

# POLITECNICO DI TORINO

Corso di Laurea Magistrale in  
Ingegneria per l'Ambiente e il Territorio

A.A. 2019/2020

## Master Thesis:

**Sustainability of the German Deposit System: Case Study in Berlin**

Investigation and analysis of environmental and social aspects of bottle collection



Supervisor:

Prof. Gian Andrea Blengini

Scientific supervisor:

Dr. Andreas Ciroth

Candidate:

Arianna De Bellis

s247021

Marzo 2020



## ABSTRACT

Sustainability is the starting point of this study, it has taken on different definitions for many years, but it has become a crucial subject especially since in 2015 the Sustainable Development Goals were defined in the 2030 Agenda. Over the years different definitions and branches of sustainability have been delineated in order to adapt to specific projects and studies, here a few of them classical and related to urban life and social aspects have been presented. To support the goal of reaching an overall sustainability in a practical way, there are tools that have been defined and are being used every day to move forward in the scientific research that are used to influence the definition of actions and policies. Sustainability is hence the thread that brings the whole study together, motivating the definition of solutions and guidelines that should be pursued.

The Case Study examined here has its starting point in the German Deposit Return Scheme (DRS). It is a well established system that was officially introduced in 2003 and further developed in 2006. An analysis of the effects of the deposit scheme has been carried out, results on the amount of recycling that this system has contributed to and a brief comparison with *other countries* that haven't taken on this type of system. The analysis has shown how the impact on the glass recycling is limited, since it represents a very small fraction of the total amount of recycled glass, because Germany has already virtuous results with the EPR system. While the PET single use bottles show a very high return rate, data has shown how their purchase has grown over the years. It is important to evaluate the difference between the impact of the recycling compared to the impact of the reuse, this is linked to many factors that need to be assessed considering specific scenarios.

As a consequence of the introduction of this system peculiar habits and phenomena have developed in the city of Berlin. The focal point has been put on the German capital, the goal is to investigate through the framework of the three pillars sustainability, and the tools most suitable, the environmental, social and economical aspects of the phenomenon that sprung from the DRS. Consequence of the system is that apart from the deposit collection from the bottles in the households, the act of leaving bottles in the street has become a habit for the people in Berlin, because it is a certainty that someone will collect them. These actions have autoregulated themselves, creating a system that lies in a grey area from a legal point of view and also from the point of view of a community that seems to accept this condition as normal part of daily life. There is a word for the people that collect bottles in the street in the German language, it

is *pfandsammler*. Keeping the city clean of litter and sustaining themselves through the collection of deposit are a few aspects that can be observed and analysed about the “*pfandsammler phenomenon*” and the social aspects linked to it. From a social point of view it presents many issues, linked to stigma, basic life needs, social classes divide.

A qualitative model of the phenomenon has been created through the use of Causal Loops Diagrams. With the CLD it was possible to represent the variables that come into play, and how they are related to one another, this made it possible to have an overall view of the phenomenon and to find issues to focus on further. It was possible to identify loops related to the sustainability framework mentioned before.

Literature research, survey and direct collection of data has been carried out to assess the habits of people living in Berlin, the impression of the general public on the social condition of the *pfandsammler* and different evaluations like the time a bottle spends on the spot where it is left. Different scenarios are presented and assessed to lay some foundation to further continue the research on this phenomenon. Ideally with the creation of a model that would estimate the optimal scenario considering the deposit value, social conditions, environment protection and also economic benefit, for Berlin and then Germany. The aim is that this can be then considered as starting point and as an example for an evaluation for different countries that already adopted a DRS or are considering implementing it.

## **Acknowledgments**

I would like to thank my master thesis advisor, professor Gian Andrea Blengini for giving me the opportunity to explore the topic of my thesis that was brought by the possibility to have an international experience that was an important occasion of growth for me. I would also like to thank Dr. Andreas Citroth for introducing me to the subject of the thesis and the collaboration showed for its realisation, and the whole team of GreenDelta for hosting me in their office in Berlin, always showing me big support during the work put on this project.

# Summary

<b>1. INTRODUCTION</b>	<b>8</b>
<b>2. SUSTAINABILITY</b>	<b>11</b>
2.1. Sustainability introduction	11
2.2. Some sustainability visions	12
2.2.1. Pezzoli	12
2.2.2. Pearce and Turner's theory	13
2.2.3. Three pillar view of sustainability	13
2.3. Sustainable development	14
2.4. Social sustainability	15
2.5. Survival sustainability	17
2.6. Social and sustainability assessment	18
2.7. Tools for sustainability	19
2.7.1. Life Cycle Thinking	19
2.7.1.1. Life Cycle Assessment	21
2.7.1.2. Life Cycle Costing	22
2.7.1.3. Social LCA	22
<b>3. THE GERMAN DEPOSIT SYSTEM</b>	<b>25</b>
3.1. Birth and implementation	25
3.2. Legal regulations	26
3.3. The deposit slip	29
3.4. Statistics	29
3.4.1. Glass recycling	29
3.4.2. Glass reuse	31
3.4.3. Plastic recycling and reuse	33
3.5. Aftermath of the deposit system	36
3.6. Initiatives	37
3.6.1. Pfand Gehört Daneben (Deposit Belongs Next to it ) [30]	37
3.6.2. Pfandgeben (Give the deposit) [31]	37
3.6.3. Spende Dein Pfand (Donate your deposit) [32]	38
<b>4. CASE STUDY IN BERLIN</b>	<b>39</b>
4.1. Modelling the case study	40
4.1.1. General	40
4.1.2. Causal Loop Diagram:	41
4.1.2.1. How it works	41
4.1.3. Operational	42
4.2. Elements of the Causal Loop Diagram:	45
4.2.1. Social elements	45
4.2.2. Economic elements	46
4.2.3. Environmental elements	46
4.3. Focus on CLDs	47
4.3.1. Environmental	47
4.3.2. Economical	48
4.3.3. Social	49
4.4. Further analysis: social issues	50
<b>5. DATA COLLECTION AND ANALYSIS</b>	<b>52</b>
5.1. Survey	52
5.1.1. Elaboration of data	53
5.1.1.1. West Berlin	54
5.1.1.2. East Berlin	56
5.2. Data elaboration and comparison East-West:	57
5.3. Variables	60
5.4. Scenarios	62

5.4.1.	Deposit value higher	62
5.4.2.	Deposit value very high	63
5.5.	Functions that bond deposit value and other variables:	64
5.5.1.	Deposit value and social conditions	64
5.5.2.	Deposit value and littering	65
5.6.	Literature research towards conclusions	66
<b>6.</b>	<b>CONCLUSIONS</b>	<b>67</b>
<b>7.</b>	<b>Sources</b>	<b>69</b>

# 1. INTRODUCTION

This thesis work has been carried out in collaboration with the German company GreenDelta GmbH (<https://www.greendelta.com>), whose work ranges from software development, data analysis and database expansion, to the study of life cycle thinking in all its branches, environmental, costing and social.

Of particular interest to the company is the continuous development of the analysis of social aspects, to be framed in technical terms. Very relevant in the Social Life Cycle Assessment (s-LCA) community is the development of the PSILCA database, which is specialised on social aspects, indeed based on the definition of social indicators related to different stakeholders, for example workers or local community.

The thesis focuses on social aspects and the goal is to frame them in a technical analysis scheme, with the overall ambition to strengthen the tools that support decision making on the sustainability topic.

This project originates from the continuous work on the technical coding of social aspects connected to a system of bottles and cans collection in Germany. Such a collection scheme is based on the application of a deposit (*pfand* in German), which is a monetary deposit added to the price of a product, which is given back when the empty container is returned to the appropriate machines or places suitable for the return. This has had consequences not only from an environmental point of view, but also from a social point of view, since as a result of the implementation of this system by the German government, a particular phenomenon in the main cities of Germany was generated, in particular in the city of Berlin.

This phenomenon has as its protagonists people who are in economic difficulty, who go in search of empty bottles left on the street in order to collect the deposit that comes from returning them and support themselves in this way, called in German *pfandsammler*.

The Deposit Return Scheme in Germany has been analysed firstly through literature from an environmental point of view, looking at the goals that have been achieved in terms of waste management that resulted in savings in raw resources that the recycling and reuse operations entail.



Subsequently, particular attention was paid through the work done in the company for the execution of the experimental work, stressing the importance of tackling problems that have an effect on everyday life.

What was done then was the investigation of the above mentioned phenomenon. Because such a social phenomenon is very dynamic and irregular, it has been translated into a design, which through precise variables has been made analysable, therefore it was possible to identify the points concerning social issues on which to focus attention on.

Social sustainability presents itself as a fundamental theme, since the analyses carried out have confirmed that it is closely linked to environmental and economic issues, which form the complete vision of sustainability defined by the classical three pillars. Nevertheless, this is a theme that has been rarely investigated so far, also because of the difficulties encountered in its objective definition.

This work was carried out through the counselling with experts present in the GreenDelta GmbH, that brought to the modelling of the phenomenon. Then field work was done through direct observation of the phenomenon in the city of Berlin, the administration of questionnaires and the study of the literature.

The aim of this work was therefore to lay the foundations and start from the qualitative data collected on social conditions, which are to be transformed into quantitative or semi-quantitative data, in turn to be studied and analysed. The overarching objective is to define a framework that can lead to a non-subjective and quantifiable definition of these issues. As a main project achievement, the data could be systematically compiled into a database to support the use of the tool (PSILCA), thus translating social aspects into indicators that provide support towards the study of social sustainability.

The chapters are divided into:

- Sustainability overview: what is sustainability, different types of definitions, focus on sustainable development and social sustainability with a section about practical tools for sustainability.
- The German Deposit Return Scheme: when was it implemented, how it works, the effects on waste management of the glass and PET fractions.

- Case study in Berlin: The field work that was brought on, the situation approached and the modelling of the phenomenon encountered, data collection, analysis and scenarios studied.
- Conclusion about the system and the phenomenon studied and outlooks about the research that could be carried out in the future.

## 2. SUSTAINABILITY

### 2.1. SUSTAINABILITY INTRODUCTION

Sustainability has become an essential aspect for every project, it has been taken on different definitions over the years, but it has become a crucial subject especially since in 2015 the Sustainable Development Goals were defined in the 2030 Agenda.

An important thing to understand is written by Philipp Sutton in “Sustainability: What does it mean?” to why sometimes is hard to define what sustainability is “is that it has to be applied to something before its meaning is clear - and people usually don't specify what it is applied to when they use the term.”

The growth in popularity of term of sustainability was born out of the necessity to see that the current direction of events would not lead to a worsening of global conditions, linked mainly to climate change, poverty, social rights and other topics that are highlighted in the SDGs.

The 17 specific goals, that have been identified, have given a name, a field and a global call for action for many projects and field of work that have started to be currently pursued and worked on.

The trends had until now keep bringing economic growth on one hand but on the other hand the expenses are burdening the environment health and less strong social classes. Thus the need to find a way to change the trend and direct this growth towards a sustainable development.

In the Report of the World Commission on Environmental and Development “*Our Common Future*” written by the Brundtland Commission it is extensively explored about what sustainable development is and what wants to achieve. The most common definition of sustainable development was formulated in this document, underlining the essential goal of the work that has to be done:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Even though this document was written in 1987 and the achievements it describes were meant to be reached by the year 2000 and beyond, it is still relevant and brings value to the current goals.

“Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of

technological development, and institutional change are made consistent with future as well as present needs. We do not pretend that the process is easy or straightforward. Painful choices have to be made. Thus, in the final analysis, sustainable development must rest on political will.”[1]

Different ways to see sustainability, or the different fields it can be applied to, don’t change the final goal, with the continuous research that has been carried out, it is being pursued in practical ways and with more and more specific aims in order to tackle different issues, especially related to the ones defined in the SDGs.

It started from the necessity to address the stress that was weighting on the environment, after years of industrial growth with a limited long term vision of the consequences that would bring, it then became more and more clear that there couldn’t be a total dichotomy between the environmental aspects, the social ones and also the economical ones as an inevitable consequence of the structure of our society.

“Sustainability should be seen as the central concern of decision making, a broad conceptual framework and set of general values for integrating the full suite of relevant considerations” [2]

Sustainability as a concept has continuously grown and it has become a word more and more present especially in the awareness gained in the last few years. The word has entered every aspect of society and in the work field. Its normalization is demonstrating the fundamental role it has in every aspect of work that is being done in many fields.

## **2.2. SOME SUSTAINABILITY VISIONS**

### **2.2.1. PEZZOLI**

In Pezzoli’s view [3] the approach is done through the identification of ten categories of literature on sustainability or sustainable development, that can be confined in three main clusters:

- Applied perspective with managerial focus;
- Technical perspective (hard sciences of sustainability);
- Philosophical perspective;

### **2.2.2. PEARCE AND TURNER'S THEORY**

Pearce and Turner created a spectrum [4] that is initially divided into:

Technocentric (weak sustainability) and Ecocentric (strong sustainability), then furtherly divided the first into Cornucopian or Accommodating, the latter Communalist or Deep ecology.

- Cornucopian;
- Accommodating;
- Communalist;
- Deep Ecology;

### **2.2.3. THREE PILLAR VIEW OF SUSTAINABILITY**

The more accurate way to conceive the theme of sustainability has been a matter of discussion. A two pillar vision has been discussed [5], taking in consideration the ecological aspects and the human ones, the three pillar view, considering the economical, environmental and social aspects, or perhaps five adding to the previous one also political and cultural issues.

The more common view is the 3 pillar one, which represents the interrelation between the economic sustainability of a system or the market related to the system taken into account, the environmental aspects that are usually the main focus of the issue and that are easier to study, since physical data are more easily quantifiable, and the social aspects.

This type of view has been used and applied at least as a starting point for many sustainability related projects and studies.

Usually data related to this kind of studies are fitting the three pillars structure, making it very easy and convenient even though at the same time they could not bring a big encouragement for innovation. [2].

If more specific aspects of sustainability are explored another conceptualization of it may fit better the purpose of a specific study, nonetheless if the three pillar vision is used effectively, finding the interconnections and influences between the pillars, and not only explore the three topics next to each other, could lead to the proposition of solutions and policies that would help to grow the sustainable condition of the issue taken into account in a well-rounded manner.

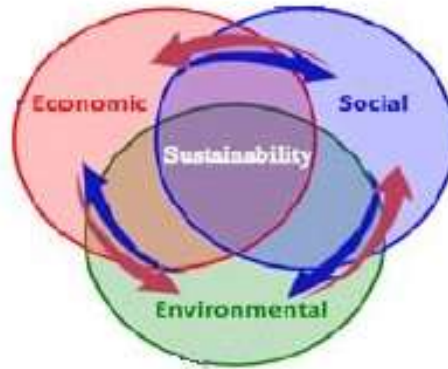


Figure 1- Sustainability pillars

The strategies to be pursued in order to reach sustainability as a whole will not be totally independent from one of the three aspects, but will be intertwined somehow, connecting and collaborating to the pursuit of the same objective from different points of view.

It is important to note that the pursuit of sustainability will not follow a linear path, since the systems that are taken into analysis are dynamic, complex, often hard to be understood. Studying, planning, modelling, analysing are fundamental in order to find the optimal way to seek a solution, since it cannot be framed in one univocally defined set of requirements.

The high number of targets linked to the SDGs shows how the issues that need focus on, are multifaceted and complex. This call for the need for the right tools and a consequent correct use.

The focus of the thesis was especially put on the social aspect of things, a field in constant growth that has a big relevance in the pursuit of sustainability, often overlooked in the engineering field.

