

Article

Accessing Consumer Perceptions of the Effectiveness of the Deposit Refund System

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Abstract: This study analyzes consumers' perceptions of the Deposit Refund System (DRS) initiative in Greece. It aims firstly to measure the effectiveness of these systems in Greece. Secondly, based on elements from the Theory of Green Purchased Behavior, it identifies the motives of DRS users and how they affect DRS usage and perception. Data were gathered using a mail-out survey to consumers in various cities in Greece. The key finding supports the argument that moral motives significantly lower the costs associated with household recycling efforts. Moreover, Structural Equation Modeling (SEM) is used to examine the research hypotheses. The findings reveal that the DRS motives positively and statistically significantly affect the process of recycling and user perception of DRS. Moreover, the DRS perception affects the adoption of the DRS and complementary mediates the effect of motives for DRS adoption. The normalized model shows that an increase in motives by 1 unit will increase the perception of consumers for refundable recycling by 0.346 units. Similarly, an increase in the motives by 1 unit will increase the use of refundable recycling by 0.296 units.

Keywords: recycling; packaging; deposit refund system; circular economy; case study; Greece



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1. Introduction

The increase in the world population and the change in consumption patterns have resulted in rapid increases in solid waste. Moreover, it is estimated that approximately 11% of total household waste comes from packaging [1]. It is estimated that if no action is taken, there will be an increase in packaging waste of approximately 20% by 2030 [2].

Recycling is among the solutions to address this critical issue; one of the crucial activities of the Circular Economy. The Deposit Refund System (DRS), one of the various collection and waste management systems, has been supported by governments and by private and public organizations [3,4]. The objective of the DRS is to reduce waste and increase recycling rapidly over a short period and to increase recycling rates. The deposit-refund system is a means of gathering a significant amount of beverage containers for the purpose of reuse, promoting awareness of sorting waste, and adding value to the waste. Furthermore, it includes a wider range of materials and other types of packaging [5]. The DRS has a green user guarantee: “with the price of the product, you pay a small fee for recycling which is returned to you when you return its packaging to an approved collection point” [6]. Deposit Return Systems are recognized today as a very efficient instrument to reduce littering, and to ensure proper recycling [7].

Today, environmental awareness has increased and the trend is expected to continue. Several stakeholders, states, institutions, organizations, companies, and consumers strongly support recycling as it is critical to sustainability. Recycling decreases the dependence on new raw materials and lessens the damage to natural resources [3,5]. Additionally, it results in a decrease in energy requirements for the production of goods. Furthermore, it reduces the amount of waste that needs to be disposed of, decreases landfill pollution and saves on

the costs of managing the landfills. However, it is generally agreed that the level of recycling, with few exceptions, should further increase. A solution to this challenge is to provide consumers with incentives to recycle. Refundable recycling motivates consumers to recycle, leads to an increase in the rate of recycling and contributes to the issue of sustainability.

Since the early 1990s when the first modern Deposit Refund System in Sweden was initiated, it has spread worldwide in several countries, especially in the European Union (EU): Denmark, Estonia, Finland, Croatia, Iceland, Lithuania, Norway, Germany, The Netherlands, and Sweden. DRSs are also in operation in the United States, Canada, Australia, Israel, and the island states of Micronesia, Kiribati, and Palau [8].

In most countries, the DRS initiative is considered to be successful. There are several studies on the effectiveness and success of the DRS initiatives in various countries. For example, Vigsø [9] evaluated the beverage packaging deposit refund system considering the cost–benefit analysis in Denmark. Linderhof et al. [10] analyzed the effectiveness of the Deposit Refund System for household waste in The Netherlands. Dace, Pakere, and Blumberga [11,12] conducted two surveys in Latvia and concluded that economic costs should not outweigh the environmental benefits. Furthermore, Lavee [13] argued that the deposit refund program in Israel is highly efficient. Based on the above findings, it is interesting to examine the application and success of the DRS practice in Greece. The scheme was initiated by the state and has been in operation for the last 10 years [14].

