The Reverse Logistics: Factors influencing Liège citizen's participation in the Deposit Refund Scheme

Jury:
Promoter:
Didier VAN CAILLIE
Reader :
Ruysschaert Benoît

Dissertation by
Amal BEKKAR
For a Master's degree in Management with a specialization in Global Supply Chain Management

Academic year 2023/2024

Acknowledgements

First of all, I would like to express my sincere gratitude to my supervisor, Mr. Van Caillie, for permitting me to explore the topic of my choice and for his continuous support, advices, and extremely generous and helpful guidance during every single phase of this thesis.

I would also like to thank my reader and member of my thesis committee, Mr. Ruysschaert, for the time and engage taken to read my research thesis. Your interest and attention are deeply appreciated.

Findings from this study would not be as relevant and rich without the contribution of all the individuals who participated in the survey, I sincerely appreciate your willingness to share your time and insights.

A special thank you goes to my sister Assia . Thank you so much for always being there for me. You are the reason I could stay strong and get to the end of this Master Programme.

And finally, I would like to dedicate this work to my beloved mother, Anissa, who passed away on November 21th 2023 which made my days incredibly tough and challenging.

Table of Contents

List of Figures

List of tables

List of Abbreviations

RL: Reverse logistics

DL: Direct logistics

CE: Circular Economy

EU: Europe

PET: Polyethylene terephthalate

DRS: Deposit Refund Scheme

PMD: «Plastic Bottles and Vials", "Metal packaging", "Drinks"

MSW: Municipal solid waste

RVM: Reverse Vending Machines

TPB: Theory of Planned Behavior

PBC: Perceived Behavioral Control

EPR: Extended Producer Responsibility

I. Introduction

1. Context

There is a growing environmental concerns caused by many crisis as the climate change, the high waste quantities and the shortage raw materials crisis.

The scale and urgency of those crises urge to implement proven solutions to meet the climate mitigation and waste prevention objectives.

The deposit refund scheme is one of those innovative solutions designed to promote recycling and responsible waste management as there is over 41 billion plastic and glass bottles and beverage cans that every year, in Europe, escape the recycling circuit and end up in landfills, rivers and the sea (Giorgia Marino, 2021).

The approach aims to create a closed-loop system, encouraging the return and recycling of packaging materials and reducing the environmental impact to meet the European commission objectives to create a circular economy and recycling growth with a target rate of 77% for PET plastic bottles by 2025 and up to 90% by 2029 and also to include 25% recycled plastic in PET beverage bottles from 2025 and 30% to all plastic beverage bottles starting in 2030 which remains a challenging target (European Commission,2023).

However, the deposit refund scheme is considered as an innovative solution to increase the recycling rate of drinks containers by increasing the return rate as it is the case in many European countries.

For instance, the least successful European country is Estonia, with an impressive 82.7% total return rate including can, PET and glass and the highest recycling rate for the same category of drinks containers is registered by Germany 98.4% which is perceived as one of the most successful examples in Europe followed by Finland and Denmark (Samantha Millette,2022).

In this context, our study will focus on the various factors influencing Liège citizen's participation in the deposit refund scheme.

Key words: Deposit Refund Scheme, Circular Economy, Reverse Logistics, Recycling, Beverage Containers, Waste Management, Consumer Behavior.

2. Objectives

Considering that around 352.9 million people around the world are living in jurisdiction where deposit return scheme systems are already implemented which is about 45 countries worldwide and in where surveys were hold to evaluate the public support for these systems, as for instance in Italy, Slovakia and Portugal where people voted in favor for the implementation of DRS with respectively 83%, 90% and 91.6% (Samantha Millette, 2022).

The primary objective of this research thesis is to investigate the factors influencing Liège citizens' participation in the DRS, understand consumer's behavior and willingness to pay to reduce the amount of litter in their area of residence and also get their opinion about the expectations and the ideal system perceived by them.

Though, the consumer plays a central role in determining the success of the DRS, there is only few studies that analyze consumers' willingness to participate in such a waste collection program (Roca et al., 2020).

Therefore, this thesis contributes to the existing body of knowledge on sustainable waste management and consumer behavior by analyzing consumer's attitudes in the face of a proposed implementation of a DRS in Liège city.

On a personal level, this research is driven by a deep commitment to addressing climate change and environmental issues as a person with keen interest in environmental policies and social responsibility.

This personal motivation underscores the importance to promote environmentally responsible behaviors among urban populations and fosters a deeper understanding of how to effectively engage citizens in sustainable waste management initiatives.

3. Research questions

The consumer's physical responsibility in returning the bottles to the collection centers and engagement in the initiative is key to achieving the desired outcomes and to the success of the implementation of the DRS.

Therefore, in order to comprehensively understand the factors influencing Liège citizens' participation in the DRS, this study is structured around several key research questions which are designed to explore various dimensions of consumer behavior and perceptions, providing a holistic view of the determinants of participation in the DRS.

RQ1*: How aware are citizens of the existence of the deposit refund scheme model?*

RQ2: *How does a positive perception of the deposit refund scheme influence consumer's engagement in the DRS?*

RQ3: *How do psychological factors, including social norms, attitudes, and perceived behavioral control impact participation in the deposit refund scheme among Liège citizens?*

RQ4*: How do consumers' environmental concerns influence their willingness to participate in a deposit return scheme?*

RQ5: *How does the convenience of a deposit refund scheme influence consumers' participation?*

RQ6*: How do financial incentives affect consumers' decision to participate in the DRS?*

RQ7: *How do demographic factors influence participation in the DRS?*

4. Thesis structure

The research thesis is composed of six chapters, we will first start with an introduction, followed by clearly defined objectives and research questions, and then we will present the literature review which comprises three chapters, each delving into distinct facets.

Chapter 1 explores the concept of reverse logistics, encompassing its definition, activities, driving forces, and its integration within the circular economy framework, with a specific focus on recycling practices and waste management in Belgium.

Chapter 2 investigates the deposit refund scheme, elucidating its definition, European context, diverse implementations, factors influencing its deployment, and the associated benefits, followed by chapter 3 which turns attention to consumer behavior and decision-making processes, shedding light on perceptions regarding DRS adoption and the factors influencing consumers' choices ,afterwards it presents the various hypothesis developed based on the literature .

Chapter 4 outlines the research design section by describing the data collection method and analysis which is followed by chapter 5 that synthesizes the different findings of the survey.

Finally, the last chapter explores the research results with more details and explanations, and the conclusion summarizes the key findings, limitations and suggests directions for future research.

II. Literature review

Chapter 1: The reverse logistics

1. Definition

The term reverse logistics was first used in the 1980s (Rogers, D. S., & Tibben-Lembke, R. 2001).

According to Lambert and Stock (1981), it was defined as "going the wrong way on a one-way street" because the great majority of product shipments flow in one direction, during the same decade the reverse logistics was described as the "movement of goods from a consumer towards a producer in a channel of distribution" by Murphy (1986) and Murphy and Poist (1989) so basically the movement of materials away from the customer to the producer, was the main activity covered by reverse logistics.

After a decade the concept of reverse logistics has evolved to include many other aspects as stated by Stock (1998) who defines it as "the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal and refurbishing, repair, and remanufacturing", this definition is comparable to the one published by Stock (1992) and Kopicki et al (1993).

Furthermore Carter and Ellram used a similar description published in the Journal of Business Logistics (1998) referring to it as "the process by which companies can become more environmentally efficient through recycling, reusing, and reducing the amount of materials used."

Although many activities was added to the definition of the reverse logistics, the most inclusive definition was the one provided by Rogers and Tibben-Lembke (1999):

"The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal" and which is also adopted by the Council of Logistics Management's.

The RL differs from direct logistics, while DL moves goods towards the customer, RL moves goods from the customer Sellitto et al (2015).

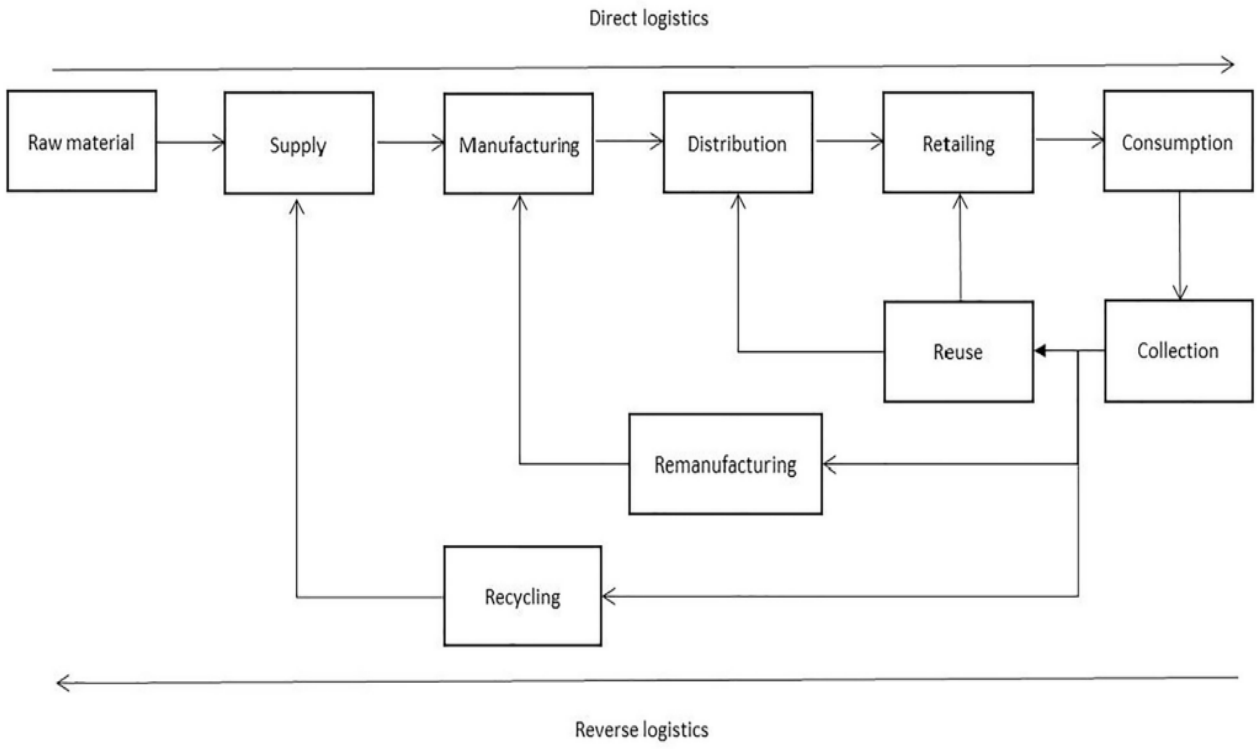


Figure 1: Representation of direct and reverse logistics typical flows. Source Sellitto, M. A. (2018)

2. Reverse logistics activities

There are many activities following the reverse logistics process depending on whether the reverse stream concerns the products or packaging.

When it comes to products Fleischmann et al. (2000) described different activities that are included in reverse logistics in order to recover the value of the returned products which are collection, inspection & separation, reprocessing & disposal, and Redistribution.

Rogers and Tibben-Lembke (2001) have also separated in their work the different activities of the RL based on whether it is a product that could be in the reverse flow for several reasons, such as remanufacture or refurbishment, or because a customer returned, or if it is a packaging which generally flows back because it is reusable or because regulations restrict its disposal.

Both products and packaging can be recycled or landfilled, but if they are reused, both can undergo various processes.

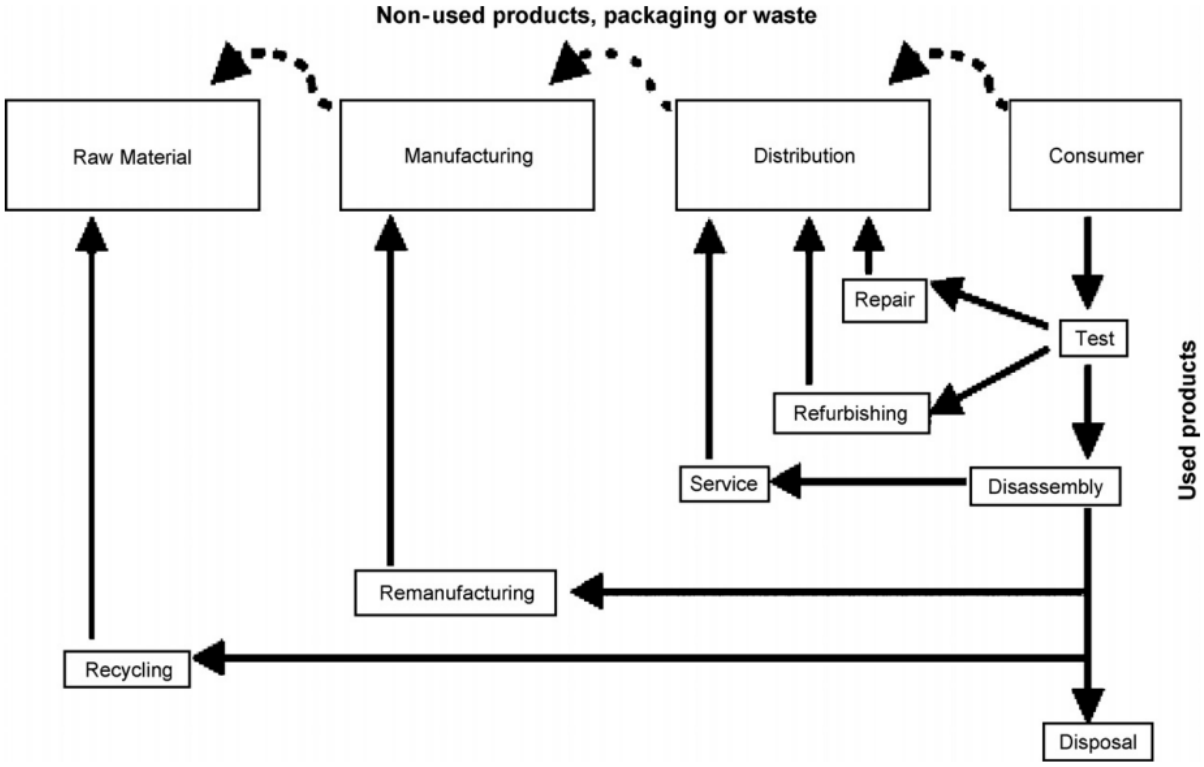


Figure 2: Basic flow diagram of reverse logistics activities. Source: Srivastava, S. K. (2008)

Since the main focus of this thesis is the recovery of the packaging after serving its purpose to consumers, we will detail only the packaging's different activities in the RL, which are the following:

- *Recycling:* cooperative or intermediate companies separate and process discarded materials (paper, glass, metals, and plastics, among others) that return as low-cost raw materials for industries (Rahimifard et al., 2009).

- *Reuse:* companies collect their waste and reuse it as low-cost raw material or route it to other companies, after small interventions like washing and cleaning (Nardi et al., 2017).

- *Disposal*: it is the last option where value recovery is unfeasible, in this case, the material routes to landfills, incineration, or renewable energy systems (Tseng, 2011).

3. Driving Forces

Drivers are described as motivational factors that lead companies to employ some sort of activity but the key drivers of RL initiatives are not well known yet (Akdoğan and Coşkun, 2012).

However the main drivers can be grouped in three main categories (De Brito and Dekker, 2004).

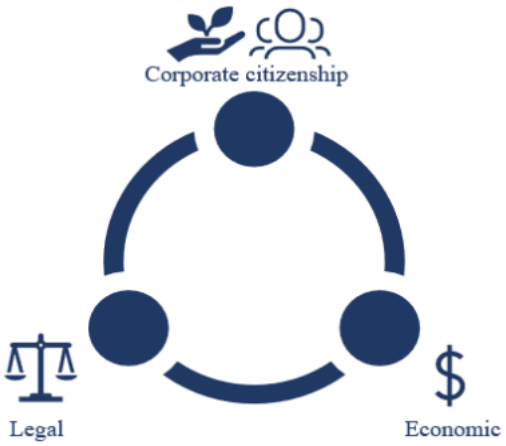


Figure 3: Driving triangle for reverse logistics. Source: (De Brito and Dekker, 2004)

3.1. Economic drivers

Processing returned or used products brings significant profits to the businesses and provide substantial gains to the companies. In some cases, product reuse can be a low-cost source of raw materials and reverse logistics may be an alternative when producing new goods is significantly more expensive than recovering existing ones (Akdoğan and Coşkun, 2012).

De Brito & Dekker (2004) have also addressed the economic benefits of the RL, by distinguishing between short and long term gains.

The short-term gains can result from decreased utilization of raw material and also through diminishing the cost of disposal or by reusing components with value from returned end-of-life products while the long term gains are rather a strategic move to prepare for the future (De Brito and Dekker, 2004).

However, executive management in companies predominantly focuses on the forward flow to gain competitiveness while it is a missed opportunity to gain from the reversed flow of products that could increase profitability if managed efficiently (Blackburn et al., 2004).

3.2. Legal drivers

The legal drivers are any jurisdictions mandating that a company should recover its products or take them back (Akdoğan and Coşkun, 2012).
As legislation can lead to higher costs for companies when enter into force, customers may be required to cover these costs since companies often treat environmental aspects as onerous tasks rather than as chances to improve their competitive position, furthermore legislation of environmental aspects can thus be a vital necessity or even a must in those cases where companies put effort into becoming viable in their business models without success (Guide Jr. et al., 2003).

3.3. Corporate Citizenship drivers

Corporate citizenship concerns a set of values or principles that impels a company or an organization to become responsibly engaged with reverse logistics (Adebamboo, S., & Iyabot, A., 2014).

The reasons for the implementation of reverse logistics activities were twofold: first, to comply with regulatory requirements and second to establish an image that customers would want of an environmentally conscious company (Akdoğan & Coşkun, 2012).

Moreover, there are more options to improve the company's reputation when customers are more aware of the reversed flow of refunds or customers returns (Akdoğan & Coşkun, 2012).

4. Circular economy

The concept of circular economy has drawn greater attention in recent years and evolved into a strategy used by businesses to act more sustainable (Urbinati et al., 2017).

We found in the literature many definitions of the CE, Malindzakova et al., (2022) has described it as an economic system that emphasizes maintaining the value of products, materials, and resources within the economy for as long as possible, while minimizing waste generation.

In the same context, the European Parliament (2023) has defined the main goal of CE as the extension of the products' life cycles through value-recovery and reduction of waste by coming up with new production and consumption practices such as sharing, reusing, repairing or recycling, therefore the purpose of the CE is the transition from the traditional linear economic model of 'take-make-use-dispose' to create a closed loop where resources are used, reused, and recycled, generating additional value across multiple lifecycles (Abejón et al., 2020).

There is a common key principles of the CE which we find in the different definitions, like long-lasting products, reuse, repair, remanufacture and recycle.

Urbinati et al. (2017) has also defined those key principles of the CE which are the product life extension that reduces consumption through designing more durable products with longer lifetime, the redistribution or reuse of a product, a product's entire added value is preserved when it is reused, the remanufacturing or refurbishment of a product that refers to products that cannot be directly reused but must go through a series of manufacturing steps to become as new or an even better product with the same warranty as a new product and finally the recycling which is the most popular method used in the CE to treat used materials to make them suitable for reuse.

The four principles explained above emphasize the aim of the circular economy, namely how to decrease waste by maximizing the lifespan of products and materials in the economy through effective use (Urbinati et al., 2017).

The figure below demonstrates how the already used products, components and materials that in the linear model was considered as waste can be recovered, processed and used as an alternative supply source in the production process (Habibi et al., 2017).

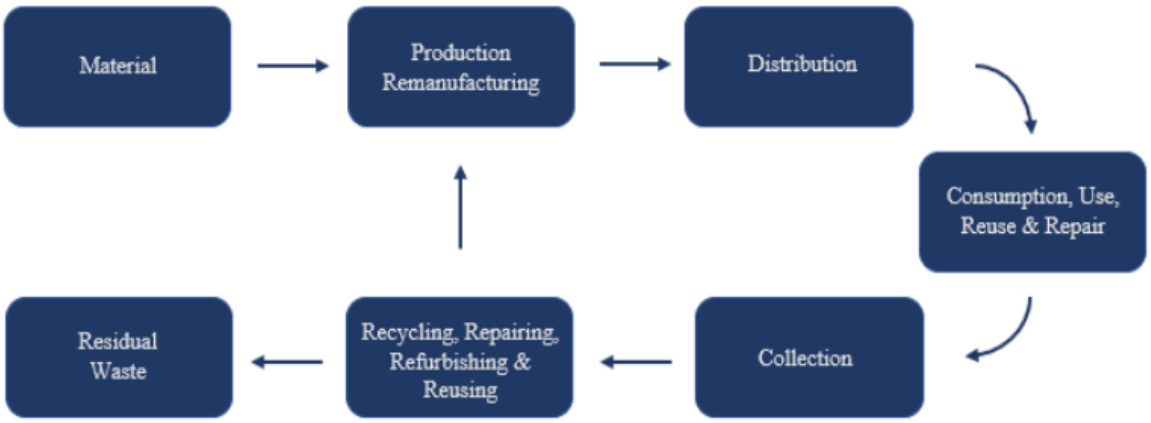


Figure 4: The circular economy .Source: (Habibi et al., 2017)

5. Recycling

Taking into account the focus of the research thesis, the recycling aspect will cover only the beverages containers.

