites without proper control structures and are located in open fields, quarries, forests, and rivers (GOK 2019). Specifically, for plastic waste, the collection rate is 27%. However, up to 92% of plastic waste is mismanaged with 8% collected for recycling and 7% undergoing local recycling (IUCN and E. Q. 2020). Mismanagement is prevalent through unsanitary landfills, open burning, open dumping, and littering. While the latter are random, open burning takes place intentionally as a solid waste management practice or unintentionally by accident at unsanitary landfills (IPCC 2006; IPCC 2019; Ramadan et al., 2022).

Kenya adopted a plastic bag ban in 2017 prohibiting manufacturing, importation, distribution, and usage of plastic bags, with a penalty of $20,000—$40,000 or 1–4 year prison terms or both. Regulatory policies target usage shifting consumption burden to legally admissible and accessible plastic based and non-plastic based alternatives (Jehangir et al., 2022). It was estimated that annual per capita single use plastic consumption in Kenya before the ban was 138 bags capita^{-1}y^{-1} (Omondi and Asari 2021). Recent studies have identified the non-woven polypropylene (NWPP) bag as the most preferred replacement of SUPB with over 50%-65% adoption followed by cloth, grass, and sisal bags in limited proportions (Enge 2018; Koros et al., 2019). Additionally, NWPP was subject to an attempted ban in 2019 by the country's National Environment Management Authority (NEMA) due to low gauge material characteristics that limited its reusability. Behaviorally, consumers in Kenya use 3.6 bags per week (Enge 2018) and a household owns an average of 12 reusable bags. This is linked to 82% of consumers purchasing new reusable bags when they forget or bring less bags when shopping (Omondi and Asari 2021).

Life cycle assessment (LCA) is a useful tool for comparative assessment of the environmental performance of a product and its substitutes (Miller et al., 2022.). There is limited application of the tool in Africa with a recent review establishing 199 papers concentrated in agriculture, electricity, and energy. In Kenya, the review established the evaluation of 2 food products, biowaste, solar, and bioenergy technology in 5 studies (Karkour et al., 2021). Within the African region, South Africa has established detailed LCA studies on the plastic sector (Goga et al., 2023; Stafford et al., 2022). There is a need to conduct more LCA studies on various plastic waste scenarios in the region.

The environmental performance of SUPB and their alternatives is mostly done with real life and hypothetical conditions with reusable bags having better environmental performance after reuse if factored (Matsuda et al., 2016). The most studied environmental impacts of SUPB and their alternatives are climate change, acidification, and eutrophication (Gómez and Escobar, 2022). However, to capture waste and environmental outcomes of a policy, a hybrid method combining environmental performance,

waste prevention, and reuse potentials studies using LCA are also emerging such as EU (Herberz et al., 2020), Sri Lanka (Kamalakkannan et al., 2022) and South Africa (Stafford et al., 2022).

Comparative carrier bag studies focus on SUPB vis a vis conventional and biobased single use and reusable plastic bags. Subsequently, comparisons between SUPB and bags from virgin plastic with variations of recycled content or 100% recycled material. Studies also compare single use and reusable biodegradable alternative carriers or biomass feedstocks. Reusable plastic alternative carriers include thicker low density polyethene (LDPE) and high density polyethene (HDPE), NWPP and polyester bags with cotton/cloth like appearance (Gómez and Escobar, 2022; Civancik-Uslu et al., 2019). The current study could not establish a study on woven polypropylene (WPP) bags as a carrier bag but as industrial packaging for cement or sugar (Dahlgren et al., 2015). Biobased bags include PE from bioethanol, polybutylene adipate-co-terephthalate (PBAT)/Starch bags Saibutrong et al., 2017). However, there is limited usage of biobased bags and bags with recycled content in Kenya. Paper and cotton bags have also been studied as alternative carriers of organic origin (Singh et al., 2023).

Organic fibers such as jute, kenaf, Sunn hemp, flax, ramie and sisal, and plant leaves and stalks are resources used to make carrier bags in African and Asian communities. However, there are limited studies on these bags except for jute composite (80% jute) bags (Bisinella et al., 2018). More recently, in evaluating the Indian carrier bag policy, a jute bag, kenaf bag, and reusable plastic bag were compared (Singh et al., 2023). Previous studies suggest a preference for bags with likelihood for mass production compared to natural fiber handmade bags from the cottage industries. The bugs are dependent on local resources from naturally growing plants for production. Moreover, improvements in agriculture and technology enable treatment and combination with other substances to increase material production such as largescale fabric production (Singh et al., 2023; Broenren et al., 2017).

Comparative LCA studies adopt 100% compliance or substitution. However, policies take time before with the most successful case rated 96% (Schnurr et al., 2018). Waste generation and the environmental effect of transition are thus an issue of concern. Carrying capacity is a leading factor in defining the functional unit and reference flows used to estimate environmental impacts in previous studies. Nevertheless, 100% utilization of carrying capacity is rarely achievable due to the material characteristics of the bag and the behavioral traits of consumers (Askham et al., 2021). Kenyan citizens like other developing nations cannot afford bulk purchases and thus underutilize bags per shopping event due to income constraints (Wichmann 2019). Moreover, the basis of reuse in LCA studies remains unestablished and most scholars adopt hypothetical value (Ahamed et al 2020; Stafford et al 2022), estimation from a survey (Civancik-Uslu et al; 2019), and environmental indicators (Bisinella et al., 2018). For instance, the assumption of 1000 reuses by Askham et al. (2021) study is important for the practical comparison of bags in daily life. Reusable bags are designed heavier than SUPB but the relationship between weight, reuse times, and bag longevity is also unestablished in the literature as

shown in Table 4.1. below (Li and Wang, 2021). It would be anticipated that the thicker the reusable bag the higher the reuse times. These phenomena should be captured within policy evaluation using the LCA approach as an advisory towards ascertaining the transitions from a reusable bag to an eco-bag.

Table 4.1. Disparities in characteristics of reusable polypropylene bags and SUPB consumption equivalent in peer reviewed studies

Source	Country	Type of bag	Reusable bag capacity (l/bag)	Reusable bag weight (g/bag)	No. of Reuses	SUPB Capita^{-1} Y^{-1}	Reusable bag Capita^{-1} Y^{-1}	Reuse cycle method
Muthu et al 2011	India[1]	NWPP	-	65.6	100	150	1.5	Assumption[3]
	China & Hong Kong[1]	NWPP	-	65.6	100	1095	10.95	
Civancik-Uslu et al 2019	Spain[1]	PP	43.3	226	20	408	21	Estimation[4]
Ahamed et al 2021	Singapore[2]	NWPP	18.98	26.25	50	141	2.82	Assumption
Stafford et al 2022	South Africa[1]	PP	12	66.47	52	52	0.88	Assumption

1. Functional unit: Carrying shopping from retail point to residence in a year by a resident
2. Functional unit: Annual bags consumed in a year in the country
3. Assumption – the reuse value is assumed in the study.
4. Estimation – the reuse value is calculated from a survey.

End of Life (EoL) treatment scenarios assessments of plastic have found that reuse and recycling have better environmental performance than landfilling, compositing, and incineration with or without energy recovery (Gómez and Escobar, 2022). Open burning and open dumping of plastic waste prevalent in the global south is seldom captured in LCA studies (Prateep Na Talang and Sirivithayapakorn, 2021). Thus, Kenya provides a unique study environment from previous studies of carrier bags in terms of capacity utilization, compliance, adoption of lightweight reusable plastic bags, and waste management practices.

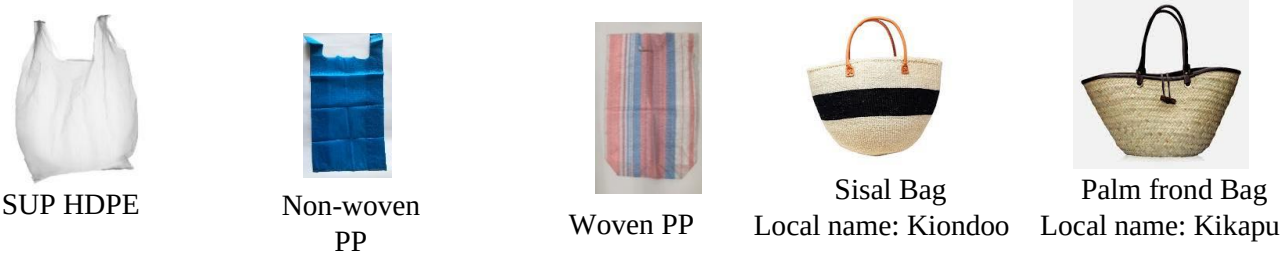
The current paper uses Kenya as a case study to assess the environmental impacts of SUPB ban based on regulatory admissible bags based on preference and unique fiber and leaf bags sometimes considered as traditional bags. The preferred NWPP bag by the populace is lightweight 12g compared to other NWPP in literature (Table 4.2.). A study on sisal and palm bags was incorporated due to their availability in the region. The objective of this study is to assess the potential waste reduction and environmental impacts of the SUPB ban policy in Kenya. This research provides waste and environmental impact implications of consumption transitions, reuse uncertainty, and compliance from a developing country perspective upon policy adoption for improvement of policy implementation.

4.2. Methods

The ISO 14040 and ISO 14044 standard recommended stages were followed for all carrier bags in the LCA study as goal and scope definition, life cycle inventory (LCI), life cycle impact assessment (LCIA), and interpretation of the results (ISO 2006).

4.2.1. Goal and Scope

The goal of the study is to compare the environmental impacts and reuse potential per reusable carrier bag and waste reduction effect at the national level for Kenya's plastic bag ban based on SUPB HDPE bag as the reference bag and NWPP bag as the mainstream alternate, and WPP as a carrier bag, Part A. The study also assessed (Part B), the environmental impacts of traditional organic carrier bags as alternatives namely sisal bag and palm bag against a heavier NWPP bag (Fig 4.1.). This attributional life cycle assessment applied a cradle to gate system boundary for processes including material extraction or production, bag production, and transportation to the retail point for 18 environmental impacts for Part A and Part B of the study. The GHG emissions related to the open burning of plastic bags were also calculated. Waste reduction was estimated by factoring increase in national population, urbanization rates, overall plastic carrier waste generation, policy compliance, and EoL infrastructure development by 2050 for Part A of the study.



SUP HDPE | Non-woven PP | Woven PP | Sisal Bag Local name: Kiondoo | Palm frond Bag Local name: Kikapu

Fig 4.1. Carrier bags under the study

Table 4.2. Bag characteristics used in study

No	Type of bag	Code		Size (cm)	Shape	Weight (g)	Source
1	Single use plastic (HDPE)	SUPB	Reference bag	-	Flat	8.6	Ślusarczyk & Kot, 2018
2	Non-woven PP	NWPP	Main alternate	41 by 23	Flat	12	Authors
3	Woven PP	WPP	Other alternate	42 by 23	Flat	18.92	Authors
4	Sisal bag	Kiondoo	Other alternate	36 by 36	Cone	1000	Sawasawa 2023
5	Palm fond bag	Kikapu	Other alternate	20 by 20	Cone	1000	Banana box 2023

4.2.2. Function and Functional Unit

Consumption in Kenya is associated with the sachet economy with consumers buying 77% of their goods from small scale stores (Iver et al., 2022). The study imagined that purchase volumes fit in one carrier bag per shopping trip. The function was defined as a carrier bag used for carrying commodities to households and the functional unit as the production including distribution to the point of purchase of a carrier bag. National SUPB consumption was adopted as 138 SUPB $Capita^{-1}$ Y^{-1} or the equivalent of 138 shopping trips in a year.

Reuse potential was estimated for reusable plastic based bags based cradle to gate environmental impacts only and adopted the corresponding difference, a reusable bag is used to equivalent new SUPB bag at the breakeven point eq. 1, net environmental emissions (Bisinella et al., 2018).

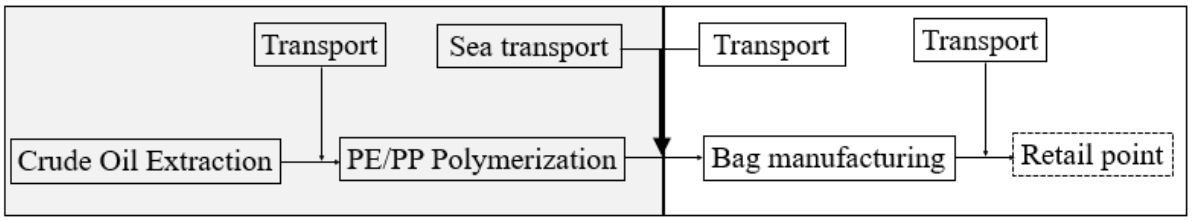
$$\frac{\text{Weight/environmental impact of reusable bag per FU}}{\text{Weight/environmental impact of HDPE bag per FU}} = \text{Reuse potential, (eq.1)}$$

To demonstrate waste reduction potential from reuse, void of a scientifically established mechanism to determine reuse, a variation of reuse potential from literature (2-21 bags $Capita^{-1}$ Y^{-1}) was considered. No secondary function was considered for SUPB or reusable bags.

4.2.3. System boundary

The study adopts a cradle to gate analysis from resource extraction, transoceanic shipping where applicable, bag production, and distribution to retail points for processes taking place inside and outside Kenya per bag as shown in Fig. 4.2. below. The environmental impacts associated with machinery production, retail and usage activities, transportation between retail and usage points, wet work/dyeing, and packaging were not considered in the study.

a.



b.

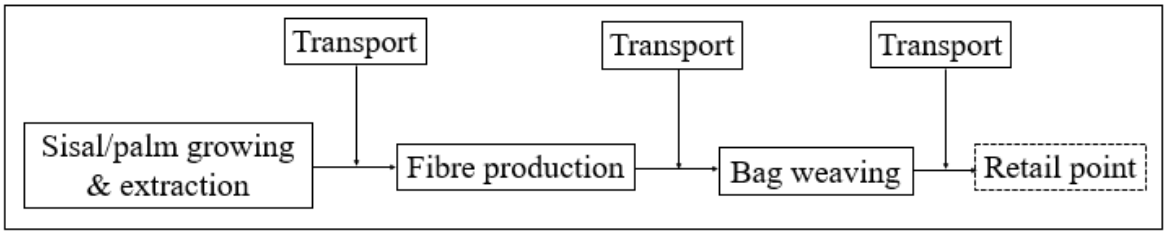


Fig. 4.2. System boundaries used in the life cycle assessment study for Plastic based bags (a) and Non plastic based bags (b)

4.3. Life cycle inventory analysis (LCIA)

The LCIA was modeled using data from primary sources, secondary literature, industry reports, and Eco invent 3.

4.3.1. Plastic bag modeling process

Table 4.3. below shows LCI data used in the production of plastic bags. *Material extraction and processing* is a background process that produces plastic pellets. Kenya does not produce virgin plastic and granulates were sourced through imports based on data from the UNComtrade database (UNIDO 2021). Saudi Arabia was identified as the main exporter of PE granulates under the HS Codes of Heading 3901: Polymers of ethylene, in primary forms for SUPB production and PP granulates under HS Code 3902: Polymers of propylene or of other olefins, in primary forms for NWPP and WPP bag production (United Nations 2022). In the *material import* process, granulates were shipped for 4560 Kilometers (Km) by sea from Jeddah port, Saudia Arabia to Mombasa port, Kenya. The distance between the two ports was obtained from Ports.com. Imports also included road transport from the port to the plastic manufacturing district in Nairobi's industrial area. All road distances were obtained from Google Maps.

The bag *production and distribution* process occurred in Kenya. Primarily, plastic bags are mainly produced from granulates and electricity (Mori et al., 2013). HDPE bags are produced through blow film extrusion, a continuous process that converts granulates to film, and finally, bags using electricity (Mori et al., 2013). NWPP bags are produced from thermally spun bound PP fabric where granulates are extruded as fibers, entangled, separated, flattened, and finally heat bonded using electricity (Muthu 2012). Finally, WPP bags are produced from the stitching of WPP fabric from a tape yarn using electricity. Initially, the PP granulates are extruded to flat film, laminated with lamination grade PP, slit into tape yarn, and wound into a bobbin. The tape yarn is afterward woven into a fabric (Manish Flexipack 2023). In the study, electricity processes were supplied through 75% from the grid electricity and 25% from the use of a standby diesel generator to factor power outages in the country (Broeren et al., 2017).

Table 4.3. Life cycle inventory data for production of plastic bags from eco-invent v3

Processes and unit data titles	Unit	Value			Comment
Bag Type		SUPB HDPE	NWPP	WPP	
Material extraction and processing					
Market for plastic granulate; GLO	Kg	0.0086	0.012	0.01892	
Material import					
Transport, freight, sea, transoceanic ship; GLO	KgKm	39.216	54.72	86.275	4560 Km, shipping distance between Saudia Arabia and Kenya
Transport, freight, lorry >32 metric ton, euro3, RoW	KgKm	4.171	5.82	9.1762	485 Km, distance between port and plastic manufacturing district
Bag production and distribution					
Electricity, medium voltage, RoW	kWh	0.0061	0.017	0.0377	Applies to 75% of production needs
Diesel, burned in diesel-electric generating set, GLO	MJ	0.0074	0.020	0.0452	Applies to 25% of production needs
Transport distribution, light commercial vehicle, RoW	KgKm	0.1772	0.247	0.3898	Distribution distance 20.6km

GLO – Global; RoW – Rest of the World
Sources of electricity data: HDPE bag - Mori et al., 2013; NWPP bag - Mori et al., 2013 and Muthu et al., 2012; WPP bag - Mori et al., 2013 and Ma et al. 2019

4.3.2. Non plastic bag modelling

Sisal bags are made by weaving sisal fibers. Kenya is a leading sisal fibers producer alongside Tanzania and Brazil globally. A cradle to gate inventory by Broeren et al (2017) on sisal in neighboring Tanzania was used to model sisal processes at the largest sisal plantation 200 km from Nairobi.

In *preparation for growth and extraction*, the land is cleared, ploughed, and harrowed. Planting was done by hand with fertilizer application. Harvesting is done manually and transported to a factory for processing. *Fiber production* involves decortication where leaves are processed using electricity and water. The leaf residue is disposed of, and fiber is cleaned, brushed, sun dried, and bailed. The bailed fibers were then transported to Nairobi where weaving of the bags locally known as Kiondoo by hand in the cottage industries and transported to retail centers (Wachiye et al., 2021). Naturally, growing sisal plants can also be used to produce sisal bags. In this study, sisal fibers from a plantation were adopted.

Palm bags or baskets locally known as Kikapu are produced from palm fronds/leaves from palm trees growing naturally in the environment. The leaves are harvested, dried then separated from the stalk to make bags locally. The stalks are subsequently burnt as a source of fuel. Based on this scenario, material input only involves transport to the market with a distribution network set at 200km (Author interview). Carbon sequestration data was adopted from Broeren et al 2017 and assumed to be the same for both plants.