### **2.3. SUSTAINABLE DEVELOPMENT**

Since the 1972 UN Conference on the Human Environment the reach of sustainable development governance has expanded considerably at local, national, regional and international levels. The need for the integration of economic development, natural resources management and protection and social equity and inclusion was introduced for the first time by the 1987 Brundtland Report (Our Common Future)

It is very important to distinguish sustainability and sustainable development, since it seems common that the two terms are used interchangeably or as synonyms but they are not, “Sustainability is about *continuity* and development is about *change*.” [6]

It is a term brought to popularity in 1987 by the World Commission on Environment and Development (The Brundtland Commission)[1], as a term it has been debated if it was a contradiction in itself or if it came out of necessity.

In a society based on constant growth, higher and higher production and consequent consumption, it seems necessary the need of a development that has to find a way to be sustainable.

This term gave a name to the direction research and actions had to follow, and has become very popular since.

In working on sustainable development it is fundamental to define the field to focus on, this is often a subjective choice. For instance in the social field the focus can be poverty, inequalities, unhappiness, etc. The issues are numerous but putting the attention on some specific ones is the right approach to define the consequent actions.

## **2.4. SOCIAL SUSTAINABILITY**

A definition of social sustainability or a precise framework of what this entails seems hard to be unequivocally delineate. Compared to the other pillars, the environmental and the economical ones that seem to have an easier, more scientifically clear definition, the social aspect of sustainability, being so connected to human science, seem harder to define in a specific framework.

Even though it is clear that the focus is on individuals, communities and societies they are represented by a very large set of needs and problems that cannot be included in one simple definition.

The main topics that drive the research for social sustainability can be found in the basic human needs: food, housing, water, clothing but can not be stopped there.

Recognition of rights, autonomy, realization of personal potential, participation, justice, gender equality, and more are topics that are inevitably becoming part of the modern debate.

It can be said that “Social sustainability occurs when the formal and informal processes; systems; structures; and relationships actively support the capacity of current and future generations to create healthy and liveable communities.”[7]

The Western Australian Council of Social Services (WACOSS) in 2000 has developed a model of Social Sustainability, that is divided in 4 parts:

- 1) definition of social sustainability;
- 2) principles of social sustainability;
- 3) characteristics of socially sustainable communities;
- 4) statements addressing the characteristics of socially sustainable communities.

This model is based on five main principles:

- Equity
- Diversity
- Interconnectedness
- Quality of life
- Democracy and governance

Social sustainability, if seen as a condition to be reached, would need to be linked to a process, that would need a series of actions to be followed in order to come towards the ideal condition. These set of actions and the initial research can be further pursued with the help of technical tools that can transform data, into indicators and useful, easily understandable information that can bring to the definition of a framework that would lead to decision making and finally towards the final aim.

It can be seen that the topic, its definition and the pursuit of it is being tackled in many disciplines, moreover because of the importance it has gained with the highlight of its importance within the sustainable development goals. A major importance has been put on the aspects of society that influence everyday life, that as a consequence have an influence on other aspects of sustainability they are correlated to, that would help to reach achievements towards better living conditions, taking into consideration the economic and environmental influences.



## 2.5. SURVIVAL SUSTAINABILITY

In the research linked to the case study, the concept of survival sustainability seems relevant:

“The most basic level of sustainability is survival sustainability. This involves the maintenance of ecological life-support systems, the social capacity to solve major problems and the economic capacity to meet subsistence needs of the population. At this basic level of sustainability all three requirements must be met simultaneously.”[6]

As the basic level of sustainability, it doesn't have a major scope but it highlights the need for a base level of sustenance, always taking in consideration the 3 pillars, but with a particular focus on the problem at hand and the stakeholders involved. The focus of the concern must be identified, to go more in depth and understand what is it that the people, or more specifically the stakeholders, want to sustain and to be able to work towards the ideal condition that will meet the objectives of sustainability. [6]

To be pragmatic it will be taken in consideration to integrate ecological, social and economic issues but also it is important to define if we're talking about local or global sustainability, to understand the path of action and the tools that would better work.

Table 1 – Aspects of survival sustainability [6]

<b>Ecological</b>	<b>Social</b>	<b>Economic</b>	
<b>Survival sustainability</b>			<b>Global</b>
<b>Protection of life support systems</b>	<b>Capacity to solve serious problems</b>	<b>Subsistence</b>	↕
<b>Prevention of species extinction</b>			<b>Local</b>
<b>Maintaining quality of life</b>			<b>Global</b>
<b>Maintenance of decent environmental quality</b>	<b>Maintenance of decent social quality (eg. vibrant community life)</b>	<b>Maintenance of decent standard of living</b>	↕
			<b>Local</b>
<b>Improving quality of life</b>			<b>Global</b>
<b>Improving environmental quality</b>	<b>Improving social quality</b>	<b>Improving standard of living</b>	↕
			<b>Local</b>

## **2.6. SOCIAL AND SUSTAINABILITY ASSESSMENT**

Social issues are complex and hard to define, studying them will inevitably bring to a simplification of the issue and a tool to study them is a Social Assessment.

A Social Assessment (SA) is a process which provides an integrated and participatory framework for prioritizing, gathering, analysing, and using operationally relevant social information. [8]

A SA can be carried out as part of a bigger project, what we want to do are:

Identify a statement as the goal of the assessment.

Identify the stakeholders: it is important to identify the subjects that are influenced by the process or events taken into study, that will be linked to the aim and focus of the assessment.

The objective of the study has to bring no harm to the people involved.

If adverse impacts are identified, there should be a suggestion on how these can be minimized, avoided or overcome.

Identifying the specific problematic to study can be difficult, as a decision is being taken it may happen that the path of the assessment changes, either the focus or the final aim, or a development related to issues that weren't initially expected. It has been taken into account that this is a possibility meanwhile the study is being carried out.

Various methods and tools are used to lay the foundations and then carry on with the social assessment like surveys, interviews, direct observations, qualitative methods.

Data needs to be gathered and elaborated in a way that is relevant and can be easily analysed and interpreted.

Data interpretation can help to define the main problematic topics and eventually form a plan of action in order to find solutions or a way to ease the issue initially found.

Along with the social assessment, taking into consideration other concepts linked to the other pillars of sustainability would bring to define a sustainability assessment. It is an multisubject work that entails the recognition of the interconnections between different fields, pursuing positive comprehensive gains even when trade-offs are unavoidable. The requirements have to be in sight at all times and always seeking the best approach, design and options.[2]

Sustainability requirements as criteria defined by Gibson et al.[2] to be taken in consideration while carrying out an assessment that has as a final general aim the sustainability of the system studied.

- Socio-ecological system integrity;
- Livelihood sufficiency and opportunity;
- Intragenerational equity;
- Intergenerational equity;
- Resource maintenance and efficiency;
- Socio-ecological civility and democratic governance;
- Precaution and adaptation;
- Immediate and long-term integration;

## **2.7. TOOLS FOR SUSTAINABILITY**

### **2.7.1. LIFE CYCLE THINKING**

In order to have an effective and realistic evaluation of the impact of a product in every aspect of its life cycle, it is necessary to take on an approach that would give a holistic view on the effects and impacts that are caused by the entire life-cycle of a good or service. That is why a life cycle thinking proves to be very useful, if not necessary, nowadays to get to a concrete evaluation between different options, in order to evaluate the better one while comparing them from the point of view of a lower impact on the environment for example, or if fits sustainability efforts and goals towards an improvement of the life-cycle itself. This approach also enables a long term view, that remains useful when dealing with problem solving issues.

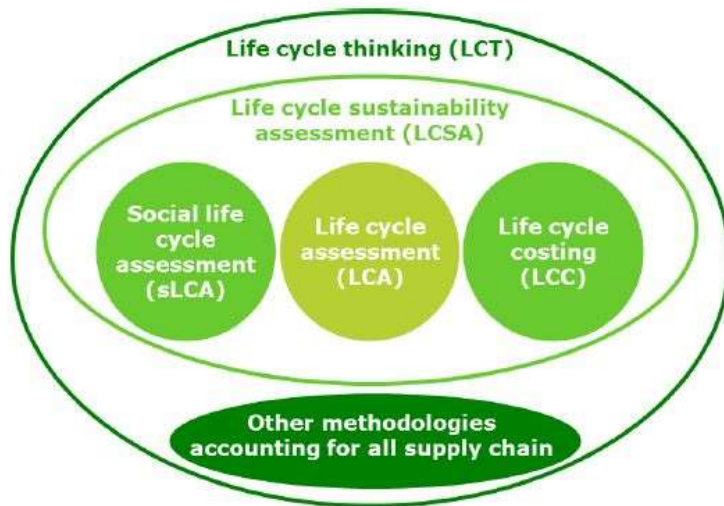


Figure 2 - Life Cycle Thinking structure

This is done through the insights that an LCA study provides thanks to the elaboration of data available.

Thanks to this type of thinking and this type of analysis it is possible to look at a product, process or service in a 360 way that can help to discover that sometimes it is an unexpected part of a process the one that causes an higher impact either in CO<sub>2</sub> emissions, water consumption, human toxicity, or influences social aspects, instead of focusing only on one aspect as can be for example greenhouse gas emissions without taking into considerations other impacts that affect our environment.

The LCT is important for big or small companies, States, local communities, etc., because it helps to make decisions between different processes, approaches or in a matter of energy savings, waste management, etc...

Other than the environmental impact it is also possible studying the social and economical impact thanks to tools like Social LCA and LCC.

A LCT takes into consideration a whole vision regarding the impact that goods and services can have

But the tools need to be developed and used in a defined, practical, way. It is fundamental also the availability of data that are up to date and have a certain level of quality. This is way the work put on database is of extreme importance.

#### **2.7.1.1. Life Cycle Assessment**

A Life Cycle Assessment is defined as “A systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle.”[9]

LCA is a standardised procedure (ISO 14040, ISO 2006a) [9], thus defined in an objective way, that makes it possible to evaluate the impacts of goods, services, chain ---, throughout their whole life cycle. This evaluation is possible with an integrated impact assessment that takes in consideration every step of the life cycle and through the use of well defined methods and the definition of categories, more precisely called impact-categories, that are affected by the analysed product. The quantification of impacts is then possible and the results are obtained as indicators values.

Depending on the method chosen the indicators values can be evaluated on different levels of specificity. This is related to the expert that is going to analyse the results.

An LCA study is well defined in its procedure:

-Goal and scope : the first step is to define the main aim of the study that will be brought on, moreover than the aim it is important to know what kind of audience is the study directed to and adjust to their specific need and level of understanding. In this first phase all the methodological choices are made: it is chosen the FU, the system boundaries, allocation procedures, impact categories, type of models, etc.

-Inventory analysis: in this phase big importance is given to the data required, data are collected and inputs and outputs, as energy, materials, products, waste, are studied and evaluated if they fit to the study. It can be an iterative process, in which the system becomes more and more clear.

-LCIA: in this step the process from data goes to impact categories and indicators, it is chosen the type of model used and the categories that best fit the scope of the study. These will give out results that have been evaluated as characterization factors, that make possible the comparison and final evaluation of an impact.

-Interpretation: the final phase consists of the interpretation of the results obtained in compliance with the scope and goal defined in the first phase.

#### **2.7.1.2. Life Cycle Costing**

Part of the LCT is the evaluation of costs related to the life cycle of the good or service took into study, this is done with the LCC since it is of fundamental importance to have an economic evaluation of the object of the study since it is part of what influences the decision making.

LCC is strongly linked to the E-LCA, because they both follow a material flow, but can sometimes be not very accurate if it falls into double counting. Still is a useful tool that can give interesting evaluations as long as boundaries are well defined and the study is checked with accuracy.

#### **2.7.1.3. Social LCA**

Also part of the LCT is the Social LCA.

It results of utter importance to take into consideration other than environmental and economical impact of a product, also the social and socio-economic aspects and impacts that all the phases of a life cycle can externalize. As it can have a positive or negative impact that has to be taken into consideration as well.

SLCA it is complementary to the “classic” E-LCA, and even though it isn’t standardised as the LCA, it has well defined guidelines provided by the documents written by UNEP/SETAC Life Cycle Initiative:

“Guidelines for social life cycle assessment products” (2009) [10] and

“The Methodological Sheets for Subcategories in Social Life Cycle Assessment” (2013). [11]

These documents provide the key elements that makes it possible to elaborate a SLCA study.

An important example of the application of the UNEP/SETAC guidelines is the “LCA of an Ecolabel Notebook” study by Ciroth et Franze, a comprehensive example of the way SLCA should be brought on following the before-mentioned guidelines.[12]

Even though S-LCA follows the same steps as an E-LCA it is noted in the methodological sheets how the impact assessment is more complex because of the limited information around the cause-effect in chain models that would make it feasible to aggregate results in a univocal manner.

The main difference is the focus of the two methodologies, while E-LCA focuses on the environmental impacts, hence focuses on physical quantities the S-LCA has its focus on social aspects and on quantities that are often hard to be quantified in the same way as it is possible for physical data.

The main distinction in the type of data used for S-LCA is that they are country related or site specific, it is of course preferred when site specific data are available but more often the country specific data are the only one available.

It is important to use this tool in an ethical way as the “Guidelines for social life cycle assessment products” tell us:

“In theory, S-LCA may be conducted on any products, even those that are knowingly harmful to society (e.g. weapons). It is recommended to use S-LCA ethically and it is assumed that peer review will prevent using the methodology inappropriately. Socially responsible investing firms often provide lists of product categories being excluded for ethical reasons. If the product category studied is listed, it is recommended to detail, in the goal and scope phase of the study, the reason why it is ethical and reasonable to conduct a S-LCA of this particular product. Documentation of the product utility and assessment of the use phase of the life cycle will also generally reflect the unethical or harmful nature of the product.”[10]

S-LCA is a tool, it is not an univocal way to decide if a product should be produced or not, but the aim is to provide further insight on a specific problem and eventually a discussion that brings to solutions or improvements.

The contentment and prosperity of the stakeholder is always the final goal, also in a prospective of sustainability and sustainable development.

The S-LCA methodology follows the one of the E-LCA.

The framework is the same regarding the main phases:

- Goal and scope;
- LCIA;
- Impact assessment;
- Interpretation;

Even though they come with the same framework there are differences highlighted in the Guidelines, the main ones are for S-LCA:

There's a high importance on the stakeholders role in a S-LCA study, they are encouraged to be involved in providing inputs on the impacts.

When a subcategory is not included this need a justification.

It may be required to have site-specific LCIA, correlated with information about the political framework of a country that is involved in the assessment.

Activity variables are a fundamental part of SLCA.

The data sources and data collection methods may vary and can be subjective.

Characterization models are different and often thresholds are effectively used for evaluation.

In the impact assessment phase there can be both positive or negative impacts.

The compiling of both types of LCAs is ideal as they provide complementary information and would give a complete and well-rounded vision of the problem addressed.

While this is a matter on which there is no total agreement on, what is proposed by the methodological sheets, and what has become common procedure, is the use of the activity variable "worker hours".

Continuous work is being brought on to find an activity variable that would better represent the social impacts, that can't be related to worker hours.

The PSILCA database was created specifically to assess the social impacts of products along their lifecycle. [13]

The implementation of data and indicators in the database goes through a thorough procedure, data transparency and quality assessment are essential. The aim is to cover the entire world economy. [13]



### **3. THE GERMAN DEPOSIT SYSTEM**

With the aim to assess the sustainability of the German Deposit Return Scheme, it is here presented the way it was born and implemented. Going ahead in the analysis of the way it works, the environmental aspects have been highlighted but the focus has been mostly put on the social aspects. Aspects that have been observed and have become the main object of research, due to their importance and influence on everyday life and society. Thus, the goal to analyse social sustainability has become a priority.

