KROK UNIVERSITY

Department of International Business

Program Subject Area: Management

Educational Program: Management

UDC005.936.5

BACHELOR'S THESIS

on the topic:

"WASTE MANAGEMENT IN COCA COLA COMPANY"

Bachelor's degree student	Scientific advisor:
Group MEH (англ)-19-ін Associate	Ph.D. in Management Sciences, Professor
Oluwanifemi Olorunjube Ebenezer.	Volodymyr Tokar
(student's full name)	(supervisor's full name)

_____ **11-12-2023** _____

(student's signature) (date) (signature)

Preliminary defense:

_____

(Resolution: "For defense in the state examination commission")

Head of Department

_____ _____ _____

(signature) (name, surname) (date)

Kyiv – 2023

DECLARATION OF HONOR

“I declare on my word of honor that I have written this paper on my own and that I have not used any sources or resources other than stated and that I have marked those passages and/or ideas that were either verbally or textually extracted from sources. This also applies to drawings, sketches, graphic representations as well as to sources from the internet.

The paper has not been submitted in this or similar form for assessment at any other domestic or foreign post-secondary educational institution and has not been published elsewhere. The present paper complies with the version submitted electronically.”

Date: 11 12 2023 Signature

PLAN

INTRODUCTION

Since plastic was first used in industrial production, the amount of trash produced by plastic has increased globally. The plastic that was mishandled and frequently found its way into the world ocean gave rise to the so-called "global plastic problem" rather rapidly. Typically, this globally significant issue has been approached from every angle: individuals opting to reduce the quantity of not recyclable containers (mostly single-use plastic) they buy, companies purchasing used plastic to recycle into a wide range of new products, supermarkets raising the price of plastic bags while lowering the price of paper bags, governments changing laws restricting the use of plastic, and so forth.

The blame is too frequently placed on the shoulders of the consumer, with an abundance of "green" advertisements bombarding us every day, sellers pressuring us, their customers, to select the greener products over the less green ones in their own stores, and manufacturers saying that consumers shouldn't purchase their goods if they are unwilling to recycle the plastic products they made.

Relevance of topic Effective waste management not only preserves the environment but also increases profitability. However, many producers are being forced to reassess their waste practices due to increasingly strict national and international legislation, even if they are not adequately motivated by these benefits. The most serious waste offenses carry prison penalties in nations like the United Kingdom and the United States of America. The Waste Framework Directive, which mandates that all waste be disposed of without endangering the environment or human health, mandates the licensing and regulation of waste management facilities, and establishes a comprehensive definition of waste that

includes materials going for recovery, are some examples of recent waste legislation from the European Union. Another example is the Landfill Directive, which was adopted in April 1999 and will end the landfill industry. the Packaging and Packaging Waste Directive, which requires businesses to decide for the recycling and recovery of sizable amounts of the packaging they handle and improve the standard of landfill management throughout the EU for the disposal of many biodegradable wastes—a goal that is viewed by many as dubious. The following distinguished academics have contributed significantly to the research of the waste management problem: Daniel H., Jutta G., and K. Ruediger.

The purpose of the work is a comprehensive study of the Beverage industry with Coca Cola being a case study with deep consideration into its environmental impact on humans in terms of pollution and other alarming impacts such as flooding.

The objective of the work is an outlook into the Coca Cola industry, and as well engaging their recent and previous approaches towards improving and protecting against environmental pollution in terms of waste management practices, a development of a pointer guide which will serve to protect the gross impact of the indiscriminate disposal of its waste in unwanted sites such as oceans and public grounds.

The object of the study is looking for ways to reducing or limiting the ill impact of waste derived from the Coca Cola industry on example of initiating diverse techniques (Waste recycling and sustainable practices) to such ends, which may include World without waste initiative, Plant bottle technology, recycling partnership, water stewardship and recycling packaging.

The subject of the study is the beverage industry of the world, with Coca Cola being the case study, and its environmental impact on example of plastic

pollution, resource depletion, greenhouse gas emission, landfill overflow and recycling challenges.

Overview of the problem. From a single product and one location, the Coca-Cola Company has expanded to over 500 brands in 200 countries worldwide (125 Years of Sharing Happiness). Figures that portray this expansion as beneficial ignore the negative environmental implications of global growth, such as waste, pollution, and resource depletion. Now that it has dominated the worldwide beverage market, Coca-Cola needs to review and accept accountability for the waste management it does with regard to water resources and packaging in order to sustain its success going forward and increase their market value because of the part they play in environmental sustainability.

To achieve this goal, the following issues that need to be addressed:

- to determine the gross impact of waste to the human society.
- to incur other diverse measures of limiting waste accumulation and build-up.
- to analyze the effect of inadequate waste management practices on brand name protection.
- to determine the current global methods incorporated to limiting waste disposal.
- to formulate measures which will help limit waste in later years to come.

Research methodology. Deduction, generalizations, analysis and synthesis, induction and abstraction, formalization, etc. Theoretically, examining the gathered data logically, come to certain conclusions, and make suggestions.

The following sources of information were used in writing the work:

- guides.
- electronic resources
- scientific journals

- web pages of waste management.

The work consists of an introduction, three sections and conclusions to them, one of which is theoretical and two – practical. The work ends with general conclusions, a list of used sources used and annexes.

SECTION 1. THEORETICAL ASPECTS OF WASTE MANAGEMENT IN COCA COLA

1.1 Need for waste management in the beverage industry

In the beverage business, waste removal has proven to be an extremely difficult task. There are many problems affecting the beverage industry. A unique issue is having a shorter shelf life than other producers during periods of high output. Despite the fact that several tactics have been implemented to reduce waste, they have not been able to live up to the expectations of the waste regulating organizations. The continual production of liquids for human use is the specialty of the beverage business. Because of the never-ending daily demands, production might be extremely difficult. Cans or bottles are used to package the drinks. This is a result of the production line's original design. Glass or plastic may also be used for the cans and bottles. The containers could be natural, standard, hot, or cold filled. Because of the fundamental characteristics of the liquid content, many elements are taken into consideration when producing containers. Certain drinks are catalyzed alcoholic upon request, while others are not. Diverse advancements in beverage plant architecture, beverage processing, and beverage packaging have been made in response to ongoing market demand specifications. Poor packing can take many different shapes. It might be the result of poor production facility design or human error. In either scenario, the monitoring bodies have an impact on product destruction. Over the years, there has been a never-ending search for improved beverage packaging. Since ancient times, a variety of beverages have been made using a range of packaging techniques. The 20th century saw the production of sodas and beer with notable acidity and relatively higher enclosure pressure. Because to internal liner technology, which prevented the flavor from deteriorating owing to chemical reactions with the metal can, they were made available in cans.

These in liners were made of plastic or waxy materials that could hold their shape for a very long time without breaking down or contaminating the can's liquid contents. There are differences in the degree of adulteration between various alcoholic and non-alcoholic beverages. Before the 20th century, drinks were served from barrels or cups. The need for less weight material led to the invention of cans in the 20th century. In contrast to glass bottles and barrels, cans were discovered to save space. The vintage beverage cans were not designed to be filled again after use and were constructed with crown cork rather than pull tabs. Because they are more resilient than glass bottles, which shatter readily when exposed to outside forces, cans with conventional pull tabs have replaced glass as the most common drinking container type worldwide.

Because canned beverages are factory sealed, a special tool is needed to open them before the contents may be consumed. For the standard cylindrical shape with flat top and bottom, a piercer, also called a church key, may be needed. The key has a finger-sized hole carved into the top rim of the can. By pulling out the key cuts, you can freely pour by accessing the air through the triangle hole engraved on the can top. Some of the twentieth-century cans were designed with caps that could be opened and emptied, just like a bottle. A tiny diameter cap was connected to a conical taper to form the top. The same crimped caps that were used on bottles and this necessary opening tool were used to seal the cans. The tops of the cans were called "cone tops" These cone tops were divided into three categories: j-spout, low profile, and high profile. The "crowntainer," which is composed of drawn steel and has a bottom cap, is an additional kind of beverage can. Crown Cork & Seal (now known as Crown Holdings, Inc.) designed these beverage cans. They are among the top manufacturers of drinks and cans. Cans and cone tops have been used by several beverage sectors up until now for product packaging. These drinks come in simple cylindrical cans that are easy for customers to handle and offer easy access to the beverage inside.

Located in the heart of our bustling city, this delightful pizza restaurant has gained a well-deserved reputation for creating the most delicious and tantalizing pizzas in the area... The growing awareness of waste reduction in the beverage industry has led to significant advancements in the sector. Various strategies have been implemented to ensure efficient optimization of beverage packaging by reducing waste. These efforts have involved the adoption of waste reduction standards that have been thoroughly and openly discussed between producers and consumers. Even with all the waste reduction strategies put in place, it is still challenging to get rid of the trash that is produced by the metallic taste of can beverage inner liners, especially in very acidic sodas. Distributors still, however, favor can beverages over glass bottles because of their practical size, weight, and shape, which facilitate storage and shipping. Can beverages also save customers time and hassle when returning glass bottles to shops for deposit reimbursement, which is another reason why many prefer them. In addition to bottles, other materials have been utilized for beverage packaging in recent times. In 2008, an aluminum container was designed to package Coca-Cola's Caribou Coffee beverage as an effort to minimize waste. Nowadays, aluminum is the primary material used for beverage cans in most parts of the world, especially in the United States. However, in many parts of Europe and Asia, more than half of the beverage cans are made of steel, with around 45 percent being made of aluminum alloy. Some steel cans even have aluminum tops. In certain regions, consumers collect and save their aluminum cans for bulk sale to scrap metal dealers, who recycle them by melting them down to create new cans. Thus, aluminum has proven to be a cost-effective material for manufacturing beverage cans in the industry.

Elements of a waste management strategy

Ensuring the safe and legal disposal of waste items is not the only aspect of effective waste management. The objective should be to attain the optimal

environmental solution for each waste stream, known as the Best Practicable Environmental Option (BPEO). A standard approach to industrial waste management may contain the following components.:

- initial audit of wastes produced (source, quantity, composition and hazards) and current waste management procedures

- risk assessment to ensure that storage and handling procedures do not present a health, safety or environmental risk

- investigation of opportunities for waste reduction, reuse, recycling and recovery - assessment of waste treatment options

- determination of Best Practicable Environmental Option for disposal of remaining wastes and treatment residues

- audit of potential waste management contractors and selection of the contractor offering the best service.

The foundation of waste policy in the European Union is the Waste Hierarchy, which aims to prioritize different methods of waste management. The most sustainable approach is to prevent waste generation altogether. In order to encourage this, waste producers are encouraged to prioritize higher-ranking options, such as recycling instead of landfilling. Some European governments have implemented economic measures, like taxes on landfill and incineration, to support this shift. There is a debate over where energy-from-waste incineration fits into the hierarchy; some believe it should be ranked alongside recycling, while others contend it should be classified as simple disposal. There is also discussion regarding whether composting should be classified as recycling or recovery. It is important to note that the hierarchy is a general guideline, and waste producers should carefully consider the characteristics of each waste stream before determining the Best Practicable Environmental Option (BPEO).

In certain cases, such as with bulky, inert demolition waste, landfill may be the most sustainable option, despite its position at the bottom of the hierarchy.

Geographical factors such as the distance to a reprocessing or energy-from-waste plant will also help to determine the BPEO. (Another important environmental principle, the Proximity Principle, directs that waste should be disposed of at the nearest suitable facility.)

Example of a waste management chain

Producer → Carrier → Transfer station or treatment plant → Disposal site

For the producer, this duty entails:

- packaging waste securely prior to collection

- ensuring that waste is only handed over to someone who is legally entitled to receive it, such as a contractor whose site is licensed to receive industrial waste

- preparing a detailed description of the waste, including its hazards, which will accompany it on its journey

- checking others in the waste chain, to ensure they are handling and disposing of the waste correctly. This often involves auditing the disposal site as well as a routine checking of credentials.

The issue of global plastic consumption and its terrible impact on the natural environment has garnered significant attention in recent years. From viral videos depicting turtles with plastic straws lodged in their noses to popular documentaries highlighting the pollution of our oceans, plastics clogging drains and killing marine life , awareness surrounding the environmental consequences of single-use plastics has grown exponentially. Consequently, both corporate and public policy campaigns have emerged, aiming to reduce consumer plastic usage.

In a notable move, the European Union recently implemented legislation (EU directive 2019/904) that imposes stricter restrictions on single-use plastic products, with a particular emphasis on packaging. Environmental organizations like Greenpeace have long advocated for reduced plastic consumption, but they argue that companies such as Coca-Cola, despite claiming to address plastic pollution, are complicit in perpetuating a misleading narrative: that recycling alone can solve the plastic crisis (Forbes/Greenpeace 2021, p. 3). These companies and businesses place the primary responsibility on plastic producers.

While Eurostat data reveals a plastic packaging recycling rate of 41.5% within the EU in 2018 (Eurostat 2020), the global long-term picture is far from promising. Shockingly, less than 10% of all plastic produced between 1950 and 2015 has ever been recycled (Geyer et al. 2017). Due to the non-biodegradable nature of most plastics, they accumulate rather than decompose, leading to near-permanent contamination of the natural environment (Geyer et al., p.1).

The 2019 EU directive on single-use plastic (2019/904 (5)) focuses even more that plastic makes up about 85% of all marine litter in the EU, of which 27% is fishing equipment and 50% is single-use plastic products. Plastics that end up in the ocean or other bodies of water break down into tiny pieces known as microplastics. These particles eventually contaminate food and drinking water for humans by making their way up the food chain.

The widespread concern over single-use plastics and their impact on the environment necessitates urgent action. While legislative measures are being implemented to restrict their use, it is crucial for both producers and consumers to actively participate in finding sustainable alternatives. Collaboration between the public, private sector, and environmental organizations is essential in combating the plastic crisis and preserving the natural world for future generations. Since a PET plastic bottle floating in water, exposed to heat and

sunlight has a half-life of 110 years (Geyer et al. 2017), much of the problems caused by plastics are visible, for example in the form of stranded macro-plastics, polluting beaches and therein also causing economic damages to tourism industries – exemplifying how plastic waste creates multifaceted and intertwined problems. According to Plastics Europe the segment “packaging” accounted for ~40% of the total demand for plastics in the EU (plus Norway and Switzerland) in 2019, making it the largest segment. Plus, most plastic only enters the recycling cycle once before being disregarded as waste. The idea and potential of a circular economy is therefore cut short Although a recycling rate of about 40% for the EU sounds high, one needs to be aware that this number only accounts for plastic packaging and excludes the plastic waste that is being exported from the EU. A dimension clearly visible from Eurostat data is the one of global waste trade. In 2020, the EU-27 states exported 3.4 times the amount of plastic waste to other countries than they imported. The global plastic problem therefore entails a significant social dimension as plastic (and other) waste is exported to less economically powerful countries like Vietnam, Malaysia or India. The export of plastic waste impacts vulnerable communities through the facilitation of largely unregulated waste management economies which expose workers to dangerous working conditions .

Plastic's deep ties to the fossil fuel industry have amplified the social and environmental consequences of practices like fracking. The surge in demand for plastic products has further exacerbated these issues. Large multinational corporations such as Coca-Cola often find themselves at the forefront of blame for the global plastic pollution crisis, with their recognizable branded plastic bottles often seen washing up on beaches or floating in the ocean.

In response to mounting pressure, these corporations have started addressing bottle recycling and exploring biodegradable plastics in their sustainability reports and marketing campaigns. However, critical documentaries

like "Plastic Tide: Choking on Coke" and "Seaspiracy" shed doubt on the efficacy of Coca-Cola's recycling efforts, portraying them as insufficient in the face of the plastic problem

While professionals in plastic science, international organizations, and environmentalists stress the seriousness of the global plastic crisis—which is mostly caused by single-use packaging and inadequate recycling methods—Coca-Cola seems to grasp the chance of making money from the problem. Presenting themselves fully committed to combating the plastic overflow and working to make their packaging as eco-friendly as possible, they advertise their intentions to roll out more ecologically friendly plastic packaging in the future.

At first glance, Coca-Cola's international website may give the impression that the company is doing everything within its power to minimize its environmental impact. However, examine carefully their efforts and initiatives reveals a more complex reality. The tension between the urgent need to address the plastic crisis and Coca-Cola's strategic response raises questions about the true extent of their commitment to sustainability.

As the world grapples with the consequences of plastic pollution, it becomes crucial to delve deeper into the actions and motivations of major corporations like Coca-Cola. By fostering a more nuanced understanding of their role, we can encourage greater accountability and drive the necessary changes to overcome the global plastic crisis. However, people who take a closer look, like environmentalist organizations, seem to be highly unimpressed by CC's sustainability efforts. Both sides of this debate seem to be communicating within at least two different frames of reference. Environmentalists are talking about a crisis. Coca-Cola is talking about an opportunity for improvement. From this observation, I derive my problem formulation: This project will investigate the external sustainability communication of the Coca-Cola Corporation regarding the issue of plastic from the perspective of crisis communication theory and aided

by deconstructive analysis in an attempt to identify the extent to and way in which the company is communicating the existence of a plastic crisis.

Through this problem formulation, it is the aim of this study to generate findings that give insights into the perception of a major environmental crisis, communicated by a transnational corporation, contributing to that crisis. The results might hence be used by businesses who seek to improve their sustainability efforts and communication to meet environmentalists' expectations. Such can be expected to become more relevant as impacts of social media campaigns and potentially following buycotts are unlikely to decline in the future. Although Coca-Cola is unlikely to lose much economic leverage in the near future, it needs to tailor its external communication to changing moral expectations to remain culturally relevant and acceptable. Moreover, the results may supply critics of corporate sustainability communication, who communicate in a crisis frame, with more understanding of the logics used by the corporations. Following, communication between these two groups might be improved based on the results as they might foster improved understanding of each side's frame of reference.