During the last years, Greece has operationalized a collection and recycling system of packaging plastic, glass, and aluminum packaging in specific recycling/collection points. According to the Greek press and mass media, these centralized recycling/collection points, and the DRS paradigm in general, have not been adopted by Greek citizens/consumers to the extent the national and local authorities believe. Nevertheless, there are no studies regarding the assessment of the success and effectiveness of this program.

The objective of this study is to examine the general attitudes, perceptions, and acceptance of the Deposit Refund System in Greece. Specifically, the study aims to (a) measure the effectiveness of the adoption of the DRS in Greece, and (b) to identify the motives of DRS users and how they affect DRS usage and the perception of consumers.

More specifically, this study aims to measure the effectiveness of the DRS in Greece and to provide answers to the following research questions:

RQ1. What are the perceptions of consumers about the DRS process?

RQ2. What are the common problems users of the DRS face during the recycling process?

RQ3. Do existing motives regarding the DRS have an effect on it?

RQ4. How is participation in DRS affected by citizens' perception of it?

RQ5. Is there any relationship between DRS motives and consumers' perception of it?

The rest of the paper is organized as follows; first, the results of bibliographic research about the success and the effectiveness of the DRS initiatives in various countries are presented, identifying also the corresponding motives of their users. Moreover, the main characteristics of the DRS program in Greece are discussed. The key parameters and the findings of the applied research methodology are presented and analyzed. Finally, insights pertaining to the findings are discussed and managerial implications are provided.

2. Effectiveness of DRS Initiatives and Research Model

2.1. Assessment of the Effectiveness of the DRS Initiatives in Various Countries

As mentioned above, the DRS is currently operating in some European countries such as Finland, Denmark, and Germany, whereas other countries such as the UK, France, and Belgium declined to apply it [15]. In Spain, especially in the eastern regions of the country, there is an ongoing debate on the suitability of such a system to increase recycling rates of household waste. The outcomes of these initiatives have been recorded and examined by many research studies [16].

Most studies have shown that the adoption of the DRS has positive economic results and identified and suggested several “best practices” to increase the effectiveness of the

initiatives. For example, Dráb and Slučiaková examined the DRS initiative in Slovakia [17] and Brizga, Moora, and Balcers [18] in Latvia. They argued that the introduction of the DRS requires substantial organizational resources. The resources needed can be reduced with the adoption of other waste collection systems operating in parallel with the DRS and shorten the payback period.

Agnusdei, Gnoni and Sgarbossa [19] argue that, “in countries where the DRS is adopted, the glass packaging recycling per capita was not higher than in countries who have adopted other waste collection and management systems”. Moreover, according to a report by Deloitte [20], “Although recycling schemes vary between countries, in terms of the mandatory nature of the system, the types of packaging/containers included or the deposit costs, their performance is similar. The average level of the waste collection in the system in the above-listed countries is approximately 91%”.

2.2. DRS Scheme in Greece

In this study, the consumers’ perception of the effectiveness of the DRS initiative in Greece is examined and assessed. Currently, there are two types of recycled waste collection systems available to citizens: the “blue” bins in neighborhoods, managed by local authorities (municipalities) which are not a refund system, and the “little houses”, which operate as Rewarding Recycling Centers located in large retailers managed by a state organization (Figures 1 and 2).



Figure 1. “Blue” bins for recycling.



Figure 2. Rewarding Recycling Centers, “Little houses” for recycling.

This study focuses on the Rewarding Recycling Centers (little houses). The 2939/2001 and 4496/2017 laws on “Packaging and alternative management of packages and other products—Establishment of the National Organization for Alternative Management of Packaging and Other Products”, created the alternative management framework operation in Greece. All companies which import, produce and supply packaged goods to the domestic market are required to install individual systems or to participate in collective systems for alternative management of these packages [21].