#### **3.1. BIRTH AND IMPLEMENTATION**

The deposit system or Deposit Return Scheme (DRS) is a system implemented in order to collect containers back from the consumers, either to be reused or recycled.

With the addition of a deposit applied to the price paid for the goods in the store, that is given back when the empty bottles or cans are returned, the system has established itself and is now been part of the habits of German society for many years.

It is important to note that previously to the introduction of the system well defined by legislation there was a voluntary system operating in Germany, this has made it easier to introduce this scheme since it was already part of the “culture” of the country.

It was introduced in 2003 and initially there was a 9 months period of transition, in which the shops could only accept the containers that they sold themselves, customers had to present a receipt, a voucher or a stamp. This kind of solution was not appreciated by customers that didn't really participate as expected.

After the initial time of adjustment to the new system, since May 1st 2006 it came into force the “third ordinance to amend the packaging ordinance”. Before this ordinance the stores would only take back and give the deposit for the containers that they sold exclusively. But after May 1st 2006 the new regulations stated that the containers could be taken back to every location.

Especially all shops with at least 200 m<sup>2</sup> of retail space would have to accept all the empty disposable bottles, as long as they are made of a material that is sold in that shop.[14]

Furthermore since May 1, 2006, all packaging for beer , mixed beer beverages , mineral and table waters, soft drinks in cans and disposable bottles (PET and glass) are subject to a deposit.

The “*pfand*” system in Germany covers different containers, materials are plastic, glass, aluminium. Not all glass or PET bottles are implemented into the deposit system but only the ones containing beer, soft drinks, mixed alcoholic drinks, but not wine for example. Since January 1st 2019 the deposit has been extended to other types of beverages.[15]

In order for the system to be well implemented and regulated the DPG (Deutsche Pfandsystem GmbH) was established in 2005, as an initiative of the German trade sector and the drink industry.

This is the organization that provides the legal framework that regulates and organizes everything that surrounds the deposit system and the companies that are involved in this.

The DPG has set the regulation for a unified labelling system, that allows the automatic of the drink containers with deposit. [14]

### **3.2. LEGAL REGULATIONS**

- At the European level packaging is governed by Directive 94/62/EC of the European Parliament and the Council of 20th December 1994 on Packagings and Packaging Waste, last amended by Directive 2005/20/EC of the European Parliament and the Council of 9th March 2005. The directive is aimed at harmonizing the various measures on packaging and packaging waste adopted in the member countries. In this way the effects of this waste on the environment were to be avoided or reduced while on the other hand the function of the single market was to be guaranteed.[16]
- In Germany this European directive was implemented via the Ordinance on the Avoidance and Recovery of Packaging Wastes (Packaging Ordinance - "VerpackV") of 21st August 1998, last amended by the Fifth Amending Ordinance of 2nd April 2008 (federal law gazette, BGBl. I, p. 531). As a means of the reduction of the effects of waste packaging on the environment, the legislator gives recycling targets in the Packaging Ordinance and adopts regulations on the organization of the collection of waste

packaging material. The decisive regulation in the Packaging Ordinance for the compulsory deposit on one-way drinks packaging is section § 9 of VerpackV.[17]

All enterprises or organisations that are involved in the deposit system procedures have to sign a contract with the DPG to be authorised to take part in the management of the German deposit and return system. In order to avoid fraud every beverage container that is being sold in Germany must carry a security mark that must be printed on the label itself, or on the container (for the aluminium ones) or on special labels including bar code and the security mark.

There are two main ways in which the deposit is given back:

- Either the consumer brings back the containers to the cashier that counts them and gives the right amount of deposit, then these containers are sent to a central counting centre, usually operated by an independent enterprise. Here are identified the number, origins, they are sorted by a high-speed counting machine and the total refund is paid to the supermarket which forwarded the containers.
- The other way is through the Reverse Vending Machines (RVM), that give back a voucher with the calculated deposit that is then given back to the cashier to obtain the deposit back.

The bottles collected by the RVM are then sent again to a central counting centre, if there is no compactor in the machines, but if there is a compactor in the RVM there is no “inter-clearing-process”.

The main distinction to be done in the system is between the different type of bottles with deposit:

- Einwegpfand:

These are the one-use bottles.

They are usually the PET bottles, that are recycled. The deposit on these is higher, 25 cents.

- Mehrwegpfand:

These are the multiple-use bottles. The deposit value is between 8 and 15 cents. These types of containers, usually glass, can be cleaned and reused. Since they can be filled up to 20-50 times.

Table 2 - Deposit values on different containers [18]

bottle	deposit
Reusable glass beer bottle (all sizes)	8 cents
Reusable beer bottle with swing top	15 cents
Reusable mineral water bottle (glass or PET)	15 cents *
Reusable bottles for juice or soft drinks	15 cents
some 1.0 liter wine bottles	2 or 3 cents
all disposable bottles and cans	25 cents

\* In exceptional cases also 25 cents

- **Multiple-use (*Mehrweg*) bottles: 8 to 15 cents**



- **Single-use (*Einweg*) bottles: 25 cents**



Figure 3 - Labels on containers with deposit [19]

The difference in price was set with two different objectives, the lower price on the refillable bottles are meant to encourage the purchase of this type of container. At the same time the higher deposit price on the PET bottles it is meant to be a downside to buy this type of packaging

but at the same time a way to make people more eager to bring it back to collect the deposit, in order to avoid the dispersion of this harmful material in the environment.

### **3.3. THE DEPOSIT SLIP**

It was calculated that 450 million euro of deposit were not collected back. The so called “deposit slip”. This money is in the retailers hand, but they cannot register them as a profit [20]

The manufacturers keep the deposit on any unreturned containers, the “deposit slip” is a matter of discussion. It lays in a grey area since it cannot be considered as profit, so it doesn't undergo any taxation, but it is the manufacturers' possession.

### **3.4. STATISTICS**

#### **3.4.1. GLASS RECYCLING**

It can be seen in this graph from 2015 that between the EU countries in which is active a DRS, Germany is the best performing with a recycling rate of 85.5% (2016) for glass packaging.[21]

But considering that the DRS in Germany includes only bottles for beer, water and soft drinks, this accounts only for 4.6% (in 2015) [22] of the total glass packaging circulating in Germany, but it is important to underline that the quality of the material recycled this way is higher.

## PERCENTAGE OF GLASS BEING RECYCLED THROUGH THE DIFERENT COLLECTION SYSTEMS IN GERMANY, FROM 2010-2015

THE HIGH RECYCLING RATES IN GERMANY ARE ACHIEVED THROUGH THE BOTTLE BANK SYSTEM

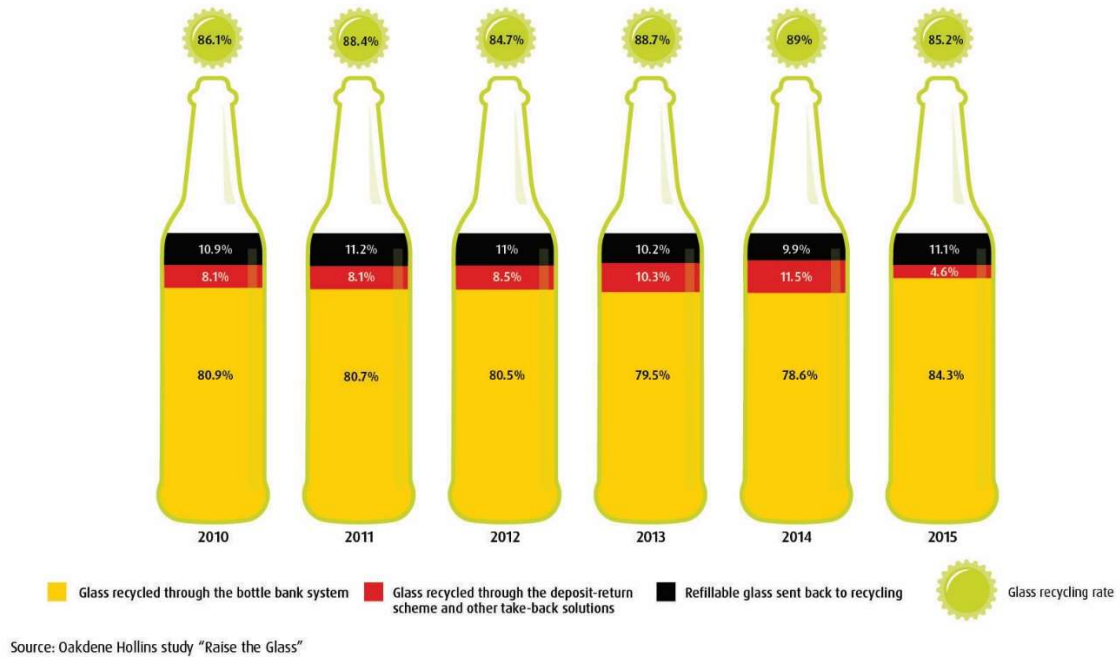
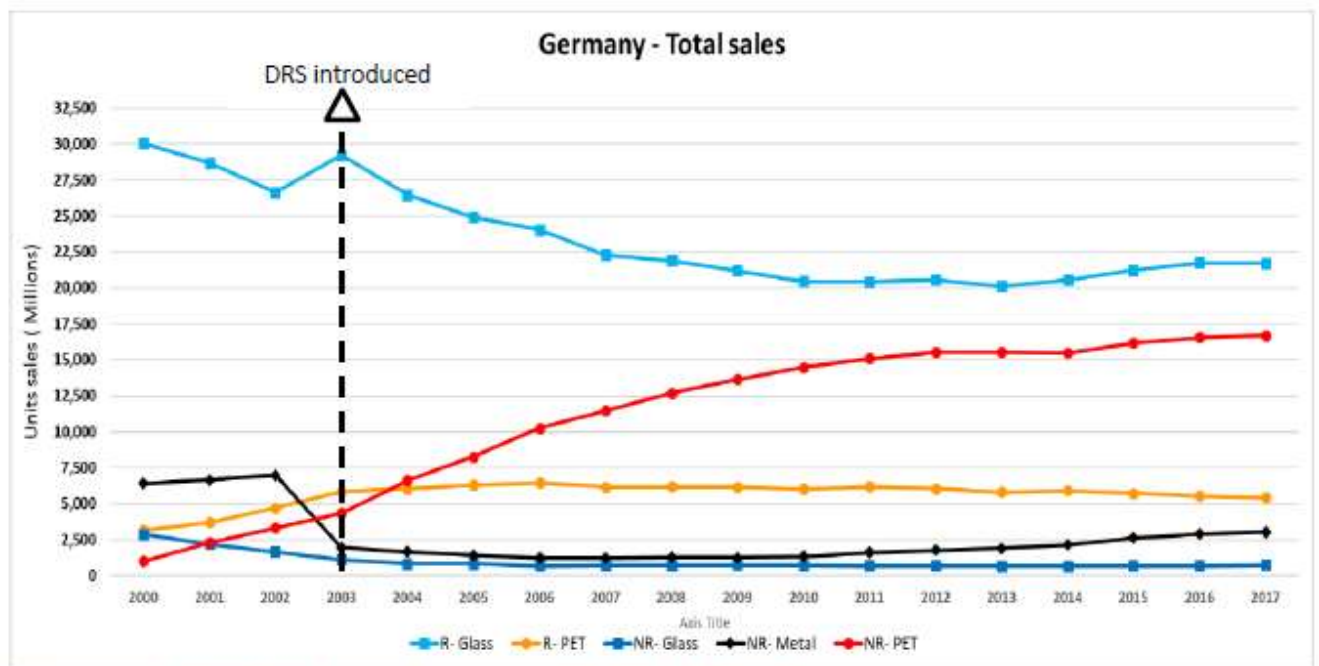


Figure 4 - Glass recycling percentages

The rest is collected through the Extended Producer Responsibility (EPR), that is a system that works very well.

Even though the target of recycling were met and overcome (EU target value was 75% [23]), the quota was not reached for the refillable bottles. That is why the mandatory deposit system was introduced in 2003.

But what was noticed is that the introduction of the deposit system has brought to a steady decline of the purchase of reusable glass bottles and has highlighted an increase of purchase the one-use PET bottle, as can be seen in Fig. 5.



Source: Produced by Oakdene Hollins using data from GlobalData

Figure 5 - Deposit containers sales

“This would appear to confirm that the purpose of the deposit scheme on one-way glass containers is to protect the share of the beverage container market in refillables rather than to meet the overall PPWD targets for glass recycling.” [22]

### 3.4.2. GLASS REUSE

In Germany it is possible to find shared, nationwide functioning reusable pools, associations and cooperatives of the various beverage categories that ensure that usage regulations are observed. For example, there are agreement on the quality so that there is a compliant number of new bottles that enter the cycle and old ones are sorted out.

In this way, reusable glass bottles can be refilled more than 50 times and reusable PET bottles up to 25 times. In the case of mineral water alone, that was over 5.5 billion litres in 2017.[18]

“It should be noted that the ecological balance sheet values of both reusable and disposable bottles have improved - but reusable is still providing better results in environmental and climate protection studies.” [18]

An unexpected benefit that can be linked to the relationship between the pillars of sustainability is something that was noted in the study "Reusable and recycling systems for selected beverage packaging from a sustainability perspective" by the auditing firm PricewaterhouseCoopers (PwC) for the Deutsche Umwelthilfe (DUH), the non for profit environmental and consumer protection association that is part of the European Environmental Bureau, is that the use of reusable packaging not only has positive ecological effects but also positive employment effects, because despite economic advantages, more jobs have been created for operating the take-back systems are needed. [24]

A deposit system that includes glass is not used everywhere in the EU countries that have a DRS but Germany has a tradition and a habit of "bringing back bottles". This tradition has made it easier to implement this kind of system and ensure that it would have worked well, establishing itself in the daily habits of the population. Even though glass is 100% recyclable without limit, it is shown that washing and reusing bottles has a lower impact than melting and producing new bottles. [25]

That said, the savings of new raw resources is always welcome, but it has to be taken into account that the transportation of the refillable bottles and other aspects. There are two main types of refillable bottles.

There are the bottles that have all been made in the same shape, in order to be used by different companies without distinction, this can lead to the bringing back of the empty containers evaluating the most convenient route from an economic and environmental point of view. Then there are bottles specifically designed by certain companies, usually craft beer companies, that want to show their brand not only with the label but also on the glass for marketing reasons. This second type of bottles have to travel all they way from the production site to the selling point and then has to come back to the specific production site. This transportation, considering the weight of the bottles when they are full and when they are empty, has to be taken into account when evaluating the impact that this type of bottle has. Making it harder to state that the refillable bottles are always better.



### 3.4.3. PLASTIC RECYCLING AND REUSE

The PET bottles, that are usually *Einweg* (single use) come with a 25 cent deposit. The higher deposit is a way to discourage the purchase of a one-use container on one hand, but an encouragement to collect everything that could be harmful to be dispersed in the environment on the other hand, so to bring the littering to be as low as possible. The return rate of the PET bottles collected with the deposit system is really high, more than 95% [28]. This makes it able to have a better recycling procedure, since the bottles collected this way are usually clean and in good condition.

Something that has to be taken into account is the percentage of recycled PET used to produce new containers that is 34%.[26]

As noticed before, the system might work well but it has seen a trend of increase in the purchase of this type of container.

There are also plastic containers that are *Mehrweg* (multi-use), that come with a lower deposit on it. That after the maximum amount of time they can be reused would eventually be recycled.

The percentage of reused PET bottles is around 26%, in 2015. [27]



Figure 6 - PET recycling outcomes

It is important to notice that it is not always possible to say with absolute certainty which kind of container, if one-way or reusable, has a lower impact on the environment since taking into account the whole life-cycle of the product shows that there are many factors that influence the impacts.