Among beverage packaging materials, glass and aluminum beverage packaging show the most promising performance in terms of recycling, followed by PET and carton,however, the recycling rate of PET bottles is progressively increasing, for instance in EU, PET bottles used to contain around 10% recycled PET content (Simon et al., 2016).

With the various European goals to promote recycling , the EU parliament has established ambitious targets for waste recycling, aiming to achieve 55%, 60%, and 65% recycling rates for municipal waste by respectively 2025, 2030, and 2035 (The Waste Framework Directive, 2018).

In the same context of recycling, the European Union has specifically targeted aluminum cans and plastic packaging (Malindzakova et al., 2022).

In addition and Based on the EU Waste Framework Directive (Directive 2008/98/EC), it places the highest priority on waste prevention, followed by reuse, recycling, and recovery as the least preferred method of waste management is waste disposal.

Figure 5: PET Bottles recycling outcomes. Source: Study into the PET recycling process

Despite recycling effort, a large proportion of PET plastic bottles is still discarded after first use as only about 35% of all PET plastic bottles in Europe are recovered (Alighiri et al., 2019).

In order to increase the efficiency of waste management systems and facilitate recycling or reusing, many countries have decided to collect beverage packaging separately from other wastes (Görgun et al., 2021).

6. Type of bottles

Glass bottle: Glass is mainly produced by mixing three components which are the sand, sodium carbonate, known as soda and lime. In order to create a new glass, combining those three ingredients with a temperatures between 1,500 and 1,600°C is required (Baeyens et al., 2010).

Glass containers are typically used only once or a few times at most in most countries before being discarded. The leftover glass should ideally be reused or remanufactured to create new glass containers. Additionally, part of the waste glass that is gathered throughout the waste collection processes is no longer suitable for reuse or remanufacturing of new glass products (Agnusdei et al., 2022).

Considering its production chain, glass gives rise to a major environmental challenge as it is produced from ore material and takes a long time to degrade (Westbroek et al., 2021), not only that, but it is undeniable that glass bottles have the highest environmental impact due to their production and transports because lot of energy is required to reach high temperature in order to create a glass bottle and its weight in the transport phase which generates more pollution (Stefanini et al., 2021).

However, some improvements can be obtained with returnable glass, even if it is considered that a bottle could be reused eight times before being disposed (Stefanini et al., 2021).

Plastic bottle : there is the single-use plastic bottle (PET Bottle) that can be defined according to the EU directives (2019/904) as "A product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its lifespan, multiple trips or rotations by being returned to a producer for refill or re-used for the same purpose for which it was conceived "

and the recyclable plastic Bottle (R-PET Bottle) which is created by recycling the single-use PET bottles after collection and sorting operations.

There are basically two main established recollection systems, the curbside collections in which PET bottles are gathered along with other packaging materials and manually or automatically sorted out of the plastic packaging fraction and the deposit systems in which the consumers return the PET beverage bottles to the retailer in order to redeem their deposit (Welle, F. 2011).

7. Comparison between plastic and glass bottles

The literature confirms that, considering factors as number of cycles, transportation, production and product end of life, PET bottles are more environmentally friendly than glass bottles.

If we compare glass packaging with Pet and R-PET bottles, the glass packaging is considered as the worst packaging option and the most impactful material according to global warming, stratospheric ozone depletion, terrestrial acidification, fossil resource scarcity and water consumption, since glass bottles are so heavy so trucks consume more and produce more pollution as a result, furthermore glass containers are already transported in their final shape, which takes up a lot of space and means that fewer bottles can be carried on each journey than plastics, which can be transported in octabins before the final packaging of the bottle creation (Stefanini et al., 2021).

The Figure 4 illustrates the various percentages differences between the contributions of each bottle to a specific environmental impact.

However, returnable glass permits saving of emissions in comparison to non-returnable glass, therefore improving the recycling rate of glass packaging has become an issue that requires urgent solutions.

Numerous countries have instituted systems that incorporate forward and reverse logistics in order to address the issue of beverage glass packaging that ends of use. These systems are founded on the extended producer/consumer responsibility (Gupt & Sahay, 2015).

Moreover, the bottle-to-bottle glass collection enables an effective glass packaging recycling and reuse which can potentially favor decreases greenhouse gas emissions and resource use (Welle, 2011).

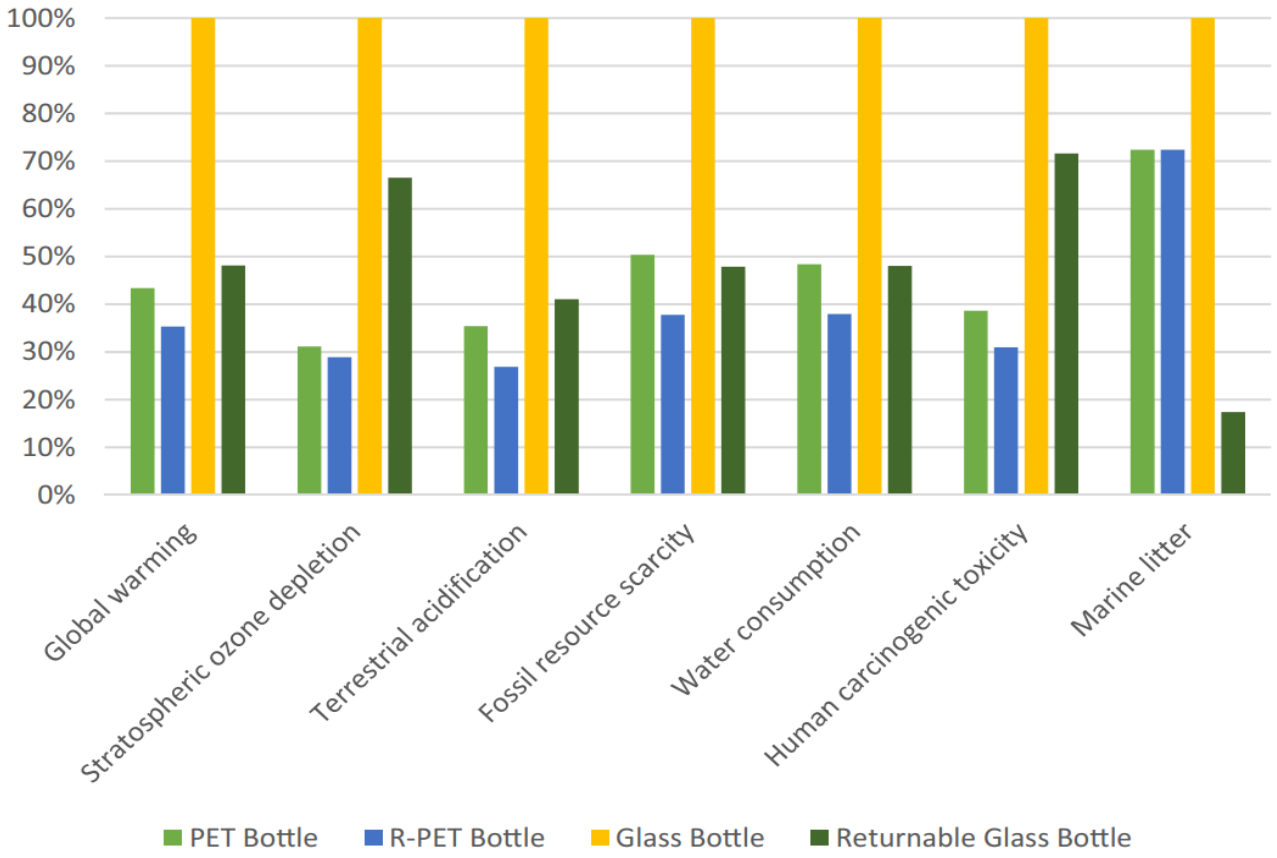


Figure 6: The contributions of each bottle type to the environmental issues. Source: (Stefanini et al., 2021)

8. Waste Management in Belgium

This research being conducted within the Belgian boundaries, it is relevant to shortly describe the system of recycling and waste management in Belgium.

There are mainly 36 inter-municipal associations, also referred to as intercommunales which are largely responsible for managing municipal solid waste (MSW), 7 inter municipalities are located in Wallonia, 28 in Flanders, and just one operator in Brussels Capital (Ferreira, 2017).

However, Belgian waste management systems are specific to each municipality and adhere to regional rules which are challenging to standardize.

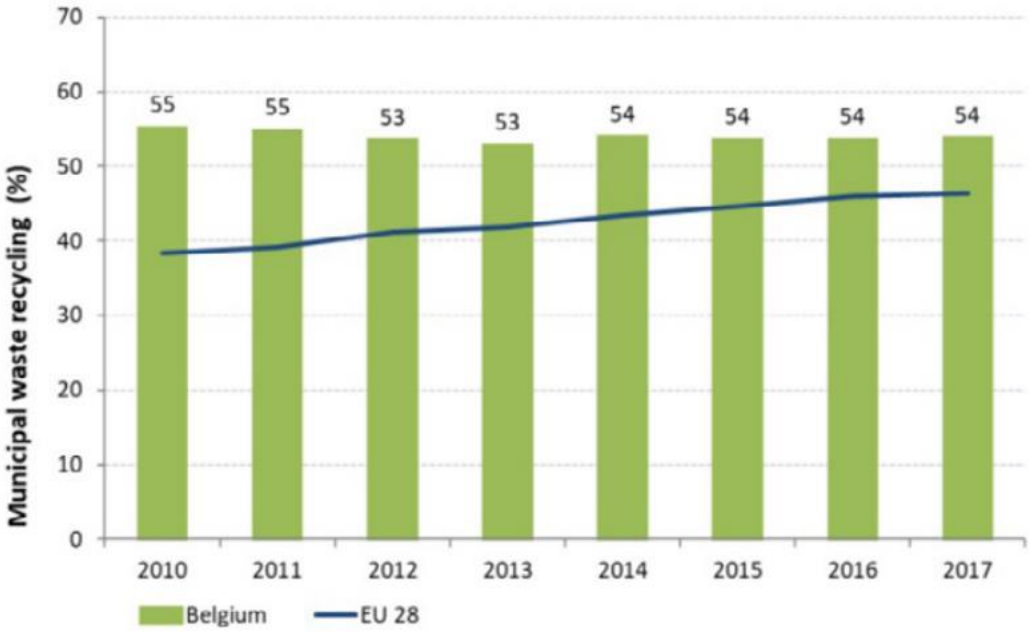


Figure 7: The Belgian municipal waste recycling rate. Source: Bio-waste generation in the EU

According to Eurostat, Belgium has one of the highest recovery and recycling rates among countries in the European Union. Indeed, in 2020, it recycled 79.2% of all waste, significantly more than the EU average of 53%.

Since the main focus of this thesis is the DRS, we will be only addressing the recycling system of plastic, glass and metal containers.

The plastic waste is collected from homes in blue PMD bags once every week (Depending on the city) and transported to five built sorting centers which can be found at Valtris in Couillet, Val'Up in Mons, Prezero in Evergem, Indaver in Willebroek, and Sitel in Liège.

After separating the various plastic types using a combination of drum sieves, infrared machines, and artificial intelligence, the plastic is compressed into big bales that are transported to recycling plants. These are melted and reshaped into new goods after being cleaned, dried, and formed into pellets or granules.

Regarding glass recycling, glass can be disposed of in bottle banks ,sorting streets and underground containers or it can be picked up right from the home, depending on the region of Belgium, these are labeled carefully to make sure colored and uncolored glass are kept apart.

After the impurities are removed from the collected glass, it is then melted and used to create new glass items with the aid of contemporary technology like optical systems.

The Fost Plus 2021 activity report states that Belgium recycled an average of 29.7kg of glass per citizen in 2021.

When it comes to recycling metal, the metal packaging (food cans, drink cans, aluminum trays…) is also placed in the blue PMD bag which is collected from houses and follows the same recycling process of plastic packaging.

Chapter 2: Deposit refund scheme

1. Definition

Deposit-refund system, sometimes referred to as deposit-return system, advance deposit fees or deposit-return scheme, is a mechanism that allow packaging to be reused rather than ending up in landfills by charging a surcharge when a product is purchased and a rebate when it is returned (Walls, M., 2011).

According to the Glossary of Environment Statistics, DRS is defined as the following:

"A deposit-refund system is the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund of the surcharge is granted" (Glossary, 2016).

So consequently, customers must pay a deposit value (fee) under DRS for beverage packaging, this amount is recovered when the empty packaging is returned to designated collection points (Görgun et al., 2021).

In the same context, Lindhqvist (2000) categorizes DRS as a part of the EPR principle.

When DRS were first implemented, it was primarily voluntary. However, as the cost of manufacture from virgin materials started to decline as compared to the costs associated with collection and recycling, the voluntary systems were replaced with mandatory ones. One-way containers are particularly well-suited for mandatory systems, which have been found to yield greater collection rates as compared to alternative-based systems (Xevgenos et al., 2015).

The deposit refund system is applied to various products. The policy instrument is largely applied to packaging products, and beverage containers like PET bottles, or aluminium cans, but it has also been applied to products such as lead-acid batteries, motor, oil, and tires (Spiegelman, 2005).

The goal of the deposit refund system is to decrease litter, reduce the volume and cost of waste disposal and discourage illegal or unsafe disposal via the improvement of collection of post-consumer products (Spiegelman, 2005).

Moreover, a major objective of deposit refund systems is to extract recyclable items out of the waste stream, increase the amount of returned empty or waste packaging so as to reduce the raw material usage, and energy (Spiegelman, 2005).

Therefore, when one-way package recycling rates rise, the greenhouse emissions, and associated environmental impacts decreases (Zero Waste Europe, 2020).

In comparison to other recycling programs, this system has garnered broad public support for its ability to collect large volumes of beverage packaging, encourage reuse, and achieve higher rates of quality recycling and recovery which is especially true when the deposit amount is set at an ideal level (Agnusdei et al., 2022).

On the other hand, putting a DRS into place requires significant resources and it is heavily reliant on public engagement in order to increase recycling rates as the success of the DRS has been evident in countries like Finland, Denmark, Germany, and Norway, where recycling rates have increased (Roca et al., 2020).

A DRS can achieve a collection rate of up to 98% when it is properly implemented (Görgun & al, 2021).

However, DRS is not the only business model favoring circular economy and complies with EPR regulations. Additional systems that contribute to the reduction of packaging waste and recycling include refill on the go (in-store dispensing systems), return from home (service for packaging collection at home), return on the go (deposit return machines), and refill at home (refills delivered through a subscription service) (Shamsuyeva & Endres, 2021).

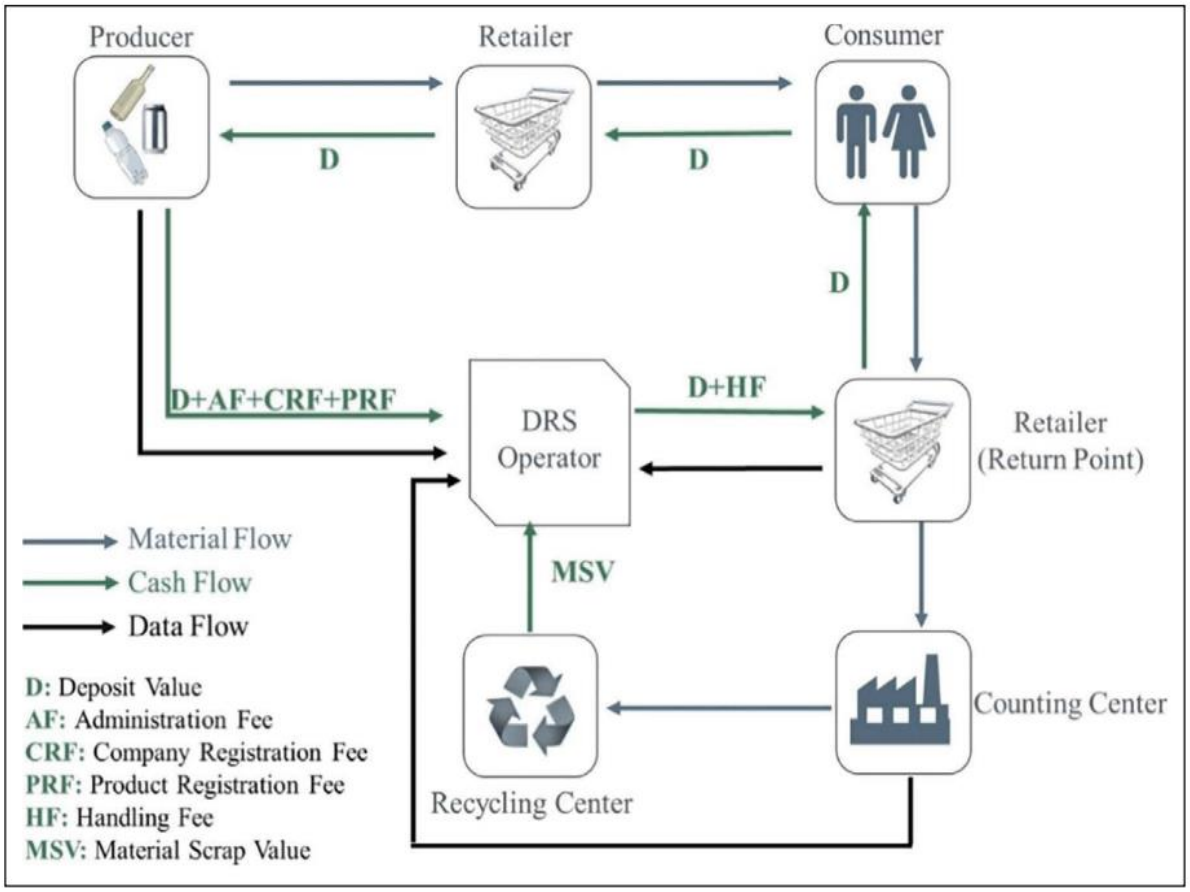


Figure 8: General presentation of the DRS. Source (Görgün, E 2021)

It is important to notice that the above figure is a general presentation of the DRS with different Flows (Material, Cash and Data). However there are other modes of DRS that we will be addressing in the section of types of DRS across Europe.

2. DRS in the European context

Containers deposit refunds are one of the most popular and best-known examples of the refund system used in many European countries and many other countries around the world as USA, Canada and Australia. In this research we will be focusing only on the European context.

Since the 1970s, deposit return schemes have been put in place in various countries in an effort to reduce the volume of packaging waste. One-way beverage containers supplanted glass bottles and reusable

containers as technology advanced and bottling and distribution became more centralized (Container Recycling Institute, 2016).

In the year 2021, they were only 10 European countries that have implemented the DRS, with mostly a centralized operating system with non-profit organizations.

However, in Germany, the operating system is decentralized even if the system operator is a non-profit organization. On the other hand, Croatia, like many other countries, has a centralized operating system but that is run by a governmental organization (Görgün, E, 2021).

Country	Mandate enacted	Mandate Implemented	Operating system	Included material
Estonia	2004	2005	Centralized (Non-Profit Organization)	Plastic (mainly PET), metal (aluminum/steel), glass
Sweden	1982, 1991	1984 (Metal), 1994 (PET)	Centralized (Non-Profit Organization)	PET, metal
Croatia	2005	2006	Centralized (Governmental Organization)	Plastic (predominantly PET), metal (aluminum/tinplate), glass
Denmark	2000	2002	Centralized (Non-Profit Organization)	Plastic (predominantly PET), metal (aluminum), glass
Iceland	1989	1989	Centralized (Non-Profit Organization)	Plastic (predominantly PET), metal (aluminum), glass
Finland	Not Available	1996 (Metal), 2008 (PET), 2012 (Glass)	Centralized (Non-Profit Organization)	Plastic (predominantly PET), metal (aluminum), glass
Lithuania	2014	2016	Centralized (Non-Profit Organization)	Plastic, metal, glass 0.1 L – 3 L
Norway	1997	1999	Centralized (Non-Profit Organization)	Plastic (predominantly PET, HDPE), metal (aluminum/tinplate)
Netherlands	2003	2005	Centralized (Non-Profit Organization)	Plastic (>0.5l predominantly PET)
Germany	1991	2003	Decentralized (Non-Profit Organization)	Plastic (predominantly PET), Metal (aluminum), glass

Figure 9: DRS implemented by European countries in 2021. (Görgün, E 2021)

Currently, 14 European countries have implemented the DRS, the latest one to introduce the system is Romania on 30.11.2023 while Sweden took the lead in implementing the System in 1982.

According to the global deposit book (2022), the DRS is used by 144, 2 million people across Europe, with a deposit fee varying from €0.07 to €0.25. The Appendix 1 gives details about the countries that already implemented the DRS and the launching date. (Romania is excluded from the study as the source date is 2022).

Despite the fact that solutions vary from country to another, in terms of mandatory nature of the system, the type of the beverage container taking into account or the deposit costs, their performance is similar as the average return rate is approximately 90%.