The concept of sustainability and sustainable development has been a topic of great interest in both research and public discourse for several decades. It gained significant attention after the release of the 1987 'Brundtland Report,' which emphasized the importance of intergenerational solidarity and defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Within the field of communication studies, scholars have developed various approaches to analyze and conceptualize how sustainability is communicated. One prominent area of study revolves around sustainability reporting, which examines how organizations disclose their sustainability practices and initiatives. Additionally, sustainability communication research, as

a sub-field within communication studies, focuses on the process of mutual understanding regarding the future development of society, with sustainability as its core vision.The literature on sustainability communication draws from a wide range of theories and disciplines, including media theory, systems theory, social constructivism, risk research, discourse analysis, and environmental psychology. These diverse perspectives contribute to a rich understanding of how sustainability is communicated and understood in different contexts.One crucial distinction made within this field is between communication of sustainability and communication about sustainability. The former refers to one-way communication from a communicator to a recipient, while the latter encompasses the multidirectional exchange of interpretations and knowledge about sustainability. Additionally, communication for sustainability focuses on the normative promotion of sustainable development, aiming to encourage positive change. Several central questions and dimensions are discussed in the field of sustainability communication. One prominent area of focus is communication for sustainable consumption, exploring how messages can influence consumer behavior towards more sustainable choices. Another critical aspect is the issue of greenwashing, where businesses may falsely claim and promote their sustainability efforts without substantial action by decieving their customers to rise up in the corporate scale. Moreover, the field of sustainability communication continuously examines how sustainability is understood and should be interpreted. This discovery seeks to shed light on the evolving nature of sustainability and the diverse perspectives surrounding its definition and implementation. Coca-Cola, as an organization, has been the subject of numerous case studies within the field of sustainability communication. Scholars have analyzed the corporation's activities in various socio-cultural environments and explored different research questions to gain insights into its sustainability practices.

In conclusion, the study of how sustainability is understood, promoted, and communicated is the field of sustainability communication, which is dynamic and constantly changing. To investigate the multifaceted facets of sustainability communication, such as reporting, consumer behavior, greenwashing, and the perception of sustainability, academics draw from a broad range of theories and disciplines. Researchers may learn a great deal about how companies handle sustainability in a variety of situations by using case studies such as the Coca-Cola company. To offer a concise and compact review of literature relevant to the research interest at hand, this literature review can and will not include all angles ever taken on the case of Coca-Cola. Major concentrations in research surrounding the CC company are to be found in the field of research on public-private partnerships and community engagement programmes, investigations of private research funding and corporate lobbying.

Similarly, a great interest in companies like CC is evident from the field of public health and children's' nutrition research. Furthermore, research within the field of CSR, sustainability and crisis management has been looking into the case of Coca-Cola. Barkay (2017) presents a qualitative sociological study of the implementation of community engagement programs by Coca-Cola's Israeli franchise against the backdrop of a critical perspective on the understanding of CSR and the relation of economic value and CSR values. By looking into the on-the-ground application of the corporation's global "Active and Healthy Lifestyle (AHL) branding strategy" This study provides valuable insights into the relationship between corporate responsibility and economic goals. It highlights a gap between CSR theory and practice, which is generally supported by others, although they view Coca-Cola European Partners (CCEP) as a positive example. The study also explores the concept of the tragedy of the commons and its connection to environmental sustainability, using Coca-Cola's bottling operations in Rajastan as a case study The author reaches the conclusion that corporate social responsibility (CSR), as practised by Coca-Cola in India, does not avert the

tragedy of the commons by focusing on water resources and the company's efforts in water stewardship. The author argues that rather from being voluntary and maybe having negative economic effects, CSR's implementation is profit-driven, which is why it is useless. In a similar context, Raman (2007) discusses CSR and Coca-Cola's historical and current relationship more broadly. Jones and Comfort (2018), using an older version of the data used in this study, analyze Coca-Cola's sustainability reports from 2012 to 2017 to investigate the relationship between branding and sustainability. Employing a loosely grounded theory approach, the authors identify recurring themes in the sustainability reports, covering environmental, social, and economic sustainability efforts. Jones and Comfort conclude that there is a lack of transparency and limited independent external assurance in the company's sustainability reporting process.

The finding about Coca-Cola's water usage reporting is supported by Walsch and Dowding (2012) and is in line with studies on sustainability reporting. Coca-Cola (CC) faced a public health crisis in 1999, which is a well-researched example of crisis management and communication. As a result, numerous Coca-Cola brands were temporarily outlawed in France, Belgium, and Spain. The outbreak of the problem was sparked by reports of ailments among Belgian students who had drunk Coca-Cola beverages that were packaged by CCEP. It was later discovered that the improper usage of carbon dioxide was the cause of the items' strange tastes and odors. Johnson and Peppas (2003) provide a thorough overview of the problem and the company's prompt communication reactions. In evaluating the government's responses to the issue, Taylor (2000) emphasizes the influence of cultural differences on the choice of whether to ban or not restrict the products. Coca-Cola's crisis reaction is subjected to a critical analysis by Siegrist et al. (2010) with respect to the ideas of trust and confidence. It is clear that a great deal of research has been done in the context of the Coca-Cola case on the topic of sustainability communication, including CSR reporting and metrics. But new initiative looks at similar data from a different angle in an

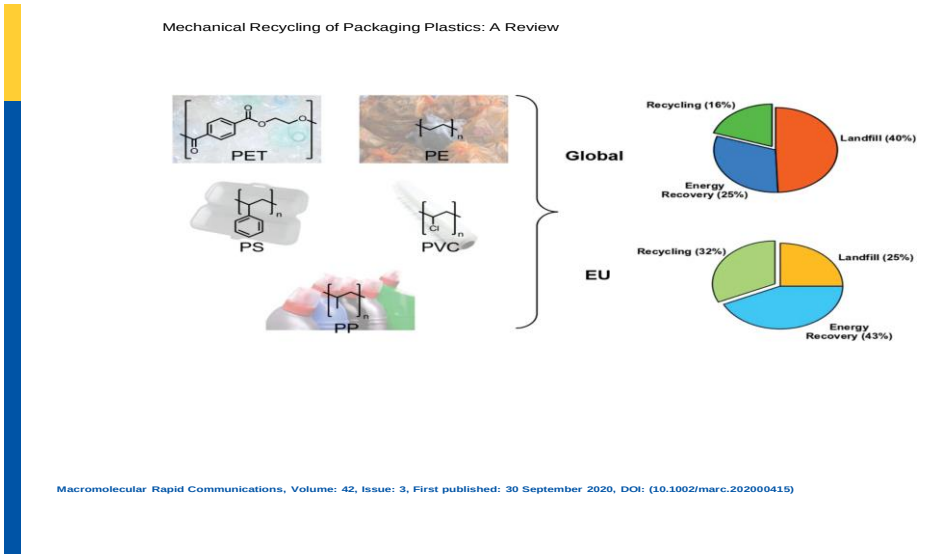
attempt to expand on earlier research. Instead of asking how and what is being monitored, reported or implemented in the name of CSR or sustainability, this project is asking for the extent to and ways in which Coca-Cola's sustainability communication is communicating a plastic crisis. By making use of data usually studied in the aforementioned contexts, the aim is to employ the strength of crisis communication research to the approved data that is corporate sustainability/CSR communication.

1.2. Structure of waste management in Coca cola

The global demand for plastics continues to rise. The amount of plastics in circulation is projected to increase from 236 to 417 million ton per year by 2030. Recycling or reuse of plastics in circulation is essential to prevent increased accidental or purposeful release of polymeric materials into the environment, and thus curb environmental pollution. In 2016, only 16% of polymers in flow were collected for recycling while 40% were sent to landfill and 25% were incinerated.[1] Recently, European countries have increased efforts to improve recycling rates. In 2018, 29.1 million tons of post-consumer plastic waste were collected in Europe. While less than a third of this was recycled, it represented a doubling of the quantity recycled and reduced plastic waste exports outside the European Union (EU) by 39% compared to 2006 levels. Much of this plastic flow (39.9%) was for packaging. Coca-Cola has established ambitious goals and strategies to tackle its plastic and packaging waste. By 2025, the company aims to collect and recycle or reuse 75% of its packaging, with a target of achieving 100% by 2030. Additionally, Coca-Cola is committed to ensuring that all of its primary packaging is 100% recyclable by 2025 and that 50% of the material used in its bottles and cans is recycled by 2030. The company also embraces a multi-stakeholder approach, monitoring and sharing its progress transparently across all its territories and stakeholders. Furthermore, Coca-Cola has

set a goal to collect and recycle a bottle or can for each one it sells by 2030. However, despite these efforts, the company has faced criticism for its plastic waste problem, as its use of plastic packaging has increased, leading to its ranking as the top contributor to plastic pollution. To address this issue, there have been calls for Coca-Cola to increase its utilization of reusable bottles.

Fig 1. [3.45p]



Packaging recycling is often more economically viable compared to other sectors of the plastic market in Europe. Approximately 42% of the collected post-consumer waste is recycled, 40% is utilized for energy recovery, and 19% is disposed of in landfills. The long-lasting nature of plastics, which contributes to their widespread use, also hinders their degradation. Consequently, landfills become overwhelmed, resulting in the release of excess waste into the environment. This has led to the fragmentation of plastics, thereby introducing micro and Nano plastics into bodies of water, urban areas, conservation sites, and the food chain. The EU Waste Directives

included landfill levies as a solution to this problem, and this has helped to raise recycling rates. Nonetheless, the efficacy of many landfill avoidance tactics, such energy-from-waste, is debatable. There are differences in the level of taxation between the 27 EU countries; 18 have waste bans and 24 have landfill taxes. Additionally, as indicated in their conclusion dated July 17-21, 2020, the European Council has voted to levy non-recyclable packaging. The current landfill fee in the UK is £94.15 per ton for plastic garbage, which is a considerable rise of 1345% from 1996. In 2018, The Waste and Resources Action Programme (WRAP) released a research that states that the United Kingdom is able to gather 47% of its plastic packaging waste for recycling, but only 43% of that is converted into valuable feedstock.

In the United Kingdom, PET accounted for 40% of the garbage collected between 2015 and 2016, followed by PE at 22%, PP at 10%, and PVC and PS each at 2% (Figure 1).Packaging is the primary application for these five polymers, as indicated in Table 1. PET and HDPE bottles are commonly used for packaging food, cleaning supplies, and toiletries. Packaging films are predominantly made from PVC, LDPE, and LLDPE. Plastic beverage bottles are typically made from PET, HDPE, and PVC, although there is a push to ban PVC due to legislative pressure. Single-use plastic bags are commonly produced using LDPE and LLDPE. PS, in either extended or solid form, is primarily utilized for packaging in the food and consumer goods industries.

Table 1. [14. 69p]
The five main packaging polymers by collection proportion and their main uses[9]

Polymer	Proportion of total waste collected from kerbside [%]	Applications in packaging
PET	**40**	**Beverage bottles**, trays, jam jars
HDPE and LDPE	22	Bottles, bags, bin liners, food wrapping material, squeeze bottles

Polymer	Proportion of total waste collected from kerbside [%]	Applications in packaging
PP	10.2	Bottles, straws, bottle caps
PVC	<2	Films, trays
PS	<2	Fast-food packaging, food packaging, disposable cutlery, consumer goods

The Coca-Cola Company's World Without Waste initiative is a comprehensive and sustainable packaging strategy that focuses on three main areas: Design, Collect, and Partner. The objective is to create a world with minimal waste, reduced carbon emissions, and less harm to the environment. This is achieved by implementing a circular economy where resources are recycled and reused. The approach to packaging is closely intertwined with addressing climate change. As up to 30% of our carbon footprint is attributed to packaging, the activities of World Without Waste play a crucial role in achieving the science-based target of lowering greenhouse gas (GHG) emissions. By prioritizing reusable packaging and improving the collection of empty items, we can effectively reduce our carbon footprint and decrease our reliance or complete use of virgin plastic.

Furthermore, Coca Cola has set an ambitious goal to eliminate oil-based virgin PET from plastic bottles in Europe and Japan by 2030, replacing it with recycled or renewable materials. While mechanically recycled content will make up most of the plastic packaging material, some virgin-quality material will still be necessary to ensure quality standards. To address this challenge, Coca Cola is investing in innovative solutions to increase the supply of feedstock from renewable technologies and enhanced recycling technology. This includes the use

of "upcycling" technology, which transforms previously used PET plastics into high-quality, food-grade PET. Additionally, the company remains committed to light weighting as a top priority.

In markets as varied as Bangladesh, Canada, Indonesia, the United States, India, and South Korea, it has implemented light weighting technology incorporating a recyclable, ultrathin glassy coating. Coca-Cola Euro pacific Partners (CCEP) introduced a lighter-weight PET bottle neck design in Germany, with other markets to follow. The move is expected to save 9.1 tons of plastic annually by 2024. The Seagram’s Label Free product in South Korea, the first labelless sparkling beverage product to be sold in the country, has also undergone light weighting— reducing 32% of the use of plastic compared to its original product and is expected to reduce the use of plastics annually by 445 tons.

Coca Cola recently announced a significant investment of $500 million in Mexico to enhance its refillable capacity and expand the country's recycling infrastructure. This investment includes the establishment of four new production lines and the expansion of PetStar, the largest food grade PET recycling plant in the world. Additionally, Coca Cola has opened the PLANETA recycling plant in Tabasco, which is expected to create over 20,000 jobs and increase Mexico's rPET capabilities by 51%. The company plans to open more than 20 new collection centers in Mexican states with limited or no capacity, greatly expanding collection capacity in PetStar and PLANETA.

In Australia, New Zealand, and the Pacific Islands, Coca Cola has joined the ANZPAC Plastics Pact to pursue four targets by 2025. These targets include eliminating unnecessary and problematic plastic packaging through redesign and innovation, making 100% of plastic packaging reusable, recyclable, or compostable, increasing plastic packaging collection and recycling by 25%, and achieving an average of 25%

recycled content in plastic packaging across the region. All Australian states now have Deposit Return Scheme (DRS) systems in place.

In Brazil, Coca Cola has collaborated with bottling partners Solar Coca-Cola and Coca-Cola FEMSA on the Recicla Solar and SustentaPet initiatives. Since its launch in 2019, SustentaPet has successfully collected 46,000 tons of PET, equivalent to over 1 billion bottles.

In Indonesia, Coca Cola has commenced a joint venture PET recycling facility with Dynapack Asia in West Java. In the Philippines, local bottling partner BIG has partnered with Indorama Ventures to establish PETValue, the first bottle-to-bottle recycling facility in the country capable of processing nearly 2 billion used plastic bottles annually. Furthermore, in Australia, Coca-Cola Euro pacific Partners has formed a joint venture with Pact Group, Cleanaway, and Asahi Beverages to construct and operate a $45 million rPET recycling facility in Victoria.

In Nigeria, The Coca-Cola Foundation has provided funding for the Recycling Scheme for Women and Youth Empowerment (RESWAYE), an innovative environmental sustainability program aimed at addressing the plastic waste challenge, strengthening recycling infrastructure, and economically empowering women in 24 coastal communities. This initiative has already recovered over 159 tones of plastic waste and empowered more than 2,000 women and youth through a plastic buy-back program.

In the United States, it has supported Colorado legislation to create the country's first true EPR program for packaging and printed paper. The program would be operated and funded by a nonprofit producer responsibility organization (PRO) and overseen by The Colorado Department of Public Health and Environment.

Coca-Cola and The Ocean clean-up, a group that has created technology and solutions to address the problem of ocean plastic, have partnered. Coca-Cola is leveraging its global reach, extensive network, and marketing know-how to assist in the execution of river projects across the globe as a global implementation partner. This includes

introducing and putting into practice the interceptor river solutions developed by The Ocean clean-up. Two projects have already been completed by the partnership: one in the Rio Ozama in the Dominican Republic and the other in the Can Tho River in Vietnam. They will also work towards sorting and recycling collected PET plastic bottles. Furthermore, The Coca-Cola Foundation supports the Benioff Ocean Initiative at the University of California-Santa Barbara, which focuses on river clean-up efforts in various countries. In addition to this, Coca-Cola is involved in other initiatives such as ReciVeci in Ecuador, which utilizes a mobile app to increase the recovery of recyclable materials, and Recycle Points in Nigeria, which incentivizes people to recycle PET bottles and other materials through a points-based system. Lastly, Coca-Cola South Africa, in collaboration with BanQu, a participant in the 100+ Accelerator program, has launched a blockchain-based payment platform to empower over 60,000 informal waste collectors in the country.

2021 World without Waste | Company Reports (coca-colacompany.com)

1.3. Methodical approach to waste management in Coca cola

Beverage manufacturing companies engage in various activities that generate waste. Environmental losses and waste in the beverage industry primarily result from production line issues such as broken packages and spilled beverages. Additionally, waste is generated through raw material inefficiencies, packaging waste in incoming beverages, and waste during the filtration process, which contributes to water waste and the production of liquid treatment sludges. Beverage companies are responsible for both on-site generated waste and the assembly of outgoing products that ultimately become waste. Reducing waste can have significant benefits for the beverage industry. This reduction affects all aspects of production, creating an eco-friendly environment that alleviates concerns from regulatory agencies. Waste reduction in the industry not only lowers the cost of materials purchases but also enhances employee and employer

satisfaction by fostering a work environment that effectively manages waste. Furthermore, waste reduction minimizes the environmental impact of waste, preserves resources, and reduces the costs associated with waste disposal or destruction. The funds previously allocated to waste destruction can instead be directed towards other sectors of the business.

Implementing and improving waste management practices often require careful planning and operational changes within the industry. This may involve employee training and raising awareness about the use of new and existing equipment to achieve minimal waste. Setting targets for waste reduction in each production cycle can further help in achieving reduced wastage. This involves establishing clear priorities regarding the need for raw materials. Ultimately, the avoidance of waste brings about satisfactory financial and environmental outcomes, which can be cultivated through effective management practices.