There are four principal actors involved in the Deposit Refund System scheme in Greece, namely:

1. The consumers: They can purchase a beverage in any retail store in the country, and pay the deposit to the retailer. Once they return the bottle (drink containers in glass, metal, and plastic) to one of the Reverse Vending Machines (RVMs), they receive a recycling ticket with a discount on it for their next purchase. This ticket can be used to purchase any product only at the retail store where the RVMs, “little houses”, are

- located. There is a refund for each packaging item deposited (EUR 0.03 for one plastic, metal, or glass packaging item).
2. The retailers: The stores where Reverse Vending Machines are located. The machines receive and compress the packages/bottles. The RVM also prints out the ticket with the amount of the deposit on it. When the RVMs are full, the retailer empties them and stores the bottles for collection by the DRS administrator.
 3. The administrator of the DRS practice in Greece “Antapodotiki”: It is a non-profit organization, approved by the Greek Ministry of Environment and Energy, serving exclusively the public interest. Its mission is to organize and promote the recycling of packaging throughout the country. The organization manages all data in the system, claims the deposits from the retailers, and supplies the labels upon request. It oversees the operation and maintenance of the RVMs, the collection and transportation of bottles, the preparation (further compaction), and the temporary storing of bottles in waste treatment facilities. The organization also manages the money flows and transfers revenues to cover the costs (for example, it compensates retailers where the RVMs are located).
 4. The social solidarity companies who are responsible for the collection, transportation and recycling of packaging.

The above system and especially the centralized collection points have been criticized by consumers. They believe that the “blue bins”, especially in the large urban centers, are not enough to cover the needs of the residents. Furthermore, they are often dirty, left open or without lids and due to poor collection timing, they are often overflowing. There is also a prevalent feeling that the “blue” bins are dealt with by municipalities as common garbage cans, and their use creates multiple feelings of insecurity and ignorance (many citizens dispose of the wrong materials or in an inappropriate way). Moreover, the “little houses” seem to have been marginalized. Most customers of big retailers know them but in the last few years, at least, they have not used them. They are present in limited numbers and consumers lack the motives to use them.

2.3. Conceptual Framework and Research Model and Hypotheses Development

The proposed conceptual framework examines the effect of the motives and the consumers’ perception of the DRS recycling on the adoption of the DRS.

2.3.1. Motives for the Adoption of Deposit Refund Systems

As noted by Janmaimool [22], the consumers’ decision to adopt waste disposal schemes is affected by environmental and health factors. Past research has shown that the lack of motives is a critical factor for their engagement in recycling package material [23]. Other studies note that the success of the DRS depends solely on the fee charged and returned to consumers [24–29]. However, factors such as the consumers’ environmental and waste sorting awareness and the number of recycling/collection points can also impact pro-environmental behavior and enhance the recycling return rate [30,31].

Furthermore, the adoption of the DRS paradigm has been proven to be environmentally effective in practice [32,33]. DRSs are designed to decrease the environmental impact of beverage packaging and to increase its resource efficiency. Furthermore, they reduce Europe’s dependency on imports, improve its competitiveness and lead to the creation of new jobs [34]. Overall, the DRS initiatives can be considered a key driver to a better environment for future generations [26,35,36].

Moreover, according to Spiegelman [36], the adoption of the DRS conserves energy, reduces air and water pollution, decreases the emission of greenhouse gases and conserves natural resources. In addition, it reduces landfill waste in the waste collection areas [37,38]. The importance of environmental norms has been underlined by Videras [39]. They argue that environmental norms have an impact on the consumers’ decision to adopt recycling practices. Based on the above literature review, the following motives related to environmental concerns for DRS adoption are examined in this study: (a) offer a better environment

to future generations, (b) protect the environment, (c) reduce landfill waste, (d) conserve natural resources, and (e) conserve energy. More specifically, we argue that there is a need to further examine the motives of consumers and their effect on the success of the DRS. Thus, we suggest that:

H1. *DRS motives affect positively the process of recycling.*

H2. *DRS motives affect positively the perception of the DRS users.*

2.3.2. Perceptions for Adoption of Deposit Refund Systems

According to Sijtsema et al. [40], it is important to understand consumers' perceptions towards circular economy practices and how they impact their adoption by society. Furthermore, they note that research has shown a great variety of such perceptions and they underline the need to further examine and understand them.