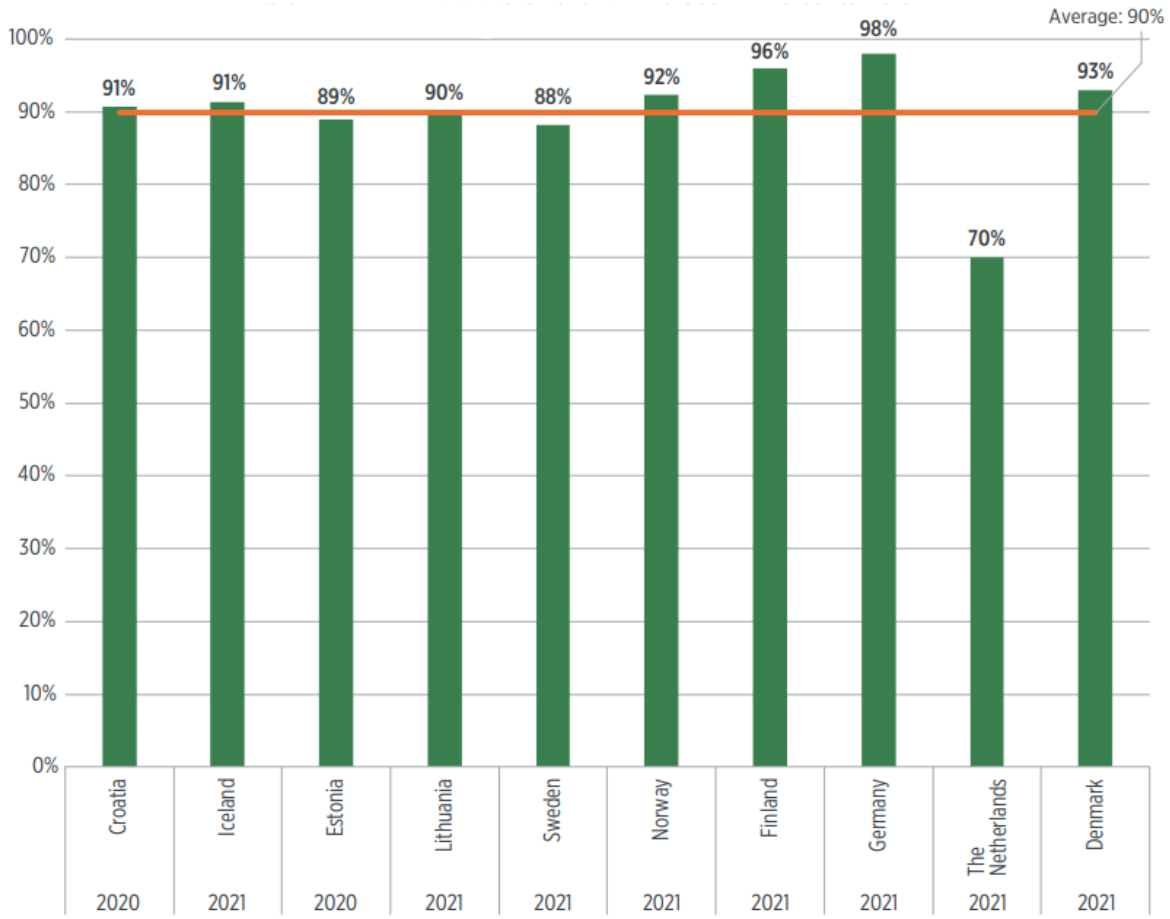


Figure 10: Return Rates in European countries with DRS for Single-use Drinks Containers. Source: the global deposit book (2022)

In the following section we will be focusing on DRS of two European countries, Germany and Netherlands, the choice of those two countries is due to many reasons:

First of all, they are both a neighboring countries of Belgium that have successfully implemented the DRS, secondly Germany is considered one of the leading countries in applying the DRS and in environmental policies within the European Union , according to the World Economic Forum, Germany was named as the world champion in recycling Plastic (Waste & The Recycling Myth).

Finally the Netherlands is also known for its innovative approaches to sustainability and environmental protection and has many similarities with Belgium, beside the Dutch language that is spoken by almost 60% of Belgians, they both have approximately similar urbanization rate and median age which are about 91.6 % & 42 years for Netherlands and 98.7 % & 41,3 years for Belgium (Worldmeters, 2023).

2.1. Germany

The launching of the DRS in Germany dates back to 1991 as part of a plan called the Packaging Regulation (Verpackungsverordnung). This plan was revised and completed over time until it was created in the form of the DRS in 2003 (DPG Deutsche Pfandsystem GmbH, 2016).

Therefore, the program was mandated in 1991 but it took place until 2003.

Since this year, One-way beverage packaging has been subject to an obligatory deposit policy in Germany, which requires consumers to pay a deposit at the time of purchase which make it a legally enforced initiative designed to encourage recycling and responsible disposal of one way beverage packaging (Zhou, 2020).

Until 2005, the DRS system was modified, but currently, it includes all small and large bottles, including plastic, glass, and cans.

There is mainly two type of containers beverages that should be returned by consumers through the deposit system the single-use and reusable containers.

For all single-use plastic bottles, aluminum cans, and glass bottles, the deposit rate is 0.25€ whereas the deposit fee for reusable bottles is lower with 0.15€ per plastic bottle and 0.08€ per glass bottle (Samantha Millette,2022).

Appendix 2 shows the labels and price range for the German single use and reusable bottles.

In order to enable consumers to return the PET plastic bottles, glass, and cans across Germany, more than 40,000 RVM have been installed (Qureshi, 2018).

The DRS setting up cost was 726 million Euros with a yearly maintenance and administrative cost of 793 million euros (Harrabin, 2018).

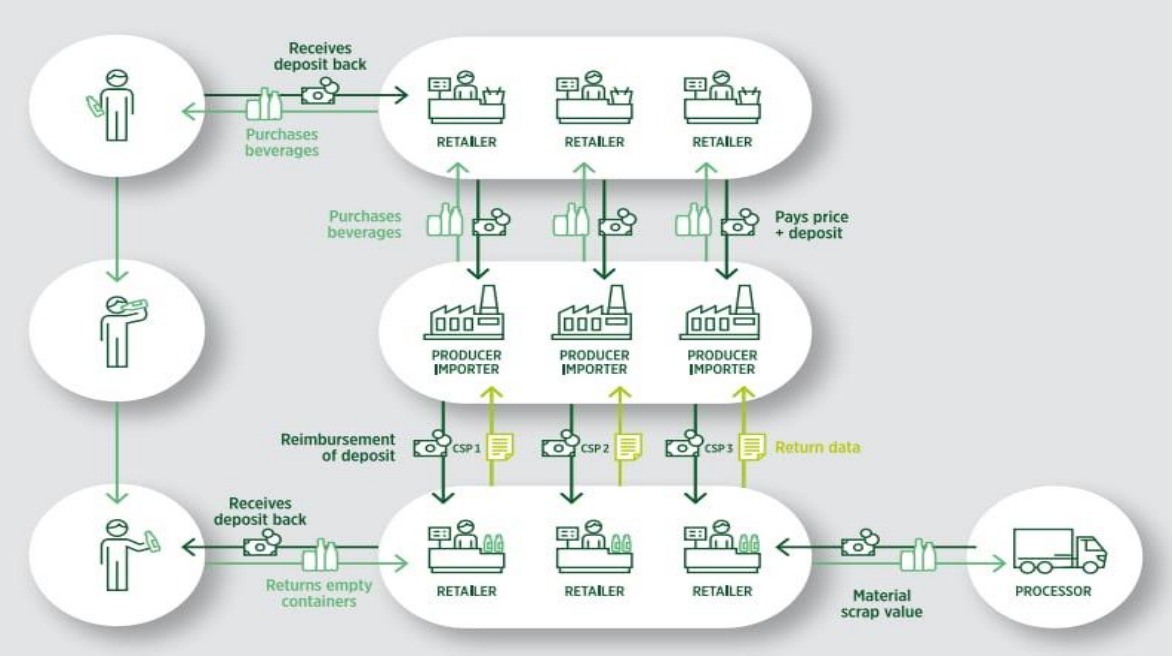


Figure 11: The german DRS-Money,material & data flow. Source: the global deposit book (2022)

German’s DRS was developed using the retailer-closing model, which implies that the retailers bear the majority of the expenses and also have the responsibility of collecting and disposing or reselling the empty packaging. Retailers are required to take back empty containers to send them for recycling, but only those of the type they sell (Rhein, S. & Sträter, K. F, 2021).

Retailers have the option of accepting containers via RVMs or automatically, the rate of the manual return method is 10% while for the automated one is 90%, so the consumer can either brings back the containers to the cashier that counts them and gives the right amount of deposit which are then transported to a central counting center where they count and sort the different containers by a high-speed counting machine and pay back the retailer that forwarded the containers or through the RVM , that gives back a voucher with the computed deposit, which is thereafter given to the cashier in order to receive the deposit back.

There are approximately 130,000 collection locations across Germany which facilitate the empty beverage return operation (Samantha Millette, 2022).

Since the implementation of the DRS, the glass recycling has increased by 85.2%, cans recycling by 99%, and plastic bottle recycling by 99.5% (Oltermann, 2018).

Not only that but the German beverage packaging deposit-refund system has shown highly effective results, with impressive return rate of 98% for standard packaging cans, and 98% for single-use plastic bottles (Zhou, 2020) and 98% for reusable glass bottles (Görgun et al., 2021).

For instance, over 2.3 billion cans were sold in Germany in 2015; 99% of these cans were recycled, and studies revealed that 96% of these cans were recycled as a result of the DRS system's deployment (Qureshi, 2018).

In Germany The Deutsche Pfandsystem GmbH (DPG) which is a not-for-profit company founded in 2005, is the one in charge of operating and managing the German beverage packaging deposit-refund system since 2005 (Zhou, 2020).

It supervises the deposit-refund system's operations and procedures to make sure everything runs smoothly and efficiently , moreover it runs the central database for deposit clearing and manages the marking standards related to the deposit label (DPG security mark and barcode identification number), Its shareholders include the German Retail Federation (50%) and the Federation of German Food and Drink Industries (50%) (Global deposit book, 2022).

2.2. Netherlands

The launching of the DRS in Netherlands dates back to the year 1960s, it was introduced for the packaging of beer, soda and water, back then the majority of bottles were made of glass but in the middle of the 1980s PET bottles quickly supplanted glass bottles, particularly in the markets for soda, water, and composite milk cartons.

This has lead the government to take measures to minimize the harmful impact of the packaging on the environment by signing an agreement between the government and the packaging producers in 1991 to promote product reuse and recycling by implementing a deposit system on all reusable and one way bottles with the exemption of the small plastic bottle (of maximum 0,5L) since they were introduced to the market after the agreement.

This has generated a high volume of litter since the small bottles were left outside of the deposit system pushing the government to extend the deposit refund scheme to include also the small plastic bottles (Bilyana Spasova, 2019).

The DRS in Netherlands has known many amendment since its implementation, it first began with only large plastic bottles, then in July 2021 the system was expanded to include small plastic bottles and in April 2023 it was again expanded to include all metal beverage containers with a maximum capacity of three liters.

The DRS in Netherlands follows a centralized system, it is operated by Statiegeld Nederland which is a non-profit organization that was founded by the soft drink and mineral water suppliers in collaboration with the food trade (Samantha Millette, 2022).

The deposit fees depends on the bottle type, for the large plastic bottles of 1 to 3 liters, the deposit fees is 0,25 EUR, while for those less than 1 liter ,the deposit value is 0,15 EUR which is the same value for the cans (Samantha Millette, 2022).

The method of return is done manually and automated with respectively 97% and 3% (Samantha Millette, 2022).

The retailers are in charge of collecting empty beverage containers that customers must deposit, although the retailers are not legally obliged to take back empty containers, there is in Netherlands approximately 5000 registered supermarkets that take them back, with other locations like cinemas, train stations and gas station who register with Statiegeld Nederland as voluntary collection points which make it a total of approximately 5,600 collection points (Samantha Millette, 2022).

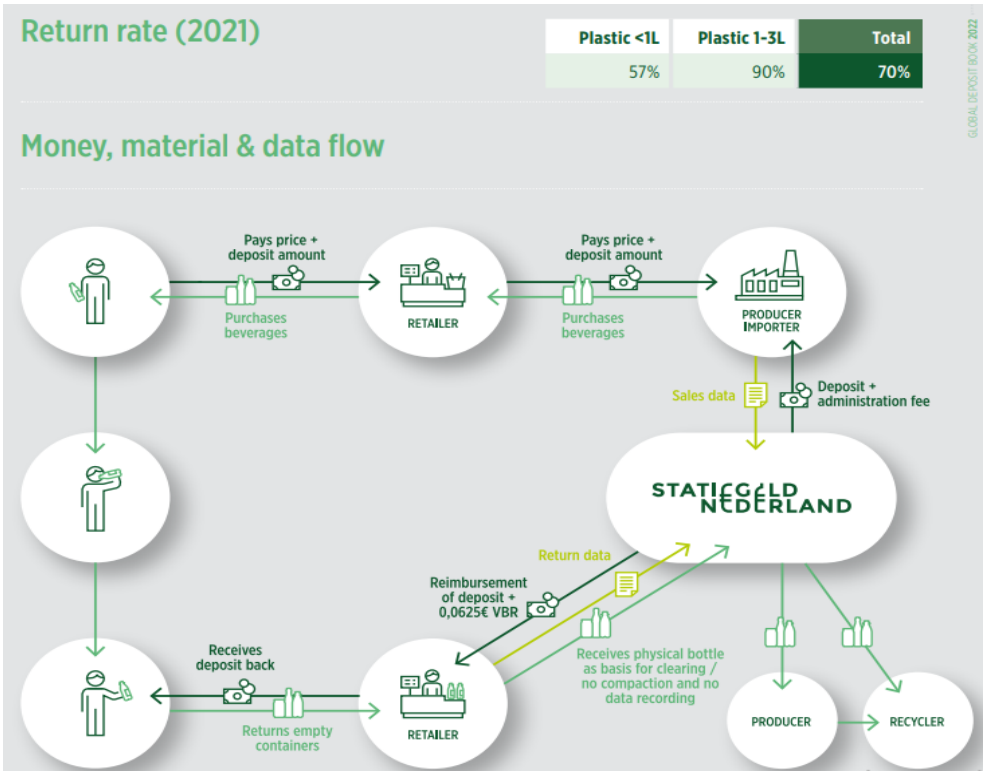


Figure 12: The German DRS-Money, material & data flow. Source: the global deposit book (2022)

3. Types of DRS implemented across Europe

In Europe, there are no standard guidelines governing the design of DRSs, hence a range of systems are currently available.

Standardizing DRS is challenging because it depends on the particular context and system goals, it can be done with varying scopes, regulations, stakeholders, deposit rates, and degrees of flexibility and efficiency (Malindzakova et al., 2022).

As with most EPR schemes, the process for product collection and recycling in deposit-refund schemes differs from nation to nation. The European Union has a variety of collection and recycling mechanisms, from industry-led voluntary programs to government-mandated. This suggests that not all programs have exactly the same procedures for assigning responsibilities which is due to the complexity involved in the transfer of responsibilities of waste collection, treatment, and recycling from local authorities to producers (Kunz et al., 2014).

According to Calabrese et al. (2021), there are 4 main DRS models for returned and recycled packaging which are:

- The operator-closing mode,

- The retailer-closing mode,

- The producer-closing mode,

- The consumer-closing mode.

The Figure below shows the 4 models which illustrates the movement of funds, resources among the various stakeholders in each system and the particular costs that each bears.

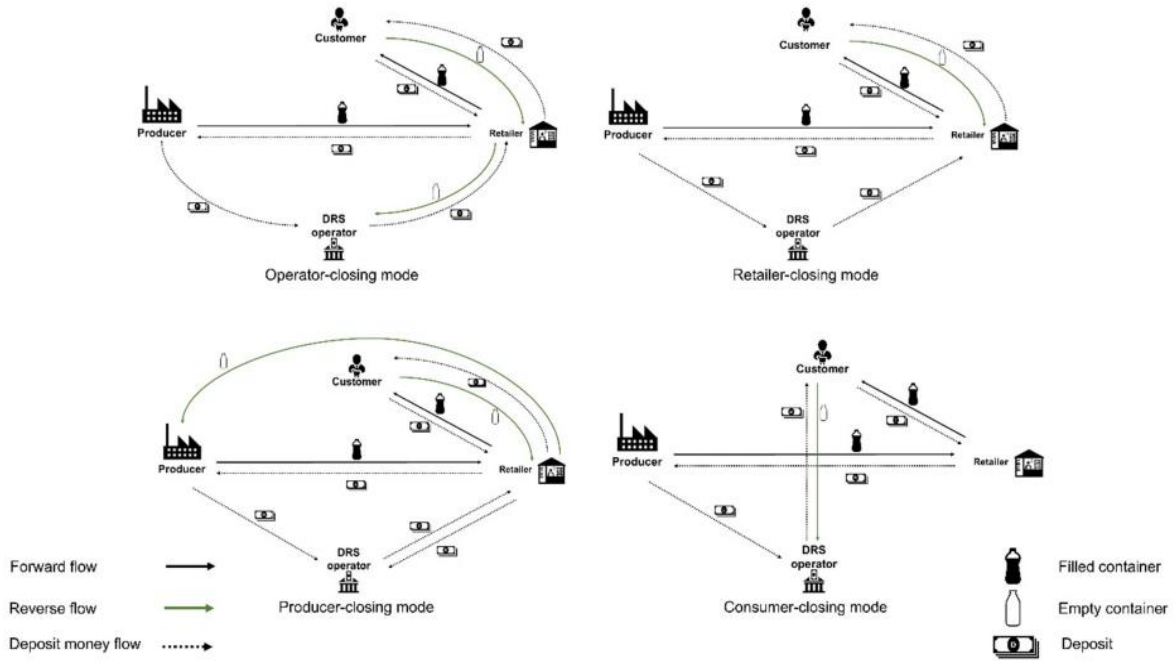


Figure 13: The types of DRS. Source (Agnusdei et al., 2022)

- The operator-closing mode:

For controlling glass packaging and encouraging recycling, the operator-closing mode is the most popular and looks to be a commonly used DRS model in several European countries, including Denmark and Sweden.

As shown in the Figure 12, in this mode of DRS, the retailers buys the goods and gives the beverage producer a deposit in the first phase, then the customer purchases the beverage and pays the retailer an additional amount together with the deposit afterwards the customer gives the retailer back the empty bottle after drinking the beverage and receive their deposit back (Agnusdei et al., 2022).

The operator finally pick up the empty packaging from the retailers and handle recycling or resale.

The retailer gets the deposit returned during this stage, afterwards, the operator takes care of moving the empty package to the collecting locations and closing the circle by disposing of it correctly.

Financing the DRS in the type of operator-closing mode has three main resources which are the handling revenues from producers, the revenue generated from packaging sales and the unredeemed deposits (Agnusdei et al., 2022).

- Retailer-closing mode:

The retailer-closing mode is the implemented DRS model in Germany, it differs from the operator-closing mode in terms of how it operates and how the cost and revenue are distributed between stakeholders (Agnusdei et al., 2022).

Following the figure 12, all the phases are quite similar to the previous mode of the operator-closing-mode, except for the final step.

In fact, the DRS operator takes empty packaging in the operator-closing mode while in the retailer closing-mode it is the retail who manage them by handling the transportation, disposal or resale.

In this mode the DRS operator is responsible for the system design, while producers and retailers manage the deposits, which they can forward it to an authorized company against fees.

Therefore, this system makes the retailers and producers active actors in the collection, transportation, recycling, disposal and resale of the empty beverage containers.

Thus, producers are not responsible on paying handling fees for handling empty packaging and can also keep the unredeemed deposits.

Consequently, the retailers bear the majority of the expenses as they are responsible of collecting, disposing and reselling the empty packaging and they can end up being unable to sell them.

Unlike with the prior approach, retailers no longer receive funding from the DRS operator to pay for storage and disposal expense but they can keep the money they get from selling the empty packaging as compensation for these costs.

-The producer-closing mode:

Such a mode is implemented in the Netherlands, in the final step of this mode, rather than giving the DRS operator custody of the empty packaging, the producers keep control of it**.**

Thus, at the last stage, it is the producers' duty to collect, dispose and resale the packaging of empty beverage as they might assign these duties to a third party.

Under this model, if the customers don’t return the empty packing, the retailers face the risk of losing the extra deposit.

In fact, retailers pay an extra deposit when they buy the product, which is not refunded to consumers during the purchase of a new beverage. Retailers only receive their deposit back after returning the empty packaging to the manufacturers.

Therefore, if customers don’t return the empty packaging, retailers face the risk of losing this additional deposit , so the producers are entitled to retain the unredeemed deposit and the unredeemed surplus deposit as compensation for the empty packaging that is not retrieved .

Furthermore, Retailers have to bear costs related to the investments in collections systems, the storage place and personal charges which are related to the personal that process the different tasks of packaging recover and have also to take responsibility of the collection, disposal, resale costs , all along with the producers .

- The consumer-closing mode:

Such a mode is adopted by Iceland, it involves consumers directly in the return of empty packaging.