The waste hierarchy provides a framework for controlling waste in the beverage industry, ensuring maximum profitability throughout the year. The waste hierarchy are:

- Avoidance of waste

-Reduction of waste

- Reuse of waste

-Recycling of waste

-Disposal and Destruction of waste .

The beverage industry may experience processing waste due to insufficient line capacity, formulation changes, and inadequate maintenance. Plant managers have the responsibility to mitigate waste by implementing effective strategies that prevent product loss and optimize production efficiency. A forward-thinking plant manager can achieve waste reduction by designing efficient plants that

incorporate equipment capable of significantly minimizing waste. Designing to minimize water consumption is also vital in the reduction of waste, e.g. processing a liter of beverage with ten liters of water. The water usage can be minimized by installing equipment that requires minimal cleaning with higher efficiencies in other areas. In the beverage industry, the choice of packaging is vital as it affects the environment and impacts greatly on the transportation and storage. Some of the beverages can only last for two weeks and electricity is required to keep them chilled during transportation, home storage and display at home by the retailers. As a result of this, a container that can protect the beverage without the use of refrigeration is required along the chain to reduce waste and prevent the use of energy that is needed for chilled storage and transportation.

Series of lean manufacturing tools have been used as production control and waste identification tools in food and beverage industries. These are wastes due to production beyond demands, waste as a result of wrong processing, waste due to over inventory and wastes that result from defective raw materials. It is expedient for a socially responsible organization to adopt continuous waste elimination strategies instead of the regular reduction approach [10]. Among others, the most widely used lean manufacturing tools are Value Stream Mapping (VSM), Just-In-Time (JIT), Line Balancing and Six Sigma.

Value Steam Mapping has been used as a lean manufacturing tool in different sectors like the health care, construction industry, service call centers transportation, mining, architecture, food and beverage industries. Although the implementation of Value Stream Mapping in the production sector is still evolving, its potential has been explicitly demonstrated by many authors. A value stream actually flows from the position of demand to the end of all activity after products and services must have been made available. In an industrial setup, the overall value stream is usually defined from the point order is made to the point of product delivery and to the point of payment by the customer.

Value stream mapping as a lean tool visualizes the flow and communication within the production process. VSMs are illustrated as picture to explain the manufacturing and waste reduction process. The process is simple but logical because it involves the representation of the current reality and the goal that will be achieved in future. Food wastes and losses in supply chain have been reduced using Value Stream Mapping. Compilations of several studies reveal that Value Stream Mapping is compatible with other lean tool for the reduction of food waste and nutrient losses. VSM was applied on a crank shaft manufacturing system within an automobile manufacturing plant. It was able to reduce the manufacturing lead time by 40 %, reduced defects and higher processing efficiency. The VSMs have the advantages of the clear exposure of waste that is available in the production process. It is also able to map the entire process and capture the flow of materials as well as information flow. The VSM is able to capture material information and this can be easily drawn on paper. Some of the draw backs of VSMs are: inability to function well in a high-variety production setup. It only works perfectly with sequential manufacturing process but performs badly with parallel processes.

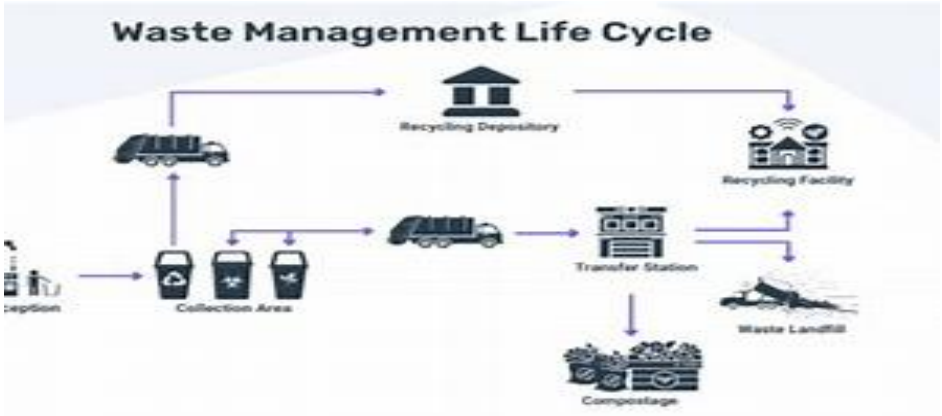
Just-In-Time (JIT): This is a production concept that was executed by Japanese producers to exterminate waste of manpower, capital, materials and inventory that exist in a manufacturing system. The goals of JIT concept are : reception of supplies just in time to be used, Manufacturing of products just in time to be made into subassemblies, Production of subassemblies just in time to be assembled into ready to use products, Production and delivery of finished products just in time to be sold.

The Just-In-Time (JIT) approach emphasizes dedication and commitment to producing high-quality products, eliminating idle resources, fostering good teamwork, and responding quickly to production or packaging challenges. The benefits of JIT include low inventory carrying costs, early

detection of defects, minimal inspection and rework, and the ability to produce high-quality products at low cost. However, JIT requires stable production levels and limits flexibility in manufacturing. When combined with Kanban, more work is required. Kanban, also known as the pull system, involves using printed cards to pull products to the logistics or manufacturing sequence as needed. It can be a single or dual card system, with the dual card system working well in a low-downtime production line. Line Balancing Process is important in industrial manufacturing, with job shop manufacturing organizing equipment by function and flow-line production organizing equipment according to the order of operation. Flow-line production is suitable for mass production, while job shop manufacturing is used for mini batch production. The pre-conditions for installing a flow-line production system include regulated products, high volume production, stable products, and continuous material supply. The Six Sigma philosophy focuses on defect elimination and combines business, engineering, and statistical principles. It can be applied across disciplines but requires advanced scientific knowledge for implementation. Waste elimination in the beverage industry is a global issue due to the economic costs associated with government levies and recycling. Therefore, there is a continuous search for waste elimination techniques in beverage industries.

Fig. 2 [11.78p]

Waste Management life cycle



Waste Prevention and Waste Minimization — These are the foundations of any effective waste management system. Various technologies and methods can be deployed throughout the manufacturing and distribution processes to eliminate waste and minimize pollution. An original equipment manufacturer (OEM), for example, might choose to work only with sustainable materials that do not cause toxic by-products when processed.

Reuse — Products or components that may otherwise have been discarded, are recovered and used for the same purpose and in their current form. For example, a manufacturer might collect material scraps or faulty components from a production line and reprocess them. This preserves the energy used to acquire or make them in the first place.

Recycling — This disposal method sees waste materials, including paper, plastics, glass, aluminum, steel, and wood, are reprocessed into new products, materials, or substances. This prevents additional waste from being sent to landfills.

Composting — Through decomposition, organic materials are converted into nutrient-rich soil, reducing landfill waste and carbon emissions.

Waste-to-Energy — Waste-to-energy plants convert non-hazardous MSW into usable heat, electricity, and fuel. Conversion methods include incineration, gasification, or pyrolysis. While these processes can significantly reduce GHG emissions and reduce demand for fossil fuels, they can contaminate air, water, and land with toxic pollutants.

Landfills — When waste materials cannot be processed using a more preferred method, this waste disposal method is used. Despite significant advancements in the waste management industry, most of the waste continues to be deposited in landfills. In the United States, landfills receive 139.6 million tons of waste annually, including 30.63 million tons of food and 26.82 million tons of plastic.

The optimal utilization of resources and environmental sustainability rely heavily on proper waste management. In this analysis, we will explore the waste management strategies of renowned countries such as Germany, Sweden, Japan, Switzerland, and the Netherlands. Additionally, we will examine waste management from the perspectives of the value chain and the supply chain, highlighting the extensive opportunities presented by plastic and agricultural waste.

These countries have established themselves as pioneers in waste management through their innovative strategies and policies. They prioritize waste reduction, recycling, and responsible waste disposal, positioning themselves as leaders in this field. Let us now closely examine their waste management approaches:

Germany has developed a comprehensive waste management system that focuses on waste separation, efficient collection, and recycling. They utilize advanced sorting technologies to effectively categorize waste, ensuring its appropriate disposal or recycling.

Sweden adopts a holistic approach by employing waste-to-energy processes to convert waste into renewable energy. They also prioritize waste sorting, recycling, and resource recovery, utilizing advanced recycling technologies.

Japan places great importance on waste reduction, recycling, and public awareness campaigns. They have implemented efficient waste separation systems, advanced recycling technologies, and strict regulations to ensure proper waste management practices.

Switzerland embraces waste separation, recycling, and waste-to-energy processes as part of its waste management approach. With an extensive network of recycling facilities, they prioritize resource conservation and sustainability.

The Netherlands boasts a comprehensive waste management system that centers around waste separation, recycling, and the principles of the circular economy. They actively promote material reuse, encourage the adoption of innovative recycling technologies, and have implemented strict waste disposal regulations.

When we come back home to the continent of Africa, there have been countries that are making commendable efforts to manage waste: Rwanda: Rwanda has made significant strides in waste management, particularly in tackling plastic pollution. The country implemented a nationwide ban on single-use plastic bags in 2008, becoming one of the first African nations to do so. This bold action has significantly reduced plastic waste and helped preserve Rwanda's beautiful landscapes.

South Africa: South Africa has made progress in waste management through the implementation of Extended Producer Responsibility (EPR) programs. These programs place the responsibility of managing the end-of-life of products on manufacturers. EPR has led to improved waste collection, recycling, and proper disposal practices, contributing to a more sustainable waste management system.

Tunisia: Tunisia has been recognized for its efforts in waste management, particularly in the area of organic waste. The country has implemented organic waste composting programs, diverting food and green waste from landfills. This approach not only reduces methane emissions but also produces valuable compost for agricultural purposes.

Kenya: Kenya has taken steps towards tackling plastic pollution by implementing a ban on single-use plastic bags in 2017. The ban has contributed to a reduction in plastic waste and has prompted the growth of alternative packaging solutions, such as reusable bags and eco-friendly packaging materials.

Egypt: Egypt has made progress in waste management through the implementation of waste sorting and recycling initiatives. The country has established waste separation

and recycling facilities, promoting a circular economy approach. These efforts have increased recycling rates and reduced the amount of waste sent to landfills.

Waste management goes beyond individual actions and involves the entire value chain and supply chain. From product design to disposal, each stage presents opportunities for waste reduction and resource optimization:

- Design: Product design should consider recyclability, use of sustainable materials, and minimal waste generation throughout the product's life cycle.
- Procurement: Sustainable procurement practices can ensure the sourcing of materials from environmentally responsible suppliers, emphasizing recyclability and reduced waste generation.
- Production: Efficient manufacturing processes, waste minimization, and recycling of production waste contribute to sustainable practices within the supply chain.
- Distribution and Logistics: Optimized transportation routes, packaging materials, and reverse logistics for product returns or recycling contribute to waste reduction and efficient supply chain operations.

There are significant opportunities for waste management and resource optimization in the broad scope of waste, with a particular focus on plastic and agriculture waste. These two types of waste can be effectively utilized in numerous ways to address concerns regarding environmental sustainability and resource scarcity. By harnessing the potential of plastic and agriculture waste, we can not only reduce the negative impact on ecosystems but also unlock valuable resources for various industries. Plastic waste, which presents a major challenge due to its non-biodegradable nature, can be transformed into valuable raw materials through innovative recycling techniques and the development of sustainable alternatives. By converting plastic waste into recycled plastic, we can not only decrease the need for new plastic production but also reduce the amount of plastic pollution in oceans and landfills. Similarly, agricultural waste,

including crop residues and by-products, can be utilized in multiple ways. Rather than disposing of agricultural waste, it can be employed as a source of renewable energy through processes like biomass conversion. Additionally, it can serve as a valuable resource for organic fertilizers, enhancing soil health and reducing reliance on chemical fertilizers. The utilization of plastic and agriculture waste can contribute to the development of circular economy models. By implementing waste management systems that prioritize recycling, reducing, and reusing, we can create a sustainable cycle where waste becomes a valuable input for new products and processes. This shift towards a circular economy can significantly reduce the extraction of finite resources and minimize the environmental impact of waste generation. In conclusion, plastic and agriculture waste have immense potential to contribute to waste management and resource optimization. By embracing innovative strategies and technologies, we can transform these types of waste into valuable resources, paving the way for a more sustainable and environmentally conscious future.

We are all empowered to play a crucial role in waste management and resource optimization. It is paramount that we assess our waste practices, both as individuals and businesses, in order to uncover possibilities for waste reduction, enhance recycling efforts, and explore groundbreaking solutions. By fully embracing the untapped potential of plastic and agriculture waste, we can actively contribute to a more sustainable future and foster a circular economy.

SECTION 2. PRACTICAL ASPECTS OF WASTE MANAGEMENT IN COCA COLA

2.1. Organizational and economic characteristics of waste management in Coca Cola;

World's perspective

The global environment is being negatively impacted by plastic waste, which is causing harm to all socio-economic sectors. Nigeria, in particular, is facing challenges in protecting its population from environmental health issues such as air pollution, heavy metals, unsanitary conditions, unsafe drinking water, and inadequate waste management. Approximately half of the plastic produced is intended for single use and then discarded, resulting in around 400 million metric tons of plastic waste annually. Urgent action is required to address this issue. The United Nations Environment Program (UNEP) reports that over one million plastic bottles are purchased every minute, and up to five trillion plastic bags are used each year, with less than 10 percent being recycled. Nigeria, with a population of 200 million people, is the ninth-largest contributor to global plastic pollution, generating approximately 2.5 million metric tons of plastic waste annually. Much of this waste ends up in rivers, drains, lagoons, and the ocean. Coca-Cola Company has taken significant steps towards environmental sustainability by implementing projects to reduce plastic waste on a global scale. The company has set an ambitious target to make 100 percent of its packaging recyclable worldwide by 2025. In February 2022, Coca-Cola announced a ground-breaking goal to have at least 25 percent of its global volume sold in refillable/returnable glass or plastic bottles or fountain dispensers with reusable packaging by 2030. This initiative builds on the company's successful use of refillable packaging, particularly in Africa and Nigeria.

To achieve these objectives, Coca-Cola has started by redesigning PET packaging for its products to enhance recyclability. Sprite, one of the brand's largest sparkling beverages, has discontinued its iconic green-coloured PET packaging and transitioned to clear PET packaging in 2020 across various global markets, including Nigeria.

This enables better recycling and easier conversion into new bottles by increasing the supply of high-value recycled plastic in the after-use market. The beverage company is investing in and developing systems to support a circular economy as part of a clear and deliberate strategy.

Coca-Cola has undertaken various initiatives in Nigeria to further its agenda, specifically focusing on establishing sustainable recycling hubs in market areas. Their efforts have included empowering over 5,000 waste operators from densely populated states and cities in the country. One ongoing project, cycleplast, is being implemented by the Nigeria Climate Innovation Center (NCIC). Its primary objective is to increase the collection of clean and food-grade PET bottles from the environment for use in recycling programs. This project is currently active in six states and has scaled the collection and recycling efforts of six recycling businesses, providing better incentives for waste pickers and those involved in the plastic waste value chain. The project has successfully enhanced the collection of packaging materials, contributing to a more sustainable and cleaner environment.

Another notable initiative is the Empowering Collectors Initiative (ECI), which is being implemented by the Growing Businesses Foundation (GBF), a non-governmental organization. The ECI aims to improve the largely disorganized process of plastic waste collection, aggregation, and recycling in Nigeria. This initiative involves the completion of predefined tasks that align with the project's goals. In the past six months, both the cycleplast and ECI projects have achieved significant progress, recovering over 200 million PET bottles and empowering more than 2,000

collectors and aggregators. These endeavors will undoubtedly strengthen the plastic value chain throughout the country.

Additionally, Coca-Cola commemorated the United Nations "World Environment Day" in June 2022 by organizing a beach cleanup campaign in Lagos state. The company collaborated with key government and non-governmental stakeholders, as well as community volunteers, to promote better waste disposal habits among residents of coastal communities in the region. Coca-Cola's support for the Nigerian community extends to providing a grant from The Coca-Cola Foundation to the African CleanUp Initiative, the implementing partners of the RecyclesPay and CleanUp Naija projects. These initiatives have positively impacted over 15,000 people in Nigeria throughout their duration. The grant was given to support the expansion of the RecyclesPay Plastic-For-Tuition project, which allows low-income families to pay for their children's tuition by exchanging used PET bottles for school fees. This initiative not only helps these families financially but also raises awareness about the impact of improper waste disposal in the country. Coca-Cola, in partnership with Nigerian Bottling Company (NBC), is taking steps towards renewable energy in its manufacturing operations as part of its commitment to achieving Net Zero emissions by 2040. This move will further enhance its reputation as a leader in sustainable manufacturing in Nigeria. Coca-Cola has received several awards recognizing its sustainability efforts in Nigeria, including the "ECOSEA Award for Environmental Sustainability Investment" and the "Best Company in Promotion of Good Health and Well-being" award. The company has also been honored by the Lagos State Government and the Waste Management Society of Nigeria for its contributions to driving a Circular Economy through recycling initiatives. With over 136 years of global impact and 71 years in Nigeria, Coca-Cola continues to prioritize sustainability in its operations, from packaging design to collection and partnerships. These initiatives are all part of Coca-Cola's overall sustainability agenda, which aims to collaborate with

stakeholders to advocate responsible waste disposal habits and promote the collection and recycling of plastic and other packaging materials to develop a circular economy.

In the current world, the need for recycling, recovery and management of plastic waste is of paramount importance. Nations from around the world are now increasingly taking action and demonstrating that whether they are from a rich or poor nation, it is possible to be global environmental leaders. However, if they fail to cope it means with the current plastic management habits, by the year 2050 there would be 12 billion tons of plastic litter in the environment distributed across the land and water bodies. These figures would mean the plastic industry will now be consuming 20% up from 8% of the global oil production. Plastics use was on the rise rapidly whilst no one was observant of the consequences resulting in an upsurge of mixed variable waste materials entering waste streams.