In regard to the adoption of the DRS, as Puigvert et al. [41] indicate, only a limited number of studies have examined the consumers' perceptions of the scheme. In their study in Spain, they found that the information they receive on the system is critical. Consumers who recycle less frequently believe it is a rather time-consuming and complicated process. Thus, clear communication and clarification of the characteristics of the DRS is important to change their perception and make it successful. A study in Hungary [42], where the DRS was recently introduced, showed that demographic characteristics and the consumers' environmental concerns have an impact on the adoption of the DRS. Furthermore, they found that level of education does not have an impact on their perception about the new scheme. Research in Catalonia has also shown that information about the system impacts consumers' perceptions. Interestingly, although the initial perceptions were positive, detailed information may result in a reduction in willingness to adopt the DRS. Moreover, the importance of communication and information campaigns have an impact on the consumers' perceptions [15]. In Scotland where the scheme was recently introduced, Oke et al. [43] found that factors such as concern for the environment and solid knowledge of the DRS have an impact on consumers' perceptions. Based on the above analysis, we suggest that:

H3. *DRS perception affects positively the adoption of the DRS.*

H4. *DRS (users') perception complement mediates the effect of motives of the DRS adoption.*

The model consists of three latent variables: (1) the motives, (2) the consumers' perception of DRS recycling, and (3) the adoption of the DRS. The dependent variable is the DRS, motives are the independent variable, and citizens' perception of the DRS recycling is the intermediate one. Each latent construct was developed based on a synthesis of factors found in the literature (Figure 3).

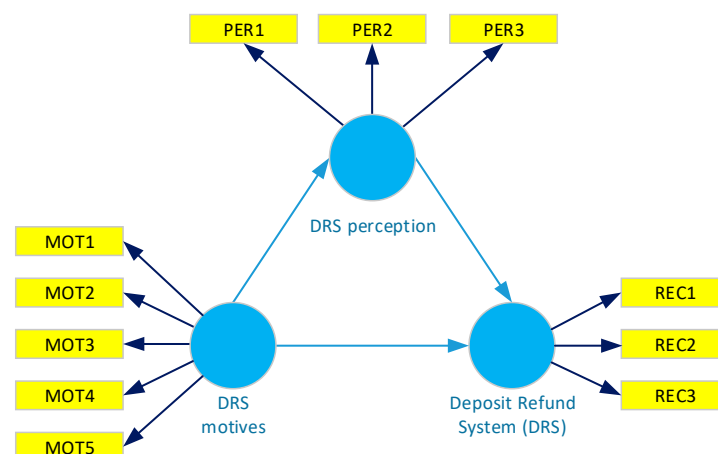


Figure 3. Model representation.

In summary, based on the proposed model, the following hypotheses are examined:

- H1.** *DRS motives affect positively the process of recycling.*
- H2.** *DRS motives affect positively the perception of the DRS users.*
- H3.** *DRS perception affects positively the adoption of the DRS.*
- H4.** *DRS (users') perception complement mediates the effect of motives of the DRS adoption.*

The latent variable of motives consists of the indicators of the findings presented in Table 1/"Key findings" column: A better environment for future generations (MOT1), protection of the environment (MOT2), reduction in landfill waste (MOT3), conservation of natural resources (MOT4), and conservation of energy (MOT5). Accordingly, the latent variable of consumers' perception consists of the citizens' perception of the ease of refund recycling (PER1), the degree to which they do not face technical or procedural issues with refund recycling (PER2), and the degree to which their values about green thinking are reflected (PER3). Finally, the latent variable of the adoption of refund recycling consists of the frequency of recycling glass (REC1), plastic (REC2), and metal (REC3), constituting the three indicators on which the latent variable reflects.

It should be noted that the following control variables were used: age, educational level and annual family income. However, their impact was not statistically significant and they were excluded from the model. The 10-times rule method was used to check the suitability of the model (the minimum required sample is defined as the number of internal or external relationships multiplied by 10) [44]. The specific model includes 15 internal or external relationships. Therefore, the minimum required sample is 150 observations, while the research collected 578, confirming the adequacy of the sample for the application of this method. Based on previous work, the Smart-PLS software was used [44,45].

Table 1. Lessons learned about the application of DRS in various countries.