The consumer-closing mode's unique consumer-centric approach streamlines and optimizes the recycling system. It reduces the intermediaries involved in the process which make the mode effective and straightforward.

In the consumer-closing mode, customers send empty packaging back to the DRS operator's collection and disposal departments directly.

The DRS operator takes the money from selling empty packaging and unredeemed deposits while managing deposit logistics, disposal and resale.

Nonetheless, since customers handle this part of the process, the DRS operator is spared the strain of transporting empty packaging from retailers to disposal or resale centers.

In contrast, the producers pay a fee for the marketed packaging in order to cover the costs of selling or disposing of it.

Retailers don't incur any expenses or make any money from the collecting and disposal procedure because they are not a part of the system.

4. Factors influencing the implementation of DRS

The successful implementation of the DRS depends on many stakeholders as government, consumers, retailers and producers.

4.1. Government

Government regulations are crucial to the adoption and implementation of the DRS (EEA, 2009 & 2011).

The major reason for governments in Europe to adopt the DRS is the requirement in the EU’s Single-Use Plastics Directive (SUPD) for Member States to achieve a target of 90% separate collection for plastic drinks bottles by 2029(Samantha Millette, 2022).

The EU's primary focus when implementing the deposit system was not only waste reduction, but it also had other goals and objectives, like achieving long-term sustainable development and creating a circular economy, which became crucial parts of the fundamental framework of the European Commission's

policies that has led to increased interest in pursuing these goals in Europe (European Commission, 2015).

4.2. Consumers

Consumers and customers play a key role in the development and improvement of the DRS (Mwanza & Mbohwa, 2017).

Given the significance of consumer involvement in the collection process, authorities ought to concentrate on encouraging it through focused legislation (Simon et al., 2016).

A DRS can effectively involve consumers as key actors in realizing sustainable recycling outcomes and advancing a circular economy for beverage packaging by addressing consumer motivations, convenience and concerns ,therefore, engaging consumers in every stage of the plastics value chain is essential to mitigate the impacts of plastic production and usage which necessitate a deeper insight into consumers' attitudes and feelings towards plastic waste to forecast the success of the DRS (i Puigvert et al., 2020; Zhou et al., 2020).

As for example Germany which has become a model for many countries around the world and the recycling champion in the world. It has initiated the DRS program by feedback from consumers where they were eager to distinguish between reusable and recyclable plastic containers from non-reusable containers on store shelves (Oltermann, 2018).

4.3. Producers

The adoption of DRS requires that producers assume duties and fees to ensure seamless functioning (Görgun et al., 2021).

To achieve sustainable recycling or reuse beverage materials and to develop a circular economy for beverage packaging, producer’s active participation in the DRS is essential since they are in charge of creating packaging that conforms to recycling or reuse regulations and taking part in financing and managing the DRS.

Therefore they play an important role in the success of the DRS as a major stakeholder of the process and they also bear significant responsibility, both financially and physically, for the treatment or disposal of post-consumer products (Görgun et al., 2021).

4.4. Retailers

Retailers have also a critical role in the success of the DRS, they are responsible for collecting the consumer's used packaging in return for a deposit refund.

Retailers are paid a handling charge by the producer to encourage them to set aside space for empty beverage packages, they serve as intermediaries for deposit collection, and assist with customer paybacks and facilitate paybacks to customers (Özdemir-Akyıldırım, 2015).

Though, smaller retailers can find it difficult to implement this strategy due to a lack of space for handling returns (Roca et al., 2020).

5. Benefits of the DRS

The implementation of the DRS for recyclable or reusable bottle packaging has many advantages that are social, environment and economic but the first major goal of the DRS is to optimally and definitively reduce environmental pollution, decrease littering and increase the recycling rate which leads to promote a more sustainable packaging and waste management practices, benefiting both the environment and the society (Samantha Millette, 2022).

First of all, the DRS has shown to be an effective tool to increase the packaging collection and prevent it from ending up in the environment (Malindzakova et al., 2022).

Based on the study of Malek et al. (2023) , it was proved that the DRS helps in decreasing the waste by 0.838 million tonnes in landfill of all types of material, on average , since the adoption of the DRS.

Moreover numerous studies proved that it is an efficient program to decrease the litter level of countries, a report done by Keep South Australia Beautiful have shown that South Australia had only 2,9% of drinks container litter in the year of 2018-2019 where the DRS is implemented compared to 14,2 % in Western Australia which at that time was not implementing the DRS, same study was published by Keep America Beautiful to compare littering between states with and without DRS which shows that those with DRS have 50% less deposit material litter and 30% less non-deposit material litter (Samantha Millette, 2022).

The DRS dose not only increases the recycling rates but it enables more control over the quality of the collected bottles (Malindzakova et al., 2022).

In fact beverage containers can be collected separately from other rubbish thanks to this system, therefore contamination is avoided, the beverage containers maintain their market value and management services fees are reduced (Görgun et al., 2021).

Therefore the DRS provide a solution by gathering and handling materials in a way that minimizes contamination and guarantees high-quality outputs which enables the production of a clean stream of materials suitable for closed-loop recycling (Samantha Millette, 2022).

Secondly, the DRS impacts positively the mining activities and the raw materials procurement.

On the long run, the need for mining operations to obtain virgin materials will be decreased as the needed materials can be gathered through the system without the need to go through the import of virgin materials process (Görgun et al., 2021).

Furthermore, reusing materials ensures that the natural resources used to produce these materials are depleted less quickly with consideration to the fact that the extraction and processing of natural resources can be very polluting and that reusing materials such as plastic bottles can have a positive impact on the environment.

Thirdly, the DRS raises awareness of environmental issues among the citizens and encourages them to participate more actively in the process and take on the duty of sorting recyclable materials (Malindzakova et al., 2022).

From another perspective, it enforces the producers to be responsible for every stage of their product's life cycle through the adoption of EPR rules which is essential to tackle environmental issues related to end-of-life consumer goods (Özdemir-Akyıldırım, 2015).

Finally, this system had earned attention on a global scale in achieving high recycling rates in more than 40 nations (Görgun et al., 2021).

The reason why governments worldwide have taken a renewed interest in DRS in recent years as no other collection method can successfully recover 90% of drink containers for closed-loop recycling therefore they are introducing new programs and amending the existing legislation to improve participation and increase redemption rate (Samantha Millette, 2022).

Moreover, it is in line with six Sustainable Development Goals (SDGs) which are Decent Work and Economic Growth (Goal 8), Industry, Innovation, and Infrastructure (Goal 9), Responsible Consumption and Production (Goal 12), Climate Action (Goal 13), Life Below Water (Goal 14), and Life on Land (Goal 15) (Görgun et al., 2021)

Chapter 3: Consumer's behavior and Hypothesis

1. Awareness of the DRS:

The literature strongly indicates that public awareness is a critical factor in the success of waste management systems, particularly the DRS.

For instance, studies by Kirakozian (2016) and Roca et al. (2020) have emphasized that an informed public is key to managing waste effectively since a general lack of knowledge about the effects of waste contributes to its mismanagement.

Similarly, Wang et al. (2019) and Knickmeyer (2020) highlight that DRS are significantly more effective when the public is aware of these systems, especially in regions without an established DRS.

Moreover, Read (1999) underscores the necessity of public understanding and awareness for the successful implementation of new recycling systems.

Given this established importance of awareness and public knowledge about the DRS, the hypothesis 1 was developed:

H1*: The majority of Liège citizens are aware of the DRS.*

2. Factors influencing consumer's decision

The determinants of the consumer decisions towards new waste collection systems which is in our study the DRS can be linked to many factors as perceptions, convenience, environmental concern, financial motives, socio-demographic and psychological determinants which will we be explaining based on the literature as follows :

2.1. Consumer's perception

Regarding the DRS's adoption, there have been limited studies that examined the consumer's perceptions of the scheme (Roca et al., 2020).

According to Sijtsema et al. (2020), it is critical to understand consumers' perceptions towards circular economy practices and their influence on societal adoption, moreover they highlight that existing research reveals a wide range of these perceptions and stress the importance of further exploration and understanding them.

Based on another study in Scotland regarding the sentiment analysis of consumers' perceptions towards the introduction of a DRS, consumers expressed concerns and skepticism about the DRS as they were worried about the inconvenience and cost associated with the scheme, including the effort and time required to participate (Oke et al, 2020).

Furthermore, Zhou et al., (2020) claim that a deeper insight into how consumers perceive and feel about the waste management program is crucial since it helps to forecast their participation.

Roca et al., (2022) study has also shown that consumer behavior is influenced by many factors, including their perceptions of DRS.

Based on the literature review on consumer's perception, the Hypothesis 2 was developed:

H2*: Positive perception of the DRS affects the engagement in the DRS.*

2.2. Psychological factors

Numerous studies have been conducted on the psychological factors that influence recycling behavior, the Theory of Planned Behavior (Ajzen, 1991) provides a well-established framework for this study, according to which behavioral achievements depend on three interdependent factors which are attitudes, subjective norm and perceived behavioral control.

The attitude towards a behavior can be described as "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" (Ajzen, 1991), while subjective norms are related to the social pressure and they are each person's interpretation of what other people expect of them (Park & Ha, 2014) and the perceived behavioral control represents personal assessments of how simple or challenging a certain behavior is to carry out (Ajzen, 1991).

According to research on social norms and models, people are more likely to recycle when the values of collectivism of the individual and the perceived social desirability and pressures associated with the behavior are stronger (Passafaro et al., 2019), in the same context Spaccarelli (1989) suggests that when surrounded by people who recycle, individuals are themselves more likely to engage in recycling.

Viscusi et al (2013) have also conducted a research on the impact of social norms and individual values in increasing the recycling of plastic water bottles, the study's findings demonstrated that social norms and personal beliefs that are in line with a suitable DRS significantly influence the rate at which plastic container collecting occurs.

In another study by Tian et al. (2019), they demonstrate that attitude have a positive correlation with recycling behavior while Botetzagias (2015) study proved that the most important predictor of recycling intention was the PBC.

However, Martin et al. (2006) agree that psychological factors play a more significant role in determining individuals' recycling behavior.

Based on the literature review on the psychological factors as a determinant to engage in the recycling behavior, which is in our study the participation in the DRS, the Hypothesis 3 was developed:

H3: *Positive social norms, favorable attitudes, and perceived behavioral control positively influence participation in the Deposit Refund Scheme among Liège citizens.*

2.3. Environmental concern

Numerous studies highlighted the influence of the environmental concern and awareness on the attitude.

Van Rensburg et al. (2020) emphasize that the increased environmental concerns and awareness of plastic waste are crucial in encouraging consumers to prevent, reuse, and recycle plastic waste where he identified the DRS as a potential solution to existing problems with plastics and cans.

Dispoto (1977) study shows that individuals who have more knowledge about environmental issues have a more pro-recycling behavior.

Furthermore, Thomas et al. (2013) concluded that the pro-environmental identities play an important role in promoting a wider range of sustainable behavior and Ramayah et al. (2012) demonstrated a significant relationship between environmental awareness and positive attitudes toward recycling.

Further research supports these findings, showing that greater environmental knowledge and concern enhance recycling behavior (Kirakozian, 2016; Roca i Puigvert et al., 2020).

Additionally, a study from Hungary, where the DRS was recently introduced, indicated that consumers' environmental concerns significantly influence the adoption of the DRS (Boros et al., 2021).

Amirudin et al. (2023) also discovered a positive correlation between environmental awareness and residents' attitudes towards waste management systems, underscoring the broader impact of environmental awareness on sustainable practices.

Given the above literature review on the positive relationship between environmental concern and attitude towards recycling, the Hypothesis 4 was developed:

H4: ***Environmental concerns influence consumers' decisions to participate in the DRS in Liège.***

2.4. Convenience

The perceived convenience has a significant influence on people's attitudes, intentions, and final behavior in the face of a change of the recycling system (Roca et al., 2022).

The features of the waste collection system influence how much inconvenience consumers feel when they have to change their habits, this includes factors such as the requirement to store and manage waste, the closeness and availability of recycling bins, and the time and effort involved in recycling (Roca et al., 2022; Roca i Puigvert et al., 2020).

Struk (2017) and Kedzierski et al. (2020) also agree on the fact that the level of inconvenience experienced by customers is shaped by the characteristics of the waste collection system, additionally, behaviors are affected by the need to manage and store waste, the availability and accessibility of collection facilities and bins, and the overall time and effort required for recycling.

Given that inconvenience has been identified as an obstacle to recycling behavior, simplifying the refund process and ensuring the scheme is easy for consumers to comprehend and participate is essential, which can be done by providing clear information about the scheme, placing a refund vending machine at each major store and bringing sites for ease of access (Oke and Kruijsen, 2016).

Moreover, Keramitsoglou and Tsagarakis (2013) discovered that the availability of recycling infrastructure for citizens significantly influences their recycling attitudes and behaviors.

Khan et al. (2019) has also concluded that convenience is an important predictor variable that can

support residents' intention to return or recycle plastic waste.

Other research has also shown an extensive body of evidence of the influence of convenience on the recycling behavior (Vicente and Reis, 2008; Refsgaard and Magnussen, 2009; Sorkun, 2018).

Based on the literature review on the convenience as a determinant to engage in the recycling behavior, the Hypothesis 5 was developed:

H5: ***Convenience influences Liège citizen's willingness to participate in a Deposit Return Scheme***

2.5. Financial incentive

Numerous studies analyze how a financial incentive program affects people's recycling behavior (Viscusi et al., 2011; Struk, 2017).

The financial incentives can be recycling refunds, rebates and prizes and their impact for recycling is the most commonly studied in the literature (Li et al., 2019).

Various research have demonstrated the potential of financial incentives to encourage recycling behavior (Ling etal., 2021).

For instance, Lu and Wang (2022) showed that incentives play a crucial role in shaping recycling behavior and drawing higher participation in recycling programs and considered financial incentives as the most effective one, Miliute-Plepiene et al. (2016) and Li et al. (2019) have also demonstrated that financial incentives encourage household recycling, all along with Knickmeyer (2020) who includes economic incentives among the motivators that should be included in the schemes.

However, researcher have shown that a plausible consequence of instituting monetary incentives for recycling is that the initial motivation and incentive for individuals to perform the task may alter, and focus may veer towards the exclusive financial gain Gneezy et al. (2011).

Furthermore, the effects of economic incentives are temporary and cease to exist when financial incentives are eliminated, so their positive effects might in the long term weaken the pro-environmental attitudes that motivate recycling (Miafodzyeva & Brandt, 2013).

On the other hand, in the presence of financial incentives, the quality and endurance of the motivations to continue recycling may change completely (Werner & Makela, 1998).

Based on the above literature review regarding the monetary incentive as a motive to engage in waste collection system, the Hypothesis 6 were developed:

H6*: Financial incentive within a DRS encourages Liège consumers' engagement in the DRS.*

2.6. Socio demographic factors

In the context of our research the socio demographic determinants are related to age, educational level, and income.

Several studies have revealed that there is a relation between those variables and the individuals recycling behavior.

According to Johnson et al. (2004), the recycling behavior is significantly influenced by factors such as age, education level, and residence, based on his research older respondents, individuals with high education levels, larger families, urban residents, and individuals who describe themselves as liberals are more likely to recycle.

These results are similar to those found by Tikka et al. (1999) where he emphasizes the fact that there is a higher rate of recycling amongst more affluent individuals and Sidique (2010) where he revealed that higher income families and bigger households recycle more than smaller households and lower income households, where he made the assumption that those who consume more are more inclined to recycle.

Furthermore, Saphores et al. (2012) have investigated the predictive value of an individual's demographic characteristics and discovered that only age and family size were statistically significant with older respondents and more affluent households showing higher willingness to recycle while Boros et al. (2021) experiment in Hungary, showed that demographic characteristics have an impact on the adoption of the DRS.

In contrast, some studies have not found any potential effects of socio-demographic variables on recycling behavior like those published by Werner & Makela (1998) and Botetzagias (2015).

Given the above literature review about the relationship between socio demographic factors and the recycling behavior, the Hypothesis 7 were developed:

H7: ***Demographic factors such as age, income and education level influence the likelihood of participation in the deposit refund scheme.***

Hypothesis	References
H1: The majority of Liège citizens are aware of the DRS	– Kirakozian, A. (2016). ONE WITHOUT THE OTHER? BEHAVIOURAL AND INCENTIVE POLICIES FOR HOUSEHOLD WASTE MANAGEMENT. Journal of Economic Surveys – Roca i Puigvert, M., Ayuso, S., Bala, A., & Fullana-i-Palmer, P. (2020). What factors determine attitudes towards the implementation of a packaging deposit and refund system ? A qualitative study of the perception of Spanish consumers. Journal of Environmental Management – Knickmeyer, D. (2020). Social factors influencing household waste separation: A literature review on good practices to improve the recycling performance of urban areas. Journal of Cleaner Production – Read, A. D. (1999). "A weekly doorstep recycling collection, I had no idea we could!" : Overcoming the local barriers to participation. Resources, Conservation and Recycling
H2: Positive perception of the DRS affects the engagement in the DRS.	– Roca i Puigvert, M., Ayuso, S., Bala, A., & Fullana-i-Palmer, P. (2020). What factors determine attitudes towards the implementation of a packaging deposit and refund system ? A qualitative study of the perception of Spanish consumers. Journal of Environmental Management – Sijtsema, S. J., Snoek, H. M., van Haaster-de Winter, M. A., & Dagevos, H. (2020). Let's talk about circular economy : A qualitative exploration of consumer perceptions. Sustainability (Basel, Switzerland) – Zhou, G., Gu, Y., Wu, Y., Gong, Y., Mu, X., Han, H., & Chang, T. (2020). A systematic review of the deposit-refund system for beverage packaging : Operating mode, key parameter and development trend. Journal of Cleaner Production – Roca, M., Ayuso, S., Bala, A., Colomé, R., & Fullana-i-Palmer, P. (2022). Evaluating the implementation of a packaging Deposit and Refund System in Catalonia. Two surveys on citizenship's expected behaviour. The Science of the Total Environment
H3: Positive social norms, favorable attitudes, and perceived behavioral control positively influence participation in the DRS among Liège citizens.	– Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes – Passafaro, P., Livi, S., & Kosic, A. (2019). Local norms and the theory of planned behavior : Understanding the effects of spatial proximity on recycling intentions and self-reported behavior. Frontiers in Psychology – Spaccarelli, S., Zolik, E., & Jason, L. A. (1989). Effects of Verbal Prompting and Block Characteristics on Participation in Curbside Newspaper Recycling. Journal of Environmental Systems – Viscusi, W. K., Huber, J., Bell, J., & Cecot, C. (2013). Discontinuous Behavioral Responses to Recycling Laws and Plastic Water Bottle Deposits. American Law and Economics Review – Tian, M., Pu, B., Chen, Y., & Zhu, Z. (2019). Consumer's Waste Classification Intention in China: An Extended Theory of Planned Behavior Model. Sustainability (Basel, Switzerland) – Botetzagias, I., Dima, A.-F., & Malesios, C. (2015). Extending the Theory of Planned Behavior in the context of recycling : The role of moral norms and of demographic predictors. Resources, Conservation and Recycling – Martin, M., Williams, I. D., & Clark, M. (2006). Social, cultural and structural influences on household waste recycling: A case study. Resources, Conservation and Recycling
H4:Environmental concerns influence consumers' decisions to participate in the DRS in Liège.	– Van Rensburg, M. L., Nkomo, S. L., & Dube, T. (2020). The 'plastic waste era'; social perceptions towards single-use plastic consumption and impacts on the marine environment in Durban, South Africa. Applied Geography (Sevenoaks) – Dispoto, R. G. (1977). Interrelationships Among Measures of Environmental Activity, Emotionality, and Knowledge. Educational and Psychological Measurement – Thomas, C., & Sharp, V. (2013). Understanding the normalisation of recycling behaviour and its implications for other pro-environmental behaviours: A review of social norms and recycling. Resources, Conservation and Recycling – Roca i Puigvert, M., Ayuso, S., Bala, A., & Fullana-i-Palmer, P. (2020). What factors determine attitudes towards the implementation of a packaging deposit and refund system ? A qualitative study of the perception of Spanish consumers. Journal of Environmental Management – Kirakozian, A. (2016). ONE WITHOUT THE OTHER? BEHAVIOURAL AND INCENTIVE POLICIES FOR HOUSEHOLD WASTE MANAGEMENT. Journal of Economic Surveys – Ramayah, T., Lee, J. W. C., & Lim, S. (2012). Sustaining the environment through recycling: An empirical study. Journal of Environmental Management – Boros, A., Kurdi, R., Lukács, Z. P., Sarkady, A., & Banász, Z. (2021). Opinion of the hungarian population on the reform of beverage packaging deposit-refund system. Sustainability (Basel, Switzerland) – Amirudin, A., Inoue, C., & Grause, G. (2023). Assessment of factors influencing Indonesian residents' intention to use a deposit–refund scheme for PET bottle waste. Circular Economy