An LCA study of WRAP [28] shows how an absolute answer is not possible to give since there are many factors to be taken into consideration.

The study found that the products are influenced by many factors:

- Raw materials and energy used in manufacture;
- Trip rates for reusables;
- Transportation distances;
- Pool size for reusable;
- Vehicle utilisation;
- Recycled content and post-consumer recycling;

If a case specific study is carried out with enough data and precise goal, a more definite evaluation can be reached, but it would be valid for that specific case only, it may be used as an example for a similar situation but the specificity of the conditions highlighted before can always change the results of a study.

The claim that “reusable is always better” has to be related to specific cases and with results in hand.

Another example of an evaluation between different types of containers can be found in the IFEU LCA study commissioned by Genossenschaft Deutscher Brunnen, “Ökobilanz, vorsprung für mehrweg”. [29]

The report shows how the refillable PET bottle results ecologically superior to the disposable PET bottle in almost all categories. The comparison between the 0.7 l returnable glass bottle with the 1.0 l PET recycling bottle, shows that the returnable glass bottle was found in four of the seven impact categories considered for the study, in an advantaged position compared to the PET bottle.

In three categories the returnable glass bottle doesn’t show a better performance compared with the PET bottle.

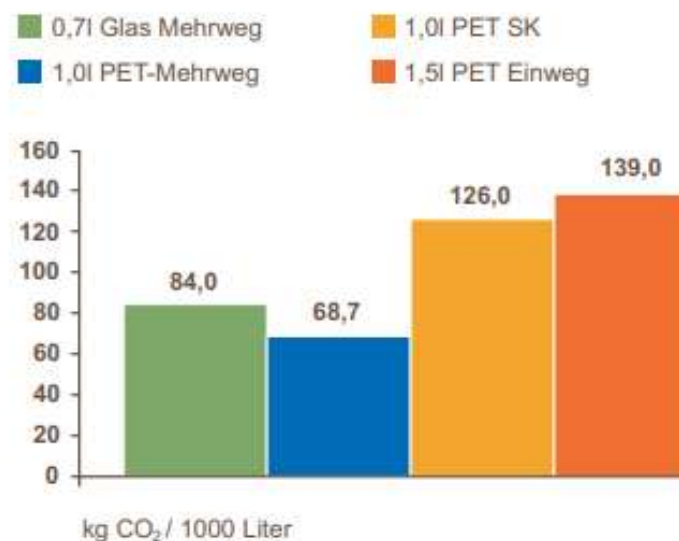


Figure 7 - Containers outputs

The poor performance of the disposable PET bottle is due to two factors. Firstly, this type of packaging consumes considerably more raw materials because it is only used once. The kilometres covered for transportation are always an important factor that is taken into account.

The advantages of reusable bottles are also not offset by other effects, such as the energy and water consumption for cleaning.

The study found that the ecologically most favourable packaging system overall is the 1.0-litre PET returnable bottle. The returnable glass bottle has been found ecologically inferior to the returnable PET bottle.

The associated environmental impacts are higher overall than when using returnable bottles, whether they are made of glass or PET.

The advantage of glass and PET reusable bottles in the category “Greenhouse effect” is important to highlight. This impact category is defined by the Federal Environment Agency as the most important factor. Since the reduction of climate-damaging gases is one of the outstanding objectives of environmental policy in Germany and at the international level, the present life cycle assessment also contains an important message from a political point of view. [29]

### **3.5. AFTERMATH OF THE DEPOSIT SYSTEM**

The deposit system has everybody contributing to it. Inside households people collect the empty bottles and take them back regularly to the RVM found in supermarkets, so they get a voucher that can be used when doing grocery shopping, to have the deposit sum discounted from the purchased goods. This is the normal scenario of a well working system, but what happens in bigger cities especially is that a series of events have generated a phenomenon, that involves the whole city.

### 3.6. INITIATIVES

#### 3.6.1. PFAND GEHÖRT DANEKEN (DEPOSIT BELONGS NEXT TO IT) [30]



Figure 8 - Campaign Label

This is an initiative that promotes the action of leaving the bottles close to the bin. Since it is common for people to drink from a bottle while walking in the city, this initiative invites everybody to not throw a bottle with deposit associated with it inside the bin, since it is a fact that people that collect bottles will look for these deposit bottles and throwing them inside the bin would make the activity more complicated and dangerous, since the bins could contain broken glass or something similarly sharp that could hurt these people. It is actually very common to see these people wearing gloves when looking for

deposit containers inside bins.

This campaign is very successful and famous, it has numerous partners, from Fritz-kola ®, the most notorious soft drink company in Germany, to various well-known breweries.

#### 3.6.2. PFANDGEBEN (GIVE THE DEPOSIT) [31]



Figure 9 - Project label

Pfandgeben was born almost by accident, and then brought ahead as a school project. It sprung from a social necessity and acts of solidarity, from people that have a big number of deposit bottles that don't want to take back to the RVMs machines or to a place where deposit can be collected to people that are in need, to whom a big number of deposit bottle can change their

daily condition. Through a system of advertisement posting, this platform is connecting people that want to donate deposit bottles to the people that want to take them to collect the deposit.

### 3.6.3. SPENDE DEIN PFAND (DONATE YOUR DEPOSIT) [32]



Figure 10 - Campaign label

It is an initiative born in 2014 from a group of students. The simple idea was to donate the deposit bonded to the bottles bought. This project was initially related to schools and then moved to many different public spaces and companies, for example airports, with the idea that educational institutions and companies become activists for a better world. The money collected from the deposit applied to the bottles donated is then used towards charities or projects that promotes sustainability.

## 4. CASE STUDY IN BERLIN

The deposit scheme has a tradition in Germany, even before it has been established as an official system, the first standard bottle for mineral water was introduced in 1969 [24], there are then several standard glass bottles for beer packaging. This tradition has made it possible for the introduction of the system to be well accepted by the population and, apart for the initial adjustment period, flourish in the way it works. Inside households it is a common habit to collect the empty bottles and containers, keeping them until the next trip to the supermarket where the RVM can be found, the deposit can be collected and used as part of the payment for the shopping or simply taken back.

Apart from this normal habit there is another habit easily observable in Berlin: drinking beer in the street while going somewhere (slang term for this: Fußpils). Usually it is not worth it for the average person that drinks in the street to take the empty container home, either because the inconvenience weights more than the few cents that would be collected from the deposit, what happens as a consequence is that the bottle will be left at a sidewalk corner, on a bench, next to a bin, sometimes on the train floor.

This is because it is common knowledge between the “bottle dissipators” that the bottle won’t stay long in the spot, there are people collecting them. These people, referred as “people collecting bottles” have a German term to be identified: *pfandsammler*.

This is because leaving a bottle with *pfand* (deposit) on the street literally means leaving money on the street, the current value of the deposit doesn’t have a huge influence on the average consumer life condition but there are people whose condition is highly influenced by the collection of said deposit, thus bottles left in the street or even inside bins are going to be taken to collect the deposit when returned.

The deposit system doesn’t work only for beer, but also for water and many non-alcoholic drinks that are bottled in glass bottles, PET bottles and cans, that are distinguished in multi-use or single use.

These habits are normalized and have regulated themselves, it is common and totally normalized to see people collecting bottles in the street, many people see this as a gesture of

solidarity towards the people that struggle to make ends meet and are earning some kind of income this way.

As a directly observable consequence this is making the city appear cleaner and less people seem to have to beg for money, everything while alimentering a system that is seen as very modern and environmentally friendly. This goes hand in hand with a phenomenon that is not regulated by state law but has become nonetheless part of daily life and the general economy.

As it has become an important part of the city, it is the intention of the thesis to analyse the social impact of a system that is part of a modern country and an advanced economy. It was underlined before that part of the study on sustainability has to have an attention for the social aspects, the focus would be put on the assessment of the social effects of this system, along with an attention to the environmental and economic ones.

## **4.1. MODELLING THE CASE STUDY**

### **4.1.1. GENERAL**

The system taken into study presents very dynamic characteristics, mostly unregulated. Even though it comes from a regulated scheme, the deposit return scheme, the human behaviour resulting from it has developed a design of events that need to be assessed in order to be well framed. It doesn't come in an organised structure, but it is now a phenomenon socially accepted, ingrained in society, that has taken shape by itself and has somehow autoregulated itself. The Causal Loop Diagram (CLD) is the right tool to represent this system, in order to have a qualitative, synthesized, graphic visualisation of a set of complex occurrences.

Hence the CLD method was adopted to represent the phenomenon resulting from the implementation of the pfand system, and the collection of bottles subsequent to it.

To determine the starting point of the CLD assumptions were made and boundaries were set, the diagram was defined in order to focus on the stakeholders, the bottle collectors (*pfandasammler*).



Without boundaries the diagram could expand further, finding more causes and effects linked to the main variables. The diagram could be linked to raw materials, water and energy sources, going until disposal of materials, and further on.

To put a focus on the main problem inspected it was decided to define boundaries to the deposit scheme, the general littering, the impression of the public, and limited to economical issues related to the job search.

The bottle production wasn't further explored than the link to the consumption of the beverages that can find their connections to other economical and social issues.

Since it was already explained how the figure of the *pfandsammler* has come to a definition from the deposit scheme that was implemented in Germany.

#### **4.1.2. CAUSAL LOOP DIAGRAM:**

A Causal Loop Diagram is one of the tools used in this project.

Causal Loop Diagram (CLD) is used, which is a comprehensive thinking tool.[33]

This is a tool that provides a qualitative method through which a complex phenomenon can be represented in order to be more easily understood and further analysed. More specifically it makes it possible to see the structure of a dynamic and connected system.

We manage to represent the causal relationship between the variables that are of interest to us. By stringing together several loops, we can create a coherent story about a particular problem or issue.[34]

It is also important to note that the CLD created by the author reflects their perspective and it is linked to their subjective view.

##### **4.1.2.1. How it works**

Every loop has its base in the variables that are chosen to be represented, the variables are then linked with arrows that have either a plus sign (+) or a minus sign (-) on them, in order to explain the relationship between the variables.

The arrow with a positive sign represents the growth of the two variables in the same direction, if one variable is increasing it causes an increase in the following one.

While the arrow with a minus sign represents a growth in the opposite direction, if the first variable sees an increase the one connected to it will see a decrease.

The signs will determine the construction of either reinforcing loops or balancing loops that will form the structure of the whole CLD.

If there is a loop with an odd number of minus signs this will be a balancing loop:

it is a loop that doesn't bring change and represents a situation that is influencing itself in being static. We could say that the final assumption is in contrast with the initial one when going around the loop. Finding this kind of loop and analysing it could bring to identify the reason why a situation is not improving and eventually proposing a solution or a new variable that could change things, hopefully toward a better condition.

If there is an even number of minus signs we would be in the presence of a reinforcing loop:

In this case the final assumption is the same as the initial one after going through the loop. This kind of loop represents a situation in which variables are enabling a specific situation, representing an increase or decrease in one direction. It produces growth or decline and could eventually bring to a collapse when overcomes a certain threshold. This is helpful to identify a critical situation. [35]

The main variables were chosen with the aim to study a specific issue, the others connected to the "main ones" were identified with a cause-effect relationship and then connected with the arrows.

### **4.1.3. OPERATIONAL**

The starting point of the diagram has been found defining "People Collecting Bottles" as the main variable.

The diagram has been defined thanks to the subjective view of the author, with support and revision of a supervisor.

Starting from the main variable, the final structure was reached first by establishing other variables linked through cause-effect relationships. Second by defining the links, represented

by arrows that show a growth in the same or opposite direction of the variables connected two by two.

When all the variables were connected and the complete CLD was formed, it was furtherly analysed for the loops to be identified.

The comprehensive Causal Loop Diagram that shows the modelling of the phenomenon is observable in Fig. 11.



The first aim of the definition of the Causal Loop Diagram was to have an overall vision of the phenomenon that could give a clearer vision of the variables and how they influence each other. The following aim was to identify how the three pillars of sustainability can be found in this phenomenon and how it is possible to study it through this framework. Demonstrating how the pillars are connected and intertwined in a phenomenon that is not far away from everyday life situations.

## **4.2. ELEMENTS OF THE CAUSAL LOOP DIAGRAM:**

Main variables

People Collecting Bottles: representing the figure of “*pfandsammler*”;

People with low income/Homeless people: they are the stakeholders whose social conditions are studied, considering them as the main people affected by the system studied;

People dissipating bottles: fundamental element of the phenomenon. Without people dissipating bottles, there wouldn't be bottles to be collected;

Deposit value per bottle: this is an important variable, since this value affects the behavior of the collectors. A higher value will make a container a preferential find compared to the lower value ones, so much so that there are collectors that focus on collecting only the “high value” pfand bottles.

### **4.2.1. SOCIAL ELEMENTS**

Challenging living conditions: Living conditions that make it hard to meet the basic life needs (food, clothing and shelter);

Public opinion: this is referred to the positive opinion that the general public has of the city. This could be an element that affects the way the city is valued and classified, or more specifically this can be related to districts. A district that sees a better public opinion could then be affected by an increase in people moving there, a population increase leads to higher

probability of social interactions and relationship that would bring to higher social trust [36]. It could also lead to an increase in the offer of restaurants and other type of services, also higher rents and so on. This can ultimately affect the stakeholders in different ways.

Good living conditions: living conditions that ensure that the basic life needs like food, clothing and shelter are met (and overcome);

#### **4.2.2. ECONOMIC ELEMENTS**

Job search: it is a fundamental variable in order to change (improve) living condition, that is affected by the time that can be dedicated to it;

Job: having a paid job can lead to a change in lifestyle, like the necessity to collect bottles in order to sustain the basic living needs;

Income: this will affect the ability to accommodate basic life needs;

#### **4.2.3. ENVIRONMENTAL ELEMENTS**

Littering: dispersion of harmful material has a negative impact on the natural environment;

Recycling/Reuse: the containers are either *einweg* or *mehrweg*, this means that if they are brought back to the right facility they will be processed accordingly;

Resources conservation/need: this is an important topic related to environmental protection and survival. Every year the Earth overshoot day, “the day in which the date when humanity’s demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year”[37] falls every year earlier (29th of July in 2019).

It is an issue that has to be taken into consideration in every production process.

Pollution: the introduction of materials or contaminants, resulting from materials or processes, that are harmful to the environment;

Waste: material that can no longer be employed or re-enter the resource flow (recheck)

From the CDL, the goal is to identify and isolate single issues or loops that are specifically related to the 3 issues linked to the pillars of sustainability.

Finding these loops would be ideal to focus on the issue and study it further. Starting from these “smaller” CLD the boundaries can be expanded and thus new effects and causes can be found in order to focus on the issues more in depth.

After research, interviews, surveys, data collection, data processing, it has been possible to identify new problems to focus on, elements that could be added to the CLD, or issues to expand on the more focused CLD.

It is not always possible to find complete loops, but it is effective in finding connections between variables, understanding how influences work.