4.4. Life Cycle Impact assessment

The environmental impact assessment was processed in Sima Pro 8.1. using the ReCiPe Midpoint 2016 (H) V1.12 method and assessed 18 potential environmental impact categories of plastic bags. Mid points were applied to the study to reduce uncertainty in the results based on the hierarchist approach (Huijbregts et al., 2017). The study results were also analyzed based on process contribution of unit processes inside and outside Kenya.

4.4.1. Estimation of annual waste prevention based on reuse for plastic based bags

Weight was used to estimate waste prevention of the policy on SUPB and different reuse potentials of NWPP and WPP bags. The national amount of waste prevented is the difference between national SUPB waste generation and national reusable bag waste generation by weight per bag and annual per capita consumption for the population data in 2021, 53,005,614 (World Bank 2023). Since there is uncertainty in reuse estimation due to material and behavioral factors, multiple reuse values per year between 2 and 21 from the literature as shown in Table 4.1. above was applied.

$$Wprev\ (t) = W_{SUPB}\ (t) - W_{REU}\ (t) \quad (eq.2)$$
$$W_{SUPB}\ (t) = SUPB\ capita^{-1}y^{-1}\ X\ SUPB_W\ X\ TP\ X\ 10^6 \quad (eq.3)$$
$$W_{REU}\ (t) = REU\ capita^{-1}y^{-1}\ X\ REU_W\ X\ TP\ X\ 10^6 \quad (eq.4)$$

Where $Wprev\ (t)$ is waste prevention in tonnes per year; $W_{SUPB}\ (t)$ is waste generated from SUPB in tonnes per year, $W_{REU}\ (t)$ is waste from reusable bags in tonnes per year, $SUPB\ capita^{-1}y^{-1}$ is SUPB per capita per year, $SUPB_W$ is the weight of SUPB, TP is the total population, $REU\ capita^{-1}y^{-1}$ is reusable bags per capita per year and REU_W is the weight of a reusable bag.

4.4.2. Estimation of annual waste generation based on policy compliance

In this study, compliance was an event where a reusable bag was reused and in noncompliance a new reusable bag was purchased again. Due to variations in compliance with 82% of the respondents purchasing a new bag when they forget or buy more products, waste volume was estimated at 25%, 50%, and 75% compliance rates where about 104, 69 and 35 bags per capita per year bought for 138 shopping cycles per year. The baseline was 2 reusable bags a year representing 100% compliance. Waste prevention is given by Eq. (5) below.

$$Wprev\ (t) = Comp\ (t) - NComp\ (t) \quad (eq.5)$$
$$Comp\ (t) = Comp_R\ -\ REU\ capita^{-1}y^{-1}\ X\ REU_W\ X\ TP\ X\ 10^6 \quad (eq.6)$$
$$NComp\ (t) = NComp_R\ -\ REU\ capita^{-1}y^{-1}\ X\ REU_W\ X\ TP\ X\ 10^6 \quad (eq.7)$$

Where $Wprev\ (t)$ is waste prevention in tonnes a year, $Comp\ (t)$ is waste generated at a given compliance rate, $NComp\ (t)$ is waste generated at a given non-compliance rate, $Comp_R$ is the compliance rate, $REU\ capita^{-1}y^{-10}$ is reusable bags per capita per year, REU_W is the weight of a reusable bag, TP is the total population and $NComp_R$ is the non-compliance rate.

4.4.3. Global warming potential (GWP) of plastic bags with open burning

The current study assumed that 100% of plastic carrier bag waste generated is transported within a 11.9 km radius to Nairobi's main dumpsite, Dandora. The site lacks sufficient engineering controls for gas and leachate capture and open burning was assumed to be the main waste management practice. The IPCC 2006 and IPCC 2019 guidelines were used to derive GHG emissions from open burning scenario only. The burning success rate for plastic waste of 71% was adopted from the guidelines. The remaining unburnt plastic were subjected to CH_4 emissions calculation resulting from incomplete combustion (Table 4.4.). N_2O was not considered due to high uncertainty (IPCC 2006; IPCC 2019).

Table 4.4. The process equations flow for deriving the total EoL GWP per bag

	Equation	Comment
Transport	= CO_2 emission per tonnes per km	Adopted from eco invent v3.1
Open burning	= $\sum$(BW*dm*CF*FCF*OF) ×44/12	Applies to fossil carbon in plastic.
	= $\sum$(BW*EF)* characterization factor (CH_4)	Applies to unburnt plastic due to fossil carbon.

Where *Bw* is the weight of carrier bag, *dm* is the dry matter content of carrier bag, *CF* is the fraction of total carbon content, *FCF* is the fraction of fossil carbon in total carbon, *OF* is the oxidation factor, 44/12 is the conversion factor from C to CO_2, EF is the emission factor of methane CH_4 and characterization factor (CH_4) is the conversion factor of CH_4 to GWP CO2 equivalent.

The study considered sanitary landfill and upscaling of current mechanical recycling as future EoL scenarios. The sanitary landfill GHG factor emission of 131 kg CO2eq/ton was obtained from Goga et al. (2022) for the study. Energy was applied to the mechanical recycling of plastic waste. In practice, reclaimed plastic is shredded and molded into bricks or fencing poles through various uncoordinated small scale projects. A locally fabricated PET extrusion machine using 0.586 kWh to convert 360 g/hr of PET into insulation material was used to model downcycling (Njihia et al 2020). Only energy burden was applied to downcycling. The IGES Grid Emission Factor was used to estimate the GHG emission (IGES 2023). Mechanical recycling GWP was determined by eq. (8) below.

$$GWP_b(t) = BW*Energy\ consumption*\ IGES\ Grid\ CO_2\ emission\ factor\ for\ Kenya \quad (eq.8)$$

The cradle to grave aggregate GWP per bag was calculated using Eq. 9

$$GWP_b(t) = CtG\ GWP_b + EoL\ GWP_b \quad (eq.9)$$

Where $GWP_b(t)$ is the aggregate GHG emission per bag, CtG GWP_b is the cradle to gate GWP and EoL GWP_b is the EoL GWP. The national waste prevention potential and GWP were calculated by multiplying waste prevention or respective GWP of a bag by the national population.

4.5. Results and discussions

4.5.1. Part A: Life cycle assessment by process contribution (cradle to gate) for plastic based bags

The process contribution results presented in this section, cover cradle to gate per bag modeled based on the functional unit. The ReCiPe Midpoint 2016 (H) method was ideal due to characterization factors considering the global scale and expanded environmental impact categories (18) relevant to policy decisions (Zibouche et al., 2023). Generally, the individual environmental impact categories are weight dependent hence SUPB has the least substance emissions, and WPP has the highest substance emissions without usage (Table 4.5.). This indicated that the usage of reusable bags is critical to reducing the environmental impacts when replacing SUPB. Moreover, three patterns emerge: material production related emissions with over 50% occurring outside the country mainly global warming potential (GWP) and fossil depletion potential (FDP), bag production and distribution related emissions with over 50% occurring in the country and relatively distributed in-country and out of the country emissions dependent on bag weight.

Table 4.5. Individual cradle to gate environmental impacts of carrier bags

Impact Category	Unit	SUPB	NWPP	WPP
Climate change	kg CO2 eq	2.33E-02	3.95E-02	7.13E-02
Fossil depletion	kg oil eq	1.59E-02	2.39E-02	4.06E-02
Ozone depletion	kg CFC-11 eq	1.01E-09	2.32E-09	4.93E-09
Ionizing radiation	kBq U235 eq	3.66E-05	6.72E-05	1.30E-04
Human toxicity	kg 1,4-DB eq	2.28E-03	5.28E-03	1.13E-02
Agricultural land occupation	m2a	3.05E-04	7.86E-04	1.74E-03
Freshwater ecotoxicity	kg 1,4-DB eq	8.65E-05	1.91E-04	4.01E-04
Freshwater eutrophication	kg P eq	1.91E-06	5.05E-06	1.07E-05
Marine ecotoxicity	kg 1,4-DB eq	8.21E-05	1.80E-04	3.78E-04
Marine eutrophication	kg N eq	9.65E-06	2.32E-05	4.95E-05
Particulate matter formation	kg PM10 eq	3.66E-05	6.72E-05	1.30E-04
Terrestrial acidification	kg SO2 eq	9.89E-05	1.76E-04	3.35E-04
Terrestrial ecotoxicity	kg 1,4-DB eq	1.07E-06	2.09E-06	4.15E-06
Photochemical oxidant formation	kg NMVOC	1.18E-04	1.88E-04	3.45E-04
Water depletion	m3	1.42E-04	2.87E-04	5.14E-04
Metal depletion	kg Fe eq	1.83E-04	3.46E-04	6.75E-04
Urban land occupation	m2a	1.22E-04	2.04E-04	3.70E-04
Natural land transformation	m2a	1.50E-06	3.23E-06	6.67E-06

4.5.2. Out of the country dominated emissions

GWP 100 years is the smallest for SUPB at 0.023 kg CO_2eq and about half the mainstream alternative carrier NWPP bags, 0.040 kg CO_2eq. GWP for WPP is 0.0713 kg CO_2eq. These emissions are fossil related material input and fossil energy demands throughout the lifecycle. NWPP bags in the Kenyan market should therefore be used at least twice to achieve a net carbon footprint. Equally, the NWPP bags in Kenya are lightweight compared to other jurisdictions such as South Africa 66.47g, Singapore 26.25g, etc. (Ahamed et al., 2021; Stafford et al., 2022). Despite the weight aspect, the NWPP

with 100 reuses had lower GWP than SUBP in India, China, and Hong Kong (Muthu et al., 2011) based on a cradle to gate scenario, unlike the current study due to reduced primary energy consumption. Material imports for plastic bags had the least GWP ranging between 0.001 kg CO_2eq to 0.002 kg CO_2eq while bag production and distribution emission contribution increased as bags got heavier as shown in Fig. 4.3. below.

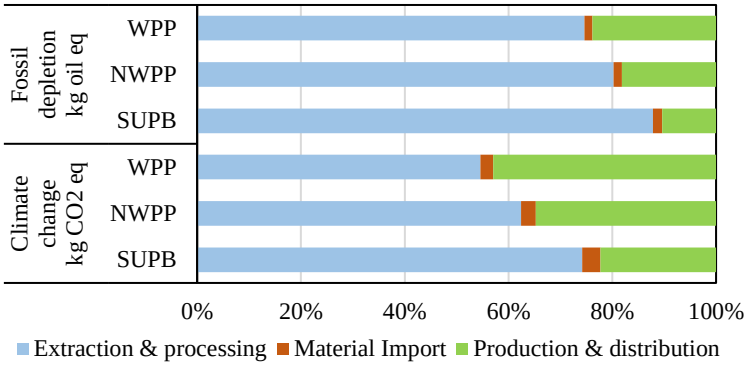


Fig. 4.3. Global warming potential (GWP) and fossil depletion potential (FDP) by process contribution

Fig.4.3. above also shows FDP of SUPB is 0.016 kg oil eq. which is 1.53 times and 2.56 times less for NWPP and WPP bags. In relative process contribution terms, the depletion of fossil resources is concentrated in raw material extraction and processing since plastic granulates are predominantly manufactured from fossil resources and additionally as energy, a process that occurs outside the country. Bag production and distribution is about 10-20% of the lifecycle of the bags.

4.5.3. In country dominated emissions

Fig. 4.4. and Fig. 4.5. below shows the second trend of about 70% of environmental impact categories from bag production and distribution processes occurring within the country. The categories include Ozone Depletion (OD), Ionization Radiation (IR), Human Toxicity (HT), Freshwater Ecotoxicity (FE), Freshwater Eutrophication (FEU), Marine Ecotoxicity (ME) and Marine Eutrophication (MEU). Grid electricity emissions technologies such as coal, gas and oil dominate electricity and total energy demands for global electricity and energy systems (Treyer and Bauer 2016; IEA 2022). Transport under EURO 3 standards for diesel consumption include carbon monoxide (CO), Hydrocarbons (HC), Oxides of Nitrogen (NO_x), Combined HC and NO_x, and Particulate Matter (PM) emissions for vehicle transport processes (EU 1998). These emissions are also emitted by combustion engines in diesel powered electricity emissions. OD, IR, and HT have direct health risks for cancer and non-cancer diseases. However, the continued decrease in OD emissions is due to the global implementation of the Montreal Protocol (WMO 2022). Recipe mid-point considers respiratory toxicity exposure while other studies also include nutritional exposures. 13,000 chemicals are related to the plastic lifecycle where 7,000 substances have potential adverse effects and 3,200 substances more than one hazardous property causing fetal development or neuro disorders (UNEP 2023).

FE, FEU, ME, and FEU are increases in ecotoxicological effects on species in rivers and marine environments from nitrogen, phosphorus, and 1,4-dichlorobenzene-equivalents. Rivers are a pathway to oceans introducing chemical transfer to marine ecosystems beyond macro and microplastic pollution (Neo et al., 2021). The distribution distance in the study was 20.6 km using light commercial vehicles. Short distances in supplier sourcing are recommended to reduce environmental impact, however, reduction in consumption obtains optimal results (Ahamed et al., 2021).

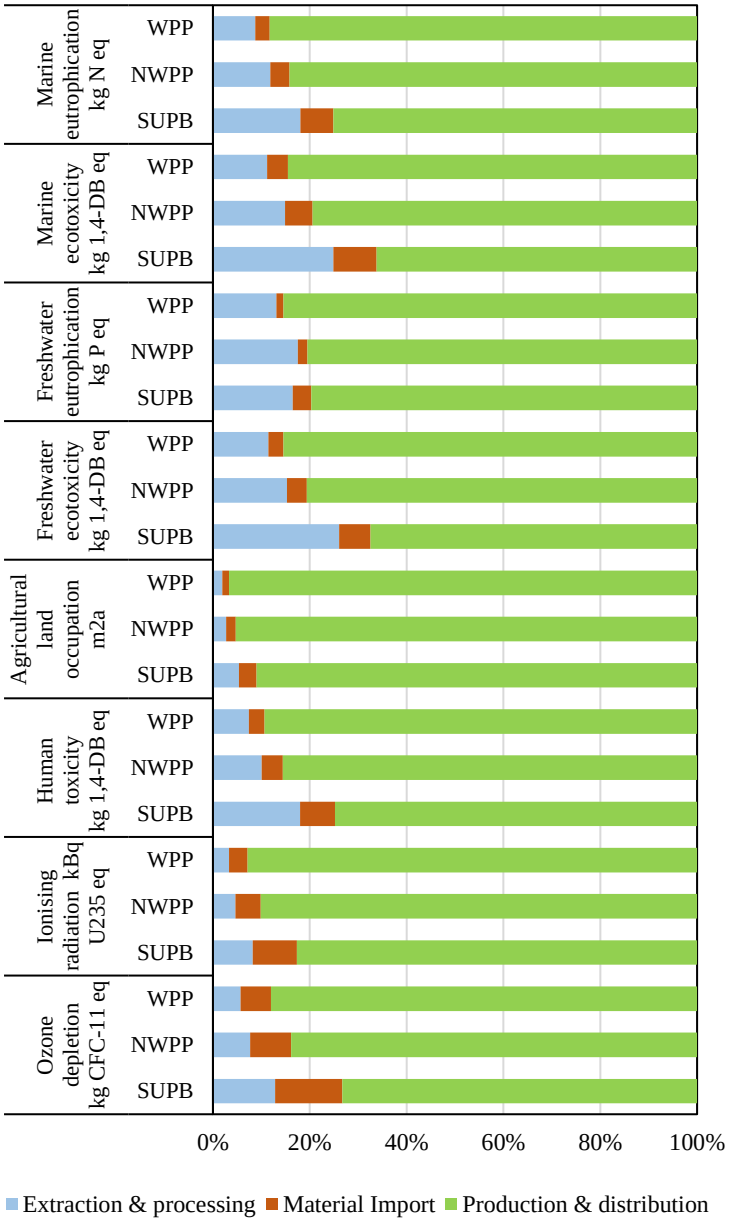


Fig. 4.4. In country dominated environmental impact categories

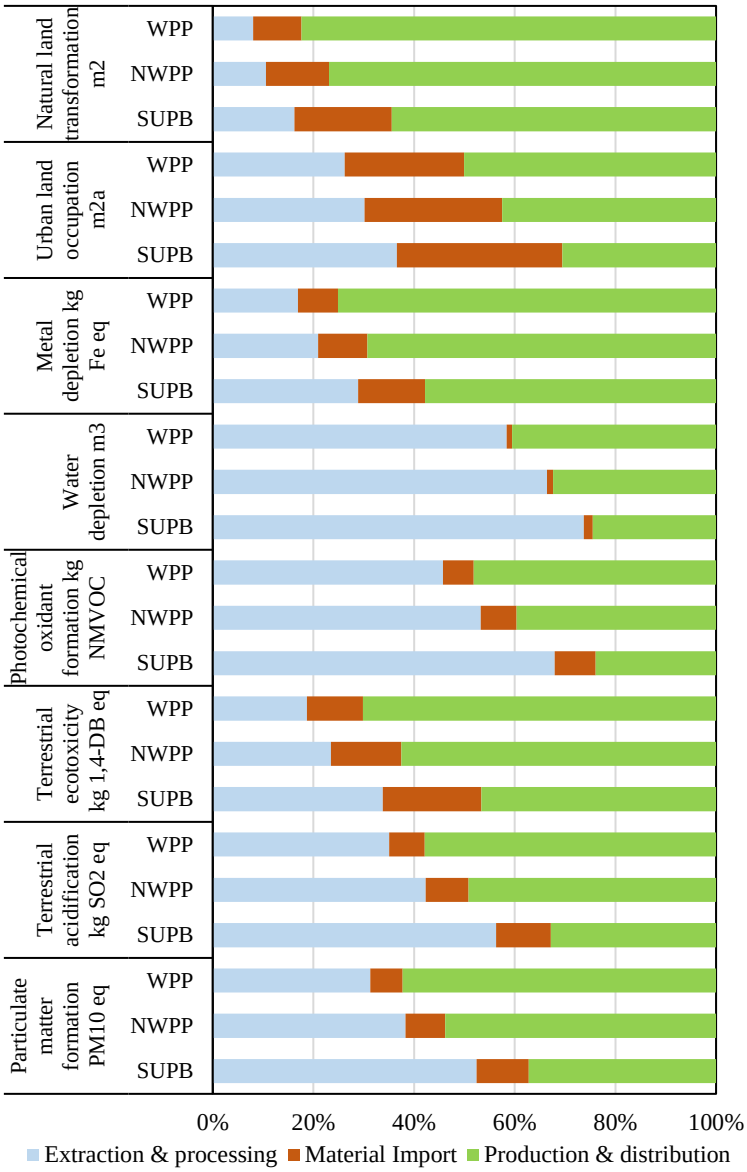


Fig. 4.5. Bag production and distribution process related environmental impact categories

4.5.4. Weight sensitive environmental emissions

Fig. 4.5. above shows impact categories where the carrier bag emissions between material extraction and bag production and distribution are within 40 – 60% inside or outside the country. The emissions are weight sensitive increasing or decreasing by unit processes. The impact indicators are health and ecosystem related. Particulate Matter Formation (PMF) and Photochemical ozone (POF) affect respiratory systems after the release of precursors such as NH_3, NOx, SO_2, and NMVOC into the atmosphere from transportation processes (Huijbregts et al., 2017).

