



## Research Article

# Deposit refund system for beverage containers as a best practice example for recycling maximization

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## ABSTRACT

Packaging waste has a detrimental impact on the pollution of the ecosystem unless it is not managed properly. Many countries try to solve this problem by collecting beverage packaging before it gets mixed with other wastes and sends the beverage packaging to recycling facilities. In order to reproduce a packaging material, in the exact same form and quality as the materials produced from the raw material, the quality and status of the used material become rather important. Therefore, a specific method, among others, becomes prominent for the re-collection of the used beverage packaging, before these become wasted and contaminated. This system is called the “Deposit Refund System (DRS)”. In the DRS, each beverage packaging shall have a certain deposit value and with each purchase, the consumer shall pay that deposit value in addition to the product price. This system leads the way to a clean and effective collection of recyclable beverage packaging. The aim of this study is to draw attention to the importance of packaging waste, to introduce the Deposit Return System, which is the best management method of used beverage packaging in the world, and to introduce the reader to the main lines of the deposit return system we have developed for Turkey. In this study, we have researched the best practices of DRS and examined the implementation of the system. The methodology we used included a detailed examination of all the administrative, technical and economic processes necessary for the sustainable implementation of the subject. The success of the system depends on a clear structuring and outlining of the relationships, duties, authorities, and responsibilities of each stakeholder. Accordingly, the legal framework shall set forth a comprehensive framework, in order to regulate all procedures and principles relating to the DRS. The main outcome of the study is to determine the advantages of implementing the DRS in Turkey, for beverage packaging waste management. In addition, we analyze the governance models of DRS, where the DRS is run by an Operator. We examine the alternative governance models, such as state-owned and Public-Private Partnership (PPP) models other than “non-profit organization model” which is common in EU countries. We further elaborate on the financial sustainability of the PPP projects and how to create “bankable projects”. As an innovative model for the DRS, we created a well-structured finance model with a resilience revenue stream in the PPP option for long-term public services. The DRS is one of the best implementation mechanisms for the separate collection of packaging waste. In the countries where DRS is applied, recycling rates

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reach up to 98% for beverage containers [1]. DRS in Turkey can increase recycling rates up to 70% for PET, glass, and aluminum materials. This outcome leads more efficient and closed-cycle source management. The New Circular Economy Action Plan by the EU aims to design the entire life cycle of products while promoting circular economy processes, fostering sustainable consumption, and aiming to keep resources available as much as possible in the EU's economy. Lastly, we also considered and examined other environmental benefits of the DRS in Turkey.

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## INTRODUCTION

Human consumption behavior is the main parameter for environmental pollution. Especially now in today's globalized world, using fast-moving consumer goods has become more widespread, eventually resulting in a significant increase in waste generation. This increase is ominously caused by the packaging wastes, especially with its implicit economic value.

The materials used in the packaging industry are plastics, metal, glass, paper, wood, and composites. The food and beverage packaging, which commonly uses plastic, metal, glass and composite materials has a market share amounting to approximately 70% in the overall packaging sector [1]. In 2018, 1,167.5 billion liters of packaged beverages were consumed worldwide [2] while 1,292 billion liters in 2020 [3].

As can be seen from the figures, the waste generated by the consumption of beverage products has increased in recent years. The beverage industry mainly uses plastics, metal, glass, paper, wood and composites as packaging materials. Some of these materials can be recycled and reused as raw materials in packaging production process, instead of virgin materials. The replacement of recycled materials enables to conserve the resources which are mostly consumed in fast-moving sectors. However, quality of the recycled materials is an important parameter to realize the replacement. The recycled materials must sustain a certain quality standard for replacement and this depends on the condition of the materials after their usage. The collection methods may have positive and negative impacts on the condition of the materials. Therefore, separate collection mechanisms for recyclable materials should be provided, in order to keep the quality of such products at a certain level.

## DEPOSIT REFUND SYSTEM

The Deposit Refund System ("DRS") is a recycling system in which consumers pay a small deposit value for beverage containers, which can be refunded upon return of the used container to a collection point. DRS is very important for achieving circularity, resource management and clean collection of the materials. The clean collection of the ma-

terials enables to sustain high quality in recycled materials.