H5: Convenience influences Liège citizen's willingness to participate in a Deposit Return Scheme.	– Roca i Puigvert, M., Ayuso, S., Bala, A., & Fullana-i-Palmer, P. (2020). What factors determine attitudes towards the implementation of a packaging deposit and refund system ? A qualitative study of the perception of Spanish consumers. Journal of Environmental Management – Roca, M., Ayuso, S., Bala, A., Colomé, R., & Fullana-i-Palmer, P. (2022). Evaluating the implementation of a packaging Deposit and Refund System in Catalonia. Two surveys on citizenship's expected behaviour. The Science of the Total Environment – Struk, M. (2017). Distance and incentives matter : The separation of recyclable municipal waste. Resources, Conservation and Recycling – Kedzierski, M., Frère, D., Le Maguer, G., & Bruzaud, S. (2020). Why is there plastic packaging in the natural environment ? Understanding the roots of our individual plastic waste management behaviours. The Science of the Total Environment – Oke, A., & Kruijsen, J. (2016). The Importance of Specific Recycling Information in Designing a Waste Management Scheme. Recycling (Basel) – Keramitsoglou, K. M., & Tsagarakis, K. P. (2013). Public participation in designing a recycling scheme towards maximum public acceptance. Resources, Conservation and Recycling – Khan, F., Ahmed, W., & Najmi, A. (2019). Understanding consumers' behavior intentions towards dealing with the plastic waste: Perspective of a developing country. Resources, Conservation and Recycling – Vicente, P., & Reis, E. (2008). Factors influencing households' participation in recycling. Waste Management & Research – Refsgaard, K., & Magnussen, K. (2009). Household behaviour and attitudes with respect to recycling food waste – experiences from focus groups. Journal of Environmental Management – Sorkun, M. F. (2018). How do social norms influence recycling behavior in a collectivistic society? A case study from Turkey. Waste Management (Elmsford)
H6: Financial incentive within a DRS encourages Liège consumers' engagement in the DRS.	– Struk, M. (2017). Distance and incentives matter : The separation of recyclable municipal waste. Resources, Conservation and Recycling – Viscusi, W. K., Huber, J., & Bell, J. (2011). Promoting Recycling : Private Values, Social Norms, and Economic Incentives. The American Economic Review – Ling, M., Xu, L., & Xiang, L. (2021). Social-contextual influences on public participation in incentive programs of household waste separation. Journal of Environmental Management – Lu, B., & Wang, J. (2022). How can residents be motivated to participate in waste recycling? An analysis based on two survey experiments in China. Waste Management (Elmsford), – Miliute-Plepiene, J., Hage, O., Plepys, A., & Reipas, A. (2016). What motivates households recycling behaviour in recycling schemes of different maturity ? Lessons from Lithuania and Sweden. Resources, Conservation and Recycling – Li, D., Zhao, L., Ma, S., Shao, S., & Zhang, L. (2019). What influences an individual's pro-environmental behavior ? A literature review. Resources, Conservation and Recycling – Knickmeyer, D. (2020). Social factors influencing household waste separation: A literature review on good practices to improve the recycling performance of urban areas. Journal of Cleaner Production
H7: Demographic factors such as age, income and education level influence the likelihood of participation in the deposit refund scheme.	– Johnson, C. Y., Bowker, J. M., & Cordell, H. K. (2004). Ethnic Variation in Environmental Belief and Behavior : An Examination of the New Ecological Paradigm in a Social Psychological Context. Environment and Behavior – Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. The Journal of Environmental Education – Sidique, S. F., Lupi, F., & Joshi, S. V. (2010). The effects of behavior and attitudes on drop-off recycling activities. Resources, Conservation and Recycling – Saphores, J.-D. M., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior : An analysis of e-waste recycling based on a national survey of U.S. households. Resources, Conservation and Recycling – Boros, A., Kurdi, R., Lukács, Z. P., Sarkady, A., & Banász, Z. (2021). Opinion of the hungarian population on the reform of beverage packaging deposit-refund system. Sustainability (Basel, Switzerland)

Table 1: Summary of hypothesis sources

3. Conceptual model

The model consists of different independent variables which are: the positive perception, the psychological factors, the environmental concern, convenience, financial incentive and socio demographic factors and one dependent variable which is the participation in the DRS.

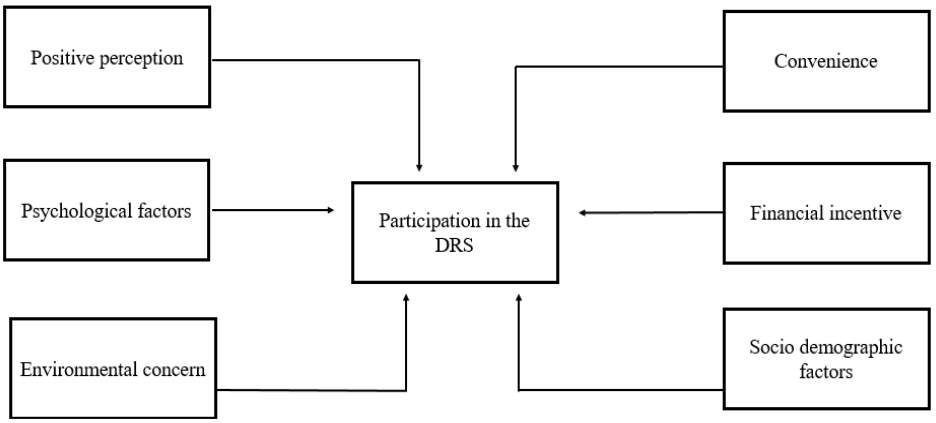


Figure 14: conceptual framework.

Chapter 4: Research design

1. Methodology

The methodology employed involves a quantitative approach to understand the factors influencing the participation of Liège citizens in the Deposit refund scheme.

A survey was designed to gather data directly from residents, aiming to capture a broad range of responses regarding their experiences, perceptions, and behaviors linked to the DRS.

The survey methodology was selected for its effectiveness in quantifying the influence of various socio demographic and psychological factors on citizens' recycling behaviors and it included various questions that were based on the literature review.

Such an approach did not only facilitate the gathering of empirical data from diverse participant but also enabled the identification of key drivers and barriers to participation in the scheme.

2. Data collection

The data collection was conducted using a structured online survey, which was created and administered via Google Forms which was chosen for its accessibility and ease of use.

The survey was distributed primarily through social networks and personal contacts to ensure a broad and diverse respondent base.

Considering the local context of the study, all survey questions were written in French as the study focused on the citizens of Liège.

In total, 138 individuals completed the survey, providing a range of insights into their behaviors and perceptions but only 123 responses were taking into account in the analysis since the rest were not living in Liège.

The survey included a variety of question types to capture detailed information on participants' responses which was ranged from open-ended questions that allowed respondents to express their thoughts freely, to closed yes/no questions, as well as multiple-choice questions.

Additionally, a five-point Likert scale was utilized for several questions with higher values assigned to more positive and favorable responses , enabling participants to express the degree of their agreement or disagreement with the statements presented, the Appendix 3 shows the survey questions.

3. Data analysis

Data analysis was performed using the IBM SPSS 27 software.

First of all a descriptive analysis was conducted to present the percentages and mean values of item frequencies, providing a comprehensive overview of the distribution and allowing a summary of data and comparison of further description of results, then a Chi-squared ($\chi 2$) Test of Goodness of Fit was utilized to determine whether the observed frequencies significantly deviate from the expected frequencies, such a test is particularly useful when examining categorical data to assess how well the observed distribution matches the expected distribution under a specific hypothesis (Cochran et al., 1952).

Afterwards Cronbach's alpha was used to calculate the internal consistency of constructs, where the indicator is reliable when the value of Cronbach's alpha is bigger than 0.6 (Hair et al., 2006) and finally a Spearman's rank-order correlation was employed to assess the strength and direction of the monotonic relationship between variables which was chosen due to its suitability for ordinal Likert scale data (Hauke et al., 2011).

Chapter 5: Results

1. Socio demographic characteristics of participants

The final sample included 123 respondents after excluding 14 participants from other cities as Namur, Brussels and Mons, with a majority of 64.2% (n=79) being women and 35.8% (n=44) men.

Within the sample five age categories were defined where the younger demographic (18-35 years) accounted for 51.6% (n=63) of participants, 13.1% (n=16) were in the category of 36-45 years and 46-55 years, while those older than 56 years accounted for 22.1% (n=27).

Regarding educational level, no participants had below primary education, with the largest groups having completed non-university higher education (35%, n=43) and university higher education (37.4%, n=46).

The monthly income varied, with the largest group (39%, n=48) earning between 2,001 and 3,000 euros and the most common professional statuses were employees or workers (51.2%, n=63) and students (22%, n=27).

		Frequency n=123	% 100
Gender	Women	79	64,2%
	Men	44	35,8%
	I prefer not to answer	0	0,0%
Age	>18	0	0,0%
	18-35 ans	63	51,6%
	36-45 ans	16	13,1%
	46-55 ans	16	13,1%
	56 <	27	22,1%
Education level	No diploma	0	0,0%
	Primary education (CEB)	2	1,6%
	Secondary education	31	25,2%
	Non-university higher education	43	35,0%
	University higher education	46	37,4%
	Doctorate or equivalent	1	0,8%
Monthly income	>1 000 euros	14	11,4%
	1 000-2 000 euros	28	22,8%
	2 001-3 000 euros	48	39,0%
	3 001-4 000 euros	22	17,9%
	4 000 euros <	11	8,9%
Employment status	Employee-Worker	63	51,2%
	Manager- liberal profession	8	6,5%
	Student	27	22,0%
	Retired	19	15,4%
	Inactive	6	4,9%

Table 2: Socio-demographic characteristics of the sample

2. Consumers' awareness of the DRS

In order to measure the awareness level among consumers in Liège, participants were asked the question: "Are you aware of the DRS?" and they were provided with two response options: "Yes" and "No", this approach was chosen to obtain a clear, binary understanding of public familiarity with the scheme.

Regarding the SPSS analysis, we used the descriptive statistics to quantify and summarize the distribution of responses and the Chi-Square Test of Goodness of Fit which was utilized to determine if the proportion of respondents aware of the DRS significantly exceeds the 50%.

The statistical analysis of the survey data reveals a significant level of public awareness regarding the DRS among the citizens of Liège.

According to the results obtained through SPSS (Figure 15), 86% (106 out of 123 respondents) indicated familiarity with the DRS, while only 14% (17 respondents) reported not being familiar with the scheme.

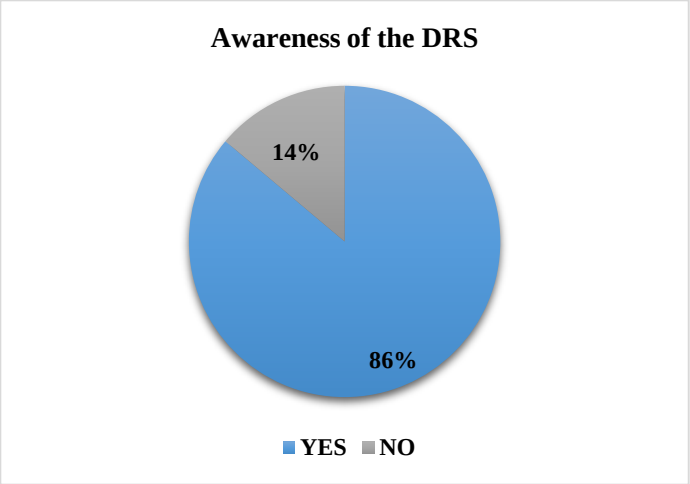


Figure 15:The awareness level of DRS among Liège citizens

Moreover the Chi-Square Test of Goodness of Fit indicated residuals of +32 for responses of yes and -32 for no responses which constitutes the difference between the observed and expected frequencies as shown in the table 3.

The results also showed a Chi-Square value of 34.736 with 1 degree of freedom which measures the size of the discrepancy between the observed and expected frequencies, moreover the test returned a p-value of less than 0.001 which is affirming that the difference is statistically significant and not due to random chance.(table 4)

	Category	Observed effectif	Expected frequencies	Residuals
1	Yes	106	74,0	32,0
2	No	17	49,0	-32,0
Total		123		

Table 3: Observed and expected frequencies of familiarity with DRS

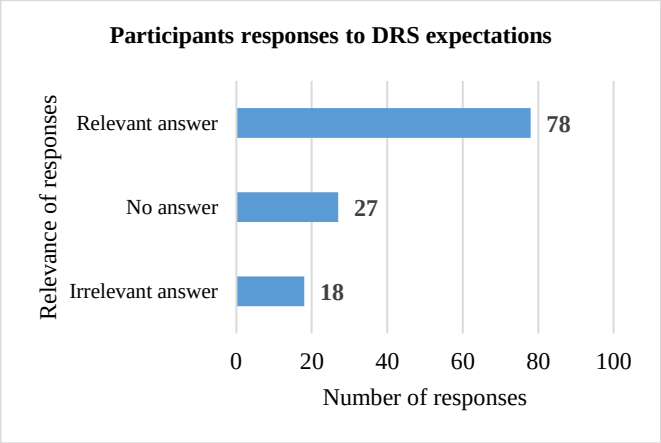
Khi-carré	34,736[a]
df	1
Sig. asymptotique	<,001

Table 4:Chi-Square Test of Goodness of Fit

3. Consumers' expectations of the DRS

To measure consumers' expectations of the DRS, two open questions were asked to the participants, the first question was about the specific expectations they would have regarding the DRS, and the second one was about how the ideal system would be.

The responses to these questions were invaluable in highlighting the key attributes that consumers value most in the DRS, the Figure 16 shows the relevance level of the collected responses.



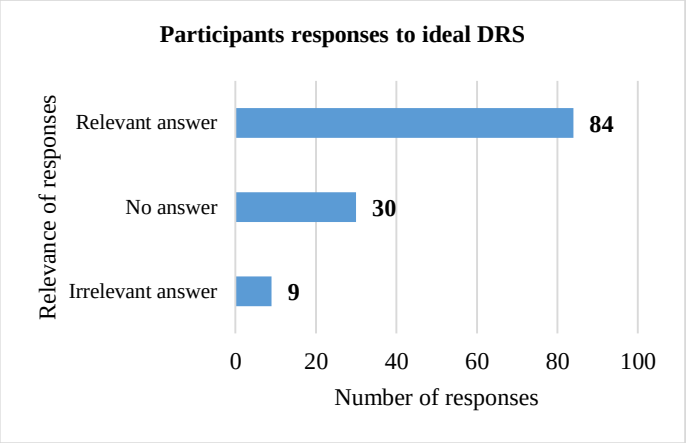


Figure 16: Data classification and sorting

Analysis of the feedback regarding the consumers' expectations shows a range of expectations for the DRS which can be grouped as follows:

-**Accessibility and convenience**: many participants emphasized the importance of the system being easy to use and widely accessible, as they mentioned that collection points should be available in frequently visited locations such as supermarkets, train stations, and residential areas with some suggesting specific requests for easy access for those without cars, including pedestrian-friendly and bus-accessible collection points.

-**Environmental impact:** a significant number of responses highlighted ecological benefits, with expectations that the system would lead to a cleaner environment by reducing waste in public spaces and promoting recycling.

-**Ease of use:** there were requests for the system to be as straightforward and non-disruptive as possible, avoiding complex digital processes.

-**Public awareness and engagement:** some responses called for increased advertising and public education to raise awareness and encourage participation in the initiative, and some suggested that the system should be mandatory and penalties should be applied for non-compliance.

-**Logistics and practical concerns:** participants expressed concerns about the practical aspects, such as the need for easy home storage, frequent collection services, and efficient processing of returned bottles, some of them suggested having home collection services or very conveniently located drop-off points to alleviate logistical burdens.

-**Broad implementation:** expectations included a comprehensive system covering all types of containers (glass, plastic, cans) and not being limited to specific brands or stores.

When it comes to the ideal system perceived by the consumers, varied responses were collected which can also be grouped as follows:

-**Ease of use and accessibility**: participants frequently mentioned that the system should be easy and quick to use, with many suggesting that collection points should be conveniently located in or near supermarkets and other commonly visited places, they were also specific requests for a system that is accessible 24/7 and located close to home, similar to existing recycling points for glass.

-**Financial refunds:** participants expressed a preference for receiving direct refunds, either in cash or credited to a bank account, rather than store-specific vouchers, and some suggested setting a minimum deposit value as €0.20/€0.30 per bottle to motivate returns.

-Inspiration from the German system: many responses indicated that the ideal system should be modeled after Germany's deposit return system, which is perceived as efficient and effective.

-Environmental and educational impact: based on many responses, the ideal system should aim to minimize plastic use and encourage recycling, with several suggesting that it should be integrated into early education to promote environmental awareness.

The responses to the questions about the DRS expectations and ideal system were diverse, reflecting a wide range of participant opinions.

The graphs below illustrate the distribution of these responses, showing the various percentages for each category.

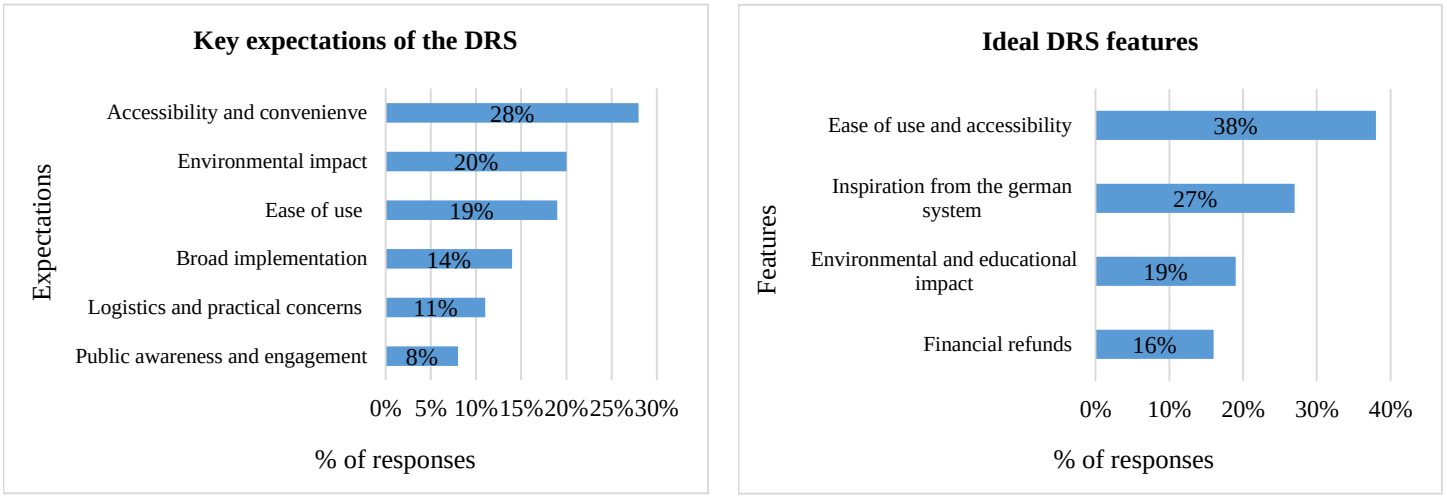


Figure 17: Distribution of participant's expectations and ideal features for the DRS

4. Consumers' perceptions of the DRS

The perception of the DRS were measured by asking the participants to rate their view on a scale from 1 to 5, where 5 indicates a very favorable opinion.

The majority of respondents expressed a positive perception of the system, with 47% giving it the highest rating of 5 while 27% rated their perception as 4, contributing to a total of 74% of participants who viewed the system favorably, a smaller segment of 13% rated their perception as neutral 3, while only a minority expressed unfavorable views, with 8% and 5% rating it 2 and 1, respectively.

This data indicates that the bottle deposit system is perceived very positively by the vast majority of the respondents.

Moreover, the figure 19 shows that the perceptions towards the DRS vary significantly across gender and age groups, men show mixed views, with 58% positive and 20% negative and women tend to be more positive, with 83% positive and only 9% negative.

Regarding age groups perceptions, those is the group 18-35 are most positive with 64%, while the 36-45 group age is slightly more divided with 83% positive and 12% negative and those in the age group 46-55 are mostly positive with 82% positive and 12% neutral, while those over 56 are the most positive of group's age with 88% positive score.

Overall, women and older individuals tend to view the system more favorably.