4.5.5. Reuse potential by environmental impact categories (Cradle to gate basis)

Concerning all (18) ReCiPe Midpoint 2016 (H) environmental impact categories, Table 4.6. below shows the mainstream alternate (NWPP) bag should be used on average twice across most impacts and about 38 times cumulatively to achieve net emissions to SUPB. Freshwater eutrophication has the highest breakeven point at 2.70 times and fossil depletion the least 1.53 times. The WPP has a reuse potential of almost an average usage of four times across impact categories and cumulatively, 75 reuse times across all impact categories to SUPB environmental impacts even though being about 6g heavier than NWPP. In a Danish consequential LCA study, the NWPP bag required 52 reuses while WPP required 45 reuses to offset 15 environmental indicators. In demonstrating the importance of reuse, Muthu et al. 2011 established that reusable bags had a lower footprint with usage and proper disposal than without usage and disposal.

Table 4.6. The breakeven reuse potential by environmental impact assessment to SUPB

Bag	GWP	FD	OD	PMF	HT	TA	TE	FE	FEU	POF	ME	MEU
NWPP	1.74	1.53	2.44	2.00	2.36	1.96	1.99	2.24	2.70	1.59	2.19	2.41
WPP	3.06	2.56	4.86	3.55	4.94	3.38	3.87	4.64	5.59	2.92	4.60	5.13

	IR	ALO	ULO	NLT	WD	MD	Average reuse	Cumulative Reus
NWPP	2.44	2.58	1.68	2.15	2.03	1.89	2.11	37.92
WPP	5.31	5.72	3.05	4.44	3.63	3.69	3.87	74.94

GWP = Global warming potential; FD = Fossil depletion; OD = Ozone depletion; PMF = Particulate matter formation; HT = Human toxicity; TA = Terrestrial acidification; TE = Terrestrial ecotoxicity; FE = Freshwater ecotoxicity; FEU = Freshwater eutrophication; POF = Photochemical oxidant formation; ME - Marine ecotoxicity; MEU = Marine eutrophication; IR = Ionising radiation: ALO = Agricultural land occupation; ULO = Urban land occupation; NLT = Natural land transformation; WD = Water depletion; MD = Metal depletion

The consideration of 18 indicators under ReCiPe is not conclusive on the environmental impacts of plastic. Scientists continue to strengthen LCA's ability to fully capture the impacts of plastic on the environment. Within the terrestrial environment, there is littering potential (Civancik-Uslu et al., 2019) and environmental persistence (Stafford et al., 2022). For marine environment, scholars have considered marine debris (Jambeck et al., 2015; Lebreton and Andrady 2019). Additionally, an effect factor on marine biodiversity loss via entanglement is under consideration (Woods et al., 2019). These indicators are still in their early development or await scientific consensus and have not been incorporated into LCIA methodologies. As a result, additional large scale reuses are potentially required for reusable bags given the finite number of reuse cycles associated with known impacts. Environmental awareness programs communicating clear reuse thresholds allow consumers to acknowledge their efforts in reducing environmental impacts. This can include the relationship between variation in reuse and associated reduction in environmental impacts (Muthu 2011).

4.5.6. Annual waste prevention potential based on net environmental impacts

With a population of 53 million in 2021, annual waste generation for SUBP was estimated at 62,907 tonnes. We used the range of reuse numbers in the literature to estimate possible waste reduction estimates. NWPP annual waste generation ranged from 1,272 tonnes and 13,357 tonnes, and WPP ranged from 2,006 tonnes to 21,060 tonnes with an annual per capita bag consumption of 2 to 21 bags. The substitution effect in waste reduction for SUPB annual waste generation ranged from 98% to 78% as shown in Fig. 4.6. below. For this waste reduction margin, the consumption of 2 bags $Capita^{-1}$ Y^{-1} requires 69 reuses while 20 bags $Capita^{-1}$ Y^{-1} require 6.9 reuses for an equivalent of 138 shopping trips annually. This suggests consistency requirements in the reuse of bags to attain waste reduction and offset environmental impacts. Based on the current study's NWPP cumulative environmental burden (37.92) about 38 reuses are required to offset the 18 environmental impacts. As a result, citizens should use about 4 bags annually generating 2,544.3 tonnes annually, a reduction of 96% to SUPB waste generation, and a GHG reduction potential of 13,145 tonnes kg CO_2eq annually from SUBP 294,785 tonnes kg CO_2eq annually. Ideal waste prevention studies should consider the rebound effect herein considered as the NWPP to avoid overestimating the effects of prevention (Matsuda et al., 2018). Given that reusable bags are at a fee unlike SUPB given for free, there be can confidence in the reduction effect.

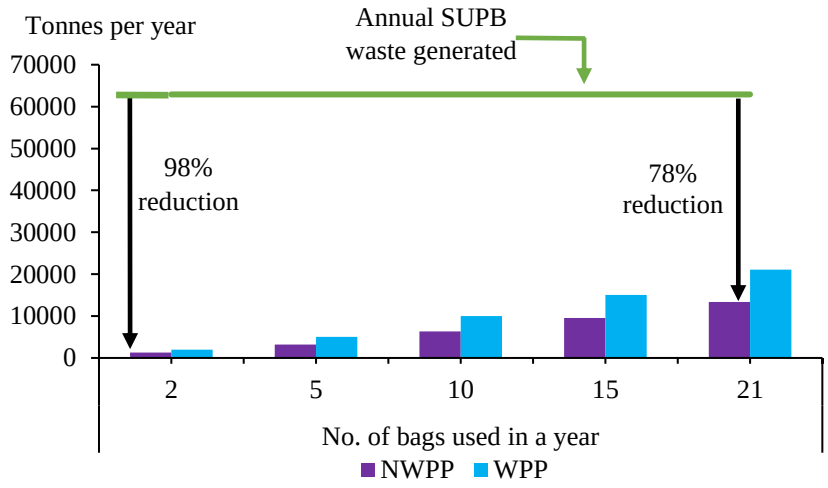


Fig. 4.6. Annual waste reduction by per capita bag consumption

4.5.7. Annual waste prevention with varying compliance

We used three compliance levels to grasp the impact of 82% of the respondents purchasing new bags whenever they forget or bring fewer reusable bags when shopping. Fig. 4.7. below shows waste generation with varying compliance assuming two bags are consumed annually as the baseline. The proper usage of 2 NWPP bags $capita^{-1}y^{-1}$ representing 100% compliance generates 1,272 tonnes of waste annually. NWPP has a substitution effect at 75% and 50% compliance levels resulting in waste prevention. At 25% compliance level, the use of NWPP bags results in a rebound effect of 5%,

generating 66,151 tonnes of waste compared to 62,907 tonnes previously generated from SUPB waste. If WPP was the main alternative reusable carrier the waste volume would supersede SUPB waste at a 50% compliance level resulting in 70,200 tonnes per year. The results emphasize the need for measures to improve compliance in the usage of reusable bags. Additionally, as the economy grows the purchasing power will increase putting pressure on compliance hence continuous monitoring of reusable bag usage is required.

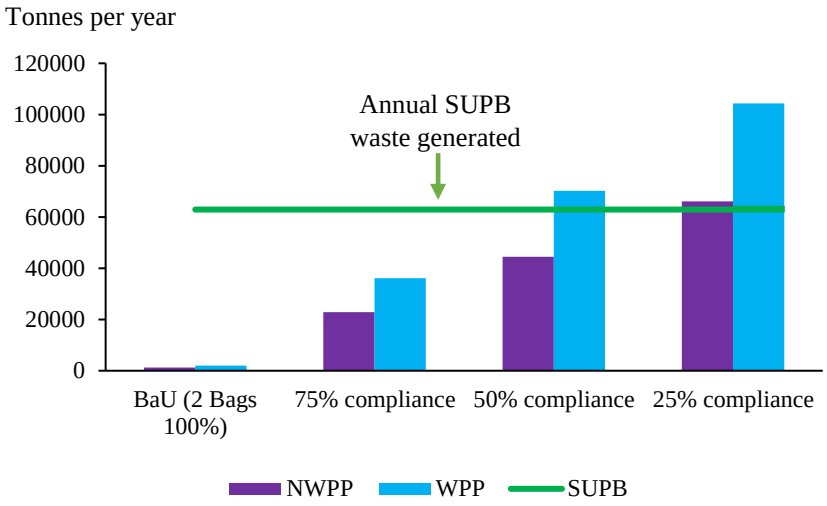


Fig. 4.7. Waste reduction potential by compliance levels

4.5.8. Global warming potential (GWP) of plastic bags with open burning

SUPB had the lowest emission per bag 0.0174 kg CO_2eq compared to the main alternate NWPP 0.0243 kg CO_2eq per bag and the heaviest bag WPP 0.0384 kg CO_2eq per bag without usage when carriers are subjected to open burning. Direct burning releases up to 96% of GHG emissions compared to waste transport and unburnt plastic emissions proportions for all bags. The final cradle to grave GWP based on open burning of SUPB is 0.0404 kg CO_2eq while NWPP is 0.0640 kg CO_2eq and WPP is 0.11 kg CO_2eq. as shown in Fig.4.8. below. The mismanagement of carrier bags doubles the GHG emissions from carrier bags, further increasing their environmental impact. In general, open burning has the highest GHG emissions followed by recycling and subsequently landfilling (Goga et al., 2023). Open burning emissions expose risks to the environment and human health with waste pickers and informal recyclers being the most vulnerable. There are however trade-offs between different EoL scenarios including mechanical recycling, co-processing in cement kilns, incineration, and sanitary landfills as infrastructure development is anticipated in developing countries (Neo et al., 2021).

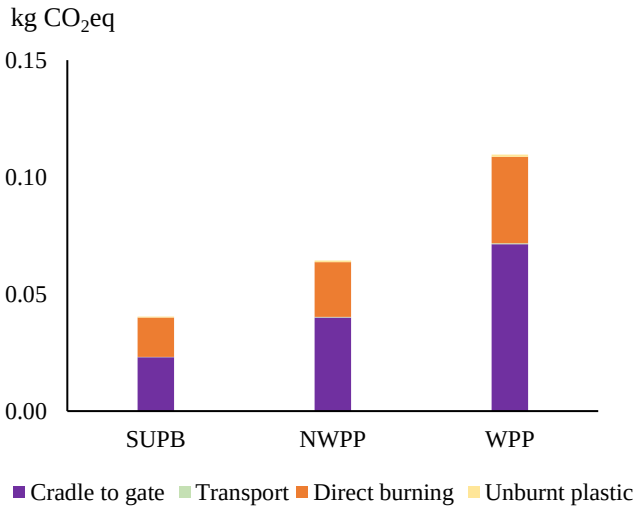


Fig. 4.8. Global warming potential (GWP) of plastic bags with open burning

4.5.9. Future annual waste prevention and EoL GWP reduction

The SUPB waste generation factoring population and urbanization growth rates increased to 72,676 tonnes by 2030 and 97,632 tonnes by 2050 compared to 62,907 tonnes in 2021. The future scenario assuming 100% waste transfer to sanitary landfill results in NWPP waste generation of 2,979 tonnes by 2030 and 3,946 tonnes by 2050 when four bags are used to offset 18 environmental impacts. This results in sanitary landfill EoL GHG emissions of 390 t CO2eq and 517 t CO2eq in 2030 and 2050 respectively. On the other hand, mechanical recycling results in GHG emissions of 69 t CO2eq and 91 t CO2eq in 2030 and 2050 respectively. This indicates that additional instruments are required to minimize the amount of mismanaged plastic waste and environmental impacts.

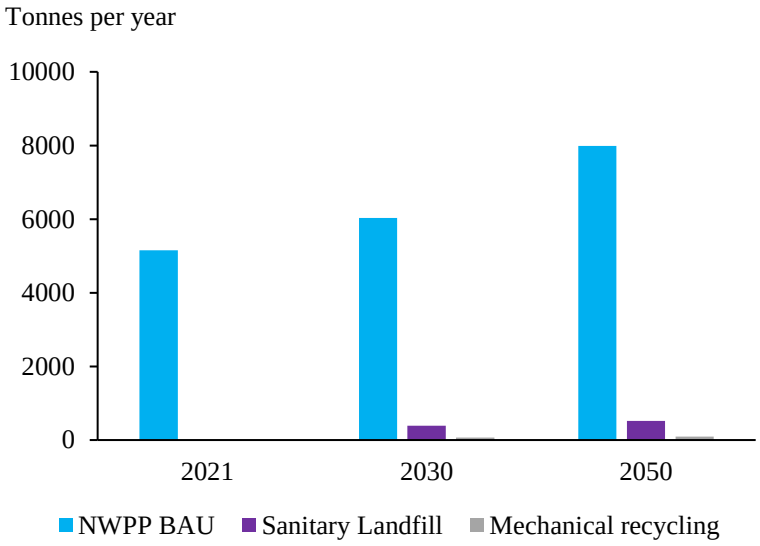


Fig. 4.9. Future generation of GWP by population growth and infrastructure development

4.6. Part B: Comparative environmental impact assessment of reusable NWPP bag and organic bags

The results presented in this section cover cradle to gate processes for the 18 environmental impact categories using the ReCiPe Midpoint 2016 (H) LCIA method for the comparison of 1 kg sisal bag, 1 kg palm bag, and 1 kg NWPP bag. SUPB was not considered since it has been phased out.

4.6.1. Global warming potential

Fig. 4.10. below shows the GWP 100 years for the production and distribution of NWPP bag was 3.29 kg CO2eq compared to sisal bag and palm bag, 0.84 kg CO2eq and 0.60 kg CO2eq, respectively. However, the net GWP is negative after factoring carbon sequestration potential of 1.54 kg CO_2eq./kg. The resulting GWP for the sisal bag and palm bag is -0.70 kg CO2eq and -1.15 kg CO2eq respectively. The production of sisal is modeled under plantation farming with mechanization and application of fertilizers compared to palm bags produced from naturally growing palm trees and all emissions are attributed to bag distribution to the market. The current GWP for sisal and palm only considers a one off production even though the original plants are renewable and can be harvested multiple times for additional bag production indicating much lower sisal and palm GWP emissions.

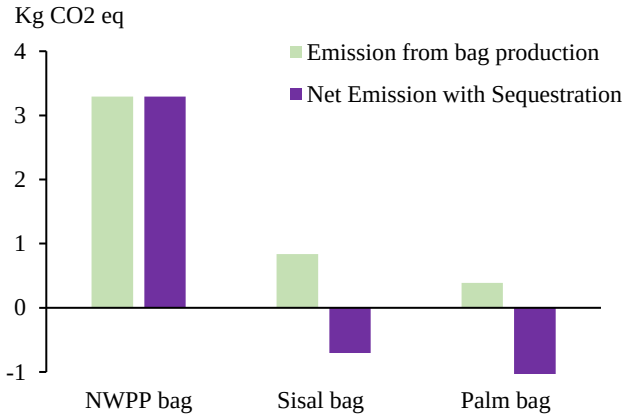


Fig. 4.10. GHG emissions of sisal bag and palm bag production factoring carbon sequestration

4.6.2. Other environmental impacts

Table 4.7. show below the comparison of other environmental impacts of organic bags and NWPP bags. The overall trend shows NWPP bag had the highest emissions across most environmental impact categories followed by sisal and palm bags except for water depletion, urban land occupation, and metal depletion impact categories. The NWPP bag production is fossil resources dependent as an input in granulate production and energy demand throughout the bag's life cycle. The FD for NWPP bag was 15 times and 7 times for the sisal bag and palm respectively. Sisal bags produced from naturally growing sisal plants can have a similar environmental footprint as palm bag at low scale production. The commercial production of sisal fiber increased FD by 54%. The other environmental impacts have an

increase variation between 31% and 97% from fuel from land preparation, fertilizer application, energy, and water in fiber processing.

Table 4.7. Individual cradle to gate environmental impacts of NWPP and traditional bags

Impact category	Unit	NWPP bag	Sisal bag	Palm bag
Ozone depletion	kg CFC-11 eq	1.94E-07	1.32E-07	6.67E-08
Terrestrial acidification	kg SO2 eq	1.47E-02	6.38E-03	1.76E-03
Freshwater eutrophication	kg P eq	4.21E-04	1.99E-04	6.89E-05
Marine eutrophication	kg N eq	1.94E-03	1.70E-03	2.48E-04
Human toxicity	kg 1,4-DB eq	4.40E-01	2.74E-01	1.19E-01
Particulate matter formation	kg PM10 eq	5.60E-03	2.57E-03	8.12E-04
Terrestrial ecotoxicity	kg 1,4-DB eq	1.74E-04	1.28E-04	4.52E-05
Freshwater ecotoxicity	kg 1,4-DB eq	1.59E-02	9.20E-03	4.48E-03
Marine ecotoxicity	kg 1,4-DB eq	1.50E-02	9.03E-03	4.36E-03
Ionizing radiation	kBq U235 eq	1.79E-01	9.21E-02	3.82E-02
Agricultural land occupation	m2a	6.55E-02	3.01E-02	5.67E-03
Urban land occupation	m2a	1.70E-02	1.78E-02	1.23E-02
Natural land transformation	m2	2.69E-04	2.42E-04	1.30E-04
Water depletion	m3	2.39E-02	1.05E-01	1.41E-03
Metal depletion	kg Fe eq	2.88E-02	6.86E-02	4.11E-02
Fossil depletion	kg oil eq	1.99E+00	2.92E-01	1.34E-01
Photochemical oxidant formation	kg NMVOC	1.57E-02	6.53E-03	2.33E-03

Traditional bags were gradually replaced by SUPB, and current usage is lower than reusable plastic based bags (Koros et al., 2019; Enge 2018). The uptake dynamics are related to the convenience attributed to plastic bags and the limited evolution in the production of traditional bags in meeting the needs of modern consumers (Buğrul 2022). Traditional bags have lower environmental impacts in various accounts even with commercial production without usage and therefore would further reduce environmental impacts with usage. Additionally, traditional bags woven from organic fibers, stalks, and leaves degrade compared to plastic bags which take years in the environment. Environmental awareness programs to demonstrate these benefits would demonstrate to the public the role of traditional in sustainable waste management and limit the uptake of plastic based reusable bags.