### 4.3. FOCUS ON CLDS

#### 4.3.1. ENVIRONMENTAL

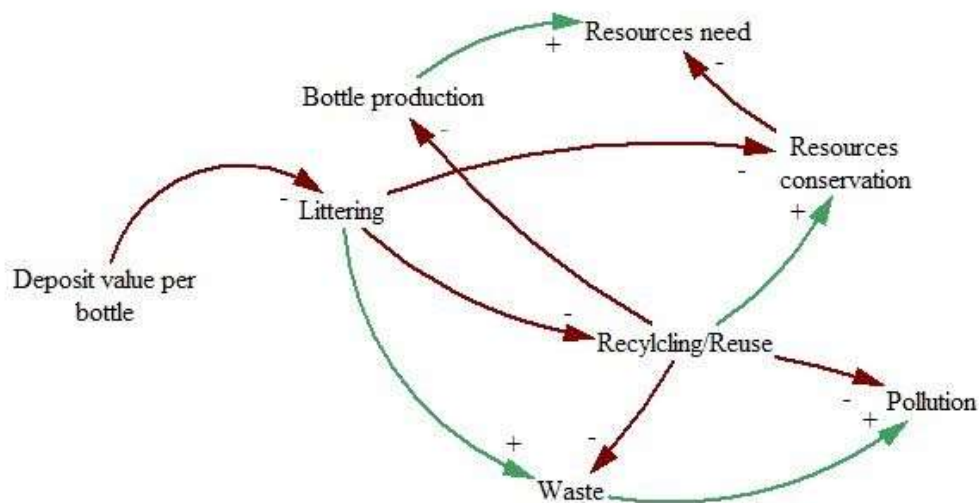


Figure 12 - Causal Loop Diagram of Environmental elements

The focus on this part of the diagram shows the relation between the deposit system implementation, the littering problem thus the resources depletion.

One of the reasons why the higher deposit was put specifically on the PET *Einweg* bottles was to avoid the dispersion of this material, that is considered the most harmful when dispersed in the environment.

It can be seen how other than avoiding the dispersion of this harmful material, it has consequences on the resources' use. Having a preservation of raw resources that have to be extracted in order to produce new containers will reflect positively on the environment. It shouldn't be considered as a final solution to pollution but a good contribution. Nonetheless it has to be discussed how this "solution" takes away the burden of consumerism linked to plastic production. The trends show how the purchase of *einweg* PET bottles has only grown since the introduction of the deposit. [22] The high rates of recycling and deposit collection are not pushing for a change of habits.

#### 4.3.2. ECONOMICAL

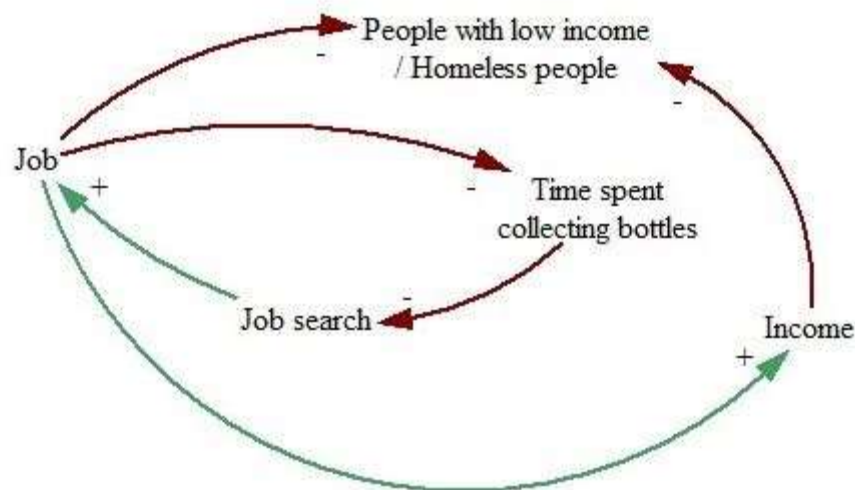


Figure 13 - Causal Loop Diagram of Economical elements

The focus on the economical CLD has a further focus on job related issues, since this is considered the main way to provide for life basic needs, it seems fundamental that final aim, for people that struggle to meet those needs, would be to find one. The **balancing loop** found in this focus area shows how the time spent collecting bottles, in order to have some minimum income to support life needs, takes away from the time that would be dedicated for job search. So the final assumption is the same as the initial one, nothing changes and the situation is static and in order to solve it or make it better there must be an external action.



To some people collecting bottles has become like a full time job, some do it as a way to support themselves, to some has given a purpose when in lack of a conventional job.

A more thorough research, that would include an high number of direct interviews of the *pfandsammler*, (and how the city economy is affected by the collection of bottles) would help to study in more depth different aspects and have a bigger vision on:

- why people do it
- how much time do they effectively spend doing it
- is it considered as a temporary or long term activity
- has this an effect on employment possibilities
- Is this affecting the economy of the city

### 4.3.3. SOCIAL

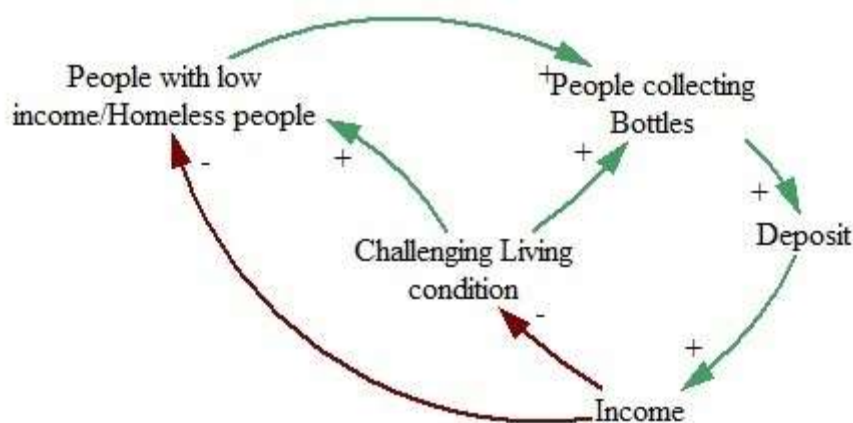


Figure 14 - Causal Loop Diagram of Social elements

In this social focus CLD, it is possible to see the reinforcing loops that underline how the collection of deposit and the consequent income that derives from it could lessen the challenging living condition that the *pfandsammler* usually face.

This can be deceitful as could show the deposit collection as a solution.

It is important to use this method as a starting point for the analysis of issues. It can oversimplify some concerning variables, it is therefore important to identify issues that need further investigation and perhaps further expansion in the CLD.

#### 4.4. FURTHER ANALYSIS: SOCIAL ISSUES

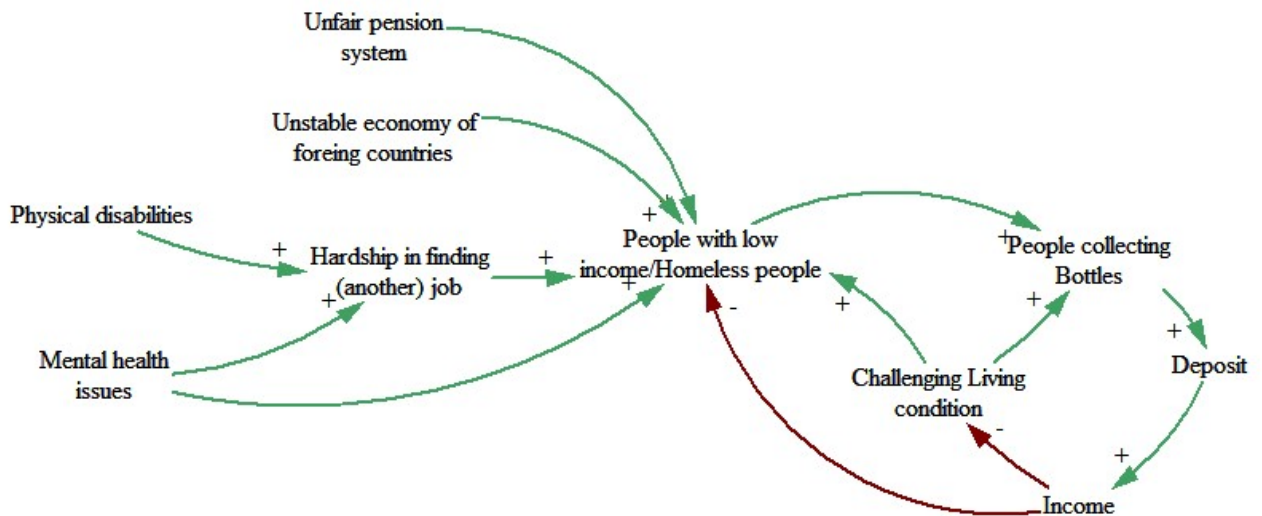


Figure 15 - Expansion of Social elements CLD

Expanding the boundaries of the main CLD on the *focus CLD* can help in identifying and highlighting further issues, the development of the diagram will always reflect the subjective opinion of the author. These opinions have been formed through research, literature analysis, and direct observation.

INCOME: this variable as defined here is very generic, without any specification could lead to misinterpretation.

The Diagram is qualitative and thus shows a connection between Income and Challenging Living Conditions (CLC) / People with low income - Homeless People. It shows that the growth of the “Income” variable moves in the opposite direction to the growth of CLC variable, hence while the first grows the second one lowers.

From a qualitative point of view it is formally correct, it is important to further explore the meaning of this connection.

The “income” is also connected to the “deposit” that is ideally collected; these two variables grow in the same direction. Meaning that the more deposit is collected the more income would be had.

Meaning theoretically that there is a certain amount of deposit bottle that would bring to a certain income that would bring to a decrease in the challenging living condition and perhaps moving from “challenging” to “good” living conditions.

This works theoretically but poses new questions.

What is the limit to which a person can collect bottles?

How many people are collecting bottles in the same area, thus making the collection of bottles a challenging or rewarding activity?

Other scenarios that need to be analysed that show how the links between the 3 pillars are inevitable.

To be explored:

How the value of the deposit on the containers influences both the social conditions and the littering.

The conclusion after studying the scenario was to find a function that represents the relationship between deposit value and social conditions, and also deposit value and waste dispersion.

How to study social conditions?

There can be an indicator that would have to include the quality of life that is related to the meeting of life basic needs and how this is related to a daily/weekly/monthly income.

## 5. DATA COLLECTION AND ANALYSIS

Part of the analysis carried out, was done through a survey that was proposed to people living in Berlin.

Which social or individual crises is it for which *pfandsammler* collecting is interpreted as an appropriate solution?; i.e. which social and individual dispositions favour the emergence of such an informal activity. With the help of these methods, a presumed change in social interpretation is to be traced. On the one hand, coming into contact with rubbish from private individuals is interpreted as a legitimate way of acquiring money, but on the other hand it is seen as a stigmatized activity. An analysis of work practice allows to diagnose both developmental tendencies of new, flexible work and newer tendencies in society as a whole.[38]

The goal is to analyse the habit of people living in different areas of the city, in order to quantify these habits related to the so called “pfand containers”. Understanding the trends regarding the amount of bottles purchased and the amount of bottles left in the street and the deposit value linked the them, will bring to a quantification of the deposit value that is “earned” by the people that collect bottles in order for them to sustain themselves.

The deposit value will then be analysed in the way it is linked to social conditions and the littering matter.

### 5.1. SURVEY

The survey that was carried out had the aim to analyse the habits of the people living in Berlin related to the purchase of the bottles linked to the *pfand* system, and moreover the habit of leaving the empty bottles in the street that will then be collected by the people in need. Another important part of the survey is related to the impression of the inhabitants of Berlin towards the people involved in the collection of bottles in the street.

Survey questions and the answer’ options are in Annex I, some questions encountered difficulties in the elaboration because of the answers received.

### 5.1.1. ELABORATION OF DATA

In the elaboration of the data it was also highlighted the differences between the east side and west side of the city of Berlin, due to historical differences that the city shows still to this time. The first question regarded where people live in Berlin:

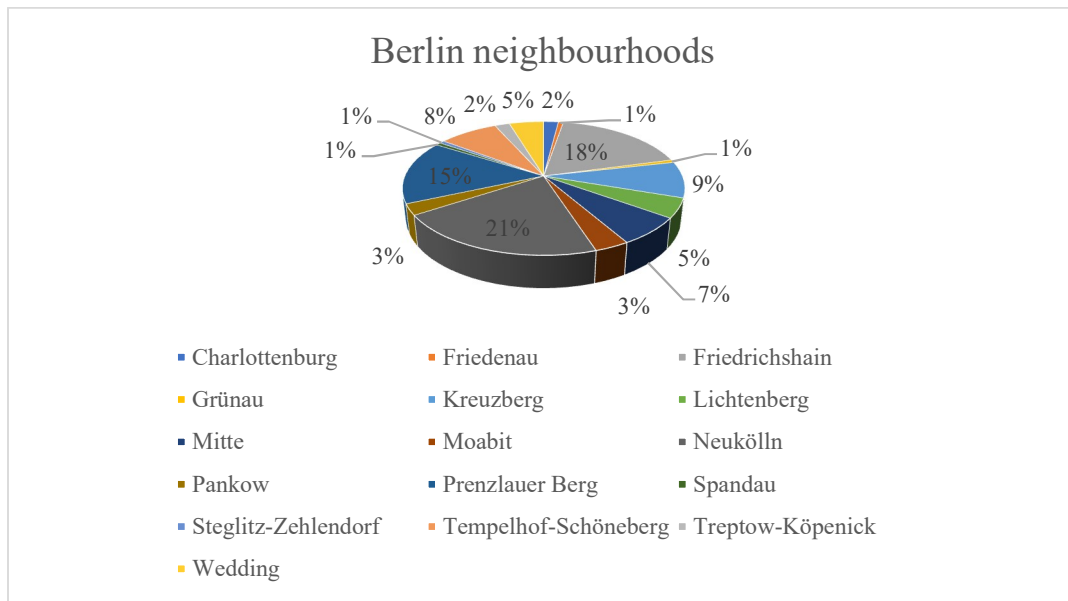


Figure 16 - Residence of interviewees

The answers have been divided into East - West for data elaboration purposes:



Figure 17 - Division of residence in East-West Berlin

There has been a higher response rate from people living in East Berlin.

#### 5.1.1.1. West Berlin

To the question:

- How many bottles with pfand do you buy weekly:

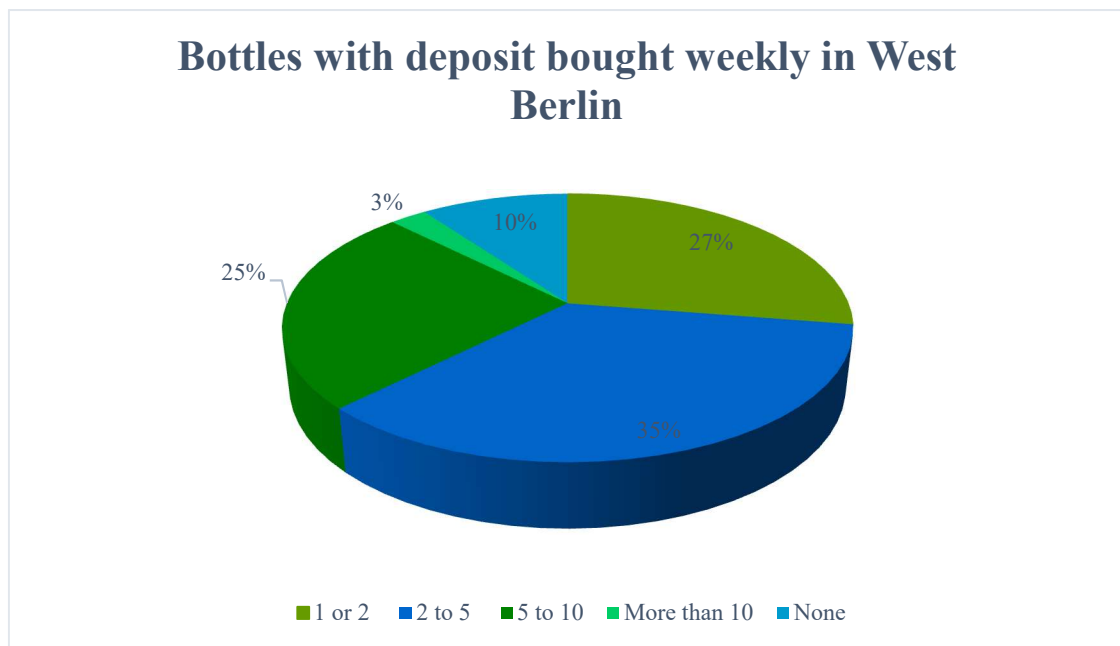


Figure 18 – Cake graph for bought containers

The most frequent answer was '2 to 5' with a 35% of the interviewed public. It is possible to see that only 10% doesn't purchase bottles with deposit at all.