Author(s)	Title of Research Paper	Key Findings
Vigsø [9]	Deposits on single use containers—a social cost–benefit analysis of the Danish deposit system for single-use drink containers	The new deposit system has considerable social costs in comparison to its benefits. This holds for all four categories of disposable drink containers analyzed, where a comparison was made between the social costs and environmental advantages of gathering these containers through the Danish deposit system and the social costs and benefits of disposing of them as part of the regular waste management system [9].
Miliūtė and Plepys [46]	Driving Forces for High Household Waste Recycling Lessons from Sweden	Creating robust connections and collaboration among the DRS organizations, the municipalities, and the waste management enterprises is crucial. Additionally, it is essential to define and agree upon the responsibilities of each of these parties clearly [46].
Lavee [13]	A cost–benefit analysis of a deposit refund program for beverage containers in Israel	The deposit refund program is clearly worthwhile economically [13].

Table 1. Cont.

Author(s)	Title of Research Paper	Key Findings
Dace, Pakere and Blumberga [12]	Evaluation of economic aspects of the deposit refund system for packaging in Latvia	The expenses associated with the Deposit Refund System rely on the amount of packaging that is introduced into the market. Similarly, the amount of packaging that is returned as deposits is dependent on the consumption of beverages. If the Deposit Refund System is implemented, it would result in higher costs for beverage packaging, since manufacturers would be responsible for paying the service fee charged by the system operator to cover its costs [12].
Dāce, Pakere and Blumberga [11]	Analysis of sustainability aspects of the packaging deposit refund system in Latvia	Although the Deposit Refund System can positively influence citizens' environmental awareness, its benefits must be weighed against its costs. In Latvia, this is particularly difficult to achieve due to the low consumption of beverages. As a result, alternative solutions should be sought to improve the existing curbside container system rather than introducing the Deposit Refund System [11].
Dráb and Slučiaková [17]	Analysis of the introduction of the deposit refund system for single-use beverage packaging in the Slovak Republic	The implementation of a mandatory Deposit Refund System for bottles and cans will not only impact the producers and the system but also lead to indirect and social costs and benefits. On the one hand, it could lead to a reduction in littering, an increase in employment, and environmental benefits. On the other hand, it could result in reduced funding for separate collection and decreased comfort for the population [17].
Linderhof et al. [10]	Effectiveness of deposit refund systems for household waste in The Netherlands: Applying a partial equilibrium model	DRS is more effective at increasing recycling rates in situations where the current recycling rates are relatively low. Additionally, having an existing infrastructure or facility for separate collection would make small goods a suitable candidate for this program [10].

Table 1. Cont.

Author(s)	Title of Research Paper	Key Findings
Brizga, Moora and Balcers [18]	DRS for beverage containers in Latvia: learnings within the Baltic states	Estonia and Lithuania have implemented DRS as a means of improving the collection and recycling rates of beverage packaging. Both countries have created mandatory centralized systems with a collection rate of over 90%. The Estonian system's strengths are due to its sophisticated IT solutions, differentiated European Article Numbering (EAN) coding logic, flexibility, and efficient management. On the other hand, the Lithuanian system is one of the most technologically advanced systems [18].
Abejón et al. [16]	Environmental impact assessment of the implementation of a DRS for packaging waste in Spain: A solution or an additional problem?	Extended Producer Responsibility System (EPRS) is the current practice for packaging in Spain. Although the environmental savings of the new system are superior to its impacts, even if the DRS could reach a value of 90% for the package return index, the current EPRS obtains significantly better environmental results [16].
Oke et al. [43]	Rethinking and optimizing post-consumer packaging waste: A sentiment analysis of consumers' perceptions towards the introduction of a deposit refund scheme in Scotland	While consumers' knowledge and view about DRS are mixed, the efficiency of DRS is questioned and raises doubts about its contribution to sustainability. The findings imply a need for the UK to negotiate and collaborate on appropriate and attractive interventions in addressing post-consumer single-use plastic containers [43].
Roca, Ayuso, Bala and Fullana-i-Palmer [41]	What factors determine attitudes towards the implementation of a packaging deposit and refund system? A qualitative study of the perception of Spanish consumers	The public perception of the DRS is very sensitive to the information provided. The description of some of the distinctive features of the new system, such as the mechanism associated with the economic deposit or the process to return packages, ultimately result in a rather negative evaluation and a reduced predisposition to participate in waste collection [41].