Governments have the most imperative part in curbing the problem of plastic waste going into the future. They should be in a position to finance basic and applied research to measure the up-to-date plastic problem and the hazards posed to human health and the environment. The information collected should be packaged effectively to reach all target audiences to school and increase consciousness on the challenges presented by the use of plastics. This would also go a long way to alter the littering habit of humans and possibly bring it to an end. As a result, the volume of waste from food packaging plastic waste would be greatly reduced to manageable levels towards achieving zero waste.

The growth of waste is inevitable due to the increasing global population and the rise in per capita consumption accompanying economic development. The impact of this will be particularly evident in urban areas and developing African nations. Africa's high population growth is driving an increase in food consumption, leading to a higher demand for plastic packaging and consequently an increase in plastic waste,

especially in single-use food packaging. To address this issue, there should be a focus on investing in the infrastructure for waste management in developing countries. However, this will require significant resources and time. Moreover, it is essential to thoroughly explore affordable alternatives and prioritize long-lasting solutions, such as eco-friendly options like biodegradable biopolymers for single-use food packaging. Governments worldwide are already implementing policies and legislation to promote the use of biopolymers in packaging, and African countries need to make widespread efforts to continuously review and revise policies aimed at reducing or banning the use of single-use plastics. Coca-Cola South Africa played a crucial role in establishing PETCO, the PET Recycling Company NPC. Formed in 2004 as a voluntary consortium of South African PET industry members, PETCO takes on the responsibility of "self-regulating" plastic bottle recycling. Over the past decade, PETCO has successfully driven recycling efforts in South Africa, achieving a recycling rate of over 50% and contributing to a reduction in landfill storage and CO2 levels.

As part of its approach, PETCO collaborates with the continent's only bottle-to-bottle recycling plant, which converts PET into food-grade PET rather than fiber, aligning with PETCO's belief that "plastic bottles are not trash." This has resulted in an impressive 822% increase in recycling tonnage since PETCO's inception in South Africa (Wells).

To achieve these results, PETCO has incubated what it calls “income opportunities” for trash collectors, often called trolleypreneurs, who sprung up on their own to meet a need they saw. In 2016, Dr. Casper Durandt, who serves as both chairman of PETCO and technical manager for Coca-Cola South Africa, estimated the number of people doing this type of work at around 40,000, with about 18% of them scavenging on landfills (Durandt).

Coke and PETCO do not support landfill picking, which is dangerous and unhygienic, though the practice persists. Rather, they support those pickers who process rubbish at the point of consumption. Named for the trolleys they push around the city and their entrepreneurial spirt, these trolleypreneurs earn cash while serving environmental and practical ends.

This work is difficult and degrading, as the folks at Coca-Cola and PETCO are quick to point out; the average trolleypreneurs was making about 200-250R, or $20 USD, a day at the time I spoke to Durandt (Durandt). But, in the absence of available employment as well as other viable methods of trash collecting, Coke and PETCO are nevertheless trying to incubate these collectors. They provide reflective vests, safer trolleys, and plastic collection bags, while paying them on debit cards and helping train them in basic business skills. The answer to this question is not straightforward, as it depends on various factors such as the distance the bottle travels, whether it is reused, and other variables. However, one thing is clear: as GDPs in Africa continue to rise, the demand for one-way (plastic) packaging will increase, leading to a greater need for sustainable PET use.

Starting from January 1, 2018, China implemented a ban on the importation of nonindustrial plastic waste. Wang et al. conducted a study that revealed China had been importing plastic waste since 1992 for manufacturing and exporting goods, making it a major outlet for managing plastic waste from many countries. In 2016 alone, China imported 7.35 million tons of plastic waste from 43 countries, accounting for approximately 50% of the plastic waste exported by 123 countries for recycling purposes. Overall, China has imported 45.1% of the total plastic waste exports. This ban on waste imports will have a significant impact on countries that have been exporting waste to China for years. The most affected regions, according to Brooks et al., include East Asia and the Pacific, Europe and Central Asia, and North America.

Consequently, this ban may result in either overwhelming plastic waste in some countries or the development of robust waste management systems that will yield positive results in the future.

The European Commission has already responded to this development. Some of the countries at the bold forefront are France and Germany, whose plastic packaging producers have already actively engaged value chain partners and invested in research and development of new plastic packaging. They have already signed a Circular Plastic Alliance and aim to have at least 90% of household packaging being recyclable or reusable by the year 2025 . Several milestones are continuously being set in Europe for managing plastic waste. Targets were set for plastic packaging recycling to reach 50% by 2025, 55% by 2030, and plastic bag bans and Styrofoam regulations . It is hoped that by the year 2050 incineration rates will reach 50%, recycling 44% and discarded waste 6% [19]. The (EU) 2018/852 directive on packaging and packaging waste also presented a new method of determining recycling performance set to commence with data from the year 2020. The “Plastics 2030” coined by the European Commission as a strategy for plastics in a circular economy is a voluntary commitment that is envisioned to transform the European Plastic industry to achieve a circular and resource efficient plastic economy. The envisioned plan is to have every packaging material on the continent be 100% reusable or recyclable with zero landfilling so as to achieve a circular economy of plastics [158]. It cannot be over emphasized that there is need for cooperation between all stake holders to achieve a plastic pollution free society.

It is also important to note the impact of the COVID-19 pandemic on the plastic industry. With social distancing measures in place, it means food consumption has been further promoted to be consumed on the go. Consumers who would have ideally ordered a sit in meal in their favorite restaurant are now forced to order a takeaway. These takeaway foods come contained in single-use food packaging plastics. After

consumption, the packaging waste is now more likely to be mixed with several other household waste materials rather than be sorted separately. This is because refuse collection rates have fallen, and curb side disposal has also been reduced leaving waste concentrated in households. In developed economies this may mean increased raw material for recycling plants whilst for developing countries temptations will be high to dispose of the waste into the surrounding environment increasing the amount of mismanaged waste. Studies have begun documenting this unique period with works from [162,163,164,165,166,167]. Soon more studies on quantities, implications and trends of generated plastic waste quantities will be documented.

2.2 Environmental Effects of waste in Coca-Cola

Coca-Cola's extensive utilization of disposable plastic bottles has made a significant contribution to the global crisis of plastic pollution. Regarded as the worst plastic polluter worldwide, the company produces a staggering 200,000 bottles per minute, equivalent to 3 million tons of plastic packaging annually. Despite numerous unsuccessful attempts to recycle more than a minute fraction of its plastic packaging, Coca-Cola has committed to a target of 25% reusable packaging by 2030 on a global scale. Nonetheless, environmental organizations have criticized the company's recycling endeavours, asserting that the value of used plastic is minimal, resulting in a lack of motivation to collect and reuse it. Consequently, numerous bottles fail to reach recycling facilities and instead find their way into landfills or are irresponsibly discarded in the environment. As a result of mounting societal pressure, the company has faced increasing demands to assume accountability for its contribution to the issue of plastic pollution.

As Coca-Cola began a small company, its growth into a successful franchise not only altered the current beverage market, but also the environment as well. Developed by Dr. John Pemberton in 1886, the syrup was mixed with carbon-dioxide and sold out of a local pharmacy in Atlanta, Georgia. As national growth expanded with the company moving locations 5 times within 12 years, it also hit international markets, with the opening of a bottling plant in Canada in 1906.

Expansion continued into Asia as early as 1912, Europe by the 1920's, and Africa by the 1930's. 125 years later, the company has grown from its single product and location to 500 brands across 200 countries (125 Years of Sharing Happiness). As figures show this growth as a positive, it neglects to factor in environmental effects associated with global growth, such resource depletion, pollution, and waste. As Coca-Cola has conquered the global beverage market, it must now reassess and take responsibility over its environmental impact of waste management in both water resources and packaging to continue its success into the future.

Countries like England and India have experienced the negative effects of Coca-Cola's success overseas on their water resources. Despite their political, economic, and social differences, both countries have found common ground in the issue of Coca-Cola "drinking their countries dry". For instance, an article from 2004 titled "Hills are Alive with Sound of Drilling: Malvern Water Facing Coca-Cola Threat" highlights the concerns about Coca-Cola's proposal to drill for water in the Malvern Hills. The company's expansion of its water-bottling operation would result in the extraction of an additional 20 million litres of water per year from the hills, necessitating the installation of a 1.7-mile pipeline (Hills are Alive with Sound of Drilling).

Despite Coca-Cola's assurance that environmental testing will be conducted to minimize damage, there is still a fear that the water resource will be exploited. This can be seen in the case of India, as discussed in a 2006 article titled "Coke 'drinks India dry'". The article criticizes Coca-Cola for depleting water resources in developing countries, stating that for every 2.7 litres of water used, only 1 litre of product is produced (Mathiason). This excessive water usage has resulted in water depletion to the point where farmers are unable to irrigate their fields and communities no longer have access to clean water. Coca-Cola responds to these concerns by claiming to believe in equal access to resources and by highlighting efforts to reduce water consumption by 24% over a span of 4 years (Mathiason). In order to continue providing their product in the future, Coca-Cola must address these environmental concerns alongside their success abroad.

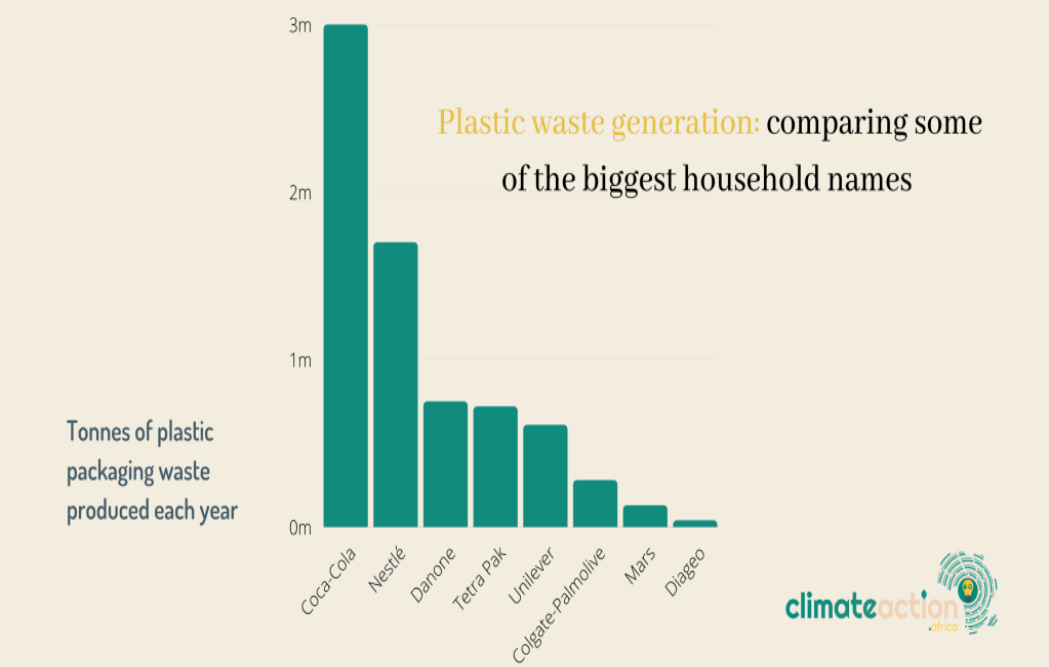
Although controversy surrounds Coca-Cola and its water resource damage across the world, the company has begun to address another environmental side effect, waste management. In an article entitled, “The Coca-Cola Company Rolls Out new Plant Bottle Packaging,” it speaks to the company’s goal of reducing their carbon footprint by tackling packaging. Plant Bottle Packaging is made from at least 30% plant material and is 100% recyclable (The Coca-Cola Company). The plant material is derived from sugarcane-based ethanol, which is cultivated from an area in Brazil known for its environmental sensitivity (The Coca-Cola Company). This life cycle analysis of not just the bottle, but its origins and manufacturing, produce a compelling solution to the traditional plastic bottle. Here the goal of packaging simultaneously addresses two fronts, the problem of emissions and waste management. While Plant Bottling Packaging is estimated to eliminate 3 million gallons of gasoline used to produce plastic bottles, it also promotes recycling and a cradle-to-cradle scenario of the product (The Coca-Cola Company). Through these actions do we see Coca-Cola beginning to

recognize the global environmental impacts of their actions, and the steps taken to ensure evolution into the future.

The globalization of the western diet has been influenced by various factors. By examining The Coca-Cola Company as a case study, we can observe the environmental consequences of this trend. Originally a small, local company, Coca-Cola's expansion from the West to the global market has not only transformed the beverage industry but also had an impact on the environment. While the growth of Coca-Cola is often viewed positively, it fails to consider the environmental effects associated with global expansion, such as resource depletion, pollution, and waste. Therefore, if Coca-Cola wants to sustain its success, it must adapt and assume responsibility for its environmental footprint in the global beverage market.

Fig. 2 [12. 51p]

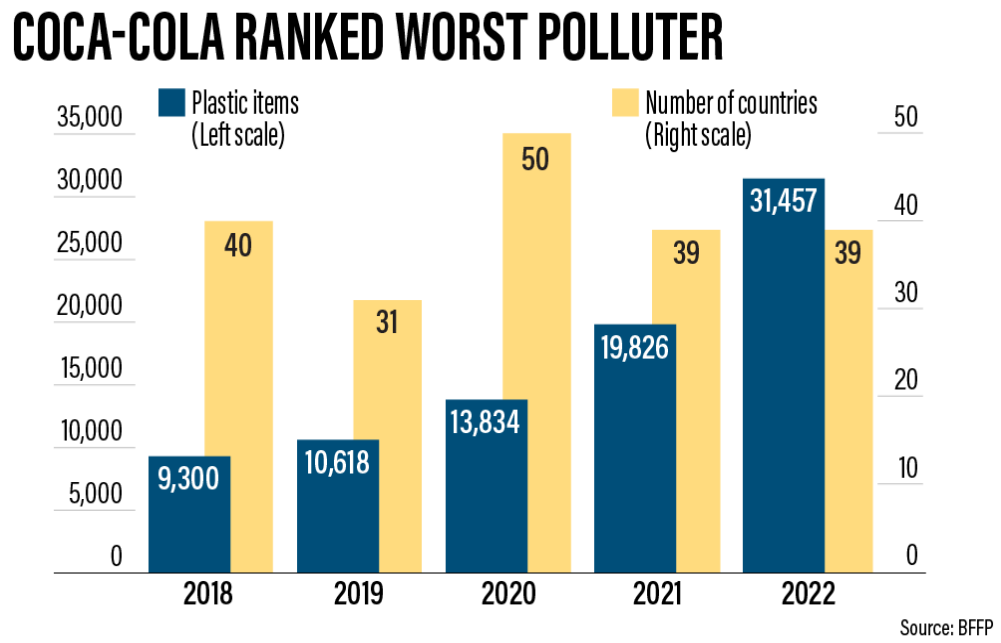
Top plastic waste generation chart of beverage product

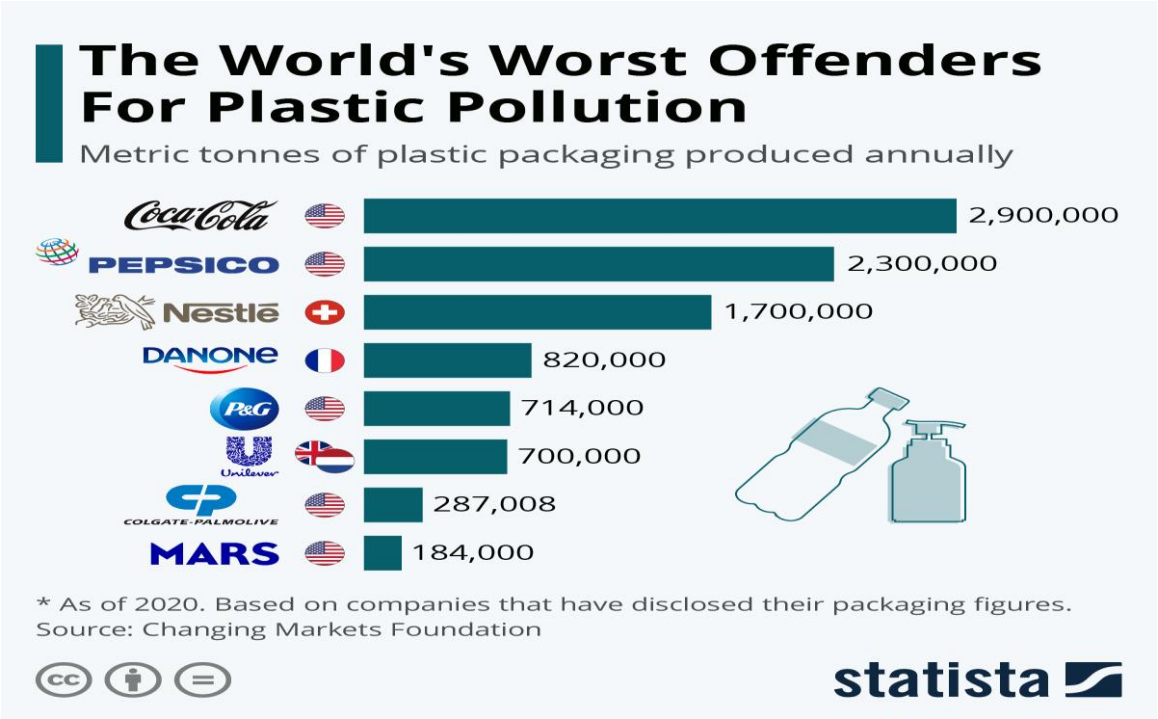


The latest global Brand Audit report by Break Free from Plastic reveals that for the 5th consecutive year, The Coca-Cola Company, PepsiCo, and Nestlé have been identified as the world's leading plastic polluters. This report also holds these companies accountable for contributing to the climate crisis. Break Free from Plastic has been collecting data through citizen science waste collection since 2018. In 2022, 14,760 volunteers across 44 countries conducted 397 brand audits on six continents. These audits involve citizen scientists counting and documenting the brands found on plastic waste to determine the companies responsible for plastic pollution. A total of 429,994 pieces of plastic waste were collected and analyzed, leading to the identification of 4,645 parent companies associated with the most plastic waste pollution. In 2022, Break Free from Plastic also analyzed the longitudinal data trends from every five years of its worldwide brand audits (2018-2022). These reveal a remarkable consistency of results: year after year, the same multinational fast-moving consumer goods (FMCG) companies - which have the largest market share and generate the most plastic- are the top plastic polluters. Most notably, The Coca-Cola Company has been the world's top plastic polluter by a significant margin every year since the global brand audit began in 2018. The 2022 brand audit found more than 31,000 Coca-Cola branded products, a 63% increase from 2021. The brand audit has found more and more Coca-Cola products each year, with the 2022 results representing more than three times the number found in 2018.