DRS is one of the methods to perform Extended Producer Responsibility ("EPR"). EPR is a policy approach under which producers are given a significant responsibility – financial and/or physical– for the treatment or disposal of the post-consumer products [4]. DRS has been implemented in more than 40 countries around the world as a part of the EPR policy and has achieved considerably high recycling rates.

Figure 1 shows the operation of the DRS; the flow of deposits, fees, beverage containers and information in general. According to EPR, producers finance the system to reach the recycling targets which are defined by the governments. Retailers are one of the most important stakeholders of the systems since they serve as collection points to which the customers can return empty containers. The DRS Operator, on the other hand, manages, controls, and operates the system.

The governance of the DRS Operator may differ from country to country. In the most common implementations, the DRS Operator is a non-profit organization which is founded by producers and retailers. However, there are few examples in which the DRS Operator is a governmental organization. In Table 1, stated below, different implementations of the DRS across Europe are shown. As it can be seen from the table, most of the countries have a centralized operating system and the operations are carried out by the Non-Profit Organizations. Nevertheless, in Germany, although the system operator is a Non-Profit Organization, the operating system is decentralized. On contrary, Croatia has a centralized operating system like many others but the system is operated by a Governmental Organization.

The return (recycling) rates of European Countries under the DRS are stated in the Figure 2, below. The figure demonstrates that Germany has the highest return rate with 98%. Even though Estonia has the lowest return rate, it still has a considerable rate of 83% [6]. The main reason of reaching a higher return rate with the DRS is motivation of the consumers to receive the deposit that they paid. When the consumers pay a deposit in addition to the product price, they are more motivated to bring empty containers in order to receive the deposit back.

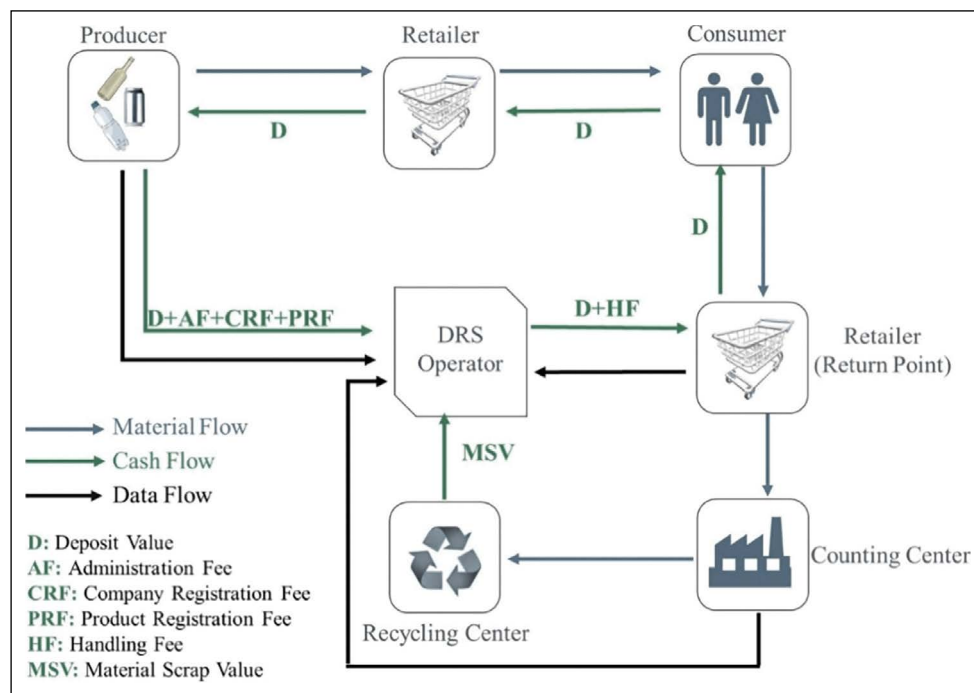


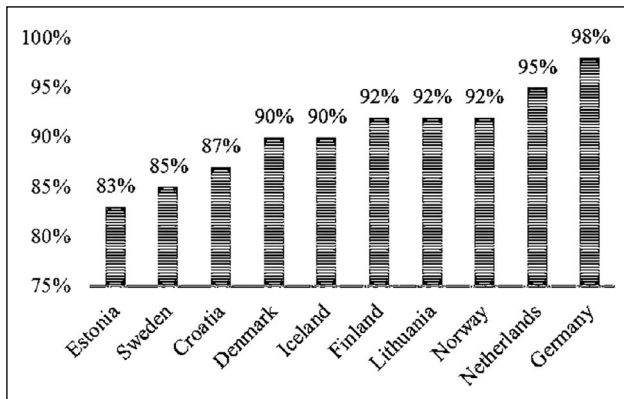
Figure 1. Flow of deposit, fees, containers, and information in the general drs [5].