This question is then compared with the next one:

- How many bottles with pfand do you leave in the street weekly?

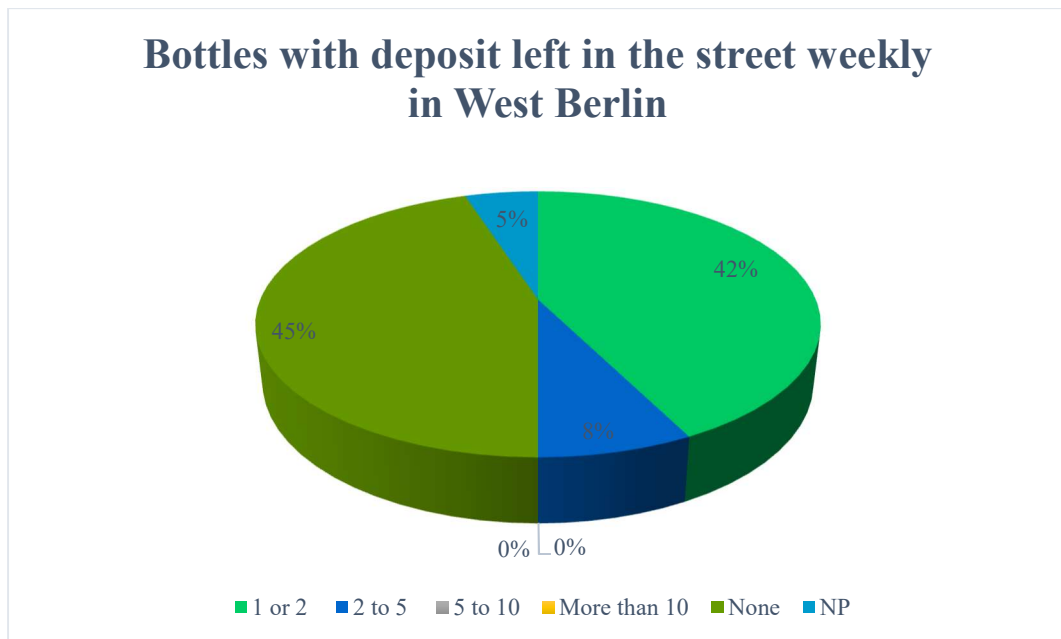


Figure 19 – Cake graph for containers left in the street

It can be observed that the most frequent answer has been “none” at 45%. Showing that that the habit of leaving bottles at all in the street is carried out from half of the people in West Berlin. This shows how there’s a habit of collecting containers with *pfand* inside households for half the interviewed people, while the rest is left on the street for other people to collect them. Another important aspect to be evaluated is the time an empty container stays where it was left, this helps to understand more the competitiveness of the activity, the amount of people that carry on with the collection

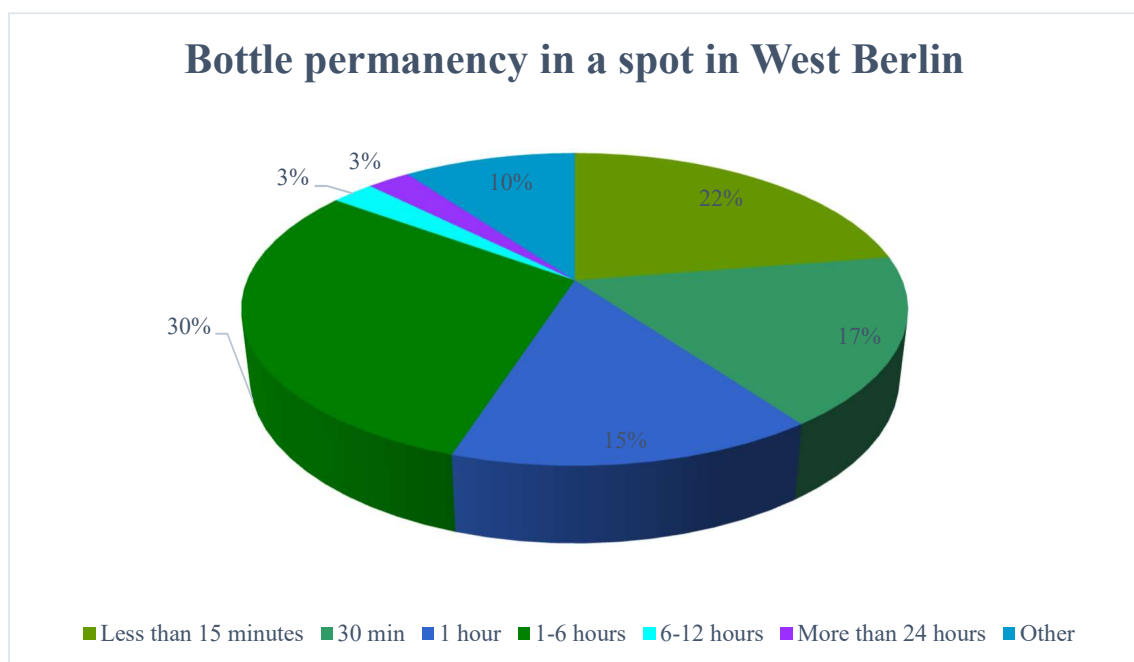


Figure 20 – Cake graph for time data

### 5.1.1.2. East Berlin

Results elaborated for the question related to the purchase of containers with deposit in Fig. 21

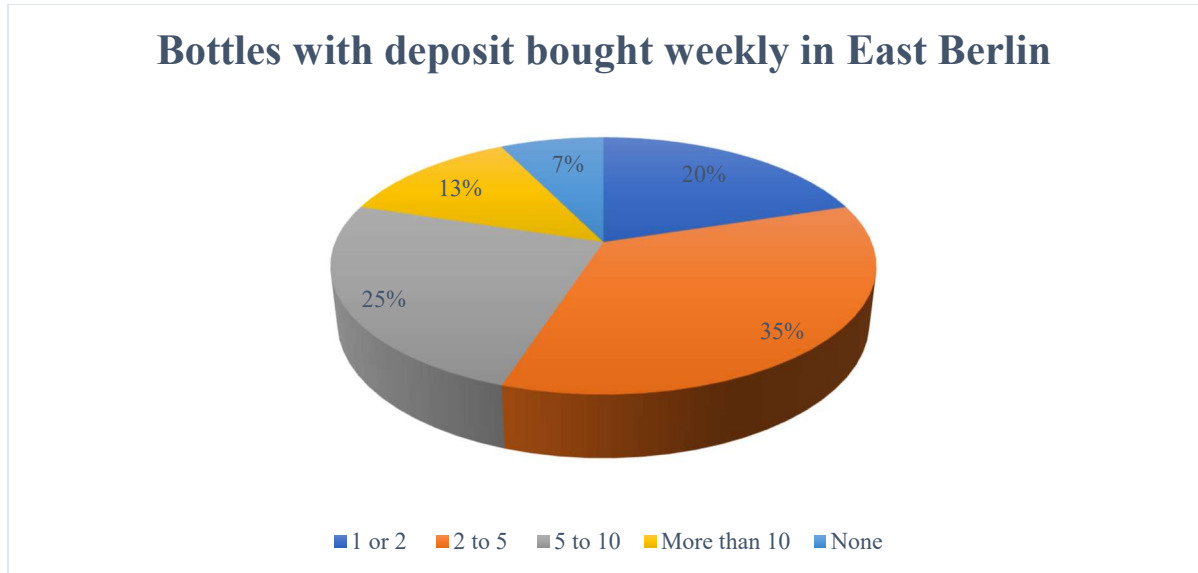


Figure 21 - Cake graph for bought containers

The purchasing habits results quite similar in the two parts of Berlin, with the answer “2 to 5” being at 35% in this case also. While only 7% answering none.

Answers for the second question related to the deposit containers:

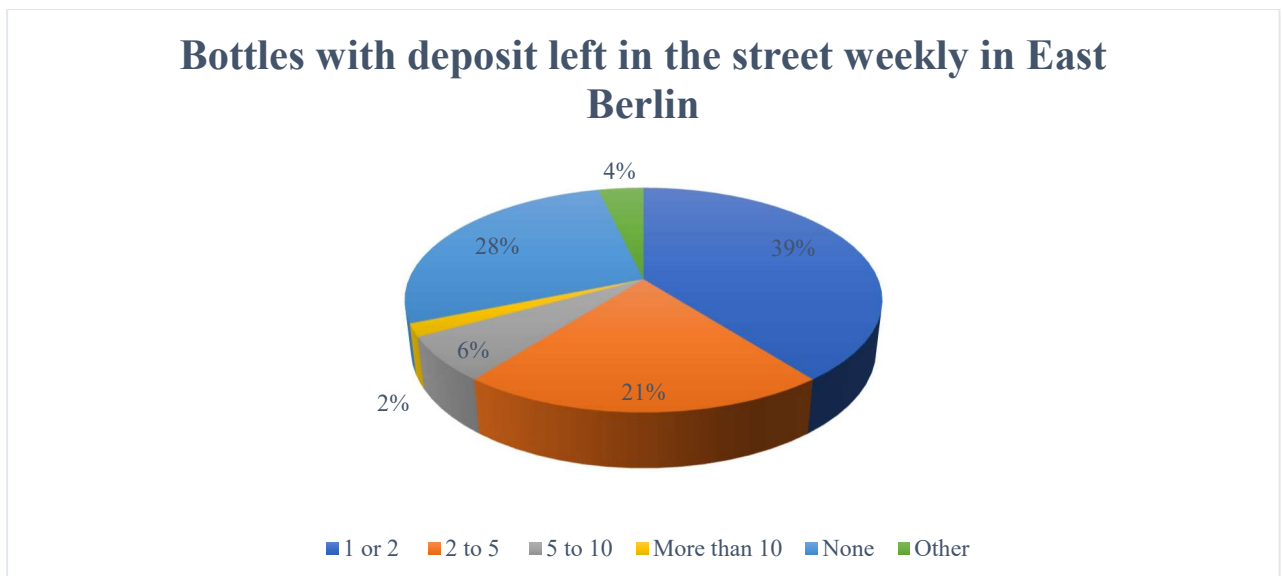


Figure 22 - Cake graph for containers left in the street

While also the answer for bottles left in the street results with the higher percentage for the answer “1 to 2”, it is possible to see how there’s higher response for the option “2 to 5”. Biggest



difference to notice is the “none” response at 28%, lower than for West Berlin that resulted at 45%.

Showing how the rate of bottles left in the streets in the East Berlin area is higher.

Regarding the time a bottle lasts in the place where it is left, the results can be seen in Fig. 23:

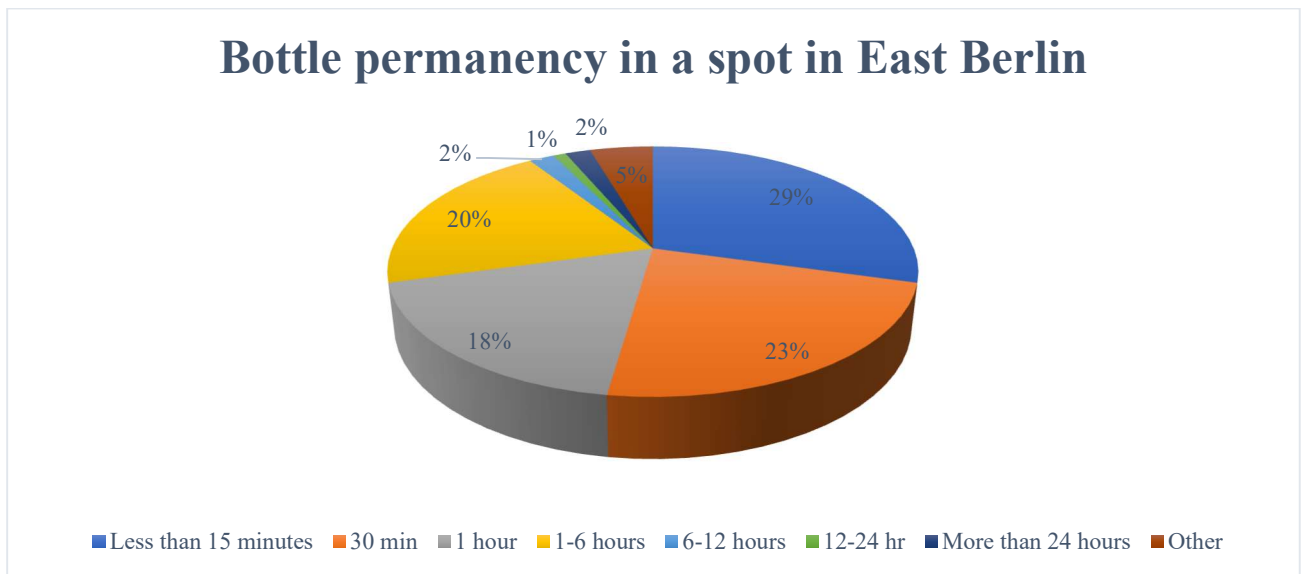


Figure 23 - Cake graph for time data

## 5.2. DATA ELABORATION AND COMPARISON EAST-WEST:

A statistical analysis was brought on to compare the data collected in the West and East side of the city, to understand if there is a relevant difference that justifies the separate analysis of the two parts of the city.

1. In the graph in Fig. 24 it is possible to see the comparison between West and East Berlin of the probability that a certain amount of bottles will be bought weekly.

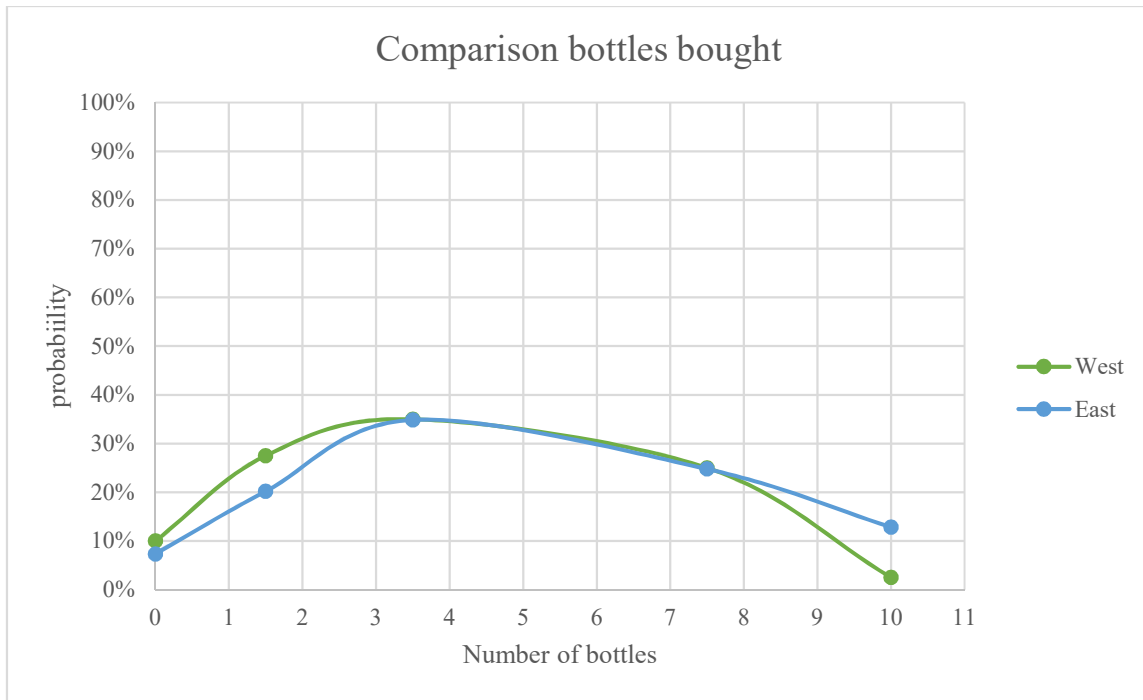


Figure 24 – Data elaboration for bought containers

The average values computed are:

West: 3.8

East: 4.7

2. In the graph in Fig. 25 it is shown the probability of the number of bottles left in the street weekly by the inhabitants of West and East Berlin.