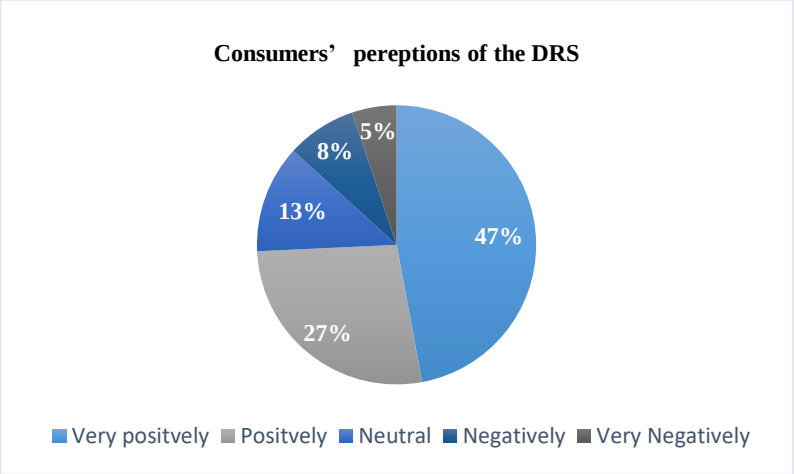


Figure 18: Positive perception towards the DRS

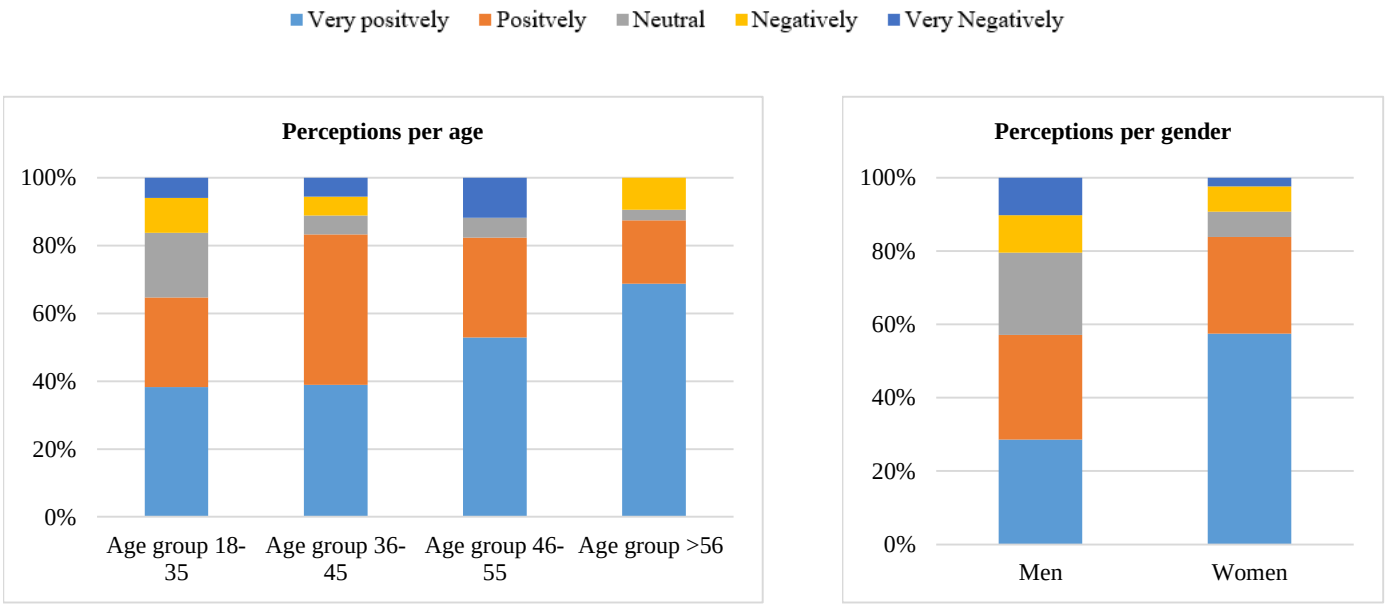


Figure 19: Perceptions of the DRS by gender and age group

5. Motivations to participate in the DRS

Participants were asked about the motivations that could encourage them to participate in the DRS , where they were given three options to consider : financial incentives, the positive environmental impact, and the convenience and proximity of the collection points, each option has a Likert scale of 1 to 5, where 5 indicated 'very important' and 1 the 'least important '.

A mean scores were calculated where convenience and proximity received the highest mean score of 4.70, the positive environmental impact followed with a mean score of 4.47, while financial incentives had a mean score of 4.10.

The respondents' evaluation revealed that all factors are considered important with a more importance to the ease of access and environmental benefits as shown in the Figure 21.

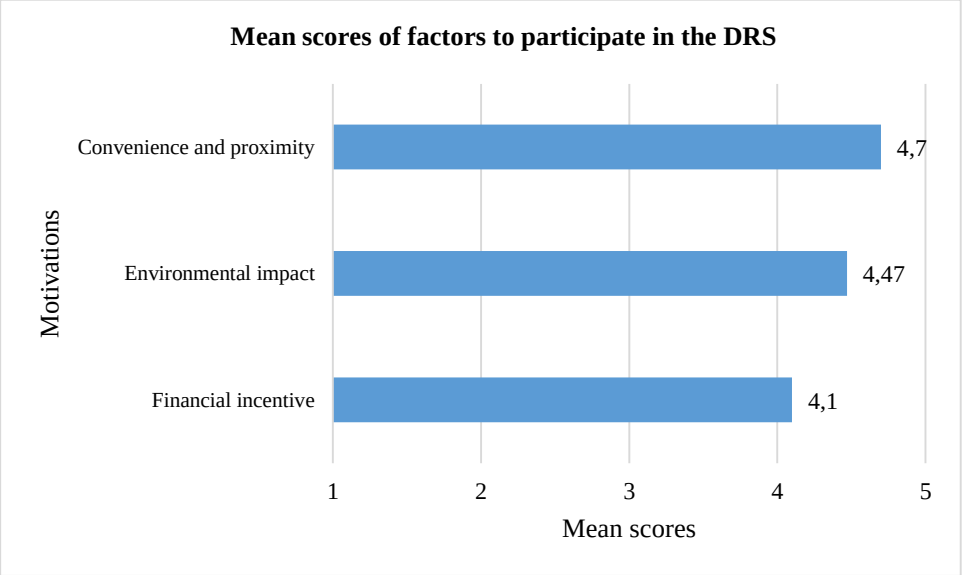


Figure 20: Mean scores of factors influencing participation in the DRS

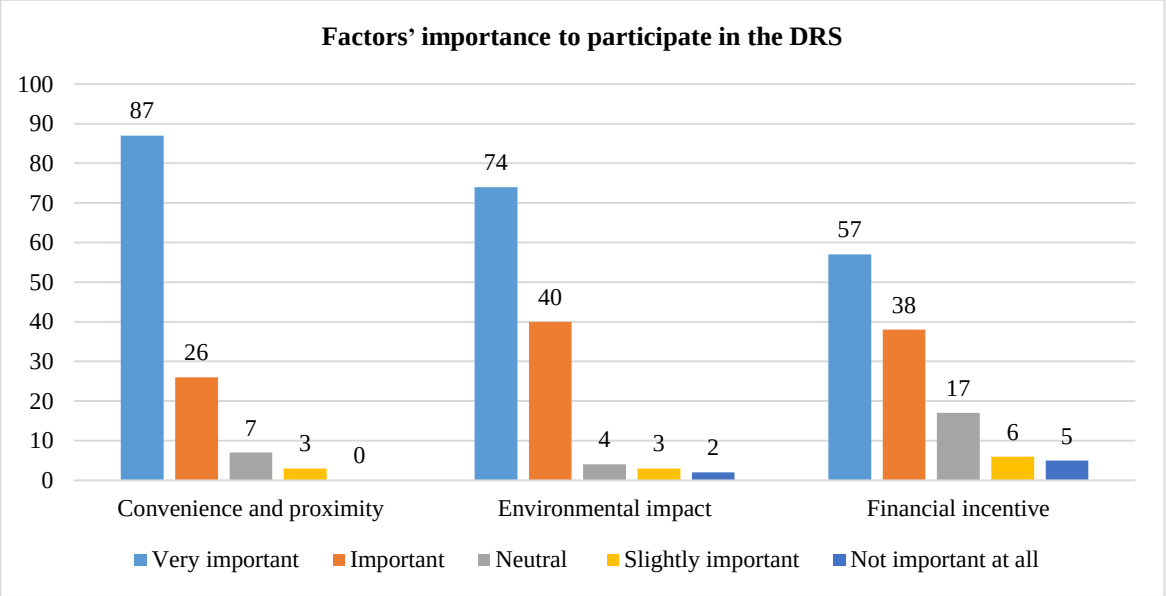


Figure 21: Importance level of factors influencing participation in the DRS

6. Psychological factors

In assessing psychological factors influencing participation in the DRS, three key questions were posed to participants, the first question aimed to evaluate the positive attitudes towards the DRS by asking the participants "Do you believe a deposit system could have a positive impact on the environment?"

The majority of responses leaned towards positivity with 47% of participants strongly agreeing and 31% agreeing that such a system could positively affect the environment.

The second question focused on social norms and pressure by asking participants "To what extent would you recycle beverage containers if you know others in your social circle are doing so?"

The results revealed that 42% of respondents expressed a high likelihood of recycling in such circumstances, while 43% indicated moderate engagement.

Lastly, participants were asked about their perceived behavioral control, with the question, "If a deposit system were introduced in our city, do you think it would be easy for you to participate given your daily routine?"

Responses were evenly distributed, with 41% strongly agreeing and 30% agreeing that participating in a deposit system would align with their daily routine.

These findings collectively underscore the role of attitudes, social norms, and perceived behavioral control which constitutes the psychological factors of the study in influencing participation in the DRS.

Moreover, to measure the internal consistency of the construct, we used the reliability test which resulted in Cronbach's Alpha: of 0.886 indicating better internal consistency among the items within the scale (Table 5).

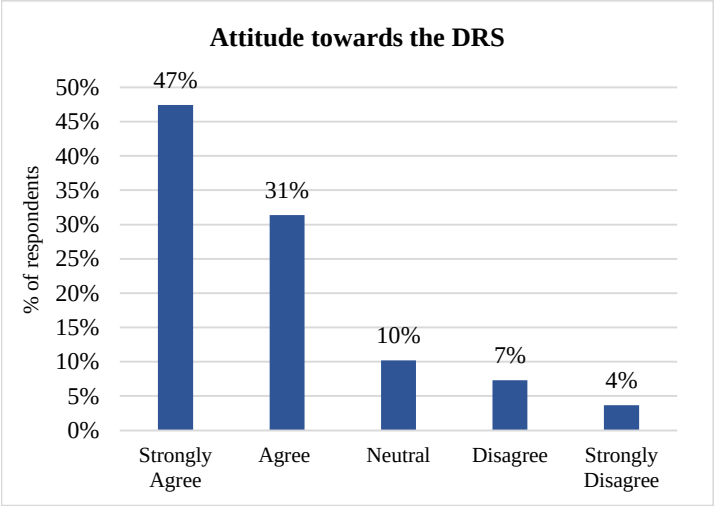


Figure 22: Consumer's positive attitude towards the DRS

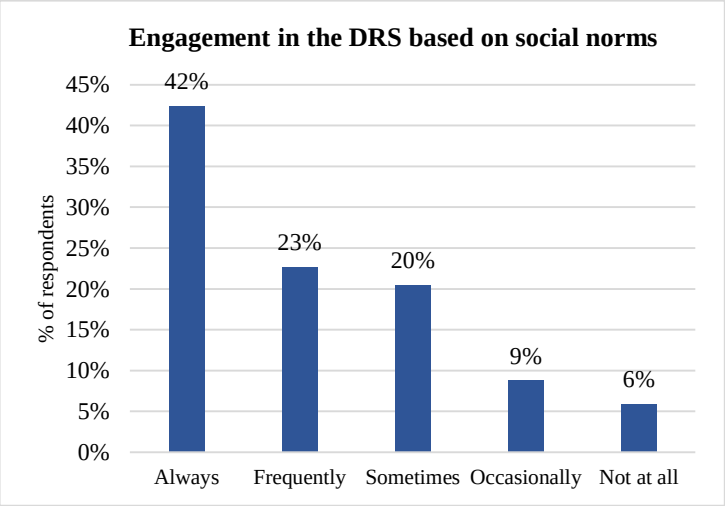


Figure 23 : Frequency of engagement in DRS based on social norms

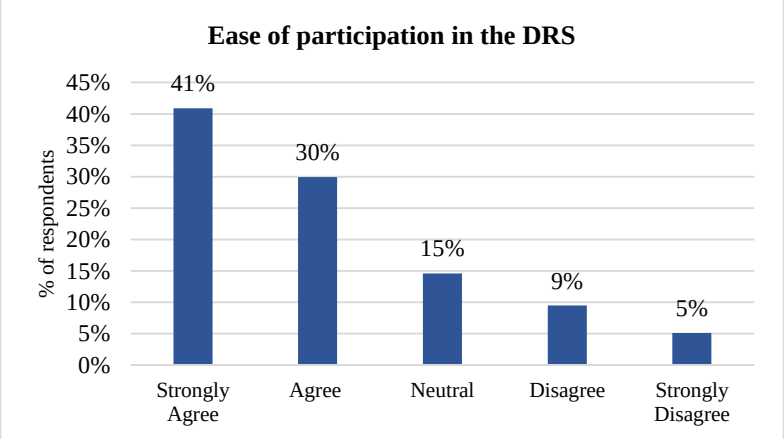


Figure 24: Perceived ease of participation in the DRS

Cronbach's alpha	Number of items
,886	3

Table 5: Reliability result

7. Environmental concern

To evaluate the environmental concern of participants, they were asked about the significance they attribute to environmental issues in their daily lives using a scale ranging from 1 to 5, where 1 represented the least importance and 5 the highest importance.

The distribution of responses revealed varying degrees of concern among participants, the largest proportion of respondents, constituting 37%, assigned a rating of 4, indicating a considerable level of importance placed on environmental matters, following with 33% of participants rating environmental concerns with the highest score of 5 which reflects a heightened awareness and prioritization of environmental issues in their daily lives.

Meanwhile, 14% of respondents assigned a rating of 3, signifying a moderate level of importance, on the lower end of the scale, 12% of participants allocated a score of 2, indicating a relatively lower level of concern, while a minority of 4% assigned the lowest rating of 1, suggesting minimal importance attributed to environmental issues among this subgroup of respondents.

Overall, the distribution of responses underscores the varying degrees of environmental concern among participants, with a significant proportion demonstrating importance to the environmental issues in their daily lives.

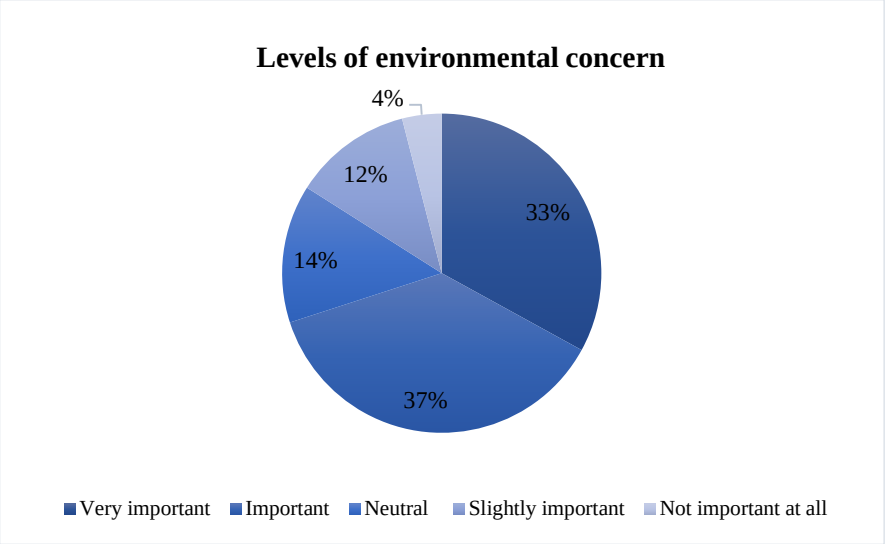


Figure 25: Distribution of environmental concern ratings among participants

8. Chi-square independence test

The Chi-square independence test was conducted to analyze the impact of demographic factors on participation in the DRS, where its result is shown in the table 6.

The variables analyzed included age, gender, educational attainment, and income levels which were gathered by providing participants with categorical multiple-choice questions allowing them to select the option that best describes their current socio-demographic status.

The figures 26 show the relations related to the willingness to participate in the DRS with socio-economic variables.

A p-value of 0.05 was established as the criterion for statistical significance, meaning that results yielding a p-value less than or equal to 0.05 were considered statistically significant.

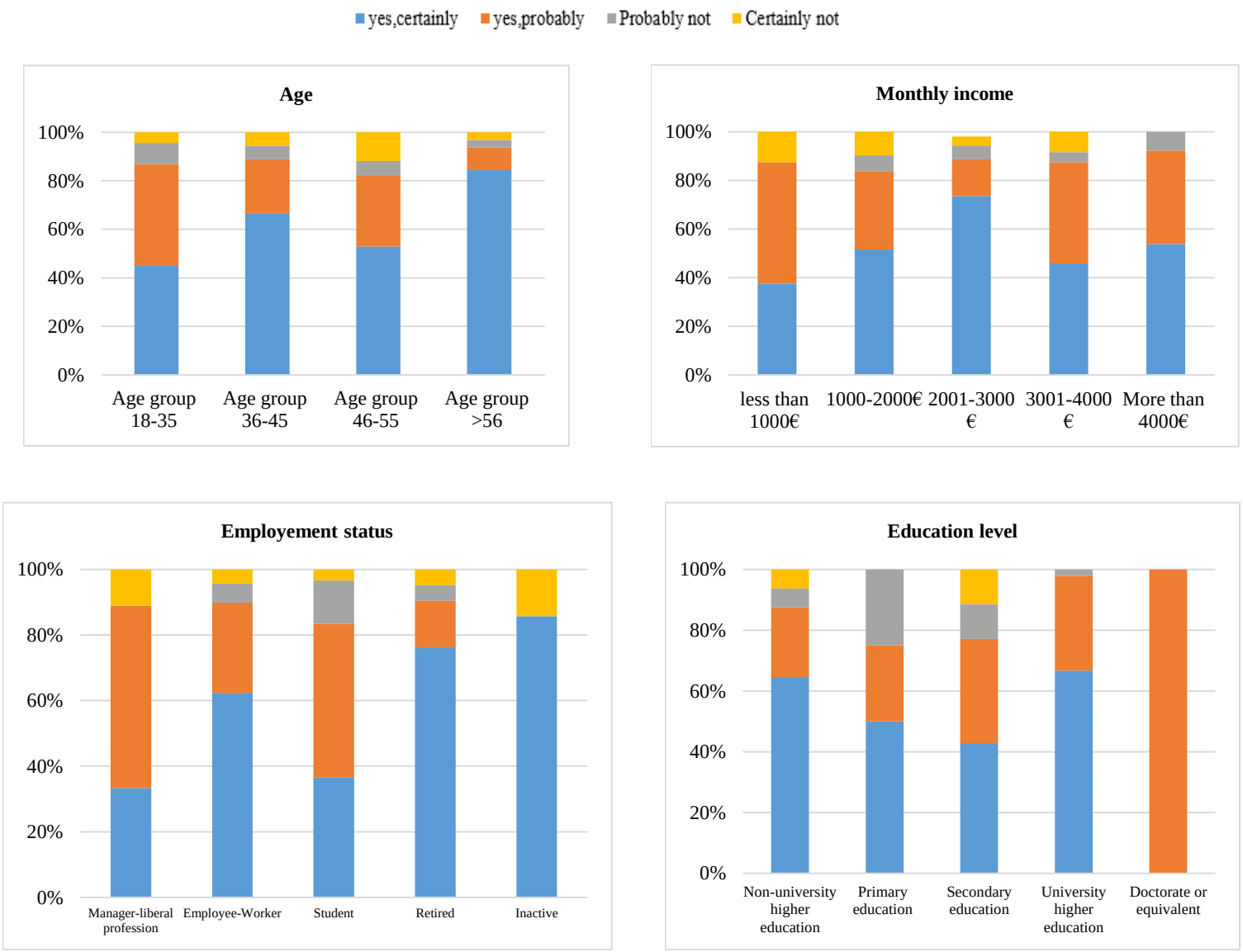


Figure 26: Characteristics of the respondents on willingness to participate in the DRS

	Education level		Age		Income	
Variable	χ2	p-value	χ2	p-value	χ2	p-value
Participation in the DRS	23.855	**0.021**	18.855	**0.026**	14.343	0.279

Table 6:Chi-square independence test results

9. Correlations

The correlation analysis is used to measure the strength and direction of the relationship between two continuous variables.

The table 7 shows the results of the correlation analysis of various constructs, the findings related to the participation in the DRS underscore the predominance of positive correlations and significant p-values among factors such as convenience, attitudes, subjective norms, positive perceptions, and perceived behavioral control, unlike the financial incentives and environmental concern, which showed negligible or no significant correlation with participation in the DRS.