DRS is not only a beneficial model for achieving the high recycling targets, but also, it has various economic and environmental benefits. The waste management cost of local

authorities may decrease with the implementation of the DRS. Apart from the cost reduction, recyclable materials do not lose their material value in the containers where

Table 1. Implementation of the DRS in European countries [6]

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



**Figure 2.** Return rates in European countries where DRS is applied [6].

they are mixed with municipal organic waste in the landfill facilities. Such materials can be recycled into high-quality materials with a source separation model. The source separation is significantly important for the recycling industry. The scrap material must sustain a certain quality level in order to be used as raw material for production. Currently, Turkey cannot implement source separation model effectively. For this reason, Turkey imports scrap plastic, glass, and aluminum from Europe to run the high-tech recycling facilities. In 2019, Turkey spent around 665 million, 10.7 million and 1.040 million Turkish Lira to import plastic, glass, and aluminum scraps respectively [7]. After the implementation of the DRS, the import rate of recyclable materials is expected to decrease as a result of the high return rates of used beverage containers achieved by the system.

## MATERIAL AND METHODS

In this study, initially, the implementation of the Deposit Refund System in other countries was analyzed in detail [6, 8]. The research involved the analysis of administrative, technical and economical processes of the system in different countries. Then, necessary data were collected from the Ministry, relevant stakeholders and literature. After analyzing the collected data, it was made available for the Turkey-specific DRS setup as a result of a series of meetings with the Ministry and relevant stakeholders.

In administrative analysis, the governance models, stakeholders and their responsibilities were examined. In technical study, collection methods of beverage containers, beverage container materials and beverage types included in the system, container monitoring, data security, method for the refund of deposit to the consumers (manually or via Reverse Vending Machines) were examined. In economic analysis, all revenues, operational and initial investment costs of the DRS were analyzed.

After that, the most effective and ineffective system alternatives were searched and system requirements for Turkey

were determined by taking the results of Turkey Deposit Refund System Project (TÜDİS), which was performed by the Ministry of Environment and Urbanization, as a reference [9]. While determining the social, environmental, and economic benefits of the implementation of the DRS in Turkey, the findings of the TÜDİS Project have been utilized. What makes the study unique is the analysis of Public Private Partnership (PPP) model in order to provide the most sustainable financial structure and the most effective system suggestion for the DRS. Finally, the best available Deposit Refund System structures are set out in the study.

## RESULTS AND DISCUSSION

The system has numerous benefits which could be achieved in consideration of several factors. First of all, the governance structure should be constituted well. Responsibilities must be shared between stakeholders properly. Producers must have responsibilities to establish and finance the DRS. Hence, they must pay some fees to the DRS. Retailers must be responsible to collect empty containers from the consumers. For this reason, retailers' operations also play a key role in the DRS because reaching the recycling targets depends on the rate of consumers' return. HORECAs (hotel-restaurant-café) must also collect beverage containers which are included in the DRS separately. It is also important to raise the awareness of the consumers who have a significant role in reaching the target rates of collection and achieving clean collection of beverage containers.

There are two options for collection: Manual collection and collection with Reverse Vending Machines (RVMs). In manual collection, beverage containers are accepted from consumers by retail staffs. The retailers scan the barcode of containers with cash registers or handsets for counting of containers. When the RVMs are used for the return of containers, consumers can refund the deposit via machines. Most of the RVMs compact the PET and metal containers inside the machine. Glasses are kept without being broken.

There are two options for refund of the deposit value to the consumers. Depending on the consumer's preference, the deposit value corresponding to the return of packaging is paid to the consumer in cash or a voucher equal to the deposit value can be provided to the consumer to be used in the same store for another purchase.