Table 1. Cont.

Author(s)	Title of Research Paper	Key Findings
Roca et al. [15]	Evaluating the implementation of a packaging Deposit and Refund System in Catalonia. Two surveys on citizenship's expected behavior	This research examines the results of two surveys: a telephone survey and an online survey that aimed to capture citizens' evaluations and anticipated behavior changes under the proposed waste collection system. The results of the two surveys differ significantly, with the DRS features receiving more favorable feedback in the telephone survey compared to the online survey. Furthermore, the willingness to adopt the system is higher in the telephone survey [15].
Schröer and Latacz-Lohmann [47]	Farmers' willingness to engage in a deposit refund system for animal manure in biogas production: A discrete choice experiment in Germany	According to the study's results, German farmers have shown a high willingness to participate in a Deposit Refund System for animal manure, with an average probability of participation being 70%. The study also suggests that the Deposit Refund System could be an efficient means of distributing nutrients regionally, with an average of 73% of nutrients being returned. Any remaining quantities of nutrient can be transferred to crop farms, possibly for a fee, which can be financed by the retained deposit [47].

3. Research Methodology

The study population consists of retail store customers who use the Deposit Refund System. A questionnaire was developed. The questions it contained were based on the literature review. A five-point Likert scale was used, as it is less time consuming and confusing, it facilitates respondents, and increases participation rate. Furthermore, the use of a larger Likert scale makes it more challenging for respondents to provide meaningful responses (the differences are rather small). A cover letter explained the purpose of the research and ensured the anonymity of respondents. Using the convenience sampling method, individuals were given a link to access and respond to the questionnaire if they were DRS users. From a total of 3113 respondents, 578 use the DRS (18.6%). This empirical analysis is based on the responses of this population. First, they were asked about the frequency of the DRS use. There were also questions about the effectiveness of the DRS and the main problems they face with the recycling process. Most of the questions were of the closed type and two were multiple choice. In addition, several demographic questions were included.

A pilot study was first conducted. Since the questionnaire was based on questions included in published work, there were no issues of clarity or structure. Data were collected in five cities in Greece: Athens, Thessaloniki, Larissa, Xanthi, and Katerini. These cities were chosen due to several recycling points ("little houses"). Respondents were asked if they use rewarding recycling and if they would like to participate in the research. The survey was carried out between August and September 2022. Following the selection of the questionnaires the Cronbach's Alpha was calculated to measure reliability. The calculated value (0.802), is larger than 0.7 and is considered satisfactory. Following the collection of the questionnaires, Cronbach's Alpha was used to measure the reliability of the questionnaire. Its value was 0.802, which is considered satisfactory (larger than 0.7). Furthermore, the Kaiser–Meyer–Olkin measure of sampling adequacy was used. Its value 0.820 is larger

than >0.7 , so the collected sample is considered adequate. In addition Bartlett's test of sphericity was used. The result of the approximate chi-square value is 3998, which is a statistically significant result (p -value = 0). This indicates that the null hypothesis of the test is rejected in favor of the alternative, which highlights that there are statistically significant correlations in the dataset, which imply underlying constructs on the data.

Almost half of the sample (51.7%) consists of females, young individuals (ages 18 to 34), 53.5%, and unmarried persons (55.0%). The majority (45%) are employed in the private sector and earn less than EUR 23,000 per year (75%). A total of 30.8% have a Bachelor's degree and 39.8% a high school diploma. More than 80% of the respondents live in Athens (the capital of Greece) and Thessaloniki (the second biggest city in the country). Table 2 shows the demographic data:

Table 2. Sample demographics.

Gender	N	%
Male	279	48.3
Female	299	51.7
Age group		
18–24	178	30.8
25–34	131	22.7
35–50	177	30.6
51–65	82	14.2
Over 65	10	1.7
Education level		
High School	230	39.8
Post-secondary non-tertiary education	106	18.3
Bachelor's degree	178	30.8
MSc/PhD	64	11.1
Marital status		
Unmarried	318	55.0
Married	260	45.0
Employment status		
University student	151	26.1
Unemployed	59	10.2
Private sector employee	259	44.8
Public sector employee	109	18.9
Annual family income		
EUR < 12,000€	162	28.0
EUR 12,000–23,000	267	46.2
EUR 24,000–35,0000	113	19.6
EUR > 35,000	36	6.2
City		
Athens	293	50.7
Thessaloniki	175	30.3
Larissa	28	4.8
Xanthi	66	11.4
Katerini	16	2.8

The use of latent variables in the model, and the study of indirect effects led to the decision to design a Structural Equation Model and use the Smart-PLS software to process the data.