		Participation in the DRS	Financial incentive	Convenience	Environmental concern	Psychological factors (Attitude)	Psychological factors (Subjective norms)	Positive perception	Psychological factors (Perceived behavioural control)
Participation in the DRS	Correlation coefficient	1	-0,011	,563**	0.002	,291**	,362**	,539**	,362**
	Sig. level		0,900	0,000	0.980	0,001	0,000	0,000	0,000
Financial incentive	Correlation coefficient	-0,011	1	0,057	,229*	-0,002	0,043	-0,047	0,043
	Sig. level	0,900		0,530	0,011	0,980	0,638	0,602	0,638
Convenience	Correlation coefficient	,563**	0,057	1	0,156	,260**	,413**	,495**	,413**
	Sig. level	0,000	0,530		0,086	0,004	0,000	0,000	0,000
Environmental concern	Correlation coefficient	0.002	,229*	0,156	1	0,089	0,015	0,136	0,015
	Sig. level	0.980	0,011	0,086		0,327	0,867	0,135	0,867
Psychological factors (Attitude)	Correlation coefficient	,291**	-0,002	,260**	0,089	1	,606**	,656**	,606**
	Sig. level	0,001	0,980	0,004	0,327		0,000	0,000	0,000
Psychological factors (Subjective norms)	Correlation coefficient	,362**	0,043	,413**	0,015	,606**	1	,610**	1,000**
	Sig. level	0,000	0,638	0,000	0,867	0,000		0,000	
Positive Perception	Correlation coefficient	,539**	-0,047	,495**	0,136	,656**	,610**	1	,610**
	Sig. level	0,000	0,602	0,000	0,135	0,000	0,000		0,000
Psychological factors (Perceived behavioural control)	Correlation coefficient	,362**	0,043	,413**	0,015	,606**	1,000**	,610**	1
	Sig. level	0,000	0,638	0,000	0,867	0,000		0,000	
** Correlation is significant at the 0.01 level (2-tailed).									
* Correlation is significant at the 0.05 level (2-tailed)									

Table 7: Correlation matrix

Chapter 6: Discussion and conclusion.

1. Hypothesis testing

Hypothesis 1: The majority of Liège citizens are aware of the DRS.

The results of the statistical analysis conducted in SPSS clearly indicate a significantly higher level of awareness of the DRS among the citizens of Liège than initially anticipated, the Chi-Square Goodness-of-Fit test revealed that the observed frequency of respondents who are aware of the DRS (106 individuals) considerably exceeded the expected frequency (74 individuals) based on our hypothesis of 60% awareness which also resulted in a Chi-Square value of 34.736 with a p-value of less than 0.001, confirming that the deviation from the expected distribution is statistically significant.

These findings suggest not only that a majority of Liège citizens are aware of the DRS, but that the awareness level surpasses the hypothesized 60%, pointing to a highly successful dissemination and recognition of the scheme within the community, therefore the Hypothesis 1 can be accepted .

Hypothesis 2: Positive perception of the DRS affects the engagement in the DRS.

The correlation analysis investigating the relationship between positive perception of the DRS and participation in the scheme revealed a strong and significant positive correlation between these two variables.

The correlation coefficient between participants' willingness to engage in the DRS and their perception of the scheme was found to be rho = 0.539, with a p-value of 0.000, these results strongly support the hypothesis that a positive perception of the DRS significantly affects engagement in the scheme.

Therefore, the findings suggest that individuals who view the DRS favorably are more likely to participate in the program which leads to accepting the Hypothesis 2.

Hypothesis 3: Positive social norms, favorable attitudes, and perceived behavioral control positively influence participation in the DRS.

The correlation analysis conducted to explore the relationship between participation in the DRS and attitude, social norms, and perceived behavioral control revealed significant and positive associations among these variables.

Firstly, regarding attitudes towards the DRS, there was a moderate positive correlation with participation as rho = 0.291 and p = 0.00, indicating that individuals with more favorable attitudes towards the scheme were more likely to participate, secondly ,social norms showed an even stronger positive correlation with participation in the DRS as the rho = 0.362 with p = 0.000 which suggests that perceived societal approval or encouragement for participation significantly influences individuals' decisions to engage with the DRS and finally, the perceived behavioral control also showed a robust positive correlation with participation with rho = 0.362 and p = 0.000 which indicates that individuals who feel more capable of performing the necessary actions to participate in the DRS are indeed more likely to do so.

Based on the above results, the hypothesis 3 is accepted.

Hypothesis 4: Environmental concerns significantly influence consumers' decisions to participate in the DRS in Liège.

The correlation analysis examining the relationship between environmental concern and participation in the DRS yielded intriguing results with a Spearman's rho coefficient of 0.002 and a p-value of 0.980, the analysis found no correlation between the two variables as participants' level of environmental concern showed no influence on their willingness to engage in a DRS.

This lack of correlation suggests that while individuals may express varying degrees of concern for environmental issues in their daily lives, this concern does not significantly impact their likelihood of participating in initiatives such as DRS, consequently, the hypothesis 4 is rejected.

Hypothesis 5: Convenience influences participants' willingness to participate in the DRS .

The SPSS results indicate a significant positive correlation between participation in the DRS and convenience as the Spearman's Rho correlation coefficient between participation in the DRS and convenience is 0.563 with a p-value of .000, suggesting a strong and statistically significant relationship between the two variables.

Given the significant positive correlation observed, the hypothesis 5 is accepted.

Hypothesis 6: Financial incentive within a DRS encourages Liège consumers' engagement in the DRS.

Based on the correlation analysis results the Spearman's rho correlation coefficient between the willingness to participate in a DRS and the financial incentives, was found to be -0.011, suggesting no meaningful correlation.

Moreover, the statistical significance of this correlation which was a p-value of 0.900 indicates that the observed lack of correlation is likely not due to sample variation but represents a true absence of any significant relationship in the population studied.

Therefore, it appears that financial incentives within the context of this study, do not significantly impact consumers' decisions to engage in a DRS which leads to rejecting the hypothesis 6.

Hypothesis 7: Demographic factors such as age, income, education level influence the likelihood of participation in the deposit refund scheme.

In order to assess the validity of the hypothesis that demographic factors such as age, income, and education level significantly influence the likelihood of participation in the DRS, a series of Chi-square tests of independence were conducted.

The analysis aimed to determine if variations in these demographic variables were associated with differences in participation rates, where the results revealed a differentiated impact of these factors as age and education level were found to significantly affecting participation decisions, with Chi-square values of 18.855 and $p = .026$ for age and 23.855 with $p = .021$ for education, indicating a strong statistical significance in how these factors correlate with the willingness to engage in the DRS.

Conversely, income did not show a statistically significant influence, with a Chi-square value of 14.343 and

$p = .279$, suggesting that income levels might not be a critical determinant in the decision to participate in the DRS.

Based on the above findings, the hypothesis 7 is partially accepted as only age and education level significantly influence the likelihood of participation in the DRS, whereas income does not.

Hypothesis	Status
Hypothesis 1: The majority of Liège citizens are aware of the DRS	Accepted
Hypothesis 2: Positive perception of the DRS affects the engagement in the DRS	Accepted
Hypothesis 3: Positive social norms, favorable attitudes, and perceived behavioral control positively influence participation in the Deposit Refund Scheme among Liège citizens	Accepted
Hypothesis 4: Environmental concerns influence consumers' decisions to participate in the DRS in Liège	Rejected
Hypothesis 5: Convenience influences Liège citizen's willingness to participate in a Deposit Return Scheme	Accepted
Hypothesis 6: Financial incentive within a DRS encourages Liège consumers' engagement in the DRS	Rejected
Hypothesis 7: Demographic factors such as age, income, and education level influence the likelihood of participation in the DRS	Partially accepted

Table 8: Hypothesis and results summary

2. Limitation and ethics

Although the study is comprehensive is still subject to some limitations.

First of all, the sample size of 123 respondents, though adequate for preliminary analysis, may not be fully representative of the entire population of Liège, secondly the exclusion of participants from other cities limits the generalizability of the findings to a broader regional context and finally the distribution of the survey through social media platforms may lead to a self-selection bias, as individuals who are more active on social media and possibly more environmentally conscious may be overrepresented in the sample ,therefore future research could address these limitations by employing larger and more diverse samples .

Ethical considerations were respected throughout this research to ensure the integrity and respect for participants' rights as the questionnaire used for the survey did not require the respondents to disclose any personal data and informed consent was obtained from all respondents, ensuring they were fully aware of the study's purpose and procedures, additionally, care was taken to present findings accurately and honestly, avoiding any form of data manipulation or misrepresentation.

3. Conclusion

The research thesis aimed to gain insight into consumer's determinants to participate in the DRS in Liège city.

A survey was conducted to capture the public opinion and measure their attitudes and the factors that influence their engagement in the DRS and the questionnaire was mostly distributed via social media.

The particular focus of the study was on awareness levels, perceptions, psychological factors, environmental concerns, convenience, financial incentives, and demographic influences which are the main factors found in the literature.

The results revealed that the socio-demographic profile of the participants predominantly consists of women (64.2%) and younger individuals aged 18-35 (51.6%).

The most respondents hold higher education qualifications and a significant proportion are employees and students which highlights the educated and economically active nature of the sample.

The findings showed that the awareness of the DRS among Liège citizens is notably high, with 86% of respondents indicating familiarity with the scheme.

The positive perceptions of the DRS are prevalent, with 74% of respondents expressing favorable views which significantly correlate with higher engagement levels, affirming that positive attitudes towards the DRS enhance participation.

The psychological factors such as positive attitudes, social norms, and perceived behavioral control also show a strong positive influence on participation, emphasizing the importance of psychological determinants in driving consumer behavior.

Interestingly, while environmental concern is high among the participants, it does not significantly influence their decision to participate in the DRS.

Moreover, the convenience emerges as a critical factor, with the highest mean score among the motivations for participation, emphasizing the fact that the ease of access and proximity of collection points are paramount for consumers which indicates that enhancing the convenience of the DRS could significantly boost engagement.

Contrary to the literature findings, the financial incentives do not impact consumers' decisions to participate in the DRS, such an insight suggests that while financial rewards are considered, they are not the primary motivator for participation among Liège citizens.

And finally, the demographic factors such as age and education level significantly influence participation rates, while income does not as the results showed that younger and more educated individuals are more likely to engage in the DRS which highlights the need for targeted awareness and engagement strategies to cater to different demographic segments.

4. References

Abejón, R., Laso, J., Margallo, M., Aldaco, R., Blanca-Alcubilla, G., Bala, A., & Fullana-i-Palmer, P. (2020). Environmental impact assessment of the implementation of a Deposit-Refund System for packaging waste in Spain : A solution or an additional problem ? The Science of the total environment, 721, 137744. https://doi.org/10.1016/j.scitotenv.2020.137744

Adebamboo, S., & Iyabot, A. (2014). Empirical Study of the Effect of Reverse Logistics Objectives on Economic Performance of Food and Beverage Companies in Nigeria. International Review of Management and Business Research https://irmbrjournal.com/paper_details.php?id=328.

Agnusdei, G. P., Gnoni, M. G., & Sgarbossa, F. (2022). Are deposit-refund systems effective in managing glass packaging ? State of the art and future directions in Europe. The Science of the Total Environment, 851(Pt 2), 158256–158256. Https://doi.org/10.1016/j.scitotenv.2022.158256

Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes, https://doi.org/10.1016/0749-5978(91)90020-T

Akdoğan, M. Ş., & Coşkun, A. (2012). Drivers of Reverse Logistics Activities : An Empirical Investigation. Procedia—Social and Behavioral Sciences, 58, 1640–1649. Https://doi.org/10.1016/j.sbspro.2012.09.1130

Alighiri, D., Yasin, M. N., Rohmawati, B., & Drastisianti, A. (2019). Processing of recycled waste PET (polyethylene terephthalate) plastics bottle into for the lightweight and reinforcement bricks. Journal of Physics : Conference Series, 1321(2), 22023-. Https://doi.org/10.1088/1742-6596/1321/2/022023

Amirudin, A., Inoue, C., & Grause, G. (2023). Assessment of factors influencing Indonesian residents' intention to use a deposit–refund scheme for PET bottle waste. Circular Economy, 2(4), 100061-. https://doi.org/10.1016/j.cec.2023.100061\

Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. Resources, Conservation and Recycling, 102, 94–100. Https://doi.org/10.1016/j.resconrec.2015.06.014

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. https://doi.org/10.1080/19397038.2010.507885

Bilyana Spasova (2019). Deposit-refund systems for one-way beverage packaging,retrieved from https://circulareconomy.europa.eu/platform/en/knowledge/deposit-refund-systems-one-way-beverage-packaging

Blackburn, J. D., Guide, V. D. R., Souza, G. C., & Van Wassenhove, L. N. (2004). Reverse Supply Chains for Commercial Returns. California Management Review, 46(2), 6–22. Https://doi.org/10.2307/41166207

Boros, A., Kurdi, R., Lukács, Z. P., Sarkady, A., & Banász, Z. (2021). Opinion of the hungarian population on the reform of beverage packaging deposit-refund system. Sustainability (Basel, Switzerland), 13(11), 6373-. https://doi.org/10.3390/su13116373

Botetzagias, I., Dima, A.-F., & Malesios, C. (2015). Extending the Theory of Planned Behavior in the context of recycling : The role of moral norms and of demographic predictors. Resources, Conservation and Recycling, 95, 58–67. Https://doi.org/10.1016/j.resconrec.2014.12.004

Calabrese, A., Costa, R., Levialdi Ghiron, N., Menichini, T., Miscoli, V., & Tiburzi, L. (2021). Operating modes and cost burdens for the European deposit-refund systems : A systematic approach for their analysis and design. Journal of Cleaner Production, 288, 125600-. Https://doi.org/10.1016/j.jclepro.2020.125600

Carter, C. R., & Ellram, L. M. (1998). Reverse logistics : A review of the literature and framework for future investigation. Journal of Business Logistics, 19(1), 85-.

Cochran, W. G. (1952). The Annals of Mathematical Statistics, 23(3), 315-345. https://www.jstor.org/stable/2236678

Cutting Beverage Container Waste, A to Z: Deposit/Return Systems. Container Recycling Institute. (2016) , retrieved from http://www.container-recycling.org/index.php/zero-beverage_container-waste/62-issues/zero-waste/338-depositreturn-s

De Brito, M., & Dekker, R. (2003, June 30). A Framework for Reverse Logistics. Reverse Logistics. Https://doi.org/10.1007/978-3-540-24803-3_1

Deposit Return Scheme: Germany, retrieved from https://www.bloomberg.com/netzeropathfinders/best-practices/deposit-return-scheme-germany/

Dispoto, R. G. (1977). Interrelationships Among Measures of Environmental Activity, Emotionality, and Knowledge. Educational and Psychological Measurement, 37(2), 451–459. https://doi.org/10.1177/001316447703700220

DPG Deutsche Pfandsystem GmbH - History of the DPG (2016), retrieved from https://dpg-pfandsystem.de/index.php/en/the-one-way-deposit-system/about-dpg.html

Enzo Favoino & Michele Giavini, Scuola Agraria del Parco di Monza (2020).Bio-waste generation in the EU: Current capture levels and future potential retrieved from https://zerowasteeurope.eu/library/bio-waste-generation-in-the-eu-current-capture-levels-and- future-potential/

European Commission (2023) .Waste Framework Directive, retrieved from https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en#by-products

European Directive (2019). Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. retrieved from https://eur-lex.europa.eu/eli/dir/2019/904/oj

European Parliament. (2023, May). Circular economy: definition, importance and benefits, retrieved from https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits

Evison, T., & Read, A. D. (2001). Local authority recycling and waste—Awareness publicity/promotion : Delivering sustainable waste management—A UK perspective. Resources, Conservation and Recycling, 32(3–4), 275–291.

Ferreira, S., Cabral, M., De Jaeger, S., Da Cruz, N. F., Simões, P., & Marques, R. C. (2017). Life cycle assessment and valuation of the packaging waste recycling system in Belgium. Journal of Material Cycles and Waste Management, 19(1), 144–154. Https://doi.org/10.1007/s10163-015-0383-x

Fleischmann, M., Krikke, H. R., Dekker, R., & Flapper, S. D. P. (2000). A characterisation of logistics networks for product recovery. Omega (Oxford), 28(6), 653–666. Https://doi.org/10.1016/S0305-0483(00)00022-0

Florence Schultz (2019) .German associations call for binding reusable packaging quotas, retrieved from https://www.euractiv.com/section/energy-environment/news/german-associations-urge-government-to-introduce-binding-reusable-quotas/

Fost Plus. Glass is perfectly suited to recycling , retrieved from https://www.fostplus.be/en/recycling/glass

Gaines, L. (2012). To recycle, or not to recycle, that is the question : Insights from life-cycle analysis. MRS Bulletin, 37(4), 333–338. Https://doi.org/10.1557/mrs.2012.40

Giorgia Marino (2021).What we waste :41 Bottles and Cans are littered every year in Europe, retrieved from https://www.renewablematter.eu/what-we-waste-41-billion-bottles-and-cans-are-littered-every-year-in-europe

Glossary of statistical terms. OECD (2016), retrieved from https://stats.oecd.org/glossary/index.htm.

Gneezy, U., Meier, S., & Rey-Biel, P. (2011). When and why incentives (don't) work to modify behavior. The Journal of Economic Perspectives, 25(4), 191–210. https://doi.org/10.1257/jep.25.4.191

Görgün, E., Adsal, K., Misir, A., Aydin, E., Ergün, Ç., Keskin, N., Acar, A., & Ergenekon, Ş. (2021) .Deposit refund system for beverage containers as a best practice example for recycling maximization. Environmental Research & Technology. Https://doi.org/10.35208/ert.862611

Guide, V. D. R., Harrison, T. P., & Van Wassenhove, L. N. (2003). The Challenge of Closed-Loop Supply Chains. Interfaces (Providence), 33(6), 3–6. Https://doi.org/10.1287/inte.33.6.3.25182

Guillaume Ragonnaud (2023).Revision of the Packaging and Packaging Waste Directive, retrieved from https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/745707/EPRS_BRI(2023)745707_EN.pdf
Gupt, Y., & Sahay, S. (2015). Review of extended producer responsibility : A case study approach. Waste Management & Research, 33(7), 595–611. Https://doi.org/10.1177/0734242X15592275

Habibi, M. K. K., Battaïa, O., Cung, V.-D., & Dolgui, A. (2017). Collection-disassembly problem in reverse supply chain. International Journal of Production Economics, 183, 334–344. Https://doi.org/10.1016/j.ijpe.2016.06.025

Hair, J. F., Tatham, R., Anderson, R., Black, W., & Simmons, G. (1999). Multivariate data analysis [Review of Multivariate data analysis]. Australian and New Zealand Journal of Statistics, 41(3), 378–378.

Hanninen, S. (1995). Accountability lost? : An environmental struggle over the economic feasibility of incineration. Accounting, Organizations and Society, 20(2), 175–192. Https://doi.org/10.1016/0361-3682(94)E0016-N

Hauke, J., & Kossowski, T. (2011). Comparison of Values of Pearson's and Spearman's Correlation Coefficients on the Same Sets of Data. Quaestiones Geographicae, 30(2), 87–93. https://doi.org/10.2478/v10117-011-0021-1

Johnson, C. Y., Bowker, J. M., & Cordell, H. K. (2004). Ethnic Variation in Environmental Belief and Behavior : An Examination of the New Ecological Paradigm in a Social Psychological Context. Environment and Behavior, 36(2), 157–186. Https://doi.org/10.1177/0013916503251478

Katha Nauriyal (2024) .Household waste and recycling in Belgium. DEPOSIT REFUND SCHEME | Urban Agenda Platform retrieved from https://www.expatica.com/be/living/household/waste-and-recycling-in-belgium-102650/#overview

Katharina Wecker (2018).Plastic waste and the recycling myth, retrieved from https://www.dw.com/en/plastic-waste-and-the-recycling-myth/a-45746469

Kedzierski, M., Frère, D., Le Maguer, G., & Bruzaud, S. (2020). Why is there plastic packaging in the natural environment ? Understanding the roots of our individual plastic waste management behaviours. The Science of the Total Environment, 740, 139985–139985. Https://doi.org/10.1016/j.scitotenv.2020.139985

Keramitsoglou, K. M., & Tsagarakis, K. P. (2013). Public participation in designing a recycling scheme towards maximum public acceptance. Resources, Conservation and Recycling, 70, 55–67. https://doi.org/10.1016/j.resconrec.2012.09.015

Khan, F., Ahmed, W., & Najmi, A. (2019). Understanding consumers' behavior intentions towards dealing with the plastic waste: Perspective of a developing country. Resources, Conservation and Recycling, 142, 49–58. https://doi.org/10.1016/j.resconrec.2018.11.020

Kirakozian, A. (2016). ONE WITHOUT THE OTHER? BEHAVIOURAL AND INCENTIVE POLICIES FOR HOUSEHOLD WASTE MANAGEMENT. Journal of Economic Surveys, 30(3), 526–551. https://doi.org/10.1111/joes.12159

Knickmeyer, D. (2020). Social factors influencing household waste separation: A literature review on good practices to improve the recycling performance of urban areas. Journal of Cleaner Production, 245, 118605-. https://doi.org/10.1016/j.jclepro.2019.118605

Kunz, N., Atasu, A., Mayers, K., & Van Wassenhove, L. (2014). Extended Producer Responsibility: Stakeholder Concerns and Future Developments. White Paper, INSEAD Social Innovation Centre, Fontainebleau. Retrieved from https://www.researchgate.net/profile/Nathan-Kunz/publication/260146056_Extended_Producer_Responsibility_Stakeholder_Concerns_and_Future_Developments/links/0f31752fc1304adcb2000000/Extended-Producer-Responsibility-Stakeholder-Concerns-and-Future-Developments.pdf

Li, D., Zhao, L., Ma, S., Shao, S., & Zhang, L. (2019). What influences an individual's pro-environmental behavior ? A literature review. Resources, Conservation and Recycling, 146, 28–34. Https://doi.org/10.1016/j.resconrec.2019.03.024

Lindhqvist, T. (2000). Extended Producer Responsibility in Cleaner Production : Policy Principle to Promote Environmental Improvements of Product Systems.