Fig. 2 [16. 79p]

World pollutant chart





2.3 Role of Packaging in waste management

Packaging plays a crucial role in the modern world, encompassing the entire life cycle of goods from their creation to their handling and disposal. Developed countries allocate approximately 2% of their gross national product to packaging, with a significant portion utilized within the food industry. The global packaging market, valued at USD 383 billion in 2000, is projected to reach USD 980 billion by 2020. The primary purpose of packaging materials is to effectively preserve, protect, promote, market, and distribute food products while minimizing environmental impact and satisfying both industry and consumer needs.

The development of packaging solutions is the result of years of design advancements, often arising from fortuitous circumstances. In ancient times, people consumed food directly from its source, relying on self-sufficiency and only producing or capturing what was necessary. Consequently, packaging materials were unnecessary. However, as the need for packaging emerged, nature provided initial resources in the form of hollowed logs, woven grasses, and animal organs. As civilization progressed, new materials with unique properties, such as ceramics, glass, metal, and paper, were introduced to meet specific packaging requirements. These materials can be classified as either rigid or flexible, offering diverse options for packaging design. Rigid packaging includes bottles, jars, cans and tins, whilst flexible packaging includes plastic films, papers, foil, cloth and sacks.

Types of Packaging

There are three types of packaging namely primary, secondary and tertiary ;

- Primary packaging is one that is in direct contact with products and will be handled by the consumer.

- Secondary packaging groups individual units (primary packages) together for transportation and can be designed to be shelf-ready where it can display primary packaging for advertisement in retail outlets.
- Tertiary packaging is for storage and handling of the secondary packaged products.

Plastic Packaging

The packaging industry requires materials that are lightweight so as to reduce the amount used to package a product, thus reducing product weight for transportation cost savings as well as reducing amount of end of life packaging waste material. Plastics have managed to fulfil this role very well and have remained unchallenged. As an example, one study by Marsh revealed that the replacement of glass bottles with plastic bottles for beverage packaging in airlines resulted in savings of over USD 1 million in fuel costs because of the weight loss.

According to a report in 2009, fossil fuels are the primary raw material for manufacturing plastics. It was found that 8% of the world's oil is used for plastic production, with half of it used as feedstock and the other half as fuel for the conversion process. A decade later, in 2019, the global oil production used for plastic production increased to 10%, with 40% of it dedicated to producing single-use plastics. The growth in plastic consumption indicates that by 2050, the estimated global plastic consumption will reach 500 million tones, with single-use products being the largest contributor. Thermoplastics are the most used polymers for packaging, accounting for 84% of the plastic market share. Table 1 below provides examples of thermoplastics used in food packaging.

The packaging industry has begun using recyclable plastics in their designs as a means of reducing waste disposed into the environment. However, recyclers must maintain contaminants in the reformed plastic to sufficiently low levels acceptable for intended

use of the resulting packaging. This has proved difficult, time consuming and costly since the collected plastic waste consists of different plastic types that have to be sorted and separated. After which, the plastic wastes may have to be washed clean to remove the different contaminate residues from products they were packaging. Additionally, plastic additives such as the popular phthalates have been shown to be persistent in recycled plastic and continue posing health problems as they have low molecular weight and can easily migrate from plastics into packaged food or water.

Food Packaging Waste

There are high amounts of food packaging waste entering the environment causing pollution. Snack food packaging is one good long-term case of a visually irritating example of environmental pollution. Most food packaging plastics culminate in waste streams within a short time after purchase especially for single use packaging applications used in short lived goods. This is because of an increase of on-the-go consumption of food and drinks that is driving the growth of single use plastic packaging. In some locations, the challenge of low availability of bins can lead to increased littering.

A significant portion of plastic food packaging ends up as litter, municipal waste, landfills, and even in oceans, with only a few being recycled. This is primarily due to the prevalent throwaway culture in developing countries. When consumers purchase food for immediate consumption, they often dispose of the packaging wherever they finish eating or drinking. This culture is also influenced by social trends and individual behaviors, which can be challenging to address. It appears that waste collection systems are struggling to manage the waste generated by this culture. Inadequate waste management systems further exacerbate this problem, along with the lack of enforcement or alternative materials.

The global recycling rates for single-use plastic packaging materials are significantly low, with only 14% of plastic packaging being collected for recycling and

a mere 5% of it successfully recycled into new plastic. The primary contributors to plastic waste pollution, in order of quantity, are drinking bottles, bottle caps, food wrappers, grocery bags, lids, straws, stirrers, and foam take-away containers. Rather than resorting to easy direct disposal methods, the food industry is strongly encouraged to embrace waste control options such as reduce, reuse, and recycle. Disposing of this waste in landfills leads to the creation of methane gas, a greenhouse gas that contributes more than 2000% to global warming compared to carbon dioxide.

A comparative lifecycle study to investigate the extent of recycling that can yield favorable impacts on the environment has been done. Results showed that recycling can greatly reduce environmental burdens posed by food packaging waste. Therefore, to deal with food packaging waste, there is need for integrated waste management schemes that can sustainably control waste generation without compromising the needs of the society and those of the environment.

Plastic Waste Disposal

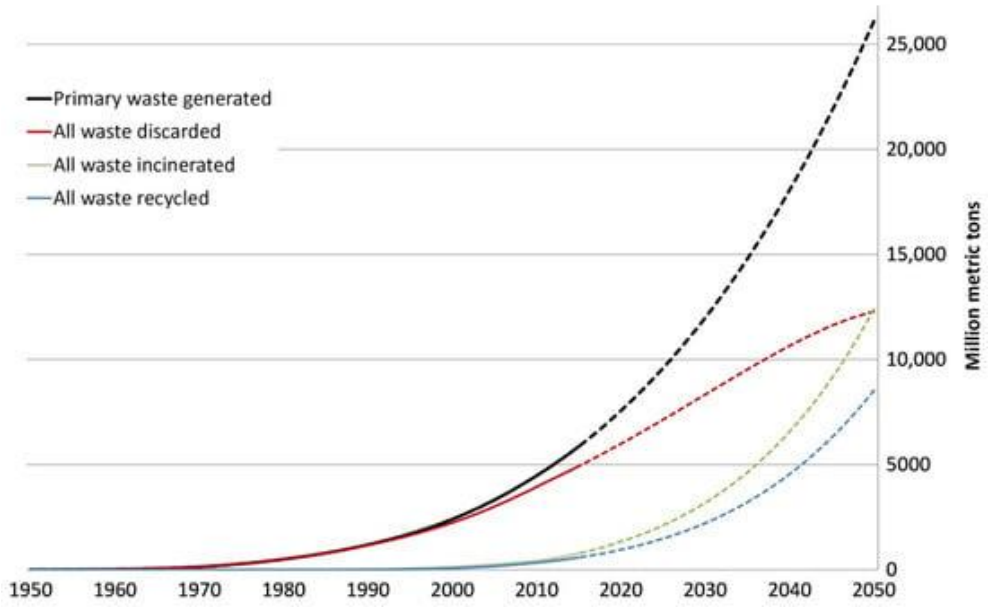
After their use, products made from plastic can be disposed, recycled or incinerated. Up to 1980, almost all plastic waste was discarded as recycling and incineration were negligible. Incineration as a method for plastic waste management started growing from 1980 and in 1990 recycling started to be appreciated as well. In 2015, approximately 6300 million tons of cumulative plastic waste had been generated and about 9% was recycled, 12% was incinerated, and 79% was accumulated in landfills or in the natural environment . From these three routes of plastic waste disposal, incineration was the only permanent route of eliminating the waste and this thermal treatment involves combustion.

Most synthetic plastics that are disposed in nature have a very unreasonably slow degradation process that takes long periods spanning hundreds to thousands of years. When plastics are thrown away by consumers, some are blown off by wind to cover more area and some are washed away by rains to even find their way into water

bodies. Plastics are one of the biggest pollutants of oceans. Living creatures like sea animals, birds and livestock have even been affected by the plastic waste that is being dumped in water bodies and on land. Figure 1 displays the cumulative plastic waste generated and disposal.

Fig. 2 [14. 88p]

Waste Recycling Projection Graph



The solid lines show historical data from 1950 to 2015 whilst dashed lines show projections up to the year 2050 based on historical trends. Following these projections, environmental pollution with plastic waste is set to rise to alarming levels. Pollution from plastics is a global challenge requiring a complete paradigm shift on how to produce, use and dispose of plastics.

Management of Food Packaging Plastic Waste

Packaging plastics have varying lifecycles, with some lasting only a day while others can endure for up to three years. Single-use plastics, such as disposable cups, plates, and take away containers, fall into the category of those with a one-day lifespan. Numerous strategies, including plastic bags, taxes, extended producer responsibility, and recycling, have been employed to manage the issue of plastic packaging waste. While a considerable amount of plastic packaging is still being used, recycling remains a crucial method in mitigating the pollution caused by such waste. The recycling process for food packaging involves three key steps: collection, sorting, and processing. These steps are conducted under strict monitoring to prevent any contamination.

In the attempt to recycle plastics, chemicals added during plastic production including the finishes like dyes for printing and coatings present unique challenges. In addition, recycling of food packaging plastics also requires the waste plastics to be clean from food contaminants as well as desorption is required of any food substances that may have found a way into the packaging polymers. Plastic recycling processes are largely focused on primary and secondary recycling methods thereby calling for growth in adoption of other recycling processes to improve the recycling capacity and efficiency. It is worth noting that as the plastic waste is continually recycled using these methods, it loses its physical and chemical properties resulting in low quality end products warranting incineration at this point. Recycled plastics of good quality would cost 60–70% of the price of virgin plastic but this value drops as properties are compromised from repeated recycling.

The food and drug administration (FDA) has noted with concern the recycling of plastics for food contact packaging. As such, these primary packaging plastics may be best incinerated or chemically recycled. Secondary and tertiary packaging have less material variation and thus are easily sorted for recycling or reuse unlike primary

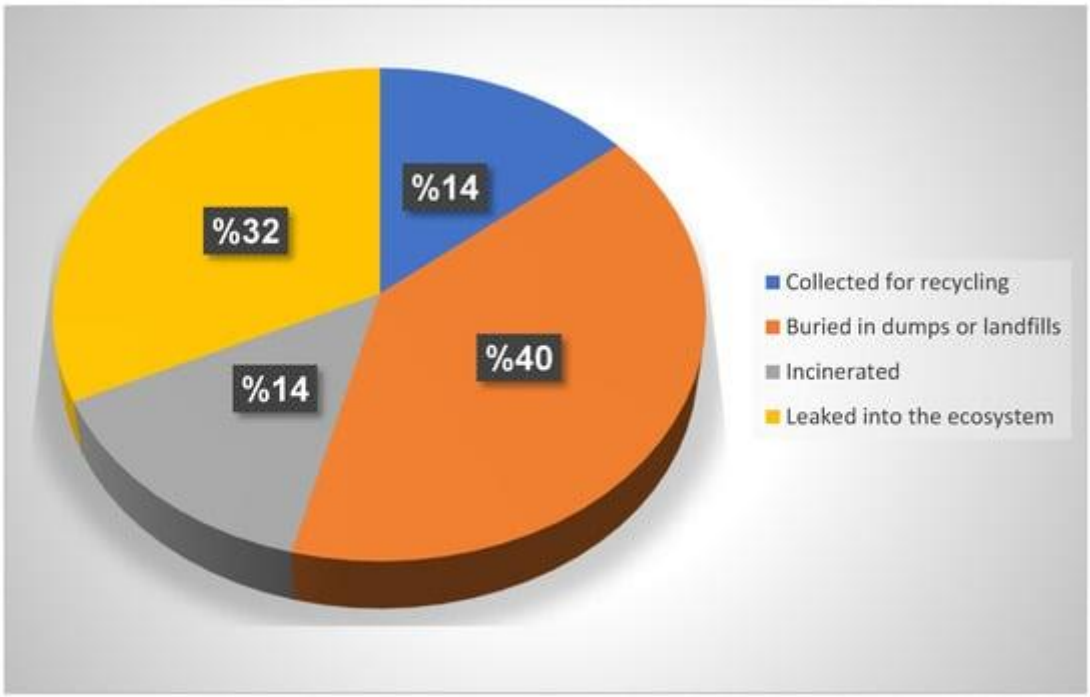
packaging that is assorted, contaminated and habitually damaged and hence presents problems in sorting, recycling and reuse.

In comparison, developed countries generally have better plastic management policies, for example in Europe, recycling and energy recovery rates have increased over the past decade resulting in reduction of landfilling. The packaging sector in Canada has the highest plastic waste recovery rate. Whilst developing countries do not have waste infrastructure to cope with the rising plastic waste.

The fate of global plastic packaging materials is depicted in Figure 2 which shows that most of the packaging waste ends up in the environment. This high amount of unrecycled plastic packaging is a cause for concern. The impacts can be reduced by sustainable waste management systems that recover materials and energy.

Fig. 2 [22. 114p]

The fate of plastic packaging materials



Collecting and Sorting

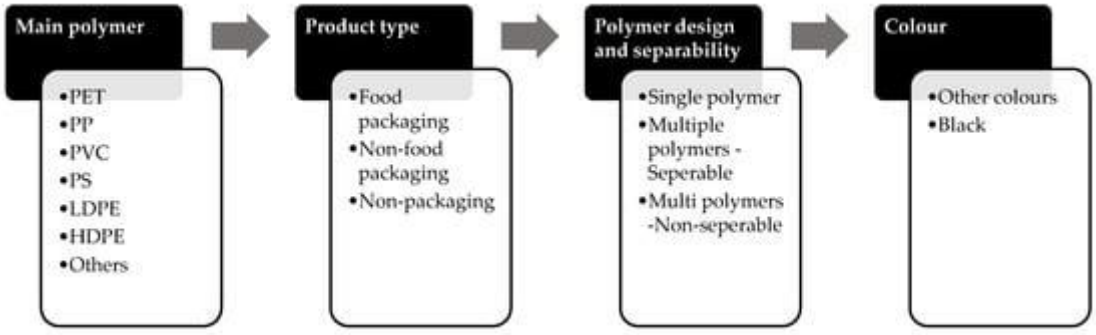
The initial and crucial steps in plastic recycling involve collecting and sorting the waste. Plastic waste is typically gathered through "bring schemes" and kerbside collection, while sorting can be done manually or with automated methods. Sorting can occur at the source of the waste or at facilities that utilize mechanical processing and sorting for mixed waste. However, the recycling industry is currently operating at only 40% capacity due to a lack of differentiated collection and separation at the source, which impacts the supply of raw materials. As a result, packaging sorting plants play a vital role in waste management and material recovery systems. To effectively and cost-efficiently separate and sort plastic solid waste, various techniques can be employed in a short time frame. These techniques include the use of machines like near-infrared (NIR) sorting machines, as well as color or induction sensors in new plants. Additionally, other sorting methods such as laser-induced breakdown spectroscopy, triboelectric separation, X-ray fluorescence, Fourier transformed infrared technique, and froth flotation can be utilized. Ultrasound technology is also an upcoming and promising technique for monitoring the separation of plastic waste and providing information on process quality.

Recycling mixed plastic waste is a challenging and cost-ineffective process. The use of intensive sorting technologies is not economically viable. The most effective approach to recycling is through source separation and separate collection of the waste. Proper sorting of food packaging waste from household waste at the source is crucial for effective waste management systems. However, the current design of food packaging does not effectively influence consumer behavior in terms of disposal decisions. By improving communication to consumers, packaging can provide specific information on how to separate and sort the packaging after use. Household waste consists of various mixed products with different types, shapes, and colors. Sorting machines have difficulty detecting black plastic food packages due to the absorption of

NIR by carbon black, the most common black colorant for plastics. The quality of the feedstock material affects the recycling process, efficiency, quality, and application of the resulting product. Four levels of characterization can be used to determine the recycling route for food packaging plastic waste. Visual inspection, polymer identification, and food contact labeling are useful tools for separating the waste. Technologies can also be employed to identify the polymers for waste separation. Various sorting methods have been widely used and are currently being optimized. State-of-the-art sorting technologies can process mixed waste as small as 2 mm.

Fig 2. [17. 80p]

Four levels of plastic waste characterization for recycling



Germany is currently working on a new method for sorting post-consumer packaging waste, which involves using trivalent lanthanide elements as tracer materials. These elements have the ability to emit bright lines of light in green, red, and near infrared (NIR) when exposed to electromagnetic radiation. To apply these tracer elements, they can be directly added to the packaging material or incorporated into printing inks used for labels, with concentrations in the range of parts per million. This innovative technology is expected to surpass the capabilities of current NIR sorting techniques, allowing for the separation of food packaging from non-food packaging, even if they are made from the same polymers. This advancement will greatly enhance recycling rates. It is crucial to distinguish food packaging waste from non-food related products, as the latter may not meet the mandatory requirements for packaging and could potentially compromise the quality of recycled goods.