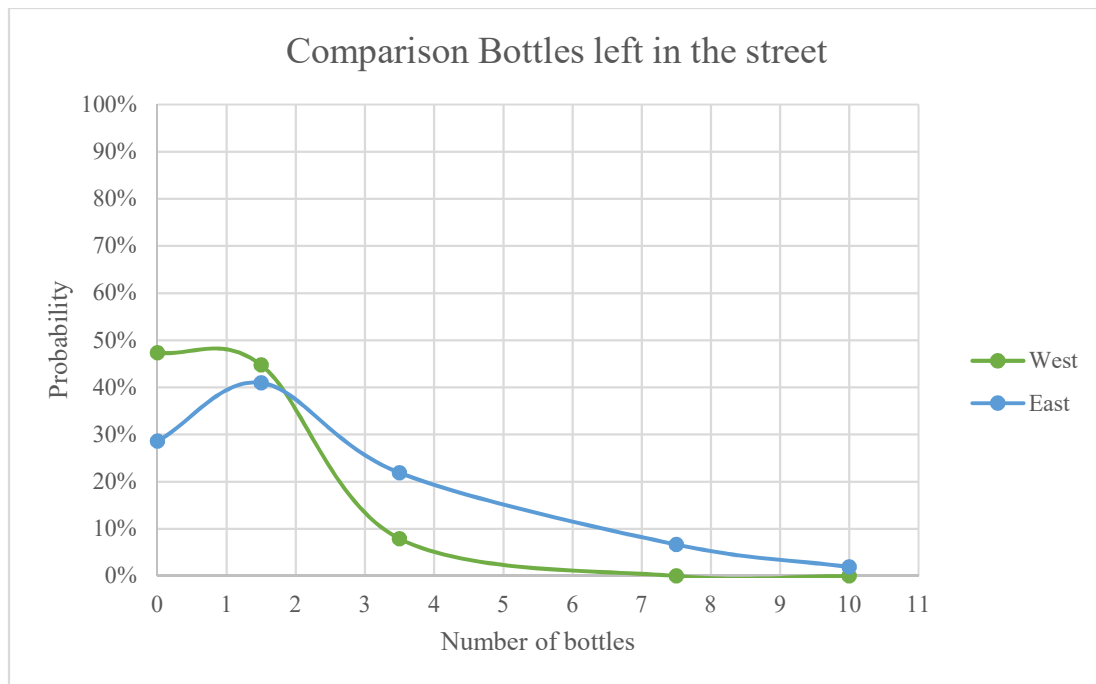


Figure 25 – Data elaboration for containers left in the street

The average values computed are:

West: 0.95

East: 2.1

From the comparison between East and West Berlin it is possible to notice the different behaviour of the inhabitants. It is another important variable to take into consideration when proceeding with the elaboration of the data.

While the purchasing habits are similar, the habits when it comes to the empty containers left in the street, to be collected by people in necessity, differ in the two sides of the city.

Most people (45%) don't leave any bottles in the street of west Berlin. While only 28% of people don't leave any bottles in the street in East Berlin.

3. The graph in Fig. 26 shows the probability that an empty container is going to spend a certain amount of time in the point where it was left before it is picked up.

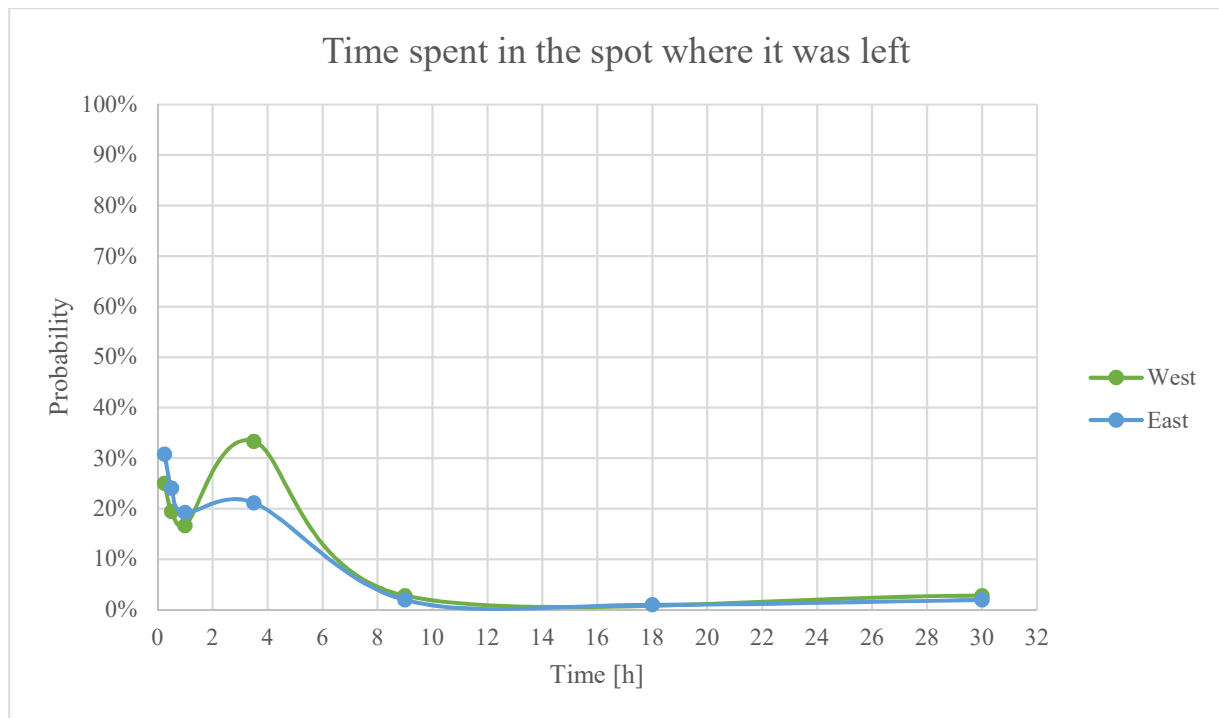


Figure 26 – Data elaboration for time data

The average values computed are:

West: 2.6 hours

East: 2 hours

It can be seen from the comparison of the time that an empty container with deposit spends on the street, the activity results to be more competitive in the East side of the city. Even though there are less bottles in the west side that are left in the street as can be seen in Fig. 25, they tend to last longer time in the spot where they are left.

This will obviously reflect on the *pfandsammler* that will look for bottles to collect the deposit from.

During field work it was indeed observed that in the East side of the city there's a higher number of homeless people that represents the main bottles collector. While in the West side of the city there's a higher presence of pensioners that are involved in this activity.

### 5.3. VARIABLES

-Area of the city: main division East/West. Neighbourhood division would be make the research more accurate;

-Time of the day: the day is ideal to look for hidden objects, but night is often preferred due to stigma associated with the activity;

-Modality of the activity: occasional, systematic;

-Inventory assessment of the bottles left in the streets: to understand the amount of money available from the deposit collection;

-Assessment of number of people taking on the activity of bottle collection: to understand the level of competition of the activity;

-Season of the year in which the data collection is carried out: winter and summer differ highly;

An important part of the study is to determine the conditions of the people collecting bottles, it was done through the impressions and knowledge of the people interviewed. Direct interviews to the people doing the actual activity is expected for further research.

Through previous research, in literature and on the field it was assessed that the main categories of people doing the deposit collection were:

- Homeless people: for obvious reasons, collecting the deposit is one of the main ways they are able to sustain some of their needs.
- People on unemployment benefits: this type of social welfare appears to not be enough for the people that find themselves in this situations, to sustain all the monthly expenses. Therefore they find themselves in the necessity to undertake the activity of deposit collection.
- Pensioners: the pension system appears not to provide enough for some of the people that finished their employable time, collecting the deposit bottles seems to be one of the options to get to meet the monthly needs.

It was given the freedom to give multiple answers:

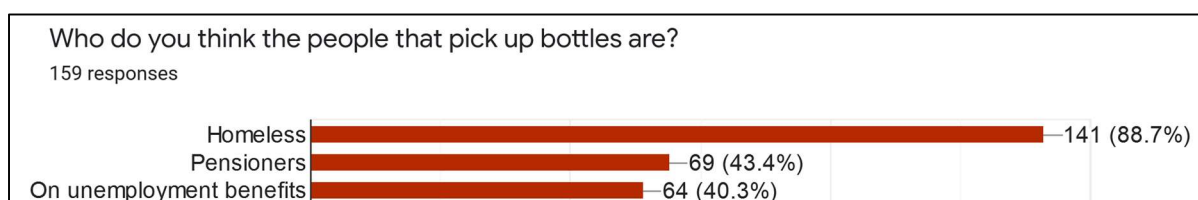


Figure 27 – People collecting bottles occupation

The results show how homeless people are the main category considered that takes on this activity. But also pensioners and people on unemployment benefits that don't receive enough to sustain life expenses each month retrieve to this activity. It has observed through field work

that the second category of people was more concentrated in the West side of the city, while there's a higher concentration of homeless in the East side.

A census of the homeless people in Berlin, has been carried out in the night between the 29<sup>th</sup> and 30<sup>th</sup> of January 2020, called “Solidarity Night” or in German “Nacht Solidarität”. The results of this census counted 1976 people being homeless in Berlin [42].

There has been no census regarding the activity that the homeless people carry on sustaining the basic life needs.

## **5.4. SCENARIOS**

Different scenarios have been hypothesised in order to study the relations between the value of the deposit that the containers bring with themselves, the littering and the social conditions.

### **5.4.1. DEPOSIT VALUE HIGHER**

The collection of empty bottles is already brought on by many people as if it was a regular job [39], but with a higher deposit this scenario would become more likely and people would manage to earn an higher income, that would bring to better social condition. This implies the entrance in a grey area from a legal point of view, regarding the taxation of an eventual income that comes from the collection of a deposit that is not a regulated way of earning a salary. It is also important to take into consideration that with a higher deposit value the collection of the bottles would become a very competitive activity.

This competitive side of this scenario is represented by the balancing loop in Fig. 28, related to the value of the deposit applied to the containers, the income gained from the deposit collection and the competition that the activity would show.

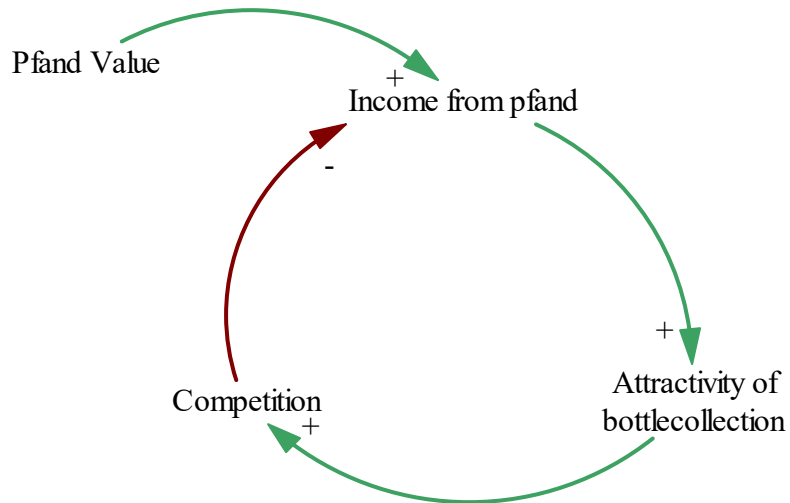


Figure 28 - CLD of bottle collecting competition

#### 5.4.2. DEPOSIT VALUE VERY HIGH

A very high deposit value applied on the containers would lead people not to leave bottles on the street at all, because it would result in too high a loss. So, there would be no bottles to collect for people in difficult situation to meet their basic needs. Their condition would therefore worsen and further burden the welfare systems offered by the city.

## 5.5. FUNCTIONS THAT BOND DEPOSIT VALUE AND OTHER VARIABLES:

### 5.5.1. DEPOSIT VALUE AND SOCIAL CONDITIONS

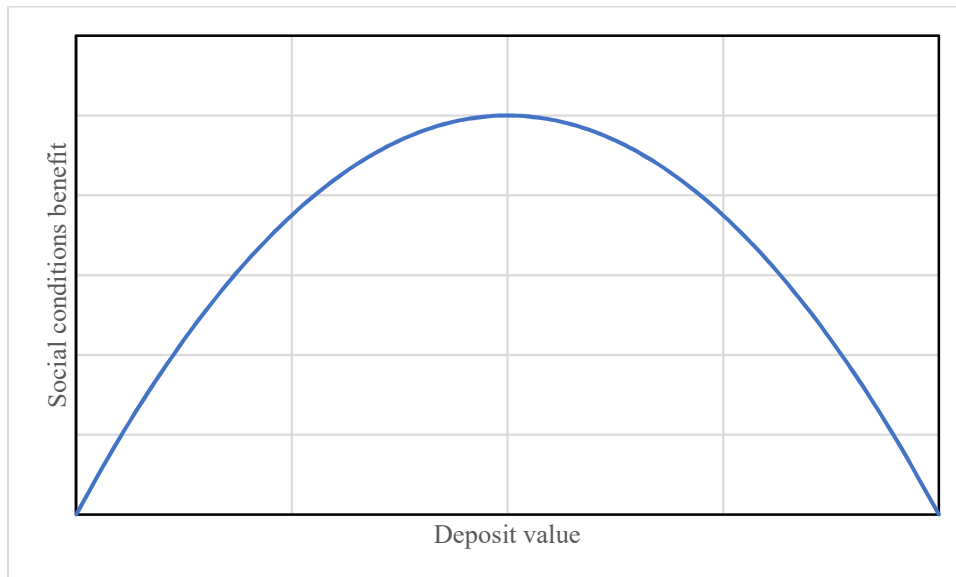


Figure 29 - Function between deposit value and social conditions benefit

Through hypothesis discussion and field work it was defined the function that bonds the deposit value and social conditions. If the value of the deposit is too low, the collection of it doesn't bring any benefit or too low benefits. For example, a common situation is that some *pfandsammler* don't collect the bottles that carry only a 0.08 € deposit but look for the one with 0.25 € deposit, even though they are scarcer the higher deposit brings a higher income.

There will be a peak in the benefit towards social conditions related to the income gained from the deposit collection, but here it was modelled specifically related to the deposit value applied per bottle. This ideal value has to be identified. The peak will decrease the moment this ideal value will be overcome, the consequence would be that there is going to be a lower number of container available to be collected, and thus not enough resources to improve social conditions or no container at all, since the consumer are not going to disperse the empty containers anymore.