4.7. Study weaknesses

Within the domains of LCA, the current study faced various setbacks. The modeling in Sima Pro 8.1 only accommodated cradle to gate system boundary due to lack of open burning and open dumping EoL scenarios. The incorporation of such common practices could increase the number of reuse cycles for bags. Additionally, LCA studies are designed to capture environmental impacts on terrestrial environments hence posing a methodological weakness for marine related environmental impacts such as marine acidification, eutrophication-induced hypoxia, and marine plastic debris (Woods et al., 2016). The study did not include wet work (coloring) hence the environmental impacts could be underestimated. Since LCA studies in Kenya are underdeveloped and there is no national lifecycle inventory database, the use of generic data, particularly energy mix rest of the world (RoW) can also

affect the results. However, this study establishes a foundation for improvement by establishing the effect of reusable plastic bags replacing SUPB in Kenya. This policy effect is important to various stakeholders due to the increased diffusion of plastic policies.

The lack of Kenya's Life cycle inventory database was reviewed against related studies from South Africa and the Gulf Cooperation Council (GCC) region. Table 4.8 below shows variations in selected environmental impacts to produce 1 kg of PP granulates. Locally produced PP granulate in South Africa emitted 12.6 Kg CO2eq/Kg compared to import emissions, 2.29 Kg CO2eq/Kg (Goga et al., 2023) and the current study value of 2.056 Kg CO2eq/Kg. Alsabri et al., (2021) established a GWP of 1.586 Kg CO2eq/Kg for PP pellets produced in the GCC. PP from GCC was produced from liquid propylene while in South Africa the local plant produced PP granulate from 85% coal and 15% locally refined imported oil. As such, local sourcing was not environmentally ideal for NWPP production in South Africa.

Table 4.8. Comparison of environmental impacts for production of 1 Kg PP granulates

Impact category	Unit	Current Study	GCC Plant Alsabri et al., 2021	SA Plant Goga et al., 2023	SA Import Goga et al., 2023
Global Warming Potential	kg CO2eq	2.06E+00	1.59E+00	1.26E+01	2.29E+00
Terrestrial acidification	kg SO2 eq	6.00E-03	5.00E-03	-	-
Human toxicity	kg 1,4-DB eq	4.40E-02	7.70E-02	-	-
Fossil Resource Depletion	kg oil eq.	1.60E+00	1.72E+00	-	-
Petrochemical Oxidant formation	kg NMVOC	8.00E-03	4.00E-03	-	-

4.8. Conclusion

The mainstream adoption of reusable NWPP after the SUPB ban signifies the importance of reducing uncertainty on reuse. Reusable bags in the study had higher environmental footprints on all indicators considered compared to SUPB before usage. It is thus important that reusable bags are used multiple times to obtain optimum environmental benefits. The consumption range of 2 to 20 bags annually per capita provides better waste and environmental outcomes than SUPB usage. This results in annual waste SUPB reduction ranging from 98% to 78%, an equivalent of 1,272 tonnes and 13,357 tonnes compared to 62,907 tonnes from SUPB annually. To offset 18 environmental impacts, 38 reuses are required for four NWPP bags resulting in 2,544.3 tonnes of waste annually from 138 shopping trips. When tested for reuse consistency, NWPP waste generation exceeds SUPB waste volumes at 25% compliance. This requires most of the citizens to be consistent with reuse as much as possible. There is thus a need for continuous sensitization of proper usage of reusable bags through environmental education programs that include the demonstration of the optimum effect that varies with the number of bags used and usage cycles. Nonetheless, since reusable bags are priced, there is an additional economic nudge to conform. The study also unveiled that GHG emissions and fossil fuel depletion

impacts majorly occurred outside the country. Most of the energy and transportation occurred in the country while material import had the minimal share contribution. Thus, renewable sources of energy and transportation are suitable to lower the environmental impact of reusable bags. Additionally, expanding the EoL options for plastic waste treatment is an important aspect of mitigating the impacts of open burning of plastic.

Chapter 5. Conclusion, recommendations, and future studies

The plastic problem is attributed to SUP and short-lived plastic including primary and secondary packaging. The consumption of plastic and generation of plastic waste is expected to increase in developing countries including Africa with infrastructure improvements failing to curb the menace. Within the waste hierarchy (3R), upstream 2R (Reduce and Reuse) strategies are the most preferred through waste prevention. Trends indicate that African countries adopt regulatory bans in the management of plastic pollution. However, the plastic problem has continued to persist even though conventional reasons for such failure have been outlined to a lack of monitoring, enforcement, alternatives, smuggling, and lobbying from the plastic industry. Moreover, back casting calls for the question of whether plastic policies are designed to manage plastic pollution. Plastic policies in Africa have not been assessed beyond exploratory studies, compared to other regions such as Asia and the Pacific. Additionally, the lack of national or regional baseline consumption data makes policy evaluation or potential assessments of policy effectiveness difficult. Potential effectiveness is important in setting policy target achievements over time as a guide for implementation and enforcement. To grasp this phenomenon, this study used Africa and Kenya as case studies for the evaluation of plastic policies in the achievement of plastic waste reduction.

The study explores all three key facets of waste reduction including quantitative and qualitative aspects, and social response to plastic policies in Africa and the single use plastic bag ban in Kenya. Beforehand, the study assessed plastic policy designs in Africa to establish policy cohesion and sources of plastic waste. The analytical principle applied dictates that policies are made of a set of interacting and interrelated elements. The connections between elements should have minimal conflicts for policy success. Quantitative waste reduction is often more directly measured by decreased weight or count volumes. The policy environment in Africa is dominated by regulatory bans with few cases of economic and other instruments mainly targeting SUPB. Thus, the consumption effect of alternatives to SUP is evaluated where successful waste reduction realizes substitution effect while increases in waste generation, the rebound effect. As seen in Kenya, alternatives include heavier reusables than SUP hence the need for numerous cycles of reuse to offset the environmental impacts. Nonetheless, there is high uncertainty on reuse due to the material features of alternatives and behavioral characteristics of consumers in the usage of SUP alternatives.

Thus, the key findings of the research are therefore as follows:

- In Africa, there were 48 active policies in 39 of the 55 countries mostly anchored on nonbiodegradability restrictions, mostly dominated by SUPB (28) policies followed by packaging policies (11) and SUP (3) policies.
- Based on the policy design, the sources of plastic waste can be mapped from partial instruments, policy scope, exemptions, and transboundary sources. Category policies have a wider scope than product policies and, hence more waste prone.

- Reusable plastic based bags replaced SUPB as the dominant carrier with ownership tripling to 12 bags per household. Within the study period, up to 82% of consumers purchased new reusable bags when they forgot or brought less bags when shopping.
- The environmental impacts are weight dependent hence the widely adopted NWPP alternative carrier has a higher impact than SUPB and should be reused 38 times. In different reuse scenarios (6-69 uses) per bag 78% to 98% waste reduction margin relative to SUPB generation. However, without proper usage, NWPP waste generation exceeds SUPB waste generation with 25% national compliance with the ban.
- The mismanagement of plastic bags through open burning releases up to 96% of EoL GHG emissions for plastic bags. The use of 4 bags $Capita^{-1}$ Y^{-1} reduces GHG from 127,277 tonnes CO2eq to 5,145 tonnes CO2eq The development of sanitary landfills results in GHG emissions of 390 tonnes CO2eq in 2030 and 517 tonnes CO2eq in 2050 by respective population growths while localized mechanical recycling results in GHG emissions of 69 tonnes CO2eq and 91 tonnes CO2eq in 2030 and 2050 respectively.

The results of this study establish various policy implications. In general, the study forecasts a shift from SUBP to SUP policies based on the trends emerging from Chapter 2. SUP policies have a broader purview on SUPs and are therefore an effective tool for plastic management. To reduce conflict, the study recommends that SUP policies should include clear category and product definitions, minimize exemptions, establish reduction targets, and apply complementing instruments on plastics in circulations. In addition, African countries should work towards a regional plastic policy to reduce illegal plastic flows through their borders. Future quantitative waste assessment is required to map MSW plastics and the availability of alternatives for policy success. This establishes baseline data on plastic consumption for monitoring and evaluation of the policies. Additionally, robust policy action items before, during the grace period (period between policy adoption and implementation), and after policy adoption is required.

Behavioral adjustments after policy adoption are gradual and continuous stakeholder engagement, especially for consumers is important. The provision of reuse potential forms a critical element of awareness campaigns on the minimum number of usage of a product by consumers. Given the margins of compliance and future scenarios in the study, policy makers can define targets and future policy adjustments in plastic waste reduction. Finally, to reduce data uncertainties in future research, the study calls on stakeholder collaboration for more countries in Africa to establish common waste management monitoring methodologies and national lifecycle inventory databases.

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Appendix

Supplementary document 2.1. List of Policies Considered in Study

Policy No	Country No	Country	Policy Title
1	1	Mauritius	Environment Protection (Banning of Plastic Bags) Regulations 2020.
2			Environment Protection (Control of Single Use Plastic Products) Regulations 2020
3			Government Notice No. 33. of 2001
4	2	Senegal	Law no 2020-04 on the prevention and reduction of the environmental impact of plastic products
5	3	Rwanda	Law N° 17/2019 Relating to the Prohibition of Manufacturing, Importation, Use and Sale of Polyethylene Bags and Single-Use Plastic Items
6	4	Togo	Decree No 2011-003-PR of January 05, 2011 Fixing the Modalities of Management of Sachets and Packaging in Togo
7	5	Benin	ANNE 2004 N ° 077 - Ecotaxes on disposable plastic packaging
8			Law No. 2017-39 - Prohibiting the production, import, export, commercialization, possession, distribution, and use of nonbiodegradable plastic bags
9	6	Cameroon	Joint Order No. 004 / Minepded / Mincommerce of 24 October 2012
10	7	DRC	DECREE No. 17/018 prohibiting the production, import, marketing and use of bags, sachets, films and other plastic packaging
11	8	Burundi	Decree N ° 100/009 Of August 08, 2018 Prohibiting The Importation, Manufacture, Marketing And Use Of Bags And Other Plastic Packaging
12	9	Burkina Faso	Law N ° 017-2014 / Prohibiting Production, Import, Marketing And The Distribution Of Non-biodegradable Plastic Packaging And Plastic Bags
13	10	Zimbabwe	Environmental Management (Plastic Packaging and Plastic Bottles) Regulations, 2010]
14			Environmental Management (Plastic Packaging and Plastic Bottles) (Amendment) Regulations, 2012
15	11	Mali	Decree No 01 -394 / P-RM OF 06 SEPT. 2001 Setting The Modalities For The Management Of Solid Waste. The President Of The Republic
16			Law 2014-024 Prohibiting the Production, Import, and Sale of Not-Biodegradable Plastic Bags
17	12	Comoros Island	Law No. 17-011 / AU prohibiting the production, import, marketing and distribution of packaging and bags non-biodegradable plastics
18	13	Zambia	Environmental Management (Extended Producer Responsibility) Regulations, No 65 of 2018
19	14	Seychelles	Plastic Bags Regulations 2017
20			Plastic Utensils and Polystyrene Boxes Regulations 2017
21			Plastic Straws Regulations, 2019
22			Environment Levies on PET Plastic Glass Bottles Cans Regulations 2020
23			Beverage Containers and Labels Regulations, 2013
24	15	Algeria	Law n ° 19-14 of 14 Rabie Ethani 1441 corresponding to 11 December 2019 on the finance law for 2020
25	16	Botswana	Waste Management (Plastic Carrier commencement Bags and Plastic Flat Bags Prohibition) Regulations, 2018

26	17	Cape Verde	Law No. 99/VIII/2015
27	18	Côte d'Ivoire	Decree No. 2013-327 of 22 May 2013 Prohibiting the production, import, marketing, possession and use of plastic bags
28	19	Djibouti	Order No. 2016-284 / PRE of 20/04/2016 prohibiting the import and marketing of non-biodegradable plastic bags, not produced in the Republic of Djibouti.
29	20	Republic of the Congo	Decree No. 2011-485 - Regulating Production, Import, Marketing and the use of Plastic Bags, Sachets and Plastic Films
30	21	Ethiopia	Solid Waste Management Proclamation no. 513/2007
31	22	Eritrea	The Legal notice for banning of plastic bags (notice No. 99/2004)
32	23	Gabon	Order No. 1489 / MECIT of June 16, 2010 Ban on import and marketing of non-recyclable plastic bags in the Gabonese Republic
33	24	Gambia	Ban on Plastic Bags Order, 2015
34	25	Kenya	Gazette Notice No.2356
35			Gazette Notice No. 4858
36	26	Lesotho	Customs & Excise Tariff 2018
37	27	Madagascar	Decree No 2017-010
38	28	Malawi	Environment Management citation (Plastics) Regulations, 2015.
39	29	Mauritania	Decree No. 2012-157 of 21 June 2012 Prohibiting the Manufacture, Importation, Marketing and Use of Flexible Plastic Bags and Bags
40	30	Morocco	Law No. 77-15 prohibiting manufacturing, import, export, marketing and use of plastic bags.
41	31	Mozambique	Decree No. 16/2015: Regulation on Management and Controlof the Plastic Bag
42	32	South Africa	No. R. 625 of 2003 Regulations under section 24(d) of the Environment Conservation Act (No. R. 543 of 2002) / Plastic Carrier Bags and Plastic Flat Bags
43	33	Uganda	Act 5 The National Environment Act 2019
44	34	Tanzania	Environmental Management (Prohibition of Plastic Carrier Bags) Regulations, 2019
45	35	Tunisia	Government decree n° 2020-32 fixing the types of plastic bags whose production, import, distribution and possession are prohibited on the internal market.
46	36	São Tomé and Príncipe	Law No. 8/2020 Approving Measures to Reduce the Use of Plastic Bags in São Tomé and Príncipe
47	37	Guinea-Bissau	Policy Title and document unavailable - Policy widely documented
48	38	South Sudan	Policy title and document unavailable - Policy documented Kwori, M. W. (2019). South Sudans ban of plastic carrier bags: An empirical move or an emulation?. City and Environment Interactions, 2, 100019.

49	39	Niger	Law No. 2014-63 of 5 November 2014 banning the production, import, sale, use and storage of bags and wrapping of low density flexible plastic
50	40	Namibia	No 6285 Amendment Of Regulations Relating To Nature Conservation: Nature Conservation Ordinance, 1975 2017
51	41	Angola	Under Review
52	42	Eswatini	Revoked
53	43	Nigeria	Under Review
	44	Egypt	Regional
	45	Chad	Regional
	46	Sudan	No policy
	47	Ghana	No policy
	48	Somalia	No policy
	49	Guinea	No policy
	50	Sierra Leone	No policy
	51	Libya	No policy
	52	Liberia	No policy
	53	Central African Republic	No policy
	54	Equatorial Guinea	No policy
	55	Saharawi Democratic	No policy

Supplementary document 2.2. Coded Text Applied in the study

No	Country	Text Code for Research	Code
1	Mauritius	Environment Protection (Control of Single Use Plastic Products) Regulations 2020	Title SUP Policy
		"single use plastic product" means a plastic product intended to be used once only before it is thrown away	Category Definition
		4. No person shall import for home consumption, manufacture, possess, sell, supply or use any non-biodegradable single use plastic product specified in Part I of the Second Schedule	Biodegradability Ban
		5. (1) No person shall import or manufacture a biodegradable single use product specified in the First Schedule unless he is registered with the Director.	Source Registration
		16. Where any person – (a) possesses or uses, other than for the purpose of trade, a nonbiodegradable single use plastic product specified in the Second Schedule, he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 2,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 5,000 rupees; (b) possesses or uses for the purpose of trade, sells or supplies a non-biodegradable single use plastic product specified in the Second Schedule, he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 20,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 100,000 rupees and to imprisonment for a term not exceeding 3 months; (c) imports a non-biodegradable single use plastic product specified in the Second Schedule, he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 50,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 100,000 rupees and to imprisonment for a term not exceeding 2 years; (d) manufactures a non-biodegradable single use plastic product specified in the Second Schedule, he shall commit an offence and shall – (a) on a first conviction, be liable to a fine not exceeding 100,000 rupees; and (b) on a second or subsequent conviction, be liable to a fine not exceeding 250,000 rupees and to imprisonment for a term not exceeding 2 years; (e) otherwise contravenes these regulations, he shall commit an offence and shall, on conviction, be liable to a fine not exceeding 25,000 rupees.	Fine
		17. (1) These regulations shall come into operation on 15 January 2021.	Grace Period
		Second Schedule [Regulations 2, 4, 15, 16 and 17] Non-BIODEGRADABLE SINGLE USE PLASTIC PRODUCTS PART I 1. Plastic cutlery (forks, knives, spoons, chopsticks), 2. Plastic plate, 3. Plastic cup 4. Plastic bowl 5. Plastic tray 6. Plastic straw, including sealed plastic straw forming an integral part of the packaging of another product 7. Plastic beverage stirrer 8. Plastic hinged container 9. Plastic lid for single use plastic products 10. Receptacles of any shape, with or without lid, used to contain food which is intended for immediate consumption, either on the spot or take away and supplied by a food service business PART II 1. Plastic tray 2. Plastic hinged container 3. Sealed plastic straw forming an integral part of the packaging of another product	Product Definition
		Environment Protection (Banning of Plastic Bags) Regulations 2020.	Title

		"plastic bag" – (a) means a bag of any size or type made of plastic, with or without handles or gussets, designed for carrying goods, materials or products and which is not biodegradable or compostable; and (b) includes – (i) a non-woven polypropylene bag; (ii) an oxidatively degradable plastic bag; and (iii) a photodegradable plastic bag;	Bag Definition Degradability Restrictions
		4. (1) Subject to paragraph (2) and regulation 5, no person shall possess, use, distribute, sell, export, import, manufacture or supply a plastic bag.	Ban
		5. (1) No person shall import or manufacture an exempt plastic bag unless he is registered with the Director.	Source Registration
		5. (2) The importer or manufacturer of an exempt plastic bag shall ensure that the following information is conspicuously displayed on an exempt plastic bag – (a) the name and contact address of the manufacturer or importer; (b) the country of origin; (c) the batch number and production date; and (d) the type of exempt plastic bag as set out in Part II of the First Schedule.	Source Labelling
		FIRST SCHEDULE [Regulations 2 and 5(2)(d)] PART I – EXEMPT PLASTIC BAG A plastic bag – (a) designed to be used for the disposal of waste, including quarantine and clinical waste; (b) designed to be used for the purpose of agriculture; (c) designed to be used for medical purposes; (d) designed to be used for the purpose of sampling or analysis; (e) that constitutes, or forms an integral part of, the packaging in which goods, materials or products are sealed prior to sale on the local market or for export; and (f) a transparent re-sealable bag with security tamper used by a passenger to contain liquids, aerosols or gels at an airport or on board of an aircraft or carried by a transfer passenger. PART II – TYPES OF EXEMPT PLASTIC BAG 1. Agriculture 2. Medical 3. Packaging 4. Re-sealable bag 5. Sampling or analysis 6. Waste	Exemption
		14. Where any person – (a) possesses or uses a plastic bag he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 2,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 5,000 rupees; (b) possesses or uses for the purpose of trade, sells or supplies a plastic bag he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 20,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 100,000 rupees and to imprisonment for a term not exceeding 3 months; (c) imports, exports or manufactures a plastic bag he shall commit an offence and shall – (i) on a first conviction, be liable to a fine not exceeding 100,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 250,000 rupees and to imprisonment for a term not exceeding 2 years, including revocation of the certificate; (d) imports or manufactures a biodegradable or compostable plastic bag not in accordance with the clearance issued under regulation 6, he shall commit an offence and shall –	Fines