Reducing Materials

The primary goal of the reduce principle is to decrease the quantities of materials used in products and processes, also known as down gauging. In the context of food packaging, this involves reducing the amount of material required for packaging while still maintaining its optimal functionality. By implementing material reduction principles, packaging products can have significantly lower environmental impacts. However, it is crucial to carefully implement packaging reduction measures to ensure they do not compromise the overall product system. Coca Cola has successfully reduced the material used in their bottles and now utilizes redesigned smaller bottles with shorter necks. Their ultimate objective is to achieve 100% recyclable packaging by 2025. Additionally, they currently incorporate up to 10% recycled plastics in their plastic usage, with plans to increase this figure to 50% by 2030.

Reusing

The process entails utilizing discarded plastic packaging waste multiple time. By reusing packaging materials that would otherwise be discarded, source reduction can be achieved, resulting in a decrease in the demand for and consumption of new raw materials. This is the most preferable approach since it requires less energy and resources. Through reuse, waste materials can acquire value rather than being disposed of. Reusable plastic packaging also offers the advantage of reducing packaging costs and can be utilized for primary, secondary, and tertiary packaging purposes. The packaging can be reused until it no longer meets its functional requirements before being disposed of or recycled. Del Borghi et al. conducted a study on food crates made from various materials, using the life cycle assessment (LCA) method. The study found that the multiuse plastic crate had superior environmental performance when it was reused multiple times. The LCA analysis was conducted based on product category rules for food crates, considering environmental indicators and impact categories such as global warming potential, cumulative energy demand, and toxicity to humans,

marine life, and terrestrial ecosystems. Another study by Popovic et al. introduced a reusable X-bin container to replace wooden crates and single-use packaging. The success of implementing a reuse model in primary food packaging largely depends on consumer behavior changes. In practical applications, both reusable and disposable packaging have advantages and disadvantages in terms of environmental emissions, cost, and logistics complexity.

5.4. Landfilling

The traditional method of waste management is commonly used. Research indicates that the amount of municipal solid waste (MSW) generated will increase from 2.4 billion tons in 2018 to 2.6 billion tons by 2025. Plastics make up a significant portion of MSW, particularly packaging waste. Landfilling is considered a necessary waste management strategy for non-recyclable and noncombustible waste, but it is the least favorable option. Unfortunately, a large portion of plastics end up in landfills, which is highly undesirable considering there are more environmentally friendly recycling alternatives. Additionally, the availability and cost of landfill space are becoming increasingly limited. Packaging plastics that are disposed of in landfills have low biodegradability and contribute to the production of explosive greenhouse gases like methane. In response to legislative pressures, there has been a continuous demand to reduce the amount of waste that is sent to landfills, with the goal of eliminating waste disposal altogether.**5.5.**

Re-Extrusion

This is the primary recycling of plastic solid waste which is a closed loop method that feeds plastic scrap into the extrusion process. This method is often used by industries to recycle polymer waste from their production process as it is easily identifiable, and the waste is generally uncontaminated. The recovered plastic is made into goods with similar performance to those from virgin plastics. The recycled plastic is generally

made into a product that serves the same function as the original plastic. However, the quality of the scrap reintroduced has a bearing on the performance of the resulting product. The process becomes almost impossible to carry out effectively and efficiently as it requires clean or semi clean scrap, strict scrap sorting so not to mix different plastics and this increases the cost of the process and thus compromises its effective application.

Mechanical Recycling

Mechanical recycling, also known as secondary recycling, involves reusing plastic waste in plastic manufacturing through mechanical means. This process is only effective when using single polymer plastics. However, the resulting recycled plastics have inferior performance characteristics compared to virgin plastics.

The process of secondary recycling includes cutting/shredding, contaminant separation, floating, milling, washing, drying, agglutination, extrusion, and quenching. During the grinding and melting stages, virgin polymer and/or additives may be added to the recycled material. Common plastic processing methods like screw extrusion and blow molding can be employed. Mechanical recycling is an affordable and efficient process, making it ideal for developing countries. However, it shares the same drawback as primary recycling, which is a limited number of recycling cycles.

Ongoing studies aim to enhance the properties of mechanically recycled food packaging materials. For instance, researchers have investigated blends of virgin and recycled PET to achieve an optimal blend for food contact applications. Rheological analysis after mechanical recycling revealed a decrease in the viscosity of PET, indicating degradation. However, blending recycled PET with virgin polymer improved mechanical and thermal properties. The optimal blend comprised 30% recycled PET and 70% virgin PET. Migration tests conducted on these blends

demonstrated their suitability for primary food packaging, as they met the EFSA standard.

Biological Recycling

Biodegradable plastics, which have recently gained attention, are primarily affected by this issue. Organic recycling, also known as biological recycling, is a type of tertiary recycling. Although the biodegradable plastic industry is still small, it is growing steadily. These plastics can be broken down by microbes and enter the biological cycle within a short period of time. The food and catering industries are expected to benefit from the successful application of biodegradable plastics. However, there is a risk that users may mistakenly dispose of more biodegradable packaging materials into the environment, contributing to plastic litter. According to Kosior Mitchell, the current waste management options may not effectively handle biobased products. The suitable options are drop-in bioplastics, such as bio-PE, bio-PP, and bio-PET, which can be used with existing technologies. However, there are other biobased polymers, like polylactic acid, that can be used alone or in mixture with organic fillers to create compostable food packaging composites. This presents an opportunity to create environmentally friendly packaging materials that can be recycled through biological processes. One option for disposing of biodegradable food packaging waste is to use compost bins for home composting. However, it is important to note that some products require industrial composting and will not break down in home composting conditions. For instance, polylactic acid polymer was previously believed to easily biodegrade in landfills, home composts, and aquatic environments. However, this is not accurate, as the polymer requires an industrial composter. Therefore, it should be referred to as compostable rather than biodegradable.

Some natural and designed microbes are reported by Drayage and Prieto to be showing potential for possible application to biodegrade problematic petroleum-based plastics.

Another new field of study reported is in the use of enzymes engineered for plastic degradation. Studies of PET, LDPE, linear-low density polyethylene (LLDPE) has been carried out. Further research is envisioned in the biological recycling field to employ microbes, fungus, and enzymes in the degradation of plastics.

Chemical Recycling

Referred to as tertiary or feedstock recycling, this method involves the division of plastic polymers into distinct, useful components such as monomers. This process entails chemically altering the polymer structure to produce liquids and gases that are commonly utilized as feedstock for the synthesis of additional petrochemicals and plastics. By generating the essential raw materials required for plastic production, tertiary recycling promotes the concept of energy sustainability. An advantage of chemical recycling is its capability to manage contaminated and blended polymers with minimal preparation.

Pyrolysis has gained significant attention in feedstock recycling due to its operational and environmental benefits, as well as financial advantages. This thermochemical process utilizes temperature, pressure, and time to produce desired hydrocarbons.

Energy Recovery

Quaternary recycling, also known as energy recovery, involves the combustion of waste to obtain heat, steam, and electricity. This method can help tackle the global issues of rising energy consumption and plastic waste production per person. Plastics made from crude oil, such as polyethylene, polypropylene, and polystyrene, have a high calorific value, making them a valuable source of energy. For instance, polyethylene has a calorific value of 44.9 mega joules per kg (Mj/kg), polypropylene has 46.5 Mj/kg, and polystyrene has 41.9 Mj/kg, while petroleum itself has a calorific value of 42.5 Mj/kg.

Plastic waste from food packaging generally gets mixed with other wastes to comprise MSW which finds its way to incinerators. WTE technologies when used for electricity generation had efficiency of 25–30%, however, improvements to cogenerate heat and electricity have seen the efficiency rise to 80%. Modern incinerators have been equipped with state-of-the-art air pollution control technologies to minimize the emitted air pollutants.

Policies and Incentives for Managing Plastic Waste

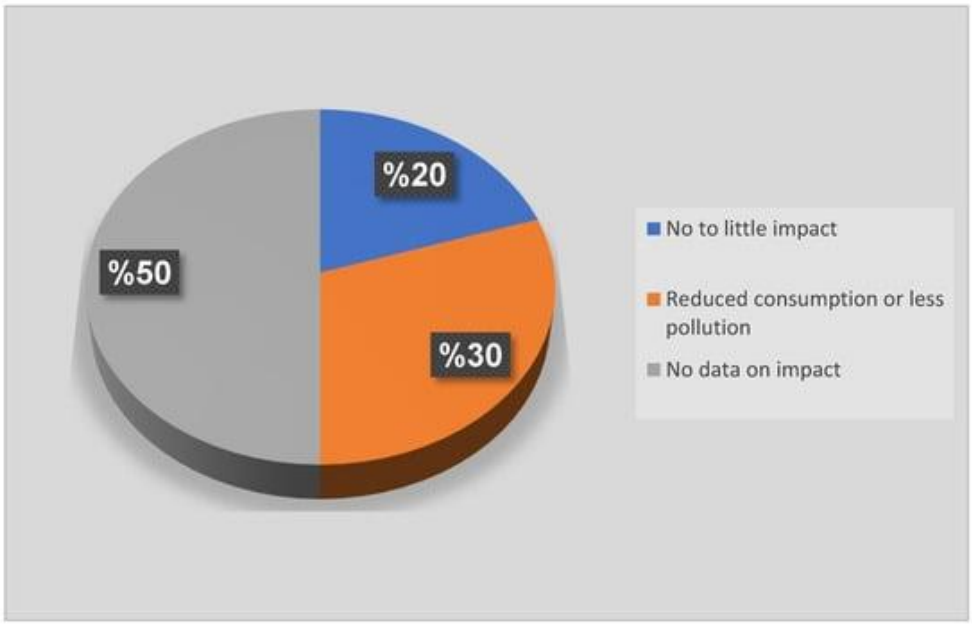
Plastic waste reduction has posed challenges for governments worldwide over an extended period. Unlike other recycling industries, plastic recycling has garnered significant legislative attention. Various approaches, such as extended producer responsibility (EPR), taxes, and bans, can be explored to ensure the efficient collection and sorting of packaging waste for recycling. To discourage the irresponsible use of packaging materials, additional fees such as taxes can be implemented. According to Maria and Leva , Norway holds the world record for the highest PET bottle recycling rates, reaching 97%. This achievement is credited to the implementation of a redeemable fee charged when purchasing PET bottles, which aims to discourage the culture of disposability. Similarly, in the United Kingdom, a tax was imposed on carrier bags, leading consumers to choose reusable bags instead of purchasing new ones. As a result, the consumption of bags decreased by approximately 16 billion units.

The implementation of plastic bans has become a popular method for addressing the issue of plastic waste. Many nations have enacted regulations regarding the use of plastic bags and Styrofoam products. Despite this widespread adoption, there is a lack of comprehensive data on the effectiveness of these bans, as they have not been consistently enforced in over 60 countries. Consequently, the problem of plastic pollution continues to persist.

The following 2.14 shows the impacts of the bans.

Fig. 2. [14. 36p]

Impact of national bans and levies on plastic bag usage

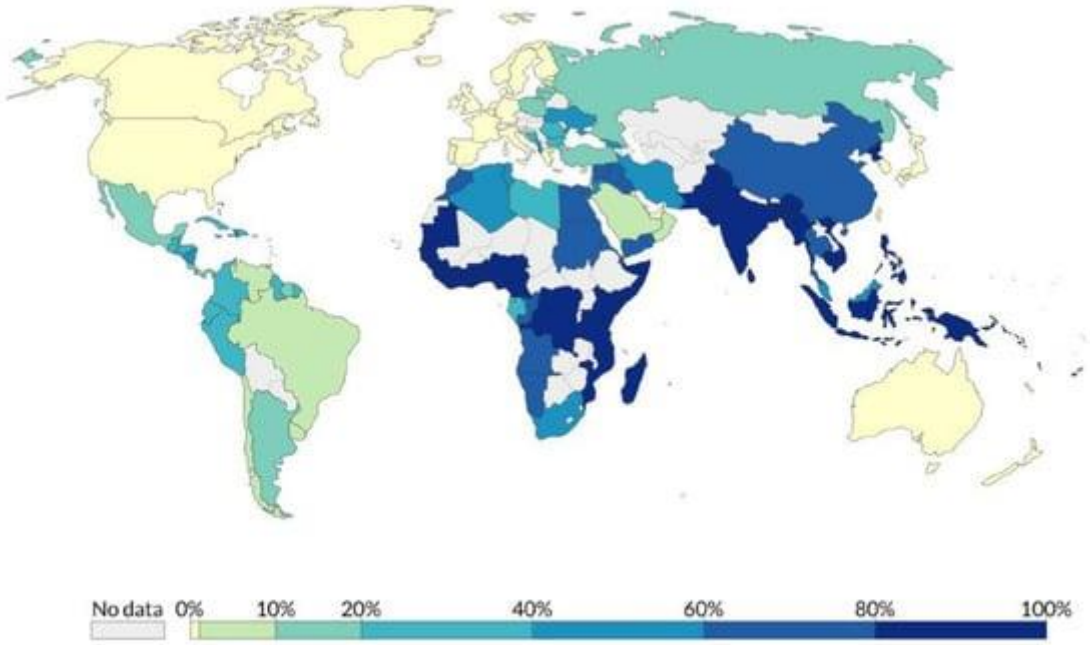


Mismanagement of Plastic Waste

I Preventing waste should always take precedence in waste management, as it is more prudent to address pollution now rather than deal with the waste in the future. A recent study conducted in a specific area found that consumers were willing to decrease their use of plastic and embrace eco-friendly packaging. However, their actions did not align with their positive attitude, and they placed blame on the industry for providing disposable packaging. By reducing plastic usage and subsequently lessening waste production, the mismanagement of plastic waste would also decrease. According to Figure 5, inadequately disposed plastic waste accounted for a significant portion of global plastic waste in 2010. Inadequately disposed waste refers to plastic waste that is not properly contained in designated disposal sites, such as dumps or regulated landfills. This type of waste can easily migrate to nearby environments and find its way into oceans. Ineffective waste management systems contribute to this waste problem.

Fig. 9. [23. 56p]

Inadequately disposed plastic waste as at 2010



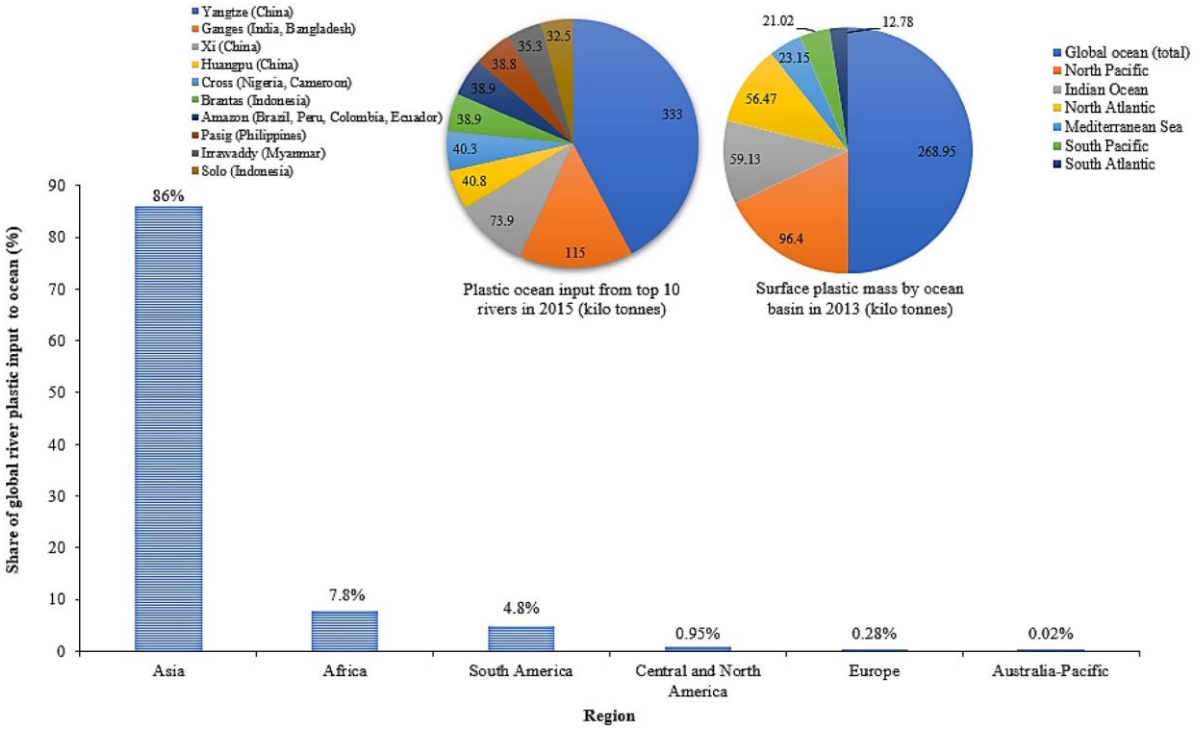
It is reported by Maria and Leva that developed countries have almost no inadequately managed plastic waste whilst countries in southeast Asia and the pacific are the chief culprits accounting for 60% of global inadequately managed plastics. Africa contributes a share of 17.2% with the Middle East and North Africa accounting for 8.3% and 8.9% for Sub-Saharan Africa (SSA). SSA is also reported to have 80–90% of plastic waste being inadequately disposed. A study by Lebreton and Andrady reports that the increase in waste management infrastructure may not be enough for some parts of the world particularly in Africa. The projections of the study were up to the year 2060 and indicated that demand for plastic in Africa would grow by 375% of the current demand whilst the global average growth was pegged at 210%.