Control of the DRS operations and material-data-finance flow are other significant elements of a successful DRS. Material-data-finance flow can be monitored through a well-designed software.

Revenues of the DRS can be classified as one-time revenues and constant revenues. The product registration fee and the company registration fee are one-time revenues whereas the administration fee, material scrap value and the unre-

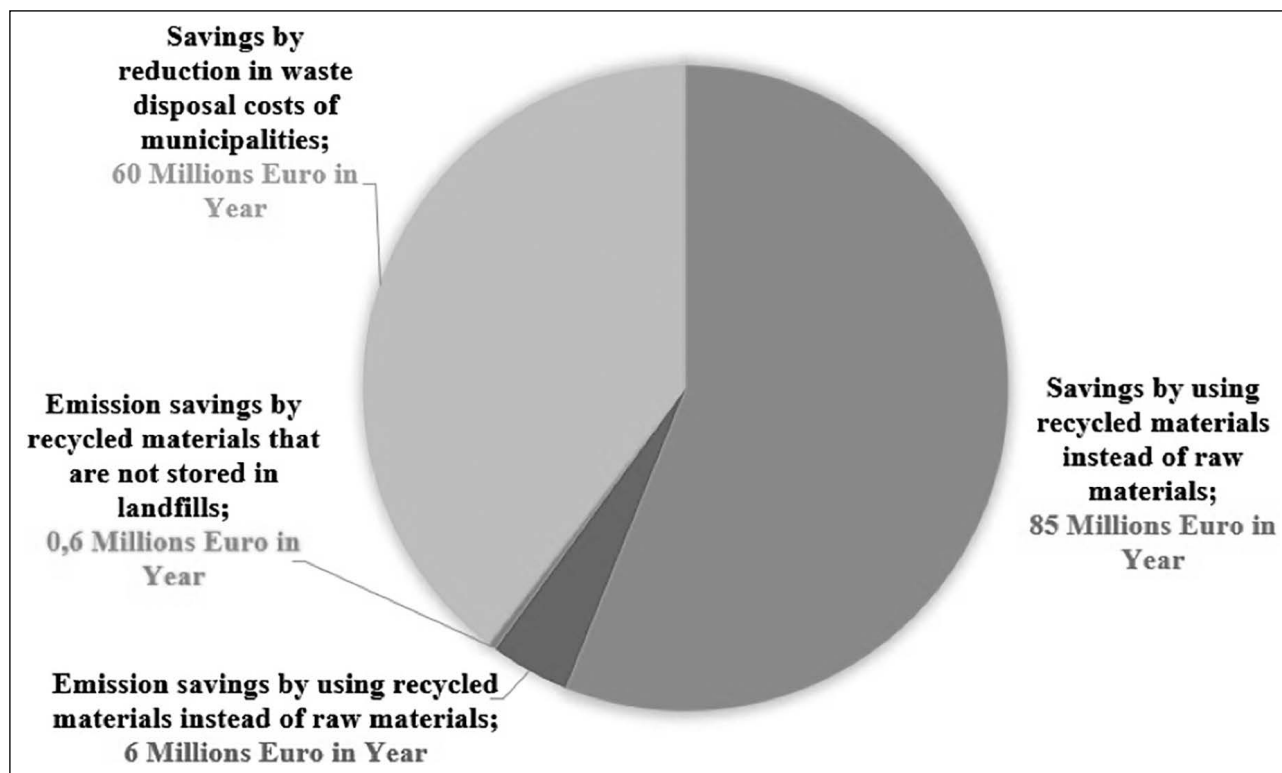


Figure 3. Estimated economic benefits of the DRS for Turkey in the first implementation year [9].

deemed deposit value are constant revenues. Costs of the DRS can be separated into two main parts: Investment costs and operational costs. Investment costs are incurred while building the counting centers and setting up the Reverse Vending Machines. Operational costs are generally classified as logistic costs, handling fees and other operational costs (central admin system, label, DRS bag).

System efficiency is an important factor to provide a sustainable DRS. System efficiency depends on required timing to implement the DRS, the balance between revenues and costs of the system and used technologies during investment and/or operation period and so on. At this point, it could be said that the Public-Private-Partnership (PPP) model is more advantageous than other governance models.