		(i) on a first conviction, be liable to a fine not exceeding 100,000 rupees; and (ii) on a second or subsequent conviction, be liable to a fine not exceeding 250,000 rupees and to imprisonment for a term not exceeding 2 years, including revocation of the certificate; (e) otherwise contravenes these regulations, he shall commit an offence and shall, on conviction, be liable to a fine not exceeding 25,000 rupee	
		8. Every person who is carrying on the business of manufacturing or importing exempted plastic bags at the commencement of these regulations shall, not later than 31 October 2015, be registered as a manufacturer or an importer of exempted plastic bags.9. Regulations 4 and 7 shall come into operation on 1 January 2016. Made by the Minister on 3 August 2015.	Grace Period
		Government Notice No. 33. of 2001 THE ENVIRONMENT PROTECTION ACT 1991 Regulations made by the Minister under section 74 of the Environment Protection Act 1991	Title
		1. These regulations may be cited as the Environment Protection (Polyethylene Terephthalate (PET) bottle Permit) Regulations 2001.	PET Bottle Policy
		3. (1) No responsible person shall bottle or cause to be bottled any beverage in a PET bottle unless he is in possession of a permit.	Source Registration
		4 (1) The Department may, subject to such terms and conditions as it thinks fit, issue a permit upon payment of a fee of 10,000 rupees.	Fine
		7. (1) The responsible person shall submit to the Department an annual return in respect of the number of PET bottles produced, collected, recycled and exported	Source Reporting
2	Senegal	Law no 2020-04 on the prevention and reduction of the environmental impact of plastic products	Title
		Article 1. - This law establishes the rules relating to the prevention and reduction of the impact on the environment and human health of plastic products and the rational ecological management of plastic waste.	SUP Policy
		Article 2. - This law applies to products made or manufactured from plastics, whether or not they are for single use and to the waste which results therefrom . Are excluded from the scope of this law, products including one or more components constituting or manufactured from plastic materials provided that the main product is designed in such a way as not to easily allow the replacement of the product (s) components by the consumer.	Citation
		Article 3. single-use plastic product or disposable plastic product produced or manufactured from plastics and which is designed, created and put on the market to be used once and then discarded	Category Definition
		Article 3. Plastic bag containing a couple, made from plastic materials, intended to contain and transport donated goods	Product Definition
		Article 4.- the production, importation, possession with a view to sale, sale, sale, provision to the user, use, in any form whether single-use plastic products or disposable plastic products are prohibited. For the purposes of the first paragraph of this article, are considered as single-use plastic products or disposable plastic products the products made of or manufactured from the following plastics: - goblets, cups and lids; - cutlery and plates; - straws and stir sticks for drinks; - sachets intended and used to condition water or any other drink, alcoholic or not, for marketing purposes.	Ban Product Definition

		Article 5.- Checkout plastic bags, with or without handles, with or without suspenders, are prohibited, regardless of their thickness. The ban does not apply to plastic bags intended for and used in points of sale to package foodstuffs in order to protect them, to allow their handling or transporting them from the producer or seller to the consumer, and ensure their presentation. The plastic bags referred to in the second paragraph of this article must be colored transparent and made from recyclable plastics. Their import is subject to the prior authorization of the Minister responsible for the Environment.	Bag Definition Exemption Source Registration
		Article 6.- A deposit is required for the purchase of any product contained in plastic bottles. The deposit amount, fixed by decree, is collected by the seller at the time of purchase and is returned in the event of the return of the empty plastic bottle.	EPR
		Article 8.- Producers are required to set up collection points for plastic bottles at the place of exercise of their professional activities or at any other appropriate place . Producers are required to recycle or recycle the plastic bottles collected by prioritizing, in order, re-use, recycling or any other recovery operation.	Recycling
		Article 9.- Producers are required, every six (6) months, to present to the Minister responsible for the Environment, a sectoral report in electronic format, including, without limitation, the following information the quantity of plastic bottles in the market; The quantity of plastic bottles collected; the number of collection points set up, their nature and their location; the percentage difference between the number of plastic bottles put on the market and the number of plastic bottles collected; the measures initiated, in the event of a negative deviation, to bridge the differential.	Source Reporting
		Article 15.- Producers are required to reduce at source the quantities of waste which may result from their activities and to put on the market products which may, after having become waste, be subject to recycling or disposal. " recovery under conditions that respect the environment.	Product design
		Article 17.- Products made up in factories from plastic materials placed on the market bear a visible, clearly legible and indelible marking affixed on their packaging or on the products themselves, indicating the identity or the company name and the address. from the producer.	Source Labelling
3	Rwanda	Law N° 17/2019 Relating to the Prohibition of Manufacturing, Importation, Use and Sale of Polyethylene Bags and Single-Use Plastic Items	Title
		Article 1: This Law prohibits the manufacturing, importation, use and sale of plastic carry bags and single-use plastic items.	SUP Policy Ban
		Article 2.1 single-use plastic item: a disposable plastic item designed to be used once before it is discarded or recycled. Single-use plastic items include plastic carry bags, oxo-degradable plastics and other items whose part is made from plastic material;	SUP Product Definition
		Article 2.2 compostable plastic material: any material made from single-use plastic or plastic carry bag made from plant-based synthetic materials capable of undergoing biological decomposition in natural conditions;	Biodegradability Status
		Article 2.3. plastic carry bag: a synthetic industrial product with a low density composed of numerous ethane molecules used in packaging or carrying products	Bag Definition
		Article 4.1. Exceptional authorization The manufacturing, importation, use or sale of home compostable plastic items or woven polypropylene is allowed subject to prior authorization from the competent authority.	Exemption: Home Compostable
		Article 4.2. A person who intends to manufacture, import and export or use plastic carry bags and single-use plastic items or pack goods in plastic material and single-use plastic items for exceptional reasons applies in writing for an exceptional authorization issued by the competent authority.	Source Registration
		Article 5: Environmental levy Imported goods packaged in plastic material or single-use plastic items are subject to an environmental levy in accordance with relevant laws.	Tax: Imports

		Article 6. Every manufacturer, wholesaler or retailer of plastic carry bags or single-use plastic items must put in place mechanisms to collect and segregate used plastic carry bags and single use plastic items and hand them over to the recycling plants	EPR
		Article 9: Manufacturing of plastic carry bags and single-use plastic items A person who manufactures plastic carry bags and single-use plastic items is liable to closure of the activity, dispossession of those plastic carry bags and such items and to an administrative fine of ten million Rwandan francs (FRW 10,000,000).	Fine
		Article 10: Importation of plastic carry bags and single-use plastic items A person who imports plastic carry bags and single-use plastic items is liable to dispossession of those plastic carry bags and such items and to an administrative fine equivalent to ten (10) times of the value of those plastic carry bags and single-use plastic items.	Fine
		Article 11: Wholesale of plastic carry bags and single-use plastic items A wholesaler of plastic carry bags and single-use plastic items is liable to an administrative fine of seven hundred thousand Rwandan francs (FRW 700, 000) and dispossession of those plastic carry bags and such items.	Fine
		Article 12: Retailing of plastic carry bags and single-use plastic items A retailer of plastic carry bags and single-use plastic items is liable to an administrative fine of three hundred thousand Rwandan francs (FRW 300,000) and dispossession of those plastic carry bags and such items.	Fine
		Article 13.1: Piling or disposing of plastic carry bag waste and other single-use plastic items on unauthorised place Any person who piles or disposes of plastic carry bag waste and other single-use plastic items on unauthorised public or private place is liable to an administrative fine of fifty thousand Rwandan francs (FRW 50,000) and is ordered to remove such waste and repair damages caused by him or her.	Fine
		Article 13.2: If the acts referred to in Paragraph One of this Article are committed by a person having exceptional authorisation to use plastic carry bags and single-use plastic items or to treat waste, he or she is liable to an administrative fine of five million Rwandan francs (FRW 5,000,000). The authorisation is also suspended or withdrawn.	Fine
		Article 14: Recidivism In case of recidivism of acts provided for in Articles 9, 10, 11, 12 and 13 of this Law, the administrative fine is doubled.	Fine
		Article 17.1: Transitional period Single-use plastic items which are already ordered or in stock are exempted from the application of this Law within three (3) months from the commencement of this Law.	Grace Period
		Article 17.2: The existing factories in Rwanda manufacturing single-use plastic items must comply with the provisions of this Law within two (2) years from the date of publication of this Law in the Official Gazette of the Republic of Rwanda.	Grace Period
4	Togo	Decree n ° 2011-003-PR of January 05, 2011 Fixing the Modalities of Management of Sachets and Packaging in Togo	Title
		Article 1 the purpose of this decree is to manage the production, importation, the distribution, marketing, use, collection and recycling of bags and plastic packaging in Togo.	Packaging Policy Recycling
		Article 2 .; the production, import, distribution and marketing of sachets and non-biodegradable plastic packaging are prohibited in Togo.	Ban Biodegradable
		Artcle 3: The production, import, marketing, use, collection and recycling are authorized: - biodegradable plastic bags and packaging; packets for medical and pharmaceutical use: hatchets used in agricultural activities; - non-toxic food bags.	Exemption
		Article 4: The authorized plastic bags and packaging must be made at from materials making them suitable for recycling or their compatible transformation with the requirements of the protection of public health and the environment.	Recycling Product design

		Article 5: Any producer, any person who markets or any professional who uses plastic bags and packaging in its professional activities biodegradable or not, is required to take back the waste resulting from its use for recycling or disposal.	EPR and recycling
		Article 9: Any public or private establishment that uses quantities of biodegradable bags or packaging or not greater than five (5) kilograms per day, is required to register with the Department of the Environment. and inform it every six months of the methods for processing the resulting waste.	Source Registration
		Article 10: Any producer of biodegradable or non-biodegradable sachets or packaging is required to affix its label on them and to communicate regularly the quantities produced and all their physico-chemical characteristics to the internal trade department and competition.	Source Labelling
		Article 10: Any producer of biodegradable or non-biodegradable sachets or packaging is required to affix its label on them and to communicate regularly the quantities produced and all their physico-chemical characteristics to the internal trade department and competition.	Source Reporting
		Article 15: Any contravention of the provisions of this decree is liable to be severely imposed. laws and regulations in force in matters of industry, commerce, protection Togo's environment and public health.	Fine
		ARTICLE 17: A six (6) month moratorium is granted to economic operators importers and nine (9) months to producers of plastic bags and packaging to comply with the provisions of this decree.	Grace Period
5	Benin	ANNE 2004 N ° 077 - Distributing Of Ecotaxes And Fines In Relation To Pollution Caused To The Environment	Packaging Policy
		Article 1: It is authorized the collection in the Republic of Benin of environmental taxes and fines for the pollution caused by the vehicles made for consumption and in transit, tires, clinker and disposable plastic packaging.	Packaging Policy
		Law No. 2017-39 - Prohibiting the production, import, export, commercialization, possession, distribution, and use of nonbiodegradable plastic bags	Title Bag Policy
		Article 1: Plastic packaging: plastic intended to contain, condition and protect goods or articles, with a view to facilitating their handling, their transport or their transport Plastic bag: content made from degradable or non-degradable polyethylene and polypropylene film Sachet: small bag or container with strap or not	Category Definition Product Definition
		Article 4: The operations of production, import, export, marketing, distribution, possession and use of non-biodegradable bags are prohibited in the Republic of Benin.	Biodegradable
		Article 6: The management and recycling of authorized plastic bags are specified by order of the Minister in charge of the environment.	Recycling
		Article 7: The production, import, export, marketing and distribution of biodegradable bags are authorized after approval by the competent services of the Directorate-General for the Environment.	Biodegradable
		Artlcle 8: Notwithstanding the provisions of Article 4, the use of bags entering directly into the packaging of manufactured products is permitted.	Exemption: Primary Packaging
		Article 9: The production, import, export, marketing or distribution of non-biodegradable bags for use in health, medical, military, war, scientific and experimental research or for public health measures, National security and safety is subject to special authorization issued by the Minister of the Environment	Exemption

		Article 12- 17: Any natural or legal person who produces, imports or exports plastic bags in contravention of the provisions of Article 4 is liable to a fine of five million (5,000,000) to fifty million (50000000) CFA francs; Anyone who sells, distributes or holds plastic bags in contravention of the provisions of Article 4 of this Law shall be liable to a fine of one hundred thousand (100000) to five million (5000000) francs and a term of imprisonment of three (03) months to six (06) months. ; Any natural or legal person who sells or gives away, unauthorized bags is punished with a fine ranging from ten thousand (10000) to five hundred thousand (500000) CFA francs and imprisonment from three (03) months to six (06) months ; Any unauthorized physical or moral person who uses a non-biodegradable bag, is punished with a fine ranging from five thousand (5000) to five hundred thousand (500000) CFA francs and imprisonment of three (03) months to six (06) months	Fines
		Article 18: Any natural or legal person who produces, imports, exports, markets, distributes or holds in stock the non-biodegradable bags, has a period of six (06) months to comply with the provisions of this law.	Grace Period
		Article 19: Producers and importers of biodegradable plastic bags have a system for the collection and recycling of waste from these bags.	EPR
6	Cameroon	Joint Order No. 004 / Minepded / Mincommerce of 24 October 2012 Regulating the manufacture, import and marketing of non-biodegradable packaging.	Title
		Article 1. This Joint Order regulates the manufacture, import and marketing of non-biodegradable packaging	Packaging Policy Biodegradable
		Article 2: Packaging: any object whatever the nature of the materials of which it is constituted, intended to contain and to protect the goods, to allow their handling and their routing from the producer to the consumer.	Packaging Definition
		Article 3.- (1) Any manufacturer, importer or distributor of authorized non-biodegradable packaging shall be responsible for the management of its waste	EPR
		Article 4.- (1) The manufacture, import and marketing or distribution of non-biodegradable packaging shall be subject to obtaining a prior environmental permit to ensure the traceability of its recovery, recycling and / or destruction in an environmentally sound manner. (2) The environmental permit referred to in paragraph 1 above shall be issued by the Minister of the Environment.	Source Registration
		Article 7.- (1) The manufacture, import, possession and free sale or distribution of non-biodegradable plastic packaging at low density not exceeding 60 microns shall be prohibited. thickness (1 micron is 1/1000 mm) and the granules used for their manufacture	Thickness Ban
		Article 7. (2) The production, import, holding and marketing of non-biodegradable plastic packaging of more than 60 microns and the granules used in their manufacture are subject to the obtaining of an environmental permit referred to in Article 4 hereof. - above	Source Registration
		Article 8.- (1) Information on the thickness, formulation, biodegradability or otherwise, the name and precise address of the manufacturer appear on plastic packaging manufactured or imported in accordance with the regulations in force. (2) The indications referred to in paragraph 1 above are clearly visible and easily legible to facilitate identification and classification.	Source Labelling
7	DRC	DECREE No. 17/018 prohibiting the production, importation, marketing and use of bags, sachets, films and other plastic packaging	Title Packaging Policy
		Art. 1st. The production, import, marketing and use of bags, sachets, films and other plastic packaging for the sale of food, water and any drink are prohibited in the Democratic Republic of the Congo. The production, import, marketing and use of bags, sachets, films and other non-biodegradable plastic packaging are also prohibited.	Ban Biodegradable

		Art. 2. The production, import, marketing and use are not affected by this decree: - bags, sachets, plastic films intended for medical use; - sachet bags, plastic films intended for agricultural activities; - bags and plastic bags used for garbage collection; - plastic films used in construction and public works; - plastic films intended for wrapping or packaging hygienic products inside production units, in particular paper handkerchiefs, napkins and toilet paper; - plastic films intended to wrap luggage for travel at airports, ports and stations; - plastic water and soft drink bottles and small jars used for packaging	Exemption
		Art. 4. The production of bags, sachets, films referred to in Article 2, point 1, 2, 3, 4, 5 and 6 of this decree is subject to obtaining accreditation issued by the minister responsible for industry. The production of water bottles, soft drinks and small plastic jars referred to in Article 2 (7) of this decree is subject to obtaining an approval valid for three (3) months, renewable issued by the minister responsible for industry. A decree from the minister responsible for industry determines the conditions for granting this approval.	Source Registration
		Art. 5. A fee for the industrial recycling of plastic waste is established, which will be collected on the occasion of the production, manufacture, import, marketing and use of bags, sachets, films, bottles and others plastic packaging and products. This fee is intended to promote the implementation of industrial projects for recycling packaging and others by plastic. A joint order of the ministers having finance and industry in their attributions determines the modalities of collection and allocation of the above-mentioned fee.	EPR
		Art. 7. In the event of failure to comply with the provisions of this decree, the competent administrative services of the ministries of Environment and Industry, as the case may be, give the offender notice to comply within 15 days. When the offender does not comply within the time limit, the competent administrative services may pronounce on his against a financial penalty, the amount of which is proportionate to the seriousness of the breach in his situation, the extent of the damage and the benefits derived from it. The pecuniary fines provided for in paragraph 2 above are collected in accordance with Ordinance-Law 13-003 of 23 February 2013 reforming the procedures relating to the basis, control and methods of collecting non-tax revenue by the DGRAD, after taxation according to the case of the administrations of the ministries having in their attributions the environment and industry, acting as a plate service.	Fine
		Art. 8. Producers, importers and distributors of bags, film sachets and other plastic packaging have a deadline six (6) months from the date of entry into force of this decree, to withdraw from the market any product referred to in Article 1 of this decree.	Grace Period
8	Burundi	Decree N ° 100/009 Of August 08, 2018 Prohibiting The Importation, Manufacture, Marketing And Use Of Bags And Other Plastic Packaging	Title
		Chapter 1 Article 1: plastic bags, a low density synthetic material composed of several single molecules of ethylene with a chemical formula (CH2 = CH2)n.	Product definition
		Chapter 2 Article 1: The purpose of this decree is to: 1° establish a control framework for the use of plastic bags and other plastic packaging; 2º to promote the use of materials that do not degrade the environment; 3º to prevent any kind of pollution caused by bags and other plastic products.	Packaging Policy
		Chapter 2 Article 3: The manufacture, import, storage, sale and use of all plastic bags and other packaging is prohibited	Ban
		Chapter 2 Article 4: Notwithstanding the provisions of article 3, the Minister in charge of the environment, after consultation with the Ministers concerned, establishes by order, a list of plastic bags to be used exceptionally in Burundi. The list is updated whenever necessary.	Exemption