Plastic Waste management in Africa

The annual growth rate of plastic consumption in Africa is pegged at 2% and has the potential to reach over 20 million tons by 2025. However, there are a few studies that account for the plastic waste and waste management strategies in Africa. Additionally, there are not many reports on the extent of amount of waste entering the coastal and oceanic waters around Africa. However, the assumption is the models of pollution follow those of developing countries from other continents. Literature states that for developing countries, the management of environmental pollution from plastic waste poses a significant challenge. It is reported that despite their efforts, recycled plastics account for only 10% of the total generated plastic waste. Africa is reported to have limitations in plastic recycling capability and inefficient waste collection. The accumulation of mismanaged plastic waste in the environment is said to remain unreasonably high in African and Asian continents even going into the foreseeable future. The African population is reported to rely on plastic as a low-priced material for packaging. Africa has been shown to be the chief driver of the growth in global population and this is seen to result in a huge market for plastics and consequently plastic waste. The population growth is expected to rise from 1.34 billion as of 1 July 2020 to 2.19 billion in 2050.

Fig. 10. [26. 89p]

Share of global river plastic input to the ocean



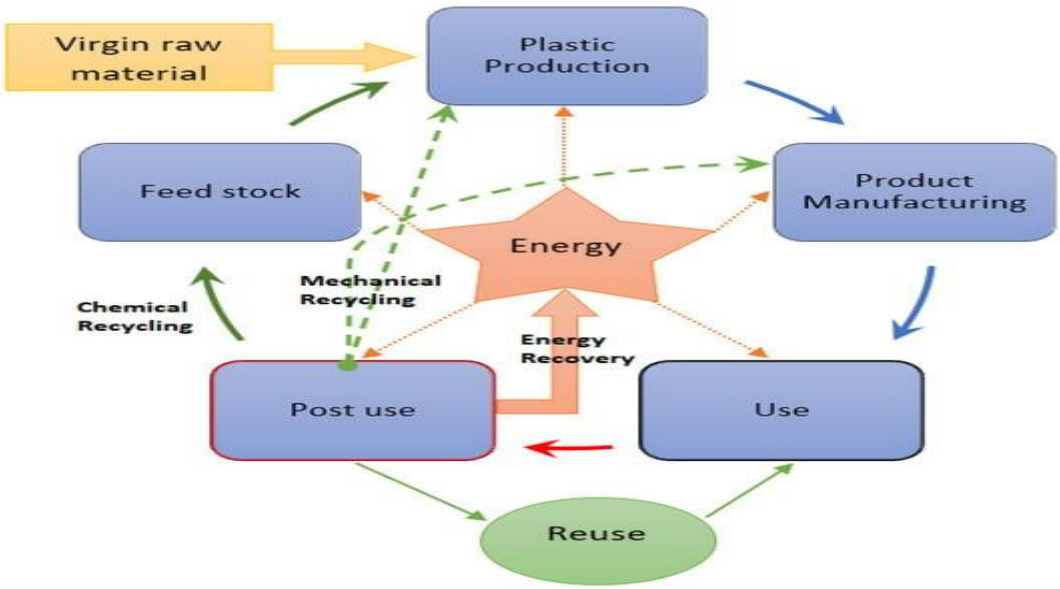
In Africa, most countries have implemented a complete ban on the production and utilization of plastic bags. While 25 countries have established regulations on plastics, more than 50% of them only began enforcing these regulations in 2014. It is important to address the issue of insufficient enforcement of plastic regulations in Africa. Furthermore, Africa lacks stakeholder involvement in the development of plastic bag policies, has limited consumer awareness, and often imposes bans without giving enough notice or providing viable alternatives. In Southern Africa, which includes Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Eswatini, Zambia, and Zimbabwe, only four countries have implemented levies and bans to combat the negative impacts of plastic waste pollution. These countries are listed in Table 2. The main target of these initiatives is single-use plastic bags, which are estimated to be consumed globally at a rate of 1 trillion bags per year, or 32,150 bags

per second. Unfortunately, a significant portion of these bags end up in the environment shortly after use due to their lightweight and parachute-like design, which allows them to easily travel through the air and waterways.

7. Circular Economy

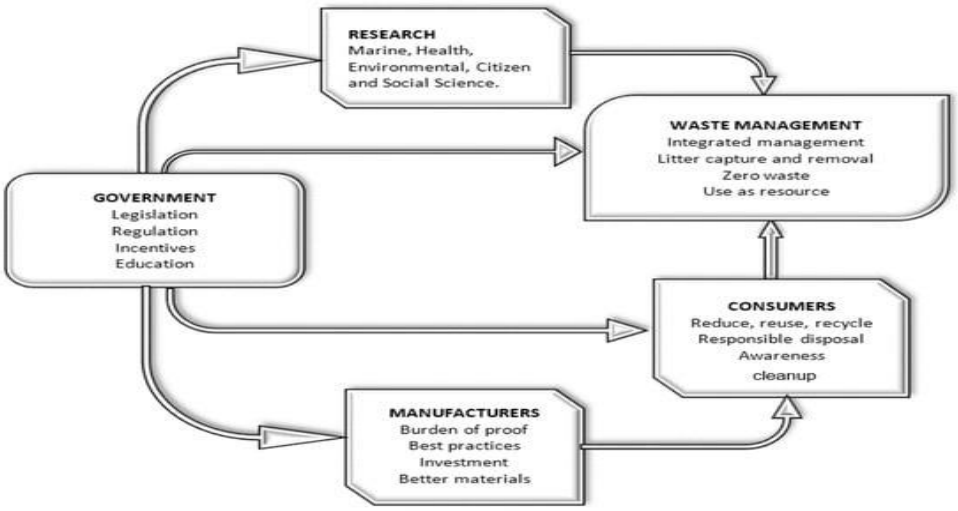
To effectively deal with waste, the old way of doing things following the “make, use and dispose” model should be abandoned for the sustainable “make, use, reuse and recycle” model. Principles like extended producer responsibility have also catapulted forward the need for recycling of aftermarket waste. Recycling ensures that post use materials are returned to the factory as raw material thereby forming a circular loopFigure 6 illustrates the circularity of plastics that can be implemented by all nations to in a bid to accomplish sustainable management of plastics. The adoption of the circular economy concept in plastic management into the future would eventually mitigate the challenges faced by plastic waste problems particularly waste from plastic packaging.

Fig 11. [38. 243p]
Plastics circular economy



In order to effectively implement a circular economy approach to managing plastic waste, it is crucial to foster genuine collaboration among all sectors of society.
Figure 7 below illustrates the interdependent relationship between various stakeholders who have the potential to drive significant transformation..

Fig. 11. [19. 159p]
Cooperation between all sectors to curb plastic pollution



The government's responsibility is to supervise and collect information on the production, usage, and disposal of plastics. This data can then be utilized to create policies and establish waste reduction systems. By combining this with thorough research on critical topics, it becomes possible to develop effective and sustainable policies that support the creation of a circular economy. Tesfaye and Kitaw have proposed a conceptual framework for implementing reverse logistics in plastics recycling, which aims to achieve a circular economy.

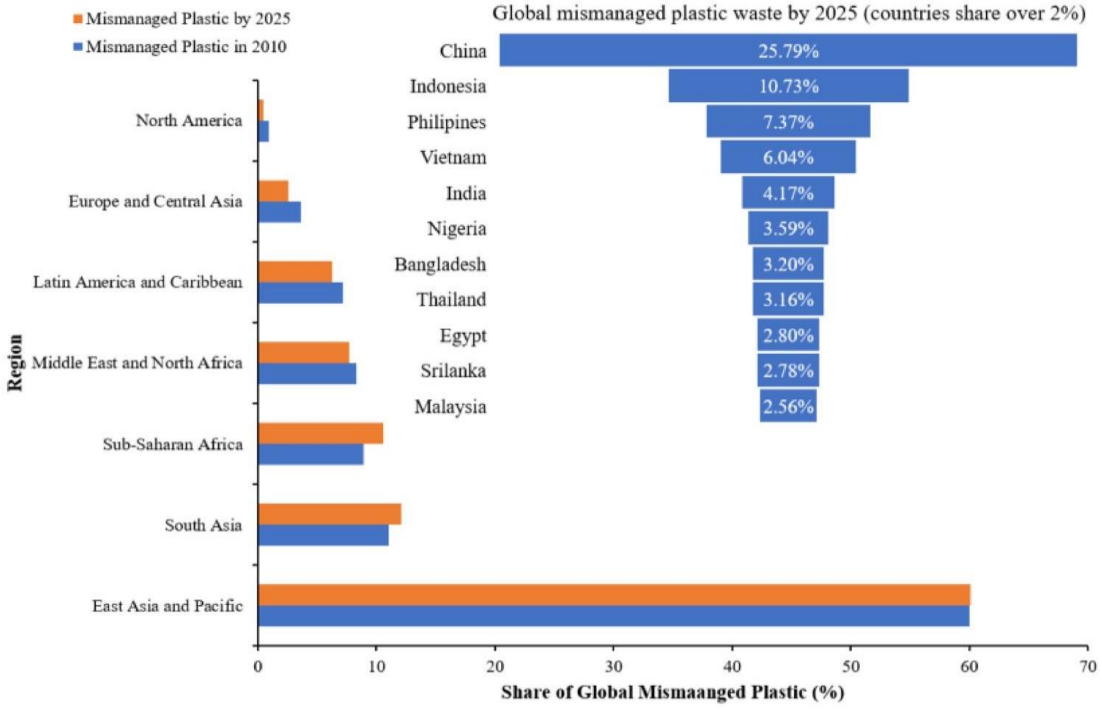
Table 2. [14. 149p.]
Global PET Waste management outcomes

Year Report	**Country**	**PET waste outcomes**	**PET marine outcome**

2010	China	8.8m	3.5m
	Indonesia	3.20m	1.29m
	Philippines	1.90m	0.75m
	Vietman	1.8m	0.73m
	Sri lanka	1.60m	0.64m
	Egypt	1.00m	0.39m
	Thailand	1.00m	0.41m
	Malaysia	0.90m	0.37m
	Nigeria	0.90m	0.34m
	Bangladesh	0.80m	0.31m
	Brazil	0.50m	0.19m
	USA	0.30m	0.11m

Fig. 12. [21. 162p]

Global mismanaged plastic waste by 2025



SECTION 3. IMPROVEMENT OF WASTE MANAGEMENT IN COCA COLA AT THE EXAMPLE OF ENTERPRISES

3.1. Tackling Global waste menace in Coca Cola

It's estimated that over 1 kilogram (that's more than 2 pounds) of trash is generated per person, per day in Mexico. Much of that trash previously ended up in landfills, on the streets, or in the oceans. But over the last few years, Mexico has become "the leading country in Latin America in PET collection and recycling," according to a report from the online magazine El Dictamen. (PET is a clear and lightweight plastic used to make many plastic bottles). Now, 60 percent of Mexico's recycled PET is repurposed for the national market, and the rest is exported abroad.

Much of that can be attributed to a multiyear investment by The Coca-Cola Company and its bottling partners in Mexico. Significant investments in local infrastructures and efforts to make recycling a cross-industry initiative have radically changed both the local recycling ecosystem and the way bottles themselves are being made, so much so that the team recently launched a 100 percent rPET (recycled) bottle for The Coca-Cola Company's water brand in Mexico, Ciel.

Mexico has embraced a circular solution in which used bottles become new goods rather than waste in landfills. PetStar, based in Toluca, Mexico, has developed an integrated recycling company that serves the Coca-Cola bottlers of Mexico, supplying them with a growing share of the recycled PET resin that will make up its packaging, while also working with waste scavengers throughout Mexico to collect thousands of discarded plastic goods. While PET bottles can be recycled for fibers or other materials, bottle-to-bottle recycling has proven the most fruitful way of maintaining the value of

the packaging. PetStar has invested heavily in technologies for extruding and decontaminating the materials the bottle is made from, so they can be reused.

The country's success is "a matter of investment, education, engagement and motivating consumers to be part of that infrastructure, as well as driving that infrastructure and making it more efficient," said Ben Jordan, senior director of environmental policy at The Coca-Cola Company, who points to the fact that emerging infrastructures are often more flexible, and better able to accommodate new initiatives, than established economies.

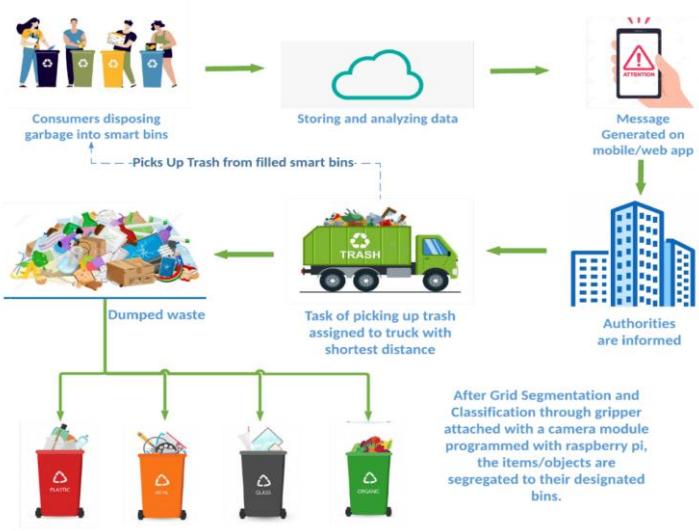
Mexico's initiative serves as a prime example of how effective and strategic programs can emerge from economic investments. It demonstrates that, although objectives may differ across regions, ultimate success lies in the discovery of innovative and sustainable solutions that can be implemented in each market. This is precisely why The Coca Cola Company is dedicating resources to projects like Circulate Capital, which will empower individuals in South and Southeast Asia to address the global plastic crisis through sustainable means.

Meanwhile, in the United States, collaborative efforts such as the Closed Loop Fund are aimed at bolstering recycling rates nationwide by enhancing existing infrastructures. The Coca Cola Company and The Coca Cola Foundation have granted funds to the Closed Loop Fund and the Recycling Partnership, enabling the expansion of curbside recycling and the provision of recycling education to over 500 communities. Additionally, they have generously donated recycling bins for public spaces to more than 1,000 communities throughout the country. Consequently, this collective endeavor has diverted over 730 million pounds of recyclable materials away from landfills. Recently, The Coca Cola Company celebrated a significant milestone

by placing their one millionth recycling bin, marking a significant achievement within this broader undertaking.

Fig 3. [23. 276p]

Waste Management processes



The Closed Loop Fund has played a significant role in waste management in Memphis, Tennessee. Through the addition of recycling containers and advanced processing methods, the city has been able to serve over 150,000 households and collect 34 million pounds of recyclables for reuse.

In South Africa, the country's entry into the global trade market in the 1990s brought about rapid economic growth. However, this growth also led to an increase in plastic waste, necessitating a more sustainable recycling infrastructure. PETCO, a national voluntary extended producer responsibility company, has been instrumental in addressing this issue. PETCO, in collaboration with The Coca Cola Company, has provided essential tools for the recycling industry, such as bailing machines, scales, and trolleys for collection centers. They have also allocated resources for coastal

cleanups, including bags and trailers for the cleaners. According to Casper Durandt, the head of sustainable packaging and agriculture for the Coca Cola Southern and East Africa Business Unit, one of the key factors contributing to South Africa's success in recycling is the voluntary contributions made to PETCO. In South Africa, the resin levy and grants from brand owners, resin producers, and retailers play a significant role in supporting the recycling efforts. These funds are distributed to contracted recyclers, which in turn incentivize bottle collectors. This unique funding model has created income opportunities for about 65,000 individuals in the country. As a result, the collection of plastic bottles has remained a priority, leading to a reduction in the amount of plastic bottle waste that ends up in landfills. The auditing results for 2017 indicate that PETCO's efforts have contributed to a recycling rate of 65 percent, aligning with the recycling standards set by the European Union.

PETCO now has a total of 11 recycling partners across South Africa. These recyclers produce food-grade PET from recycled bottles in three state-of-the-art, bottle-to-bottle recycling plants. The Coca-Cola Company in South Africa now uses up to 25 percent recycled content in its new bottles via a closed-loop structure.

Durandt believes so strongly in this model that he is currently focused on expanding the program throughout Africa with The Coca-Cola Company’s support. “We are working on a project to accelerate Kenya’s [recycling rates] from 16 percent to 50 percent within one year, and we think it’s possible,” he said, optimistically.

“The key to its success was that it was very collaborative, with all the necessary market players involved—producers, retailers and local governments,” said Nele Normak, Coca-Cola’s public affairs and communications manager for the Baltic region. “The success of these vending machines has less to do with any design or technology innovation than simple convenience: Consumers can easily find and use the machines, making the recycling process feel like a simple trip to the ATM.” Other nations with developed recycling infrastructures have also benefited from a collection

network driven by consumers. Take Australia, for example. Since 2017, the country has started to change how it recycles containers, working to ensure that as many as possible are collected in some way, shape or form—either through a network of container-return collection points and vending machines or through curbside collection services. From there, all of the collected bottles are recycled and reused to support a circular-economy approach.

One of Australia's greatest successes has been in opening up the collection market to competitive bidding. "We find that instead of one collection methodology dominating, we can open the market and encourage innovation in the way the collection is done," said Jeff Maguire, group head of container deposit scheme implementation and sustainable packaging at Coca-Cola Amatil, the company's bottling partner. This offers opportunities for nonprofit organizations, especially those that have a preexisting collection infrastructure for used clothing and goods, to use the collection model to supplement their existing work. An example is in the newly commenced Queensland program, where nearly half of the 307 collection points are run by charities.

Recently, the system has been expanded from South Australia, where the program has been operating for 42 years, to other Australian states. "With the exception of two states, by the middle of 2020 the majority of the country will be under similar collection models," said Maguire.

Australia's vast and often remote geography is a challenge, with many smaller towns unable to provide recycling infrastructures on a level with larger cities.