The variables to be assessed and balanced are:

- Acceptable deposit value for consumers: for the consumer to purchase the good;
- Deposit value high enough for the collection to be carried out: it has to be worth it to carry on the activity of collection;



- Competitive deposit value: there is a value that will make it too competitive, if too many people carry on with the activity, even in if the deposit value is high the number of units found won't be enough for the collecting activity to be worth it;
- Actual change in the social conditions due to the deposit collection;

The value for the deposit that goes over the peak value for the social conditions, shows a condition in which the bottles wouldn't be left in the street to be collected because consumers wouldn't consider it acceptable to lose that amount of money. The value of deposit too high would then bring to an absence of bottles in the streets and consequently, when reached the extreme, no betterment of social conditions.

Social condition benefit: from a point of difficult social conditions, this variable roots its definition in the ability to sustain basic life needs: shelter, food and clothing. The benefit would then include overcoming dangerous living conditions towards the ability to find a job and stability.

### 5.5.2. DEPOSIT VALUE AND LITTERING

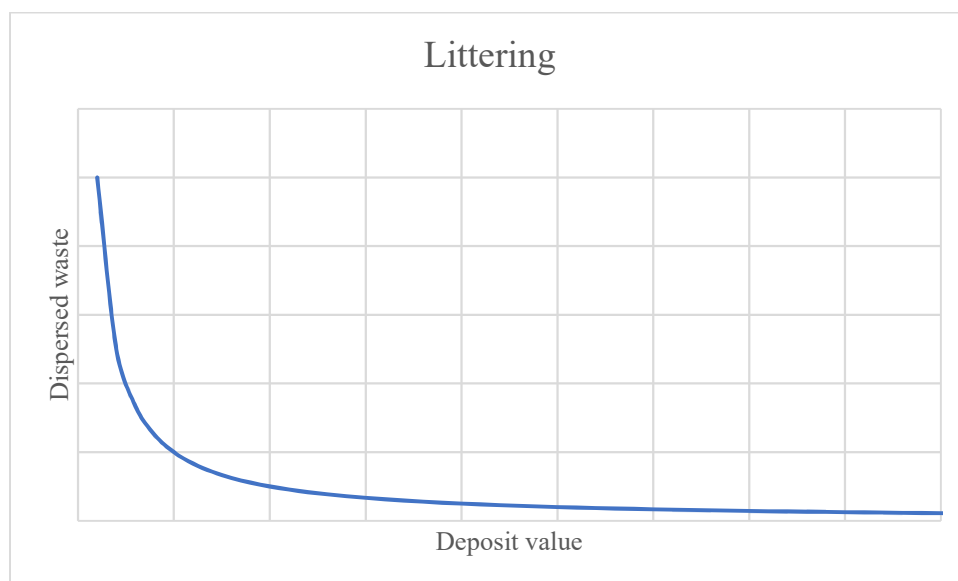


Figure 30 - Function between deposit value and dispersed waste

The other aspect related to the deposit value is littering.

It is found how the increment of the deposit value influences littering. The qualitative bond between the variables is correctly represented by a hyperbola.

Assuming as a hypothesis that the attention put towards the dispersion of empty containers is only related to the benefit that a citizen could get from bringing it back in order to get the deposit back.

Considering the worst-case scenario of littering and not the right way to dispose of waste.

A low value of the deposit applied on the containers, or the absence of a deposit, will have therefore little to no attention towards the right way of disposing of an empty container, will eventually bring to the dispersion in the environment.

The value linked to the empty containers pushes towards a higher attention to the dispersion of harmful materials.

The more the deposit value is increased the less waste will be dispersed in the environment, that will be consequently recycled, obtaining a saving in the use of raw resources and lower stress on the environment.

These containers will be either collected by people in the street, the higher value will make more appealing the search, or by the consumers that would bring back what they bought.

When a condition with a very high value of the deposit is reached, there would be no longer bottles left in the street. Because of the high investment of the consumers, the empty containers will be collected inside the households and correctly disposed to obtain the deposit back.

Variables to be investigated:

- Value of the deposit high enough for people to look specifically for dispersed containers;
- Value of deposit that brings consumers not to disperse empty containers;

## **5.6. LITERATURE RESEARCH TOWARDS CONCLUSIONS**

Deposit collecting must be seen as a new form of informal economy. In contrast to familiar forms such as moonlighting or neighbourhood assistance, this activity is dependent on public space, where the consumers leave their rubbish behind, and is therefore characterised by its public visibility. Visibility is precisely a structural feature of informal activities, which are mainly known from less developed countries. At the same time, they are stigmatized and/or criminalized as supposedly homeless because their "digging in the trash" contradicts civilizing standards of cleanliness. [38]

## 6. CONCLUSIONS

The thesis presented the analysis of the system (DRS) that provides for the application of a deposit on specific drink containers, glass bottles, PET bottles and aluminium cans. This system has changed consumer habits and the related environmental impacts, including changes within society that had not been initially foreseen.

A summary of the sustainability assessment carried out:

From an environmental point of view, the analysis of waste management showed that the impact was not so significant from a numerical point of view. However, Germany waste recycling habits are the most virtuous at European level, the DRS system contributes but is not fundamental, but the highest influence is on the littering. Since there is money “attached” to the empty containers these are brought back to collect the money and this has influenced the dispersion of harmful materials in the environment.

From an economic point of view the most peculiar issue is the deposit slip, a complicated situation that has led producers to receive a lot of criticism and has created tension with the consumers.

The social aspects have proved to be the most intricate and interesting to explore as they have generated a phenomenon that does not exist elsewhere, which is linked to many different aspects and has consequences on many sections of society. The phenomenon that involves every part of society but mainly sees people that live in economic difficulty taking part in the collection of the empty containers from the street in order to have an income that can help sustain the minimum of life basic needs cannot be ignored.

Furthermore, the social aspects themselves have consequences and links to new environmental and economic aspects.

The irregular and dynamic consequences of the implementation of this system have made it necessary to create a model. The model has made it possible to split the phenomenon into different areas. In particular, the focus is on social sustainability, a fundamental part of all-round sustainability, which has many facets that have not yet been studied. The phenomenon under examination presents many grey areas, has no formality and no previous research. So the study was created without any pre-existent model to start from, and presents the intention to lay the foundations for a future deeper and more specialized research.

The definition, therefore, of variables that represent the phenomenon, has made it possible to frame it. The consequent data collection and elaboration of them has laid the basis for the formalization of this phenomenon with the consequent objective to quantify the social aspects explored.

The study of social conditions, which influence other spheres of life, proves to be a fundamental part of the analysis of social sustainability, which contributes to the objective of a sustainability assessment, and in turn to a better overall sustainability.

The hope is that with further research we can arrive at a better formalisation of the phenomenon, which is challenging because it presents numerous and even unexpected variables. Ideally, this could become part of a life cycle study framework, in this case regarding the process that sees glass bottles, PET bottles and aluminium cans, specifically in the European countries that have adopted the deposit return system. And for many other processes, that are present in everyday life, with heavy social consequences that could enter into these life cycle schemes in order to be taken into account when an all-round impact analysis is carried out.

## 7. SOURCES

- [1] WCED, “Report of the World Commission on Environment and Development : Our Common Future Acronyms and Note on Terminology Chairman ’ s Foreword,” *Rep. World Comm. Environ. Dev. Our Common Futur.*, 1987.
- [2] G. W. Robert B. Gibson, Selma Hassan, Susan Holtz, James Tansey, *Sustainability Assessment - Criteria, Processess and Applications*, vol. 91, no. 5. 2005.
- [3] K. Pezzoli, “Sustainable development: A transdisciplinary overview of the literature,” *J. Environ. Plan. Manag.*, vol. 40, no. 5, pp. 549–574, 1997, doi: 10.1080/09640569711949.
- [4] David W. Pearce ; R. Kerry Turner, “Pearce D Turner K 1990 Econ Nat Res Enviro Chap 4 Chap 5 Chap 8.pdf.” .
- [5] I. Gujit and A. Moiseev, *IUCN RESOURCE KIT FOR SUSTAINABILITY ASSESSMENT Part C: Slides for Facilitators*, no. May. 2001.
- [6] P. Sutton, “Sustainability: What does it mean?,” *Sustainability: What does it mean?*, 2000. [Online]. Available: <http://www.green-innovations.asn.au/sustblty.htm>.
- [7] A. H. Rasouli and D. A. Kumarasuriyar, “The Social Dimention of Sustainability: Towards Some Definitions and Analysis,” *J. Soc. Sci. Policy Implic.*, vol. 4, no. 2, 2016, doi: 10.15640/jsspi.v4n2a3.
- [8] K. McPhail and S. Jacobs, “Social Assessment,” *Accountability*, no. 13, 2003.
- [9] ISO 14044:2006, “Environmental management — Life cycle assessment — Requirements and guidelines,” 2006.
- [10] C. Benoît, B. Mazijn, United Nations Environment Programme., CIRAIG., P. and S. Interuniversity Research Centre for the Life Cycle of Products, and Canadian Electronic Library, *Guidelines for social life cycle assessment of products*. 2013.
- [11] C. Benoit-Norris, “T He M Ethodological S Heets for S Ub - Categories in S Ocial L Ife C Ycle a Ssessment ( S-Lca ),” *Pre Publ. Version. Methodol. Sheets Subcategories Soc. Life Cicle Assess. (S-LCA).*, 2013, doi: 10.1007/978-1-4419-8825-6.
- [12] J. Franze, *Lca of an ecolabeled notebook - consideration of social and environmental*. 2011.
- [13] GreenDelta, “PSILCA – A Product Social Impact Life Cycle Assessment database. Database version 1.0. Documentation,” no. March, pp. 1–99, 2016.
- [14] “Deutsche Pfandsystem GmbH.” [Online]. Available: <https://dpg->

- pfandsystem.de/index.php/en/function-of-the-dpg-system.html.
- [15] VerpackG, “Gesetz über das Inverkehrbringen, die Rücknahme und die hochwertige Verwertung von Verpackungen (Verpackungsgesetz - VerpackG),” p. VerpackG, 2017.
  - [16] The European parliament and the council of the European union, “Directive 2005/20/EC of 9 March 2005 amending Directive 94/62/EC on packaging and packaging waste,” *Off. J. Eur. Union*, vol. L 70, pp. 17–18, 2005.
  - [17] T. F. Government, W. M. Act, W. M. Objectives, and W. M. Objectives, “Packaging Ordinance 1,” vol. 1998, no. 1, 2009.
  - [18] “Mehrweg für die Umwelt.” [Online]. Available: <https://www.mehrweg.org/>.
  - [19] “Pfand bottles Guide.” [Online]. Available: <https://allaboutberlin.com/guides/pfand-bottles>.
  - [20] A. Stefanidis, “Wo steckt der Pfandschlupf?,” 2003. [Online]. Available: [https://www.zeit.de/2004/01/06\\_2f13\\_2fBerner\\_\\_Dosenpfand\\_/seite-2](https://www.zeit.de/2004/01/06_2f13_2fBerner__Dosenpfand_/seite-2).
  - [21] P. Lee, N. Bell, T. Garcia, O. Lee, J. Harding, and K. Baker, “Recycling DRS in Scotland Recycling DRS in Scotland Written by :,” no. September, 2019.
  - [22] P. Lee, “Raise the Glass,” no. October, p. 18, 2018.
  - [23] EC, “Amending Directive 2008/98/EC on waste,” vol. 0275, no. 1, pp. 1–5, 2015, doi: 10.1007/s13398-014-0173-7.2.
  - [24] M. S. PricewaterhouseCoopers AG WPG.Dr. Patrick Albrecht, Jens Brodersen, Dieter W. Horst, “Reuse and Recycling Systems for Selected Beverage Packaging from a Sustainability Perspective An analysis of the ecological , economic and social.”
  - [25] D. R. Systems and D. R. Systems, “Deposit Return Systems perfect for re-useable packaging but not a universal solution for one way More recycling Consumer pays.”
  - [26] Z. Der Studie and K. Stoffstrommodells, “„ Aufkommen und Verwertung von PET-Getränkeflaschen in Deutschland 2015 “ Inhaltsübersicht 4 . Recycling- und Verwertungsquoten 5 . Übertragbarkeit auf Teilgesamtheiten 6 . Fazit und Ausblick,” no. September, 2016.
  - [27] S. Toloken, “German plastics group highlights success of bottle deposits in recycling,” *Plasticnews*. [Online]. Available: <https://www.plasticsnews.com/article/20161207/NEWS/161209886/german-plastics-group-highlights-success-of-bottle-deposits-in-recycling>.
  - [28] WRAP, *Single Trip or Reusable Packaging - Considering the Right Choice for the Environment*, no. May. 2010.
  - [29] M. Mehrweg-, “VORSPRUNG FÜR MEHRWEG Mehrweg- und Einwegflaschen im

- Mineralwassermarkt 2008,” 2008.
- [30] “Pfand Gehört Daneben.” [Online]. Available: <https://www.pfand-gehoert-daneben.de/>.
  - [31] “Pfandgeben.” [Online]. Available: <https://www.pfandgeben.de/>.
  - [32] “Spende dein Pfand.” [Online]. Available: <https://spendedeinpfand.com/>.
  - [33] J. Peraphan, H. Knoflacher, and M. Mailer, “Understanding decision makers’ perceptions of Chiang Mai city’s transport problems an application of Causal Loop Diagram (CLD) methodology,” *Transp. Res. Procedia*, vol. 25, pp. 4438–4453, 2017, doi: 10.1016/j.trpro.2017.05.350.
  - [34] D. H. Kim, “Guidelines for Drawing Causal Loop Diagrams,” *Syst. Thinker*, vol. 3, no. 1, pp. 5–6, 1992.
  - [35] G. Bellinger, “Reinforcing loop,” 2004. [Online]. Available: <https://www.systems-thinking.org/theWay/sre/re.htm>.
  - [36] M. Ranjbari, G. Morales-Alonso, Z. S. Esfandabadi, and R. Carrasco-Gallego, “Sustainability and the sharing economy: Modelling the interconnections,” *Dir. y Organ.*, vol. 68, pp. 33–40, 2019.
  - [37] Global Footprint Network, “Earth Overshoot Day.” [Online]. Available: <https://www.overshootday.org/about/>.
  - [38] S. J. Moser, “Die Rückkehr der Sammler: Konturen einer neuen Sozialfigur in deutschen Städten,” 2008.
  - [39] “Studie über Pfandsammler -Auf Sinnsuche,” *Spiegel*, 2014. [Online]. Available: <https://www.spiegel.de/consent-a-?targetUrl=https%3A%2F%2Fwww.spiegel.de%2Flebenundlernen%2Funi%2Fpfandsammler-studie-erklaert-das-phaenomen-der-flaschensammler-a-971255.html>.

## Annex I

### Survey questions

1) Where do you live or you hang out mostly? (The following questions will be related to the district you choose here)

Charlottenburg;

Friedrichshain;

Kreuzberg;

Lichtenberg;

Mitte;

Neukölln;

Pankow;

Tempelhof-Schöneberg;

Steglitz-Zehlendorf;

Treptow-Köpenick;

Wedding;

Moabit;

Prenzlauer Berg;

Grünau;

Spandau;

Friedenau;

2) How many bottles with deposit (pfand) do you buy weekly?

None1 or 2;

2-5;

5-10;

More than 10;

3) How many bottles do you leave in the street weekly?

None1 or 2;

2-5;

5-10;

More than 10;



4) How long do you think (or have you noticed) a bottle stays in the spot where it was left?

Less than 15 minutes;

30 min;

1 hour;

1-6 hours;

6-12 hours;

12-24 hours;

5) Who do you think the people that pick up bottles are?

Homeless;

Pensioners;

On unemployment benefits;

Open answers;

6) How many people collecting bottles do you think there are your area ? (If you have no idea write 00)

Open answers;

7) Have you ever talked to a person that was collecting bottles, if yes would you like to share the story?

Open answers;