		Chapter 2 Article 4: The initial list of plastic material benefiting from a special exemption is as follows: 1 Biodegradable plastic bags and sachets; 2 ° Plastic materials used in medical services; 3 ° Plastic materials used in industrial and pharmaceutical packaging; 4 ° Plastic materials used in industrial construction, including pipeline pipes; 5 Plastic materials used in the manufacture of tents; 6 Plastic materials used in research laboratories; 7 Plastic materials used in education as teaching aids	Biodegradable Exemption: Primary Packaging
		Article 5: Anyone wishing to import, manufacture, sell or use any plastic bag specified in article 4 makes a written request addressed to the Minister in charge of the environment.	Source Registration
		Article 7: Plastic waste, including plastic bottles and flasks, is returned to suppliers for storage, recycling and recovery.	EPR
		Article 9: A grace period of eighteen months is granted, from the entry into force of this decree to dispose of available stocks and orders placed.	Grace Period
9	Burkina Faso	Law N ° 017-2014 / Prohibiting Production, Import, Marketing And The Distribution Of Non-biodegradable Plastic Packaging And Plastic Bags	Title
		Article 1: The purpose of this Act is to prohibit the production, import, marketing and distribution of nonbiodegradable plastic packaging and plastic bags in Burkina Faso.	Packaging Policy
		Article 5: Any production, import, marketing and distribution of non-biodegradable plastic packaging and bags on the national territory.	Biodegradable
		Article 4: Under this Act, the following terms mean: - plastic packaging: any plastic product intended to contain and to protect objects, goods or articles in order to facilitate their handling, transportation or transportation; - plastic bag: any variety of biodegradable plastic packaging or non-biodegradable, low density, composed of several chemical molecules;	Packaging Definition
		Article 7: Is punishable by imprisonment from three months to five years and a fine of one hundred thousand (100,000) to ten million (10,000,000) CFA francs, or one of these two penalties, whoever produces, imports, markets or distributes non-biodegradable plastic packaging and plastic bags in violation of the provisions of this law. In case of recidivism, the penalty is doubled.	Fine
		Article 11: Notwithstanding the provisions of Articles 5, 6 and 7 above, the use of plastic packaging and bags directly into the packaging manufactures whose list is fixed by joint order of the Ministers in the environment, industry, trade and crafts, health, economy and finance	Exemption: Primary Packaging
		Article 12: The production, import, marketing and distribution of biodegradable plastic packaging and bags are only allowed after approval by the competent departments of the ministries responsible for the environment and sustainable development, industry, trade and crafts.	Source Registration
		Article 13: The production, importation, marketing or distribution of non-biodegradable plastic packaging and plastic bags intended **directly for sanitary activities**, scientific and experimental research or for the purpose of security and national security, are subject to a special authorization issued by the Minister charge of industry, commerce and craftsmanship after the opinion of the Minister in charge environment and sustainable development. The conditions of use, recovery and disposal of such packaging and non-biodegradable plastic bags are determined by order of the Minister in the environment and sustainable development.	Exemption: Other Industries
		Article 14: A period of six months is granted to producers, importers, traders and distributors of plastic packaging and bags to comply with provisions of this Law, from the date of publication in the Official Journal of Faso.	Grace Period
10	Zimbabwe	Environmental Management (Plastic Packaging and Plastic Bottles) Regulations, 2010]	Title Packaging Policy

		2C plastic packaging" means plastic barrier packaging, plastic carrier packaging and plastic bread packaging;	Category Definition
		3(1) The manufacture for use within Zimbabwe, commercial distribution or importation of plastic packaging with a wall thickness of less than thirty micrometers is prohibited; Unless it can be provided that they are: (1) Plastic bread packaging and clingy film used as plastic barrier packaging of a wall thickness of between twentyfive micrometers and thirty micrometers; or (2) biodegradable plastic packaging.	Thickness Ban Exemption: Biodegradable
		4(1) The Agency shall require from time to time, every responsible person to set plastic waste prevention targets and to notify the Agency of such targets. (2) The Plastic waste prevention targets shall provide for any of the following as may be appropriate (a) the disposal of plastic waste by the responsible person in designated receptacles or sites; or (b) the design of plastics containing few pollutants, are recyclable and durable when put to their intended use; or (c) the use of biodegradable plastics; or (d) the creation of the mode of distribution and return systems, that reduce residual plastic waste to a minimum	EPR Source Reporting Product Design
		5(1) The following information shall be provided, either in print on each plastic packaging, or in the form of a consignment slip included in every consignment, batch or packaging¾ 1. the name of the manufacturer and the country of manufacture of the plastic packaging; 2. the name of the person in Zimbabwe importing or distributing plastic packaging; 3. The name of the country on which the plastic packaging is consigned, if it is not consigned from the country of manufacture.	Labelling
		6. Any responsible person who contravenes section 3 shall be guilty of an offence and liable to fine not exceeding level fourteen, or to imprisonment for a period not exceeding one year or	Fine
		Environmental Management (Plastic Packaging and Plastic Bottles) (Amendment) Regulations, 2012	Title
		4. Section 3 is amended by the deletion of section 3 (1) (a) and (b) and the insertion of the following subsections Prohibition of certain Plastics "(1) The manufacture for use within Zimbabwe, commercial distribution or importation of plastic packaging whether biodegradable or not, with a wall thickness of not less than 30 micrometeres is prohibited except for plastic barrier packaging "	Thickness Ban
		(2) The manufacture or importation of polystrene for use or commercial distribution within Zimbabwe is prohibited	Polymer Restriction
		Fees 4. The plastic levy payable by manufacturers, importers and commercial distributors of plastics is as follows 1. Annual registration fee US$32.00 2. Annual Monitoring fees US$80.00	Source Registration
		Responsibility of Producers (1.) The responsibilities of an establishment or undertaking which produces, distributes, imports, collects, transports or recovers, and or generates waste, must take all such measures available to it for: (a) Prevention; (b) Preparing for re-use; (c) Recycling; (d) Other recovery(for example energy recovery);and (e) Disposal in an appropriate manner and place as is registered with the Agency.	EPR
11	Mali	Decree No 01 -394 / P-RM OF 06 SEPT. 2001 SETTING THE MODALITIES FOR THE MANAGEMENT OF SOLID WASTE. THE PRESIDENT OF THE REPUBLIC	Title
		CHAPTER II: PLASTIC WASTE AND PACKAGING MANAGEMENT	Packaging Policy

		ARTICLE 7: The packaging must be made from materials making them suitable for recycling or transformation compatible with the requirements of the protection of public health and the environment. The proliferation of packaging and plastic waste must be avoided by: - the limitation of the minimum volume necessary for the protection of the content and the marketing of the product and using the minimum of materials and coloring products, taking back packaging and recycling it.	Product Design Overpackaging
		ARTICLE 8: Any producer and any distributor who markets or uses in his activities professionals in plastics or other non-biodegradable packaging and any person responsible of their first placing on the market, in case the producer and the distributor are unknown, is required to proceed to take back its plastics and packaging used for recycling.	EPR
		ARTICLE 10: Any public or private establishment that uses quantities of plastic materials greater than five kilograms per day, is required to register with the competent administration and to communicate semi-annually the methods of treatment of said plastics.	Source Registration Source Reporting
		ARTICLE 11: Any producer of plastics is required to affix his label on them and to regularly communicate the quantities produced and other physicochemical characteristics to the competent Administration before their delivery to the market.	Source labelling
		Law 2014-024 Prohibiting the Production, Import, and Sale of Not-Biodegradable Plastic Bags	Title
		ARTICLE 1st : This law prohibits, from 1 st January 2014, the production, import and marketing of plastic bags not biodegradable in the Republic of Mali	Bag Policy
		ARTICLE 3 : Breaches of the provisions of this law are sought, noted and prosecuted in accordance with the laws in force in particular the law n ° 01-020 of May 30, 2001 relating to pollution and nuisances and the Customs Code. ARTICLE 4 : Will be punished by a fine of 20,000 to 120,000francs, and a prison sentence of 11 days to 3months or of one of these two sentences whoever has obstacle to the performance of the duties of enforcement officers without prejudice to other provisions in force. In the event of a repeat offense, the fine and the penalty will be increased to double. ARTICLE 5 : Anyone who produces, imports or sells non-biodegradable plastic bags is liable to the payment of 100 francs per bag of small format and 200 francs per large format bag. In addition, these plastic bags are seized and confiscated.	Fine
		ARTICLE 7 : This law repeals Law n ° 2012-003of January 23, 2012 prohibiting production, importation, holding, marketing and the use of non-biodegradable plastic bags and non-biodegradable granules intended for the manufactures aid sachets in the Republic of Mali.	???
12	Comoros Check one more time	Law No. 17-011 / AU prohibiting the production, import, marketing and distribution of packaging and bags non-biodegradable plastics	Title Packaging Policy Biodegradable
		Penalties incurred by potential offenders are in the order of three months to five years' imprisonment, a fine ranging from 100,000 francs to 10 million or one of these two penalties	Fine
		by the law have six months to comply with it.	Grace Period
13	Zambia	Environmental Management (Extended Producer Responsibility) Regulations, No 65 of 2018	Title
		Part 1 2. "packaging material" includes a carton, plastic carrier bag, plastic flat bag, non returnable glass, beverage can or plastic bottle used for the general purpose of carrying goods or waste; "plastic carrier bag" means a bag, made of plastic film, with handles, and with or without gussets, which have the properties specified in Zambian Standard on plastic carrier bags and flat bags; "plastic flat bag" means bag, made of plastic film, without handles, and with or without gussets, which has the properties specified in Zambian Standard on plastic carrier bags and flat bags;	Category Definition Product Definition

		PRINCIPLE OF EXTENDED PRODUCER RESPONSIBILITY 3. (1) The Agency may, other than for a packaging material or product or class of products listed in the First Schedule, specify— (a) a product or class of products; (b) the producer responsibility measures that must be taken in respect of a specified product or class of products; and (c) the category of persons required to take responsibility measures.	EPR Regulations
		Part II 3 (3) The manufacture, trade and commercial distribution of domestically produced and imported plastic carrier and flat bags, for use within the Republic, other than those having the properties in the Zambian Standard on Plastic Carrier Bags and Flat Bags is prohibited "4.2 Film thickness When the film thickness of a plastic carrier bag or flat bag is measured in accordance with 6.1, no individual thickness measurement shall be less than 24 µm"	Bag Ban
		PART III REGISTRATION 4. (1) A person who intends to manufacture, retail, import, trade or commercially distribute in Zambia a packaging material or a product specified in the First Schedule shall apply to the Agency for registration in Form I set out in the Fourth Schedule on payment of the application fee set out in the Second Schedule.	Source Registration
		Bags and Bottles	
14	Seychelles	S.I. 37 of2017 ENVIRONMENT PROTECTION ACT, 2016 (Act 18 of 2016) Environment Protection. (Restriction on manufacturing, importation, distribution and sale of Plastic Bags) Regulations 2017	Title
		1. These Regulations may be cited as the Environment Protection (Restriction on manufacturing, importation, distribution and sale of Plastic Bags) Regulations, 2017 and shall come into force on 1 st July, 2017.	Bag Policy
		2. "plastic bag" means a bag made of plastic;	Product Definition
		3. The manufacturing, importation, distribution and sale of plastic bags, for use within the Republic of Seychelles, which does not fall into the category of exempted plastic bag as specified in the First Schedule are hereby prohibited	Ban
		4.(1) The Ministry responsible for Finance and Trade, subject to the approval of the Ministry may issue import permits for (a) exempted plastic bags; or (b) biodegradable bags	Source Registration Biodegradable
		5. Any person w ha contravenes these Regulations shall be guilty of an offence and is liable an conviction a fine not exceeding SCR20,()00 or ta imprisonment far a term not exceeding one year, or to both such fine and imprisonment.	Fine
		FIRST SCHEDULE (see Regulation 3) . EXEMPTION LIST. Any plastic bag which is (h) a bag used for perishables which has been portioned, pre packed and sold in frozen condition such as meat, poultry, fish, seafood, repacked whole or portioned vegetables and fruits (as clients need to see their quality); (i) a bag that constitutes or forms an integral part of the packaging in which goods are sealed prior to sale on the local market or for export such as ham, sausages .and processed meat, meat products and other vacuumed packed products; G) a bag used for repacked foods in granular forms such as pulses, sugar, rice, beans etc; and (k) a bag used for packaging snacks and products such as bread, banana chips, ice cakes etc. to preserve their freshness, preyent rancidity and mould growth and prevent contamination during storage and transportation.	Exemption
		S.I. 38 of 2017 ENVIRONMENT PROTECTION ACT, 2016 (Act I8of2016) Environment Protection (Restriction on importation, distribution and sale of Plastic Utensils and Polystyrene Boxes) Regulations 2017	Title

		1. These Regulations may be cited as the Environment Protection (Restriction on importation, distribution and sale of Plastic Utensils and Polystyrene Boxes) Regulations 2017 and shall come into force on 1" July, . 2017.	Utensils Policy
		"plastic utensil" includes fork, spoon, knives, plates, bowls, cups and trays made of plastic	Definition
		4.(1) The Ministry responsible for Finance and Trade, Issue or subject to the approval of the Ministry responsible for pennits environment may issue import permits for the importation of- (a) Biodegradable utensils; or (b) Biodegradable boxes.	Source Registration Biodegradable
		5. Any person w ha contravenes these Regulations shall be guilty of an offence and is liable an conviction a fine not exceeding SCR20,()00 or ta imprisonment far a term not exceeding one year, o rto both such fine and imprisonment.	Fine
		S.I. 31 of 2019 ENVIRONMENT PROTECTION ACT, 2016 (Act I8of2016) Environment Protection (Restriction on, the "manufacturing, Importation, distribution and ,sale of ' ',." Plastic Straws) Regulations, 2019	Title
		"3.(1)' The manufacturing, importation, distribution and sale of 'plastic straws .for use within the Republic of Seychelles are prohibited	Plastic Straws Policy
		(2).' Subre~l~tion' (1) shall not. apply to the 'plastic straws which form part of pre-packaged beverages or any other , pre-packaged products.	Exemption: Pre packaged straw
		5. Any person w ha contravenes these Regulations shall be guilty of an offence and is liable an conviction a fine not exceeding SCR20,()00 or ta imprisonment far a term not exceeding one year, or to both such fine and imprisonment.	Fine
		S.I 81 of 2020 Environment Levies on PET Plastic Glass Bottles Cans Regulations 2020	Title Bottle Policy Levy
		PET Bottle and Plastic Bottles containing beverages	Product Definition
		S.I. 27 of 2013 ENVIRONMENT PROTECTION ACT (Act 9 of 1994) Environment Protection (Beverage Containers and Labels) Regulations, 2013	Title
		1. These Regulations may be cited as the Environment Citation Protection (Beverages Containers and Labels) Regulations, 2013 and shall come into force on 15th March, 2013	Labelling Policy
		3. The import, manufacture, trade and commercial distribution of polyvinyl chloride (PVC) labels shall be prohibited for the purpose of labeling beverage containers for use within the Republic of Seychelles.	Product design
		4.(I) All beverage containers imported, manufactured, distributed, traded in or use shall be made of PET or glass and labeled by paper or PET film. (2) All PET beverage containers shall have the standard symbol for PET moulded at the bottom or side wall of the container and the symbol of PET shall be clearly indicated on any label used.	Product design
		5. Where plastic outer packaging is used for the transportation of beverage containers, the packaging shall be made of PET film.	Product design
		7. Any person who contravenes these Regulations shall be guilty of an offence and is liable upon conviction to a fine not exceeding SCR5,000 or imprisonment for a period not	Fines

		exceeding one year, or to both such fine and imprisonment. The court may in addition impose a fine of SCR2000 for each . day which the default continues.]	
15	Algeria	Law n ° 19-14 of 14 Rabie Ethani 1441 corresponding to 11 December 2019 on the law of finances for 2020 for the Ministry of the Environment and Renewable Energies foresees:	Title
		1- ecological taxes: "Art. 117. - A tax is instituted on polluting or dangerous activities for the environment .... (unchanged until):	Bag Policy
		Art. 53. - A tax of 200 DA per kilogram is established on plastic bags imported and / or produced locally. The proceeds of this tax are allocated as follows: - 73% to the state budget; - 27% to the National Environment and Coastal Fund. The terms of application of the provisions of this article are specified by regulation	Tax
16	Botswana	Waste Management (Plastic Carrier commencement Bags and Plastic Flat Bags Prohibition) Regulations, 2018	Title
		3. (1) A person who manufactures, trades, imports, possesses or for commercial purposes distributes a plastic carrier bag or plastic flat bag, for use in Botswana, commits an offence	Bag Policy
		(2) The prohibition in sub regulation (1) shall not apply to — (a) bread bag; (b) plastic bin liner; (c) barrier bag; (d) plastic refuse bag; and (e) primary packaging.	Exemptions
		5. A person who contravenes these Regulations commits an offence and is liable — (a) for a first offence, to confiscation of the plastic carrier bag or plastic flat bag possessed in contravention of the provisions of these Regulations; and (b) for a second or subsequent offence, to a fine not exceeding P5 000 or to a term of imprisonment not exceeding 30 days; or to both.	Fines
17	Cape Verde	Law No. 99/VIII/2015	Title
		Article 1 Object1. The object of the present diploma is the prohibition of production, from import to marketing and use of conventional plastic bags for packaging	Bag Policy
		Article 1 2. The present diploma also disciplines the application of measures aimed progressively at the reduction of amount of the same plastic bags in the environment or its replacement by degradable bags and/or biodegradable and compostable that are compatible with the minimization of waste generation and disposal.	Biodegradability
		Article 2 Scope of application Article 2 1. The bags of plastic for the packaging of goods, other than reusable, supplied in wholesale or retail trade.	Product Definition
		Article 2 2. The following are outside the scope of application of the present diploma: a) Degradable and biodegradable bags whose non-care for the environment is properly attested by the central environmental service; and b) Plastic bags used exclusively to store fish, meat and poultry. fresh mestica or its fresh products, fruits and vegetables as well as ice	Exemptions
		Article 4 subjective incidence The agents are subject to this diploma. economics with registered office or permanent establishment in the national territory, that practice so much commerce to wholesale as retail, formal or informal, or engage in industrial activity	
		Article 5 Interdiction of production and import The production and import of plastic bags are banned in the national territory from the 1st of July2016.	Ban
		Article 6Prohibition of marketing and use The marketing and use of plastic bags conventions are prohibited in the national territory to from January 1, 2017	Ban