3.2. Management Implementation practices in waste eradication

Waste management improvements may require forward planning and some changes to the way business operates. For example:

- Proposed actions, such as repair of damaged wooden pallets, may need to be discussed with managers, workplace safety representatives, unions, insurers, investors, suppliers and customers to check that they suit your operations and will not impact negatively on food hygiene, safety and other standards.
- Employee training and awareness may be required to successfully implement actions and support the introduction of new equipment or processes, such as better segregation of wastes.
- Results are more likely to be achieved and maintained if you have a written plan and clear targets agreed by all areas of management. Priorities actions and consider beginning with the 'low-hanging fruit' for fast gains and to generate enthusiasm.
- Monitoring waste generation and disposal, such as checking collection contractors' invoices or benchmarking production against raw material purchases, is important for environmental compliance, stock control and to measure (and reward!) improvements. Some common waste reduction opportunities for small to medium beverage manufacturers are provided in the following table. The costs, savings and payback periods are provided as a rough guide only. They include estimates of upfront costs such as capital, labour and installation, but do not include ongoing costs unless these are fundamental to the option itself (e.g. improved maintenance regimes). The suitability and benefits of each option depend on the nature and size of your business and the scale of application. You should also check that they comply with local environment, safety and other requirements. The waste hierarchy provides a framework for managing waste: avoid; reduce; reuse; recycle; and dispose. Waste avoidance generally delivers the best financial and environmental outcomes.

3.3. Scope to Waste Management in Coca Cola

To settle plastic pollution to a minimum level, the world-leading organizations should promote a circular economy to ensure maximum utilization of our recyclable inputs. Beyond these, first of all, conventional mindsets should be changed in using plastic products. In this case, educational institutions, media, and respective government authorities should come forward to raise public awareness as well as to set up a goal for the sustainable waste management program.

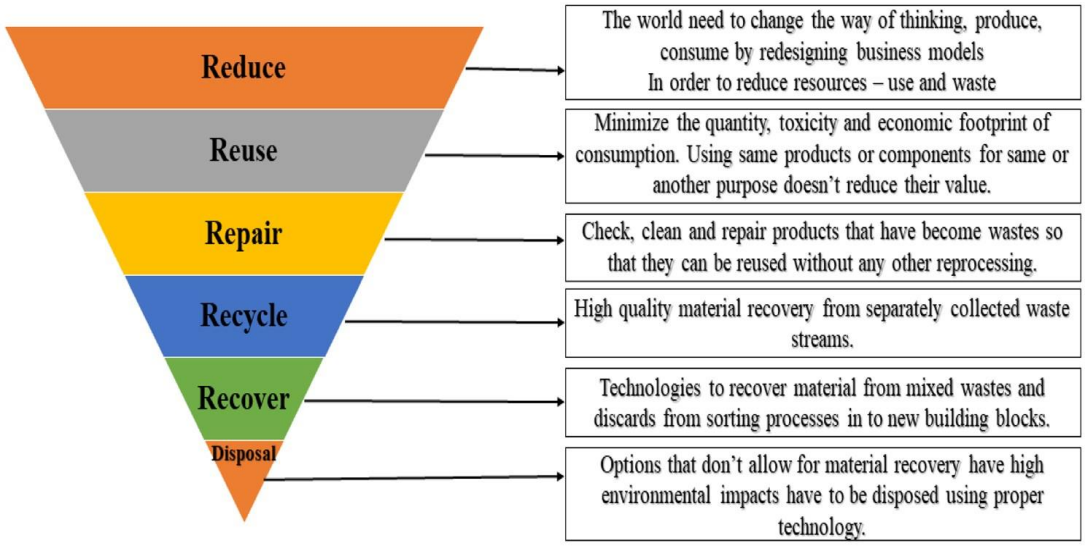
Figure 23 epitomizes the potential strategies to minimize pollution from plastic wastes as well as to set for a sustainable waste management policy. It includes with the behavioral changes, administration activeness, rules and regulations and overall awareness for plastic pollution. Thus, it is now important to rethink about the uses of plastics and find out some suitable alternatives to plastics in our daily lives. Introducing Incentives Financial rewards and incentives for the return of used plastic commodities not only ease the collection process but also helps the sorting process for recycling and recovery. People generally do not show the intention to recycle because of the inconvenience of time and money. But if proper incentives can be placed upon take back policy of used plastics and time can be minimized by setting up frequent take back stations, then people may get much more interest in recycling. On the other hand, it is always difficult to manage people to dump their waste plastic in some fixed spots to ensure easy collection by the respective authorities. Thus, adding collection and recycling costs to the product can be a viable option aware people of the necessity of waste management as well as the protection of the environment. To mitigate the problems identified administration has to take the necessary steps to combine the policies. Figure 24 illustrates an overview of policies distinguished in behavioral, regulation, rights-based and price based (Alpizar *et al*. 2020). Government should consider implementing these policies to obtain a considerable reduction in plastic waste as well as to establish a well-balanced waste management system.

Table 14. [13. 59p]
Various steps by various countries (Laskar *et al*. 2019)

Country	Policies
U.S.A	San Francisco bans the sale of any kind of plastic water bottle
	California is the first state to ban plastic shopping bags
	In 2015 a bill was passed to ban all cosmetics products that contain plastics microbeads
Ireland	A bill was introduced in 2002 to charge 10 cents fee for plastic bags and 4 cents if it goes for the recycling program again
France	It passed a law 'Plastic Ban' in 2016 to ban all plastic by 2020
Sweden	It is the world's largest recycling nation. Less than 1% of Sweden's household waste goes to dumping yards. It recycles all most every waste
China	It passed a Law in 2008, the consumer has to pay for the use of plastic bags, and within two years, usage of plastic bags dropped by 50%
India	Union Government of India banned the use of plastic bags below 50 μm in 2016, amended under Plastic waste Management rules 2016
Bangladesh	In 2002 government of Bangladesh banned the use of thin plastic bags, and in 2020, single-use plastic was strictly banned in coastal areas, hotels, and motels by the High Court of Bangladesh

Fig. 15. [28. 88p]

Six level pyramids to reduce plastic wastes



CONCLUSIONS

The Coca Cola Company has not been successful in its efforts to reduce global waste from its products, resulting in harmful effects on the human ecosystem. The company is likely considering future measures to address the global impact caused by its products. The study mentioned above highlights the company's progress in addressing waste disposal issues on streets, beaches, and oceans, which have left many people without shelter due to unexpected flooding. The industrialization era has been marked by the generation of high amounts of industrial and hazardous waste, which have had negative effects on human populations. It is important to note that these types of waste directly and indirectly harm and disrupt normal human life. Despite the implementation of laws worldwide, proper disposal of industrial and hazardous waste has not been satisfactory. Plastics remain a popular choice for consumer packaging solutions and are the most produced material globally for various industries, such as electronics, automotive, agriculture, toys, and textiles. Plastics, especially single-use packaging in the food industry, often end up in the environment after a short period of use. This pollution of land and water bodies, as well as the entry of plastics into the food chain, can have adverse effects on animal and human health. Therefore, there is an increasing need for packaging materials that are economically viable, convenient, and environmentally friendly. While efforts to find environmentally friendly packaging solutions are ongoing, it is crucial to adopt the reduce, reuse, and recycle approach. Governments, businesses, institutions, and individuals all have a role to play in achieving a circular economy for plastics and implementing effective waste management systems to address the pollution caused by plastic use. This is particularly

important for Africa, as studies predict that the continent will become the largest consumer of food packaging plastics.

REFERENCES

1. "125 Years of Sharing Happiness." *The Coca-Cola Company*. Coca-Cola. Web. <www.thecoca-

"Hills are Alive with Sound of Drilling: Malvern water facing Coca-Cola threat". Birmingham Post. England:Novemeber 24, 2004.

2. "The Coca-Cola Company Rolls Out New PlantBottle Packaging." Entertainment CloseUp. Jacksonville: Apr 7, 2011.

3. Adam, I.; Walker, T.R.; Bezerra, J.C.; Clayton, A. Policies to reduce single-use plastic marine pollution in West Africa. Mar. Policy **2020**, 116, 103928. [Google Scholar] [CrossRef]

4. Adyel, T.M. Accumulation of plastic waste during COVID-19. Science **2020**, 369, 1314–1315. [Google Scholar] [PubMed]

5. Alkaya, E., & Demirer, G. N. (2015). Water recycling and reuse in soft drink/beverage industry: a case study for sustainable industrial water management in Turkey. Resources, Conservation and Recycling, 104, 172-180.

6. Annu. Rev. Environ. Resour. **2017**, 42, 1–26. [Google Scholar] [CrossRef]

7. Arena, N., Sinclair, P., Lee, J., & Clift, R. (2017). Life cycle engineering of production, use and recovery of self-chilling beverage cans. Journal of cleaner production, 142, 1562-1570.

8. Arvanitoyannis, I. S. (2010). Waste management for the food industries. Academic Press.

9. Avella, E. Bonadies, E. Martuscelli, R. Rimedio, *Polym. Test.* 2001, **20**, 517. **Web of Science®Google Scholar**

10. Avikal, S., Jain, R., Mishra, P. K., & Yadav, H. C. (2013). A heuristic approach for U-shaped assembly line balancing to improve labour productivity. Computers & Industrial Engineering, 64(4), 895-901.

11. Baeyens, J., Brems, A., & Dewil, R. (2010). Recovery and recycling of post-consumer waste materials. Part 2. Target wastes (glass beverage bottles, plastics, scrap metal and steel cans, end-of-life tyres, batteries and household hazardous waste). International Journal of Sustainable Engineering, 3(4), 232-245.

12. Brahney, J., M. Hallerud, E. Heim, M. Hahnenberger, S. Sukumaran, *Science* 2020, **368**, 1257.

13. Brooks, A.L.; Wang, S.; Jambeck, J.R. The Chinese import ban and its impact on global plastic waste trade. Sci. Adv. **2018**, 4, eaat0131. [Google Scholar] [CrossRef][Green Version]

14.CEWEP. Landfill taxes and bans overview, http://www.cewep.eu/wp-content/uploads/2017/12/Landfill-taxes-and-bans-overview.pdf (accessed: April 2020).**Google Scholar**

15. Chruszcz, A.,S. Reeve, WRAP, Composition of Plastic Waste Collected via Kerbside, https://wrap.org.uk/content/composition-plastic-waste-collected-kerbside (accessed: April 2020). **Google Scholar**

16. Cocacolacompany.com/heritage/pdf/Coca-Cola_125_years_booklet.pdf>.

17. Dahlgaard, J. J., & Mi Dahlgaard-Park, S. (2006). Lean production, six sigma quality, TQM and company culture. The TQM magazine, 18(3), 263-281.

18. De Stefano, V. (2015). The rise of the just-in-time workforce: On-demand work, crowdwork, and labour protection in the gig-economy. Comp. Lab. L. & Pol'y J., 37, 471.

19. De Steur, H., Wesana, J., Dora, M. K., Pearce, D., & Gellynck, X. (2016). Applying value stream mapping to reduce food losses and wastes in supply chains: A systematic review. Waste management, 58, 359-368.

20. Dean, R. PPE: Polluting Planet Earth. Br. Dent. J. **2020**, 229, 267. [Google Scholar] [CrossRef] [PubMed]

21. European Council, Conclusions from Special Meeting of the European Council (17, 18, 19, 20 amd 21 July 2020), https://www.consilium.europa.eu/media/45109/210720-euco-final-conclusions-en.pdf (accessed: September 2020). **Google Scholar**

22. European Parliament and Council, *Off. J. Eur. Union* 2008, **51**, 3.**Google Scholar**

23. European_Commission. Joint Statement of the Plastics Packaging Industry in France and Germany on the Circular Economy Action Plan. 11 March 2020. Available online: https://newsroom.kunststoffverpackungen.de/wpcontent/uploads/2020/06/joint_statement_circular_economy_action.pdf (accessed on 25 November 2020).

Fig. 1. http://www.siliconeer.com/past_issues/2004/december2004.html

Fig. 2. www.google.com...//www.pamelaspunch.com...&imgrefurl=www.pamelaspunch.com

24. Fillaudeau, L., Blanpain-Avet, P., & Daufin, G. (2006). Water, wastewater and waste management in brewing industries. Journal of cleaner production, 14(5), 463-471.

25. Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. Journal of operations management, 19(1), 81-96.

26. GOVUK. Landfill Tax rates, https://www.gov.uk/government/publications/excise-notice-lft1-a-general-guide-to-landfill-tax/excise-notice-lft1-a-general-guide-to-landfill-tax (accessed:April 2020). **Google Scholar**

27. H. Thomson, K. Illingworth, H. McCoach, M. Jefferson, S. Morgan, Based on Analysis of UK Grocery Packaging Data from – PlasticFlow 2025: Plastic Packaging Flow Data Report, https://wrap.org.uk/sites/files/wrap/PlasticFlow%202025%20Plastic%20Packaging%20Flow%20Data%20Report_0.pdf (accessed: April 2020). **Google Scholar**

28.https://businessday.ng/climate-and-environment/article/coca-cola-leading-the-charge-in-environmental-sustainability/

29. *International Conference on Engineering for Sustainable World Journal of Physics*: Conference Series 1378 (2019) 022048 IOP Publishing doi:10.1088/1742-6596/1378/2/022048

30. Jacob, J.; Lawal, U.; Thomas, S.; Valapa, R.B. Chapter 4—Biobased polymer composite from poly(lactic acid): Processing, fabrication, and characterization for food packaging. In Processing and Development of Polysaccharide-Based Biopolymers for

Packaging Applications; Zhang, Y., Ed.; Elsevier: Amsterdam, The Netherlands, 2020; pp. 97–115. [Google Scholar] [CrossRef]

31. Jambeck, J.R.; Geyer, R.; Wilcox, C.; Siegler, T.R.; Perryman, M.; Andrady, A.; Narayan, R.; Law, K.L. Plastic waste inputs from land into the ocean. Science **2015**, 347, 768–771. [Google Scholar] [CrossRef]

32. Kahlert, S.; Bening, C.R. Plastics recycling after the global pandemic: Resurgence or regression? Resour. Conserv. Recycl. **2020**, 160, 104948. [Google Scholar] [CrossRef] [PubMed]

33. Kalpakjian, S. (2001). Manufacturing engineering and technology. Pearson Education India.

34. Kannan, V. R., & Tan, K. C. (2005). Just in time, total quality management, and supply chain management: understanding their linkages and impact on business performance. Omega, 33(2), 153-162.

35. Kosior, E.; Mitchell, J. Chapter 6—Current industry position on plastic production and recycling. In Plastic Waste and Recycling; Letcher, T.M., Ed.; Academic Press: Cambridge, MA, USA, 2020; pp. 133–162. [Google Scholar] [CrossRef]

36. Kumar, C. S., & Panneerselvam, R. (2007). Literature review of JIT-KANBAN system. The International Journal of Advanced Manufacturing Technology, 32(3-4), 393-408.

37. Mathiason, Nick. “Coke ‘drinks India dry’: Critics claim beverage giant’s bottling plants are interfering with irrigation in drought-ridden regions”. The Observer. England: March 19, 2006.

38. Mohammad, A.; Goli, V.S.N.S.; Singh, D.N. Discussion on ‘Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic, by Sharma et al. (2020)’. Resour. Conserv. Recycl. **2020**, 164, 105175. [Google Scholar] [CrossRef] [PubMed]

39. Monden, Y. (2011). Toyota production system: an integrated approach to just-in-time. Productivity Press. [33] Hopp, W. J., & Spearman, M. L. (2004). To pull or not to pull: what is the question?. Manufacturing & service operations management, 6(2), 133-148.

40. Nallusamy, S. (2016). Productivity enhancement in a small-scale manufacturing unit through proposed line balancing and cellular layout. International Journal of Performability Engineering, 12(6), 523-534.

41. Nash, M. A., & Poling, S. R. (2011). Mapping the total value stream: a comprehensive guide for production and transactional processes. CRC Press.

42. Ncube LK, Ude AU, Ogunmuyiwa EN, Zulkifli R, Beas IN. An Overview of Plastic Waste Generation and Management in Food Packaging Industries. *Recycling*. 2021; 6(1):12. https://doi.org/10.3390/recycling6010012

43. Ncube, L.K.; Ude, A.U.; Ogunmuyiwa, E.N.; Zulkifli, R.; Beas, I.N. An Overview of Plastic Waste Generation and Management in Food Packaging Industries. *Recycling* **2021**, *6*, 12. https://doi.org/10.3390/recycling6010012

44. Ncube, Lindani Koketso, Albert Uchenna Ude, Enoch Nifise Ogunmuyiwa, Rozli Zulkifli, and Isaac Nongwe Beas. 2021. "An Overview of Plastic Waste Generation and Management in Food Packaging Industries" *Recycling* 6, no. 1: 12. https://doi.org/10.3390/recycling6010012 **CASPubMedWeb of Science®Google Scholar**

45. Olajire, A. A. (2012). The brewing industry and environmental challenges. Journal of Cleaner Production.

46. Patrício Silva, A.L.; Prata, J.C.; Walker, T.R.; Campos, D.; Duarte, A.C.; Soares, A.M.V.M.; Barcelò, D.; Rocha-Santos, T. Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. Sci. Total Environ. **2020**, 742, 140565. [Google Scholar] [CrossRef] [PubMed]

47. Plastics_Europe. Plastics-The Facts: An Analysis of European Plastics Production, Demand and Waste Data; Plastics Europe: Brussels, Belgium, 2019. [Google Scholar]

48.PlasticsEurope. PlasticsFacts, https://www.plasticseurope.org/application/files/9715/7129/9584/FINAL_web_version_Plastics_the_facts2019_14102019.pdf (accessed: October2019).**Google Scholar**

49. Singh, N.; Hui, D.; Singh, R.; Ahuja, I.P.S.; Feo, L.; Fraternali, F. Recycling of plastic solid waste: A state of art review and future applications. Compos. Part B Eng. **2017**, 115, 409–422. [Google Scholar] [CrossRef]