Ling, M., Xu, L., & Xiang, L. (2021). Social-contextual influences on public participation in incentive programs of household waste separation. Journal of Environmental Management, 281, 111914–111914. Https://doi.org/10.1016/j.jenvman.2020.111914

Lu, B., & Wang, J. (2022). How can residents be motivated to participate in waste recycling? An analysis based on two survey experiments in China. Waste Management (Elmsford), 143, 206–214. https://doi.org/10.1016/j.wasman.2022.02.034

Malek, W., Mortazavi, R., Cialani, C., & Nordström, J. (2023). How have waste management policies impacted the flow of municipal waste ? An empirical analysis of 14 European countries. Waste Management (Elmsford), 164, 84–93. Https://doi.org/10.1016/j.wasman.2023.03.040

Malindzakova, M., Štofková, J., & Majernik, M. (2022). Economic–Environmental Performance of Reverse Logistics of Disposable Beverage Packaging. Sustainability (Basel, Switzerland), 14(13), 7544-. Https://doi.org/10.3390/su14137544

Martin, M., Williams, I. D., & Clark, M. (2006). Social, cultural and structural influences on household waste recycling: A case study. Resources, Conservation and Recycling, 48(4), 357–395. https://doi.org/10.1016/j.resconrec.2005.09.005

Miafodzyeva, S., & Brandt, N. (2013). Recycling Behaviour Among Householders : Synthesizing Determinants Via a Meta-analysis. Waste and Biomass Valorization, 4(2), 221–235. Https://doi.org/10.1007/s12649-012-9144-4

Miliute-Plepiene, J., Hage, O., Plepys, A., & Reipas, A. (2016). What motivates households recycling behaviour in recycling schemes of different maturity ? Lessons from Lithuania and Sweden. Resources, Conservation and Recycling, 113, 40–52. Https://doi.org/10.1016/j.resconrec.2016.05.008

Mwanza, B. G., & Mbohwa, C. (2017). Drivers to Sustainable Plastic Solid Waste Recycling : A Review. Procedia Manufacturing, 8, 649–656.Https://doi.org/10.1016/j.promfg.2017.02.083

Nardi, P. C. C., Silva, R. L. M. da, Ribeiro, E. M. S., & Oliveira, S. V. W. B. de. (2017). Proposal for a methodology to monitor sustainability in the production of soft drinks in Ref PET. Journal of Cleaner Production, 151, 218–234. Https://doi.org/10.1016/j.jclepro.2017.02.181

Ngadiman, N. I. B., Moeinaddini, M., Ghazali, J. B., & Roslan, N. F. B. (2016). Reverse logistics in food industries : A case study in Malaysia.

Oke, A., & Kruijsen, J. (2016). The Importance of Specific Recycling Information in Designing a Waste Management Scheme. Recycling (Basel), 1(2), 271–285. https://doi.org/10.3390/recycling1020271

Oke, A., Osobajo, O., Obi, L., & Omotayo, T. (2020). Rethinking and optimising post-consumer packaging waste : A sentiment analysis of consumers' perceptions towards the introduction of a deposit refund scheme in Scotland. Waste Management (Elmsford), 118, 463–470. Https://doi.org/10.1016/j.wasman.2020.09.008

Owens, J., Dickerson, S., & Macintosh, D. L. (2000). Demographic Covariates of Residential Recycling Efficiency. Environment and Behavior, 32(5), 637–650. Https://doi.org/10.1177/00139160021972711

Özdemir-Akyıldırım, Ö. (2015). Deposit-refund system vs. Compliance scheme membership : How to comply with producer responsibility regulations ? International Journal of Production Economics, 162, 25–44. Https://doi.org/10.1016/j.ijpe.2014.12.027

Park, J., & Ha, S. (2014). Understanding Consumer Recycling Behavior : Combining the Theory of Planned Behavior and the Norm Activation Model. Family and Consumer Sciences Research Journal, 42(3), 278–291. Https://doi.org/10.1111/fcsr.12061

Passafaro, P., Livi, S., & Kosic, A. (2019). Local norms and the theory of planned behavior : Understanding the effects of spatial proximity on recycling intentions and self-reported behavior. Frontiers in Psychology, 10, 744–744. Https://doi.org/10.3389/fpsyg.2019.00744

Philip Oltermann (2018). Has Germany hit the jackpot of recycling? The jury's still out. The Guardian, retrieved from https://www.theguardian.com/world/2018/mar/30/has-germany-hit-the-jackpot-of-recycling-the-jurys-still-out

Rahimifard, S., Coates, G., Staikos, T., Edwards, C., & Abu-Bakar, M. (2009). Barriers, drivers and challenges for sustainable product recovery and recycling. International Journal of Sustainable Engineering, 2(2), 80–90. Https://doi.org/10.1080/19397030903019766

Ramayah, T., Lee, J. W. C., & Lim, S. (2012). Sustaining the environment through recycling: An empirical study. Journal of Environmental Management, 102, 141–147. https://doi.org/10.1016/j.jenvman.2012.02.025

Read, A. D. (1999). “A weekly doorstep recycling collection, I had no idea we could!” : Overcoming the local barriers to participation. Resources, Conservation and Recycling, 26(3), 217–249. Https://doi.org/10.1016/S0921-3449(99)00008-7

Refsgaard, K., & Magnussen, K. (2009). Household behaviour and attitudes with respect to recycling food waste – experiences from focus groups. Journal of Environmental Management, 90(2), 760–771. Https://doi.org/10.1016/j.jenvman.2008.01.018

Reusable vs Single-Use Packaging Report (2020), retrieved from https://zerowasteeurope.eu/library/reusable-vs-single-use-packaging-a-review-of-environmental-impact/

Rhein, S., & Sträter, K. F. (2021). Intended and unintended effects of statutory deposit return schemes for single-use plastic bottles : Lessons learned from the German experience. Gaia (Heidelberg, Germany), 30(4), 250–256. Https://doi.org/10.14512/gaia.30.4.8

Roca i Puigvert, M., Ayuso, S., Bala, A., & Fullana-i-Palmer, P. (2020). What factors determine attitudes towards the implementation of a packaging deposit and refund system ? A qualitative study of the perception of Spanish consumers. Journal of Environmental Management, 270, 110891–110891. Https://doi.org/10.1016/j.jenvman.2020.110891

Roca, M., Ayuso, S., Bala, A., Colomé, R., & Fullana-i-Palmer, P. (2022). Evaluating the implementation of a packaging Deposit and Refund System in Catalonia. Two surveys on citizenship’s expected behaviour. The Science of the Total Environment, 806(Pt 2), 150640–150640. Https://doi.org/10.1016/j.scitotenv.2021.150640

Roger Harrabin (2018).Drinks bottles and can deposit return scheme proposed, retrieved from https://www.bbc.com/news/science-environment-43563164

Rogers, D. S., & Tibben-Lembke, R. (2001). AN EXAMINATION OF REVERSE LOGISTICS PRACTICES. Journal of Business Logistics, 22(2), 129–148. Https://doi.org/10.1002/j.2158-1592.2001.tb00007.x

Samantha Millette (2022) . Global Deposit Book, retrieved from RELOOP_Global_Deposit_Book_11I202 (1).pdf

Saphores, J.-D. M., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior : An analysis of e-waste recycling based on a national survey of U.S. households. Resources, Conservation and Recycling, 60, 49–63. Https://doi.org/10.1016/j.resconrec.2011.12.003.

Sellitto, M. A. (2018). Reverse logistics activities in three companies of the process industry. Journal of Cleaner Production, 187, 923–931. Https://doi.org/10.1016/j.jclepro.2018.03.262

Shamsuyeva, M., & Endres, H.-J. (2021). Plastics in the context of the circular economy and sustainable plastics recycling : Comprehensive review on research development, standardization and market. Composites. Part C, Open Access, 6, 100168-. Https://doi.org/10.1016/j.jcomc.2021.100168

Sidique, S. F., Lupi, F., & Joshi, S. V. (2010). The effects of behavior and attitudes on drop-off recycling activities. Resources, Conservation and Recycling, 54(3), 163–170. Https://doi.org/10.1016/j.resconrec.2009.07.012

Sijtsema, S. J., Snoek, H. M., van Haaster-de Winter, M. A., & Dagevos, H. (2020). Let’s talk about circular economy : A qualitative exploration of consumer perceptions. Sustainability (Basel, Switzerland), 12(1), 286-. Https://doi.org/10.3390/su12010286

Simon, B., Amor, M. B., & Földényi, R. (2016). Life cycle impact assessment of beverage packaging systems : Focus on the collection of post-consumer bottles. Journal of Cleaner Production, 112, 238–248. Https://doi.org/10.1016/j.jclepro.2015.06.008

Sorkun, M. F. (2018). How do social norms influence recycling behavior in a collectivistic society? A case study from Turkey. Waste Management (Elmsford), 80, 359–370. https://doi.org/10.1016/j.wasman.2018.09.026

Spaccarelli, S., Zolik, E., & Jason, L. A. (1989). Effects of Verbal Prompting and Block Characteristics on Participation in Curbside Newspaper Recycling. Journal of Environmental Systems, 19(1), 45–57. Https://doi.org/10.2190/FXPM-UHC7-GXY6-JMJE

Spiegelman, J. (2005) Using economic incentives to control pollution. (2005). In Business and the Environment (Vol. 16, Issue 4, pp. 4-). Aspen Publishers, Inc.

Srivastava, S. K. (2008). Network design for reverse logistics. Omega (Oxford), 36(4), 535–548. Https://doi.org/10.1016/j.omega.2006.11.012

State of implementation of Deposit Refund Systems (DRS) across Europe (2024), retrieved from https://www.unesda.eu/deposit-refund-systems/

Stefanini, R., Borghesi, G., Ronzano, A., & Vignali, G. (2021). Plastic or glass : A new environmental assessment with a marine litter indicator for the comparison of pasteurized milk bottles. The International Journal of Life Cycle Assessment, 26(4), 767–784. Https://doi.org/10.1007/s11367-020-01804-x

Struk, M. (2017). Distance and incentives matter : The separation of recyclable municipal waste. Resources, Conservation and Recycling, 122, 155–162. Https://doi.org/10.1016/j.resconrec.2017.01.023

Study into the PET recycling process (2020) .PET bottles increasingly environmentally friendly, retrieved from https://newsroom.kunststoffverpackungen.de/en/2020/11/19/study-pet-recycling-process-bottles-increasingly-environmentally-friendly/

The Pfand system: how to return bottles in Germany**.** Retrieved from https://allaboutberlin.com/guides/pfand-bottles.

The Netherlands expands national deposit return system to include aluminium and steel beverage cans (2023).Packaging Europe ,retrieved from https://packagingeurope.com/news/the-netherlands-expands-national-deposit-return-system-to-include-aluminium-and-steel-beverage-cans/9618.article

Thomas, C., & Sharp, V. (2013). Understanding the normalisation of recycling behaviour and its implications for other pro-environmental behaviours: A review of social norms and recycling. Resources, Conservation and Recycling, 79, 11–20. https://doi.org/10.1016/j.resconrec.2013.04.010

Tian, M., Pu, B., Chen, Y., & Zhu, Z. (2019). Consumer's Waste Classification Intention in China: An Extended Theory of Planned Behavior Model. Sustainability (Basel, Switzerland), 11(24), 6999-. https://doi.org/10.3390/su11246999

Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. The Journal of Environmental Education, 31(3), 12–19. Https://doi.org/10.1080/00958960009598640

Tseng, M.-L. (2011). Importance-performance analysis of municipal solid waste management in uncertainty. Environmental Monitoring and Assessment, 172(1–4), 171–187. Https://doi.org/10.1007/s10661-010-1325-7

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). Towards a new taxonomy of circular economy business models. Journal of Cleaner Production, 168, 487–498. Https://doi.org/10.1016/j.jclepro.2017.09.047

Van Rensburg, M. L., Nkomo, S. L., & Dube, T. (2020). The 'plastic waste era'; social perceptions towards single-use plastic consumption and impacts on the marine environment in Durban, South Africa. Applied Geography (Sevenoaks), 114, 102132-. https://doi.org/10.1016/j.apgeog.2019.102132

Vicente, P., & Reis, E. (2008). Factors influencing households' participation in recycling. Waste Management & Research, 26(2), 140–146. Https://doi.org/10.1177/0734242X07077371

Viscusi, W. K., Huber, J., & Bell, J. (2011). Promoting Recycling : Private Values, Social Norms, and Economic Incentives. The American Economic Review, 101(3), 65–70. Https://doi.org/10.1257/aer.101.3.65

Viscusi, W. K., Huber, J., Bell, J., & Cecot, C. (2013). Discontinuous Behavioral Responses to Recycling Laws and Plastic Water Bottle Deposits. American Law and Economics Review, 15(1), 110–155. https://doi.org/10.1093/aler/aht005

Walls, M., 2011. Deposit-Refund Systems in Practice and Theory. Resources for the Future Discussion Paper No. 11-47 https://doi.org/10.2139/ssrn.1980142

Wang, S., Wang, J., Zhao, S., & Yang, S. (2019). Information publicity and resident's waste separation behavior: An empirical study based on the norm activation model. Waste Management (Elmsford), 87, 33–42. https://doi.org/10.1016/j.wasman.2019.01.038

Waqas Qureshi (2018). Look at the German model for a deposit return scheme, retrieved from https://www.packagingnews.co.uk/news/carsten-schleeberger-look-german-model-deposit-return-scheme-07-09-2018

Welle, F. (2011). Twenty years of PET bottle to bottle recycling—An overview. Resources, Conservation and Recycling, 55(11), 865–875. Https://doi.org/10.1016/j.resconrec.2011.04.009

Werner, C. M., & Makela, E. (1998). MOTIVATIONS AND BEHAVIORS THAT SUPPORT RECYCLING. Journal of Environmental Psychology, 18(4), 373–386. Https://doi.org/10.1006/jevp.1998.0114

Westbroek, C. D., Bitting, J., Craglia, M., Azevedo, J. M. C., & Cullen, J. M. (2021). Global material flow analysis of glass : From raw materials to end of life. Journal of Industrial Ecology, 25(2), 333–343. Https://doi.org/10.1111/jiec.13112

Wiesmeth, H., Shavgulidze, N., & Tevzadze, N. (2018). Environmental policies for drinks packaging in Georgia : A mini-review of EPR policies with a focus on incentive compatibility. Waste Management & Research, 36(11), 1004–1015. Https://doi.org/10.1177/0734242X18792606

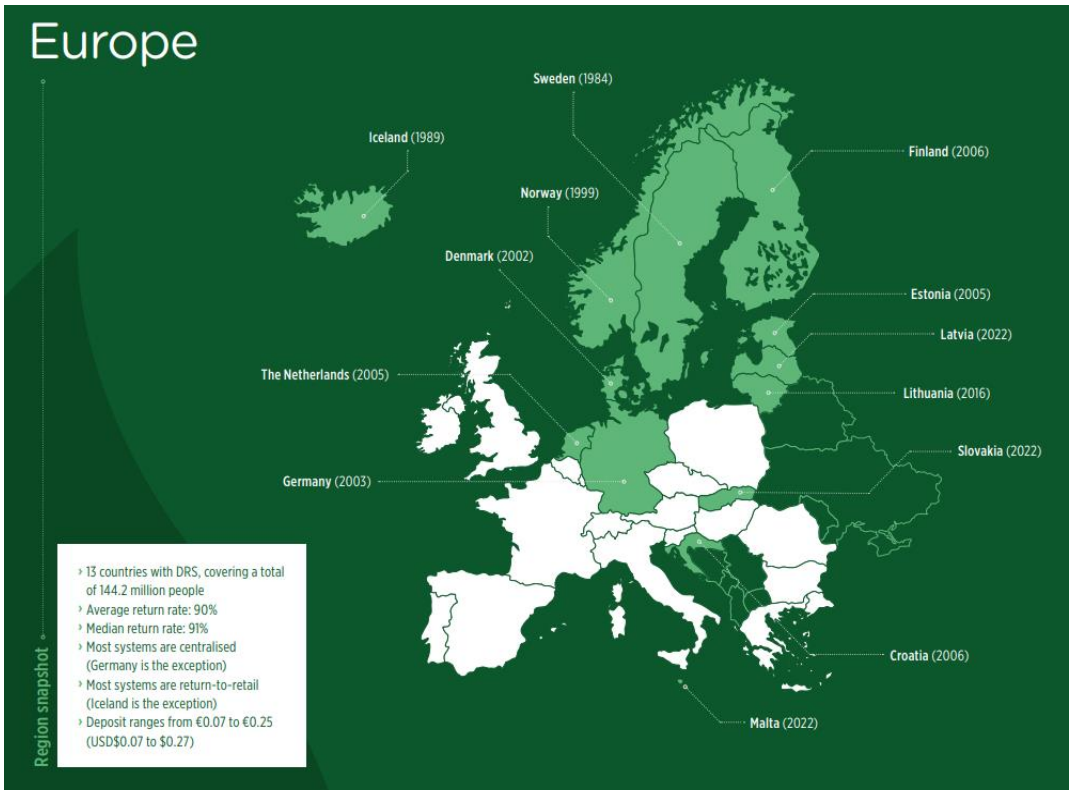
Worldometer , retrieved from https://www.worldometers.info/world-population/belgium-population/

Xevgenos, D., Papadaskalopoulou, C., Panaretou, V., Moustakas, K., & Malamis, D. (2015). Success Stories for Recycling of MSW at Municipal Level : A Review. Waste and Biomass Valorization, 6(5), 657–684. Https://doi.org/10.1007/s12649-015-9389-9

Zhou, G., Gu, Y., Wu, Y., Gong, Y., Mu, X., Han, H., & Chang, T. (2020). A systematic review of the deposit-refund system for beverage packaging : Operating mode, key parameter and development trend. Journal of Cleaner Production, 251, 119660. Https://doi.org/10.1016/j.jclepro.2019.119660.

5. Appendices

Appendix 1: The implemented DRS across Europe. Source: The global deposit book (2022)



Appendix 2: Labels on containers with deposit. Source: The pfand system

Appendix 3: survey questions

1. **Votre lieu de résidence se situe à Liège ?**

Oui
Si non, Merci d'indiquer votre lieu de résidence

2. **Êtes-vous ?**

Une femme
Un homme
Je ne souhaite pas répondre

3. **Dans quelle tranche d'âge vous situez vous?**

Moins de 18 ans
18-35 ans
36-45 ans
46-55 ans
56 ans ou plus
Je ne souhaite pas répondre

4. **Quel est le diplôme ou le certificat d'étude le plus élevé que vous ayez obtenu ?**

Pas de diplôme
Enseignement primaire (CEB)
Enseignement secondaire
Enseignement supérieur non universitaire
Enseignement supérieur universitaire
Doctorat ou équivalent

5. **Quel est votre revenu familial approximatif ?**

Moins de 1 000 euros par mois
1 000 à 2 000 euros par mois
2 001 à 3 000 euros par mois
3 001 à 4 000 euros par mois
Plus de 4 000 euros par mois

6. **Quelle profession exercez-vous actuellement ?**

Employé-Ouvrier
Cadre-Profession libérale
Etudiant
Retraité
Non actif

7. **Etes-vous familiarisé(e) avec le concept de consigne pour les bouteilles ?**

Oui
Non

8. **Seriez-vous disposé(e) à participer à un système de consigne pour les bouteilles ?**

Non, certainement pas	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	Oui, certainement

9. **Quels facteurs pourraient influencer votre décision de participer à un tel système ?**

	Très important	Important	Neutre	Peu important	Pas du tout important
Avantages financiers (compensation financière, remise, coupon d'achat...)					
Impact positif du système sur l'environnement					
Facilité et proximité des points de collecte des bouteilles					

10. **Sur une échelle de 1 à 5, quelle importance accordez-vous aux problèmes environnementaux dans votre vie quotidienne ?**

Pas du tout important	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	Extrêmement important

11. **Pensez-vous qu'un système de consigne pourrait avoir un impact positif sur l'environnement ?**

	1	2	3	4	5	
Pas du tout	◯	◯	◯	◯	◯	Certainement

12. **À quel point êtes-vous susceptible de recycler les contenants de boissons si vous savez que d'autres personnes de votre cercle social le font également ?**

	1	2	3	4	5	
Très peu probable	◯	◯	◯	◯	◯	Très probable

13. **Comment percevez-vous le Système de consigne pour les bouteilles ?**

	1	2	3	4	5	
Très défavorablement	◯	◯	◯	◯	◯	Très favorablement

14. **Si un système de consigne était introduit dans notre ville, je pense qu'il me serait facile d'y participer compte tenu de ma routine quotidienne**

	1	2	3	4	5	
Tout à fait en désaccord	◯	◯	◯	◯	◯	Tout à fait d'accord

15. **Quelles attentes particulières auriez-vous par rapport à ce système ?**

16. **Comment serait le système idéal pour vous ?**