#### Public-Private Partnership (PPP) Model for the DRS

PPP model has many advantages for public projects. Under the PPP model, projects are realized with the involvement of private sector investors and financial institutions. Management tools can be used effectively in the PPP model and thus, many innovations can be made to monitor the market [10].

Firstly, the private sector can act faster. The best available technologies can be used in the investment and/or operation period. Secondly, the private sector provides excellent performance for profitability. Therefore, system can be more recoverable and efficient. In PPP model, all risks are

shared between the public and the sector. It is also possible to access the best practice in PPP projects to benefit from the project more effectively and in a more innovative way in order to increase the quality of the service. For a successful implementation of the DRS under the PPP model, there are preliminary issues, which must be dealt with as demonstrated below:

- The existing legal infrastructure must be identified to determine deficiencies (if necessary).
- The areas included in the projects, the stakeholders who will take responsibility during the operation phase, how the process will be controlled and how the service will be monitored by the state, should be planned.
- An effective monitoring and coordination mechanism must be ensured in order to detect inefficiencies in time and to reduce the costs incurred.
- Internal capacity must be developed for the continuity and sustainability of the PPP projects and for an effective control and coordination by the institutions.
- It is essential to work with independent consultants to develop the PPP project and to carry it to the project implementation phase.
- All stakeholders must be informed and engaged in every step of the PPP Project. (This is extremely important for the success of the project as it has been identified in many exemplary projects.)

### Economic and Environmental Benefits of the DRS

DRS has many economic and environmental benefits since it is one of the best ways for the separate collection of beverage containers. With the DRS, beverage containers can be collected without being mixed with other waste. Therefore, their economic value for sale does not decrease caused by any contamination. Accordingly, the waste management service fees decrease. Beverage containers are not thrown to the municipal waste containers at curbsides. Materials are saved and resource recovery is provided.

Mining activities to obtain virgin materials will be reduced. Since the required material can be collected with the DRS, there will be no need to import waste material. The recycled material will be used in new production.

Turkey imports waste PETs to use in textile and plastic industry. If the DRS is implemented in Turkey, it is assumed that the import rate of used raw material will decrease by 42%. With this way, the current deficit can be reduced as well. Furthermore, with the reduction in carbon emission, saving of raw materials and decrease in the waste disposal cost of municipalities many economic benefits can be provided. Figure 3 shows the estimated economic benefits of the DRS for Turkey within the first implementation year [9].

In addition to the economic benefits stated above, there are also several environmental benefits of the DRS for Turkey, which are listed below:

- Decrease in sea, land and air pollution,
- Reduction of approximately 1 million tons of waste annually,
- Reduction of carbon emissions,
- Extension of landfills' lifespan due to a decrease in the amount of waste being sent to landfills,
- Saving and effective use of raw materials and resources,
- Decrease in fossil fuel-based energy consumption in packaging production,
- Development of technology and capacities of recycling facilities in Turkey [9].

Lastly, it must be noted that, with the implementation of the DRS, 6 of the Sustainable Development Goals of the United Nations Development Program (UNDP) can be achieved. These goals are, namely Decent Work and Economic Growth (Goal 8); Industry, Innovation and Infrastructure (Goal 9); Responsible Consumption and Production (Goal 12); Climate Action (Goal 13); Life Below Water (Goal 14) and Life on Land (Goal 15). UNDP has aimed to ensure resource conservation, ecosystem prevention and sustainability in each stage of mining, production, logistic and consumption. Therefore, it is very important to achieve these goals in order to contribute to sustainable growth and to leave a better planet for future generations.

### CONCLUSION

The implementation of the DRS, which enables the efficient use of country resources, is environmentally and economically vital for Turkey. In this sense, the system must be well-structured and constructed on a strong governance model. Under the PPP model, the system will be developed in a more effective, profitable and innovative way with the involvement of the private sector and financial institutions in the realization of the project. By establishing a strong infrastructure for the system, the waste management and separate collection of the waste at source will be improved as well. In line with the circular economy principles, it is anticipated that the bottle-to-bottle recycling will be enabled and resource efficiency will reach the highest level in general. Furthermore, the implementation of the DRS will also contribute to the achievement of the Sustainable Development Goals of the UNDP in Turkey.

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### DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

### CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### ETHICS

There are no ethical issues with the publication of this manuscript.

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