		Article 7 Prohibition of free distribution1. Conventional plastic bags, except for biodegradable, cannot be distributed free of charge. mind in any commercial establishment of sale to the public.2. About each conventional plastic bag supplied these establishments are of an importance whose maximum amount will be determined by order of Member of the Government responsible for the Environment, under pro-post of the Superior Council of Chambers of Commerce, to be paid by the consumer who requested it.3. The amount charged to the consumer for the purchase of conventional plastic bags has to be broken down, per bag purchased, on the receipt given to it.	Ban
		Article 8Conditioning of production and import of bagsplastic1. The production and import of plastic bags cam subject to the prior authorization of the central service. environment	Source Registration
		2. The request for authorization must be substantiated and present the modalities of waste management of-from the use of plastic bags	EPR
		Article 9Prohibition of commercial advertising1. Commercial advertising is not allowed on bags of conventional plastic, which, in addition to the logo or commercial or corporate name of the establishment which supplies them, in an area not exceeding twenty percent of its total, only contain printed information that is intended to raise awareness among consumers not to use conventional plastic bags and encourage reuse and recycling.2. Plastic bags must be bet information on whether or not they are biodegradable.3. The environment's central service performs at least one once a year and on all the islands, a campaign to raise awareness.to reduce the consumption of plastic bags.	Awareness Campaigns Source Labelling
		Article 12reduction targets1. Economic agents producing or importing should, as appropriate, progressively reduce the production and import of plastic bags.2. The percentage rate of reduction referred to in the previous number should reach :a) 60% in 2015;b) 100% on July 1, 2016	Reduction Target
		Article 13Replacement Measures To fulfill the goals and objectives set out in the previous article, the economic agents referred to in article 4.should promote, among others, the following measures :a) Availability of biodegradable bags;b) Provision of reusable bags ;c) Environmental awareness of employees and of consumers in order to promote the responsibility for protection the environment; and) Promotion of environmental awareness campaigns with consumers, with a view to separating ration of waste at source and its adequate referral within legal systems existing management tools	Awareness Campaigns
		Article 14Plastic bag reduction and replacement program1. The Government draws up a reduction and replacement program. plastic bag distribution consisting of :a) Measures to achieve the reduction target and replacement of plastic bag distribution conventional, by reusable bags ;b) Carry out dissemination and awareness campaigns on the rational use of degradable material and or non-biodegradable, for packaging. of products purchased at an establishment. commercial items for sale to the public ;c) Inform and train citizens about the possible alternatives that can replace then non-degradable plastic packaging and/or biodegradable; and) Promote the use of packaging materials. which are environmentally safe.	Awareness Campaigns
		Article 15Against ordinances and fines1. Non-compliance with the present diploma by economic agents, being punishable with the following fines :a) If practiced by natural persons, from50,000$00 (fifty thousand escudos) to400,000$00 (four hundred thousand escudos) and, in double, in case of recurrence; and b) If practiced by legal persons, 250,000$00(two hundred and fifty thousand escudos) to800,000$00 (eight hundred thousand escudos), and, in double, in case of recurrence.2. The provision of false statements within the scope of the tion provided for in number 2 of article 9 and in number 2 of the Article 8 constitutes an administrative offense punishable by a fine of100,000$00 (one hundred thousand escudos) to 500,000$00 (five-hundred-thousand escudos)	Fine
		Article 18environmental awareness1. Environmental associations must develop active consumer awareness campaigns on the importance of reducing bag consumption of conventional plastic, namely through there use and use of recycled bags and/or with lesser impacts on the environment.2. For the purposes of the preceding paragraph, they maybe developed economic incentive	Awareness Campaigns

		mechanisms to environmental associations, such as funding for lost fund by the Environment Fund to be projected. tending to the replacement of plastic bags	
		Article 21 awareness campaign The first awareness campaign referred to in paragraph 3 of article 9 shall be carried out in the maximum period of sixty days after entry into force of this diploma	Awareness Campaigns
18	Côte d'Ivoire	Decree No. 2013-327 of 22 May 2013 Prohibiting the production, import, marketing, possession and use of plastic bags	Title Bag Policy
		Article 2: The purpose of this decree is to prohibit the production, import, marketing, possession and use of plastic bags.	Ban
		Article 3: This decree aims to: Promote biodegradable packaging	Biodegradability
		Article 11: Any production industry, any company importing or marketing plastic bags, any holder of such packaging, must contribute or provide for the disposal of these bags, in accordance with the legislation in force.	EPR
		Article 12: Companies producing, importing, marketing plastic bags and users, have a period of six months to comply with the provisions of this decree from its entry into force.	Grace Period
		Decree No. 2013-803 of 22 November 2013 Prohibiting the production, importation, marketing, possession and use of plastic bags	Title
		Article 1: A new period of six months is granted to companies producing, importing, marketing plastic bags and plastic bag users, to comply with the provisions of Decree no. 2013-327 of 22 May 2013 prohibiting the production, importation, marketing, possession and use of plastic bags	Grace Period
19	Djibouti	Order No. 2016-284 / PRE of 20/04/2016	Title
		Article 1: The import and marketing of non-biodegradable plastic bags and packaging not produced in the national territory, are strictly prohibited from 1 May 2016 in the Republic of Djibouti.	Bag Policy Ban Biodegradable
		Done at Djibouti, the 20/04/2016	Grace Period
20	Republic of the Congo	Decree No. 2011-485 - Regulating Production, Import, Marketing and the use of Plastic Bags, Sachets and Plastic Films	Title
		Article 1: Production, import, marketing and the use of plastic bags for the sale of food, water and any other drink, are prohibited in the Republic of Congo	Bag Policy Ban
		Article 2: Production, import, marketing and use of plastic bags, bags and films called oxo-biodegradable are also prohibited.	Degrability Restrictions
		Article 3: Production, import, marketing and use are authorized: - plastic films for packaging or packaging hygienic products inside production units, especially handkerchiefs of paper, napkins and toilet paper	Exemption
		Article 5: Import, Marketing and Use of bags, films and raw materials referred to in Articles 3 and 4 of this Decree, are subject to obtaining a special authorization from the Minister responsible for trade.	Source Registration
		Article 6: The production of bags, sachets and films referred to in Article 3 of this Decree is conditioned by obtaining an approval issued by the Minister responsible for industry, upon presentation of a file comprising: - the identity of the applicant; - product specifications; - the impact study or the environmental audit	Source Registration
		Article 9: Fees for treatment/handling by the administration of products seized pursuant to Article 7 of this decree are the responsibility of the offender.	Fine

		Article 10: Producers, Importers and Distributors of bags, sachets and plastic films have six months from the date of the publication of this decree, to withdraw from the market any product referred to in Articles 1 and 2 of this decree.	Grace Period
21	Ethiopia	Solid Waste Management Proclamation no. 513/2007	Title
		8. Plastic Bags: 1/ As of the date fixed under a directive to be issued by the Authority, it shall be unlawful to put on the market any plastic bag that is not labeled to how whether it is biodegradable or not.	Labelling: Biodegradable
		2/ It is prohibited to grant permit for the manufacture or importation of any nonbiodegradable plastic bags with a wall thickness of 0.03 millimeters and less than 0.03 millimeters.	Ban: Thickness Source Registration
		3/ Without prejudice to Sub-Article (2) of this Article, the Authority shall, through the issuance of a directive, determine the conditions under which plastic bags with wall thickness of 0.03 millimeters and less than 0.03 millimeters may be imported or manufactured locally for specified purposes.	Exemption
22	Eritrea	The Legal notice for banning of plastic bags (notice No. 99/2004)	Title Bag Policy
		The notice states that polyethylene plastic bags that are not bio-degradable and their thickness with less than 100 micrometer are not allowed to be imported, produced, used and disposed.	Ban: Biodegradable Ban: Thickness
23	Gabon	Order No. 1489 / MECIT of June 16, 2010 Ban on import and marketing of non-recyclable plastic bags in the Gabonese Republic	Title
		Article 1. .- The present decree concerns the prohibition of importing and marketing of non-recyclable plastic bags in Gabon	Bag Policy Ban: Non-recyclable
		Article 2 .- Non-recyclable plastic bags present on the national territory must be imperatively and immediately removed from the production cycle or points of sale at later June 30, 2010.	Grace Period
24	Gambia	Ban on Plastic Bags Order, 2015	Title
		4. Prohibition and ban of the use of plastic bags A person who- (a) manufactures or imports; (b) uses; or (c) sells, plastic bags in The Gambia, commits an offence.	Bag Policy Ban
		5. Exceptional use of plastic packaging materials (1) The Chairman shall issue a Notice in the gazette to establish a list of plastic packaging materials that may be used in exceptional cases in The Gambia.	Exemption
		(3) An importer of packaging materials for exceptional use is responsible to return the waste to its source of origin or recycle it at his or her own cost.	EPR
		9. Offences and penalties (1) A person who contravenes this Order commits an offence and is liable on conviction, in the case of- (a) a manufacturer or an importer, to a term of imprisonment of not less than six months but not more than twelve months or a fine not less than two hundred thousand dalasis but not more than five hundred thousand dalasis or both the fine and imprisonment; (b) an individual who sells plastic bags, to a fine not less than two thousand dalasis but not more than five thousand dalasis; and (c) an individual who uses plastic bags, to a fine not less than one thousand dalasis but not more than three thousand dalasis.	Fines

		Annex: Schedules for exempted plastic packaging materials: 2. Plastic packaging materials whose uses are limited to storing, displaying, and shipping of perishable items such as: i. fish ii. Meat iii. milk products iv. Bread v. biscuits/sweets	Exemption
25	Kenya	Gazette Notice No.2356	Title
		This notice banned the use, manufacture and importation of all plastic bags used for commercial and household packaging defined as follows: (a) Carier bag - bag constructed with handles, and with or without gussets; (b) Flat bag - bag constructed without handles, and with or without gussets	Bag Policy
		2. Category 2: Flat bags Flat bags used for carrying items outside industrial setting e.g. groceries, garbage, are banned. However, in this category EXEMPTION is extended for bags used for industrial primary packaging where the product is direct contact with the plastic and is done at the source.	Exemption: Primary Packaging
26	Lesotho	Customs & Excise Tariff 2018	Title
		SCHEDULE 1 PART 3 ENVIRONMENTAL LEVY	Bag Levy
		1. Any rate of environmental levy specified in this Section in respect of any goods shall apply to any such goods which are manufactured in the Republic or imported into the Republic.	Charge
		Carrier bags, with a thickness of 24 microns or more Flat bags, with a thickness of 24 microns or more (excluding immediate packings, zip-lock bags and household bags including refuse bags and refuse bin liners)	Product Definition
		Carrier bags, of other thermoplastic materials, with a thickness of 24 microns or more Flat bags, of other thermoplastic materials, with a thickness of 24 microns or more (excluding immediate packings, zip-lock bags and household bags including refuse bags and refuse bin liners)	Product Definition
27	Madagascar	DECREE N ° 2017-010	Title
		Article 1: In application of the general provisions of the updated Environmental Charter, the National Environment Policy for Sustainable Development, and the Basel Convention on control of transboundary movements of hazardous wastes and their disposal, this Order fixes the regulations of the prohibition of the production, the import, the marketing, the creation and the use of plastic bags on the national territory.	Bag Policy
		Article 3: All bags and plastic bags with a thickness less than or equal to 50 microns, whatever the density, size, shape and manufacturing are subject to the provisions of this Decree. However, plastic packaging incorporated into imported finished products or local products, bags made of plastic packaging for pharmaceutical products and plastic bags and bags used for sampling for analysis at the research laboratory or the medical laboratory are not covered by the provisions of this Decree. The name or distinctive emblem of the laboratory or pharmacy must appear on these bags and plastic bags.	Ban: Thickness Exemption
		Article 5: From 01 April 2017, the identity of the producer and the thickness in micron must appear on all plastic bags with a thickness greater than 50 microns circulating on the national territory. The words "to be reused to preserve our environment" must also appear on these products. For plastic bags over 50 microns thick imported, the identity of the distributor Madagascar must be mentioned.	Source labelling
		Article 6: In case of import, without prejudice to the customs penalties that may be taken against them, importers of plastic bags covered by Article 3 of this Decree are obligated return these products to the country of origin within a maximum of 30 days, at their expense. In the event of a repeat offense, an exclusion for a fixed period of time from the authorization to import or export is pronounced. In the event of production of the plastic bags referred to in Article 3 of this Decree, the Ministry responsible for industry suspends the activity, the temporary or permanent closure of the establishment in compliance with the legislation in force. In the case of marketing or stockpiling of plastic bags and bags referred to in Article 3 of decree, notwithstanding the penalties provided by Law	Fines

		No. 2015-014 of 10 August 2015 on guarantees and consumer protection, the Ministry of Commerce carries out the of activity, temporary closure of the establishment.	
		Article 7: In collaboration with the stakeholders, the Environment Ministry Will carry out education and awareness-raising activities for the general public on the negative impacts of in plastics on human health and the environment and lead development actions and eco-citizenship.	Awareness Campaigns
		Article 8: A transitional period is granted until 31 March 2017 for marketing and use plastic bags and bags not exceeding 50 microns in thickness, without straps or handles.	Grace Period
28	Malawi	Environment Management citation (Plastics) Regulations, 2015.	Title
		3. The importation, manufacture, tratde and commercial distribution of plastics, plastic bags and plastic sheets made of plastic film with a wall thickness of less than sixty micrometres is prohibited for use within Malawi.	Bag Policy Ban: Thickness
		4. The following plastics made of plastic film are exempted from the prohibition set out in regulation 3- (a) plastic bread wrapping; (b) plastic bags, plastic wrap and plastic sheets used solely to contain or wrap- (i) fresh meat and fresh meat products; (ii) fresh fish and fresh fish products; and (iii) fresh poultry and fresh poultry products; whether pre-packaged or not; (c) plastic bags used as primary packaging solely used to package-- (i) fruits or nuts; (ii) confectionary products; (iii) dairy products; (iv) cooked food whether hot or cold; (v) liquid or frozen products; (vi) seeds; (vii) small hardware items; (viii) medicinal products; and (ix) veterinary products; (d) polythene tubes for seedlings; (e) laundry dry cleaning bags; (f) plastic bags used in waste storage and disposal such as bin liners and refuse; and (g) any other plastic bags that the Minister may designate as exempt from the ban.	Exemptions
		5.—(1) Each plastic bag shall have printed on it in English and a local language, the following information- (a) the name and registration number of the manufacturer; and (b) thickness of the plastic bag. 5.(2) Each recyclable plastic bag shall have written on it the words "recycled" or "reusable" or symbol indicating that it is recyclable or reusable.	Source labelling
		6.—(1) Any person who imports, manufactures, trades or engages in commercial distribution of plastics, plastic bags and plastic sheets made of plastic film with a wall thickness of less than sixty micrometres, commits an offence and on conviction, shall be liable to imprisonment for a tenn of three months	Fines
29	Mauritania	Decree No. 2012-157 of 21 June 2012 Prohibiting the Manufacture, Importation, Marketing and Use of Flexible Plastic Bags and Bags	Title
		In accordance with the provisions of Articles 3, 6, 8, 9, 26 and 30 of the Framework Law on the environment n ° 2000-045 of July 26 2000, the purpose of this decree is prohibition of import, manufacturing, marketing and the use of plastic bags used to package and carry products.	Bag Policy
		Article 3: Prohibition It is forbidden throughout the territory of the Islamic Republic of Mauritania import, manufacture, marketing and use of bags and flexible plastic bags for packaging.	Ban
		Article 5: Fines Violations of the provisions of Article 3 of this decree shall be the subject fines defined as follows: Importing or manufacturing results in the fine provided for in Article 91 of the Framework Law on the environment n ° 2000-045 of the 26 July 2000, an amount of from 10,000 to 1,000,000 Ouguiyas; Sales will be liable the fine provided for in Article 90 of framework law on the environment No. 2000-045 of 26 July 2000, that is an amount ranging from 5000 to 500,000 Ouguiyas; Consumers will be liable the fine provided for in Article 89 of framework law on the environment No. 2000-045 of 26 July 2000, that is Official Gazette of the Islamic Republic of Mauritania July 30, 2012 1268 735 an amount ranging from 3000 to 200,000 Ouguiyas.	Fine

		Article 6: transitional provisions Importers, manufacturers, distributors and bag users have a period of six (6) months from the entry into force of the this decree, to sell their products.	Grace Period
30	Morocco	Law No. 77-15 prohibiting manufacturing, import, export, marketing and use of plastic bags.	Title
		Article 1. 2. Bags made of plastic: bags, with or without handles, plastic compounds, which are provided, expensive or free, to consumers in sale of goods, goods or services, for packaging their goods;	Product Definition
		Article 2 As of July 2016, manufacturing is prohibited bags of plastics, as provided for in paragraph 2 of Article 1 above, as well as their import, export, their retention with a view to sale, their implementation sale, sale or distribution, even for free.	Bag Policy Ban
		Article 3 Excluded from the prohibition provided for in Article 2 above, plastic bags for industrial or agricultural use, Isothermal plastic bags, bags made of plastic freezing or deep-freezing plastics and those used for the collection of waste as defined in paragraphs 3, 4, 5, 6, 7 and 8 of article 1 above.	Exemption
		Article 4 The plastic bags referred to in paragraphs 3, 4, 5, 6, 7 and 8 of Article 1 above, can only be used for the purposes for which they are intended. They must, according to their destination or their category, wear a mark or print according to the terms and conditions laid down by regulation.	Source labelling
		Article 9 Anyone who makes the bags in materials plastics referred to in paragraph 2 of Article 1 of this law is punishable by a fine of 200,000 to 1,000,000 of dirhams. Article 10 Anyone who holds plastic bags referred to in paragraph 2 of Article 1 of this Law sell them, and put them on sale, or sell them or sell them distributed, for a fee or free, is punished by a fine from 10,000 to 500,000 dirhams. Article 11 Is punished with a fine of 20,000 to 100,000 dirhams anyone who uses plastic bags, vises in paragraphs 3, 4, 5, 6, 7 and 8 of Article 1 above, for purposes other than those for which it is intended.	Fine
		Article 15 From the date provided for in Article 2 above, this law repeals and replaces Law No. 22-10 concerning the use of degradable plastic bags or biodegradable promulgated by the Dahir No. 1-10-145 of 3 chaabane 1431 (July 16, 2010). The text in Arabic has been published in the general edition of the "Official Bulletin" No. 6420 of 28 Safar 1437 (December 10, 2015).	Transition
31	Mozambique	Decree No. 16/2015: Regulation on Management and Control of the Plastic Bag	Title
		The ARTICLE 2(Object) The purpose of this Regulation is to establish rules and procedures relating to the management and control of the plastic bag, with regard to its production, importation, commercialization and use, with a view to reducing negative impacts on human health and the environment in general	Bag Policy
		The RTICLE 4(Prohibitions)1. Under the terms of these Regulations, it is prohibited to: a) The production, import, retail sale or thick plastic bag whose thickness is less at 30 micrometers; b) The free distribution of plastic bags in all places where the commercial activity is carried out; c) The marketing or distribution of plastic bags that contain more than 40% recycled material in establishments that sell products food	Ban: Thickness
		2. It constitutes an exception to the provisions of subparagraph a) of paragraph above, the plastic bag used for weighing products food stuffs and specifically used for package in urban solid waste.	Exemption
		The ARTICLE 5(Production, use and marketing of plastic bag) 4. Without prejudice to the provisions of the Mozambican Standard above, the producer must label the plastic bag produced following the instructions below: a) Company name and/or logo; b) Physical address; c) Product characteristics including volume, material used, plastic symbol, thickness and, if it contains recycled material, indicate its percentage	Source labelling Charge

		The RTICLE 6(Skills) 3. It is incumbent upon the Ministry that oversees the area of Industry and Commerce :a) Licensing and the activities of production and commercialization of the plastic bag. b) Register entities that produce, sell and import plastic bags.	Source Registration
		The RTICLE 7(Offenses and Penalties)1. Violations of the provisions of this Regulation are subject to the following fines: a) Production of the plastic bag whose thickness is less to 30 micrometers - Fine in the corresponding amount to 40 minimum wages; b) Import of plastic bags whose thickness is less to 30 micrometers - Fine in the corresponding amount 80 minimum wages; c) Retail or wholesale sale of plastic bags less than 30 micrometers – Fine of 50minimum wages; d) Free distribution of the plastic bag - Fine in the amount corresponding to 25 minimum wages e) No separate indication of the price of the plastic bag in relation to the price of the products - Fine on the value corresponding to 30 minimum wages ;f) Distribution of the plastic bag that contains above40% recycled material in establishments that sell food products – Fine in value corresponding to 60 minimum wages	Fines
		2. They come into force 180 days after the publication of this Decree, the rules relating to:	Grace Period
32	South Africa	No. R. 625 of 2003 Regulations under section 24(d) of the Environment Conservation Act (No. R. 543 of 2002) / Plastic Carrier Bags and Plastic Flat Bags	Title
		The manufacture, trade and commercial distribution of domestically produced and imported plastic carrier bags and plastic flat bags, for use within the Republic of South Africa, other than those which comply with paragrap4h sa nd 5 of the Compulsory Specification, is hereby prohibited	Bag Policy Ban
		Offences and penalties 3. (1) Any person who contravenes regulation 2 shall be guilty of an offence and liable on conviction- (a) to a fine; or (b) to imprisonment for a period not exceeding 10 years; or (c) to both such a fine and such imprisonment; and (d) to a fine not exceeding three times the commercial value of anything in respect of which the offence was committed. (2) Any person convicted of an offence in terms of these regulations and, who after such conviction, persists in the act or omission which constituted such offence, shall be guilty of a continuing offence and be liable, on conviction, to a fine or to imprisonment for a period not exceeding2 0 days or to both such fine and such imprisonment in respect of every day on which such offence continues.	Fines
		Compulsory Specification 4.2 Film thickness - When the film thickness of a plastic carrier bag or flat bag is measured in accordance with 6.1, no individual thickness measurement shall be less than 24 microns 5 Printing requirements - Not relevant	Thickness Ban
33	Uganda	Act 5 The National Environment Act 2019	Title
		76. Management of plastics and plastic products. (1) The import, export, local manufacture, use or re-use of categories of plastic carrier bags or plastic products made of polymers of ethene (polythene) and propylene (polypropylene) is prohibited, except for plastic carrier bags or plastic products made of polymers of ethene (polythene) and propylene (polypropylene) of above thirty microns and those listed under Schedule 9	Bag Policy
		(3) A person who manufactures or imports plastics or plastic products shall as a precondition for continued operation— (a) ensure that recycling is part of that person's active operations; (b) label the plastics or plastic product; and (c) put in place a mechanism that is satisfactory to the Minister to buy back or remove from the environment plastic and plastic products.	Source labelling Recycling EPR

34	Tanzania	Environmental Management (Prohibition of Plastic Carrier Bags) Regulations, 2019	Title Bag Policy
		4. The objectives of these Regulations are to- (a) impose a total ban on the import, export, manufacturing, sale, and use of plastic carrier bags regardless of their thickness;	Ban
		8. Any person who imports, exports, manufactures, sells, stores, distributes, supplies, possesses and uses plastic bags and plastic wrappings in contravention of this Part commits an offence and shall, upon conviction be liable, in case of- (a) manufacturing or importation, to a fine of not less than twenty million shillings but not exceeding one billion or to imprisonment for a term not exceeding two years or to both. (b) exportation, to a fine of not less than five million shillings but not exceeding twenty million or to imprisonment for a term not exceeding two years or to both (c) storing, supplying and distributing to a fine of not less than five million shillings but not exceeding fifty million or to imprisonment for a term not exceeding two years or to both. (d) selling, to a fine of not less than one hundred thousand shillings but not exceeding five hundred thousand shillings or to imprisonment for a term not exceeding three months or to both. (e) possessing and using to a fine of not less than thirty thousand shillings but not exceeding two hundred thousand shillings or to imprisonment for a term not exceeding seven days or to both.	Fines
		9. Without prejudice to the provisions of regulation (5), plastic or plastic packaging for medical services or industrial products or construction industry or agricultural sector or food processing or sanitary and waste management are exempted from the prohibition.	Exemption
		12. Subject to regulation 6, any person who imports, manufactures, supplies, or sells commodities wrapped in plastics shall ensure that the plastic wrappings are managed or disposed of in accordance with the Environmental Management (Solid Waste Management) Regulations, 2009.	EPR
35	Tunisia	Decree no 32 of January 16, 2020, fixing the types of plastic bags whose production, import, distribution and possession are prohibited on the domestic market	Title
		Article 1 - This government decree fixes the types of plastic bags including the production, import, distribution and possession are prohibited in the lower market	Bag Policy
		Art. 3 - The production, import, distribution and domestic possession of the following types are prohibited of plastic bags:- single-use plastic bags,- primary packaging bags with a thickness greater than 15 microns,- oxodegradable or oxo-fragmentable plastic bags, as well as bags marked "biodegradable bag" whose tests and analyzes show that they do not meet the biodegradation requirements,- plastic bags which include in their chemical composition a total concentration of heavy metals greater than 100 ppm. This threshold may be revised, if necessary, by order of the Minister responsible for the environment,- plastic bags intended to come into contact with foodstuffs which do not meet the requirements of the aforementioned decree n ° 2003-1718 of August 11, 2003,- plastic bags not bearing the marking mentioned in article 4 of this government decree.	Thickness Ban Degradability restrictions
		Art. 4 - All types of plastic bags that are permitted, in accordance with the provisions of this decree, to produce, import, distribute and hold on the domestic market bear a marking, compulsorily affixed by their producers and importers. This marking must be visible, permanent and written in the Arabic language, with the possibility of adding another language. He must also include in particular the following data:- the name of the manufacturer or importer and the date of manufacture,- the materials of manufacture, dimensions, thickness and capacity.- the bag management methods after their use,- the words "biodegradable bag" and the reference of the relevant standard or technical regulation. Art. 5 - This government decree comes into force as of:- March 1, 2020 for shopping centers and pharmacies,- January 1, 2021 for all producers, importers, distributors and holders of plastic bags	Source labelling
		Art. 5 - This government decree comes into force as of:- March 1, 2020 for shopping centers and pharmacies,- January 1, 2021 for all producers, importers, distributors and holders of plastic bags	Grace Period
36	Sao Tome	Law No. 8/2020 On Measures to Reduce the Use of Plastic Bags in São Tomé and Príncipe.	Title

		Chapter I General Provisions Article 1 Object The purpose of this Law is to prohibit the production, import, marketing and distribution of non-biodegradable plastic bags in the National Territory.	Bag Policy biodegradable ban
		Article 1 2. Plastic film (adherent) intended for packaging fish, meat, chicken or their fresh products, fruits, vegetables and ice are excluded from the scope of application of this Diploma.	Exemption
		Article 1 3. This Diploma applies to conventional plastic bags for packaging, namely bags with or without sleeves and garbage bags, as defined in paragraph b) of the following article. Article 3 Definitions For the purposes of this Diploma, it is defined as: a) «Plastic bags», disposable packaging provided free of charge or not by economic agents, with the aim of containing or allowing the transport of goods purchased there; b) 'conventional plastic bags' means bags polyethylene of chemical formula (-CH2-CH2-), high density (HDPE) and low density (LDPE) which are intended for packaging products purchased from commercial operators;	Product Definition
		Article 5 Market Measures Market measures aimed at reducing the use of conventional plastic bags are as follows: a) Prohibition of its production; b) Prohibition of its importation; c) Increase in the customs duty on imports; d) Incentives for the import and production of products alternatives; e) Prohibition of free distribution.	Charge
		Article 6 Awareness-raising actions Awareness actions are taken to reduce the use of conventional plastic bags.	Awareness
		Article 20 Illegal production or manufacturing The illegal or clandestine production of plastic bags, that violates the provisions of article 19 of this Law, is punished with a fine of 10,000.00 to 45,000.00 dobras. Cumulatively, the advisory sanction of closure of the production site and loss of objects instruments and utensils used in production in favor of the State. Article 22 Commercialization Marketing of non-biodegradable plastic bags is punishable by a fine of 10,000.00 dobras to 100,000.00 dobras, when practiced by a legal person maximum penalty is applied. Article 23 Free distribution of plastic bags forbidden 1. Free distribution of plastic bags in violation of the provisions of this Diploma is punished with fine of 1.100, 00 dobras, in the case of natural persons, and 7.500,00 dobras, in the case of legal persons. 2. Recidivism in the practice of free distribution entails the imposition of a fine in the amount of 2,500,000 dobras, for natural persons, and 25,000.00 folds, for legal persons, plus the loss to favor of the State of all plastic bags stored by the offender. Article 24 Rejection of plastic bags The rejection of plastic bags, in places that are not either at the designated collection or recovery points for this purpose, is punished with a fine of 1,000 to 30,000 folds.	Fine
		Article 28 Implementation This Law enters into force from 1 January of the year 2021. The National Assembly, in São Tomé, on 11 August 2020. - The President of the National Assembly, Delfim Santiago das Neves. Enacted on September 04, 2020.	Grace Period
37	Niger	Law No. 2014-63 of 5 November 2014 banning the production, import, sale, use and storage of bags and wrapping of low density flexible plastic, and its implementing Decree No. 2015-321 PRN/MESU/DD of 25 June 2015. Original text not found	Title / Bag Policy/Ban
38	South Sudan	Policy title and document unavailable - Policy documented Kwori, M. W. (2019). South Sudans ban of plastic carrier bags: An empirical move or an emulation?. City and Environment Interactions, 2, 100019. Original text not found	No Title Bag Policy Ban
39	Guinea Bissau	Policy Title and document unavailable - Policy widely documented in publications Original text not found	No Title Bag Policy Ban

Supplementary document 3.1. Waste Survey Questionnaire

A. Demographic Factors

1. Geographic location	☐	Urban	☐	Rural					
2. Gender	☐	Male	☐	Female					
3. Marital Status	☐	Single	☐	Married	☐	Divorced			
4. Age	……..								
5. Household Size	☐	1-2 people	☐	3-4 people	☐	5-6 people	☐	7+ people	
5. Education Level	☐	Primary	☐	High School	☐	College/ University	☐	Masters	☐ PhD
6. Occupation	☐	Agriculture/ Farmer	☐	Self Employed	☐	Government Official	☐	Enterprise Employee	
	☐	Casual laborer	☐	Retiree	☐	Unemployed	☐	Other	
7. House Hold Income Level	☐	Less than 10,000	☐	10,000 – 24,999	☐	25,000 – 39,999	☐	40,000 – 54,999	
	☐	54,999+							

B. Shopping Patterns and Habits

1. Who does major shopping in your household? ☐ Myself ☐ Family member

2. Where do you and your family do your household shopping? (Choose all that apply)

☐ Departmental store e.g. Two Rivers ☐ Supermarket ☐ Open air market

☐ Local shop ☐ Greengrocers ☐ Online Shopping

3. Has your shopping frequency changed since the introduction of the plastic bag ban (since 2017 August) ?

☐ Increased ☐ Same ☐ Reduced

4. Kindly select your household shopping frequency pattern from the table below? Please select in all shopping places that apply

Shopping place	Once a day	Several times a day	2-3 times a week	Once a week	Once a month	Other Please comment
Departmental store						
Supermarket						
Open air market						
Local shop						
Greengrocers/Mama Mboga/Food takeout						
Online shopping						

B. Guided Recall on Plastic Carrier Bags Before the Ban

1. How many bags were you receiving in each shopping trip?

Shopping Place	 Branded Supermarket Bag	 Big Black Bag	 Small Black Bag	 Big Blue/Yellow Bag	 Thin Plastic Bag
Departmental store					
Supermarket					
Open air market					
Local shop					
Greengrocers/Mama Mboga/Food takeout					
Online shopping					

C. Previous plastic carrier bag use after reception

1. How many plastic bags did your household use for the following functions in a week?	
Reuse for shopping per week	
Reuse as waste bag (putting waste) per week	
Discard as waste per week	
Keep in the house per week	
Other reasons ……..	

D. Reusable bags

How many reusable bags did you possess before the ban?	
How many reusable bags do you currently possess?/Cotton bag	
How many reusable bags do you currently possess?/ Plastic based bag	
How many reusable bags do you currently possess? / Locally fabricated (sisal, banana)	
How many reusable bags do you currently possess?/ Other material	
After how long do you discard your reusable bag? (1) Not yet (2) 1-3 months (3) 4-6 months (4) 1 year (5) Not Applicable	Cotton bag . Plastic based bag . Sisal/Banana . Other Material .

E. Waste Disposal

1. What do you use to put your waste before discarding?
   - ☐ Special waste plastic bag
   - ☐ Shopping plastic bag
   - ☐ Drum
   - ☐ Other
2. After the ban, how easily do you access special plastic bag for waste?
   - ☐ Easy
   - ☐ Normal
   - ☐ Difficult

F. Perceptions and attitudes towards ban

1. The plastic bag ban covers branded supermarket plastic bags, unbranded plastic bags without handles and plastic bags without handles. Do you support the ban?
   - ☐ Yes ☐ Neutral ☐ No
2. Do you think the ban has lead to a cleaner environment?
   - ☐ Yes ☐ Neutral ☐ No
3. Has the ban improved your awareness on waste management and plastic pollution?
   - ☐ Yes ☐ Neutral ☐ No
4. Normally, do you take your own shopping bags or buy when shopping?
   - ☐ Take own ☐ Buy from store ☐ Both ☐ Other: Specify
5. How many times do you forget to take your own bags when shopping?
   - ☐ Rarely ☐ Sometimes ☐ Always
6. How often do you not take enough bags to carry your shopping?
   - ☐ Rarely ☐ Sometimes ☐ Always
7. When you forget your own bags or don't take enough, what do you generally do?
   - ☐ Buy from store ☐ Carry by hand ☐ Other: Specify_____.
8. Have you seen/met traders with plastic bags since the ban came into the force?
   - ☐ Yes ☐ Neutral ☐ No
9. Do you still receive plastic bags from traders?
   - ☐ Yes ☐ Neutral ☐ No

G. Knowledge and use of bioplastic bags

1. Do you use bioplastic bags for shopping?
   - ☐ Yes ☐ No ☐ Not Sure
2. Do you use bioplastic bags as waste bags?
   - ☐ Yes ☐ No ☐ Not Sure
3. Do you use bioplastic bags for agriculture?
   - ☐ Yes ☐ No ☐ Not Sure
4. Can you differentiate between bioplastic bags and conventional plastic bags
   - ☐ Yes ☐ No ☐ Not Sure

Consumption of Single Use and Common Plastic Products.

Please select the product usage frequency in your household and state the quantity used?

PET Bottle 500ml (Water/Soda/Juice) /soda mwala		PET Bottle 1-1.5 Litres (Water/Soda/Juice)		PET Bottle 2 Litres (Water/Soda/Juice)	
	1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____
Milk Sachets		Food Wrappers/Sachets		Bread	
	1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____	 (Sweets/snacks/royco etc)	1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____
Straws		Yoghurt Cups		Soap Sachets (100g)	
	1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____
Plastic cups		Plastic Plates		Wrapped nonfood products	
	1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____		1. Usage ☐ Daily ☐ Weekly ☐ Monthly 2. Quantity Used _____

Has your household shopping frequency for self-dispensed or loose goods changed since the plastic bag ban?
(Examples: Milk from vending machine or liquid soap from vendor)

☐ Increased	☐ Same	☐ Reduced	☐ I don't purchase

Please select the most suitable answers if you purchase the following products from shop dispensers or product vendor

Product	I purchase	I do not purchase	When buying, I use my container	When buying, I also buy container	Product is sold with container
Milk					
Liquid Soap					
Cereals (Rice, beans)					
Cooking Oil (Salad)					
Kerosene					

D. Reusable bags

How many reusable bags did you possess before the ban?	
How many reusable bags do you currently possess?/Cotton bag	
How many reusable bags do you currently possess?/ Plastic based bag	
How many reusable bags do you currently possess? / Locally fabricated (sisal, banana)	
How many reusable bags do you currently possess?/ Other material	
After how long do you discard your reusable bag? (1) Not yet (2) 1-3 months (3) 4-6 months (4) 1 year (5) Not Applicable	Cotton bag_____ Plastic based bag _____ Sisal/Banana_____ Other Material_____

E. Waste Disposal

1. What do you use to put your waste before discarding?
   - ☐ Special waste plastic bag
   - ☐ Shopping plastic bag
   - ☐ Drum
   - ☐ Other
2. After the ban, how easily do you access special plastic bag for waste?
   - ☐ Easy
   - ☐ Normal
   - ☐ Difficult

F. Perceptions and attitudes towards ban

1. The plastic bag ban covers branded supermarket plastic bags, unbranded plastic bags without handles and plastic bags without handles. Do you support the ban?
   - ☐ Yes ☐ Neutral ☐ No
2. Do you think the ban has lead to a cleaner environment?
   - ☐ Yes ☐ Neutral ☐ No
3. Has the ban improved your awareness on waste management and plastic pollution?
   - ☐ Yes ☐ Neutral ☐ No
4. Normally, do you take your own shopping bags or buy when shopping?
   - ☐ Take own ☐ Buy from store ☐ Both ☐ Other: Specify
5. How many times do you forget to take your own bags when shopping?
   - ☐ Rarely ☐ Sometimes ☐ Always
6. How often do you not take enough bags to carry your shopping?
   - ☐ Rarely ☐ Sometimes ☐ Always
7. When you forget your own bags or don't take enough, what do you generally do?
   - ☐ Buy from store ☐ Carry by hand ☐ Other: Specify_____.
8. Have you seen/met traders with plastic bags since the ban came into the force?
   - ☐ Yes ☐ Neutral ☐ No
9. Do you still receive plastic bags from traders?
   - ☐ Yes ☐ Neutral ☐ No

G. Knowledge and use of bioplastic bags

1. Do you use bioplastic bags for shopping?
   - ☐ Yes ☐ No ☐ Not Sure
2. Do you use bioplastic bags as waste bags?
   - ☐ Yes ☐ No ☐ Not Sure
3. Do you use bioplastic bags for agriculture?
   - ☐ Yes ☐ No ☐ Not Sure
4. Can you differentiate between bioplastic bags and conventional plastic bags
   - ☐ Yes ☐ No ☐ Not Sure

Clarify if yes _____