4. Results and Discussion

Most of the respondents had used the DRS for less than a year (41.5%), and almost 30% of them for 1 to 3 years. A total of 28.7% can be considered experienced DRS users. They learned about the DRS mainly by word of mouth (34.6%), from retailers and chain stores (15.2%), social media and blogs (13.7%), news media (12.8%) and advertisements (12.1%).

The respondents recycle more plastic than glass and metal. Nearly 53% recycle plastic “often” and “very often”, almost 60% recycle glass “sometimes” and “often”, and approximately 53% recycle metal “sometimes” and “often” (Figure 4).

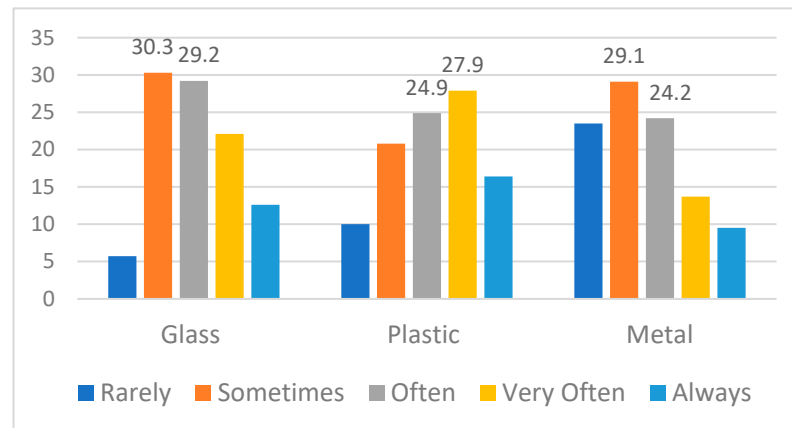


Figure 4. Frequency of recycling glass, plastic and metal.

The majority of the respondents recycle less than 50 units in each visit to the recycling/collection points. This is anticipated since they receive EUR 1 for every 33 plastic, metal or glass items of packaging they deposit (Figure 5). This also indirectly shows that the DRS has not been fully assimilated in their consciousness. Once again, plastic seems to be recycled more than glass and metal.

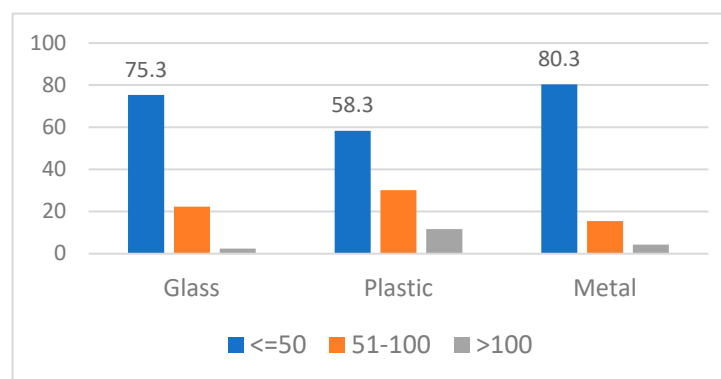


Figure 5. Number of recycling glass, plastic and metal items.

4.1. Measuring the Effectiveness of the DRS in Greece

The majority of the respondents agree that rewarding recycling is an easy and enjoyable process, that they do not encounter any technical or procedural problems, and that the process reflects their recycling values. It is interesting that the majority of respondents answer “no” to all problems related to deposit refund recycling. The same applies to the questions about the motives for reciprocating, with the exception of “more recycling points”. Lastly, respondents have mixed feelings about the financial benefit of this process and whether the process is time consuming. The responses are depicted in Table 3.

Table 3. Opinions of the consumers about the DRS process (%).

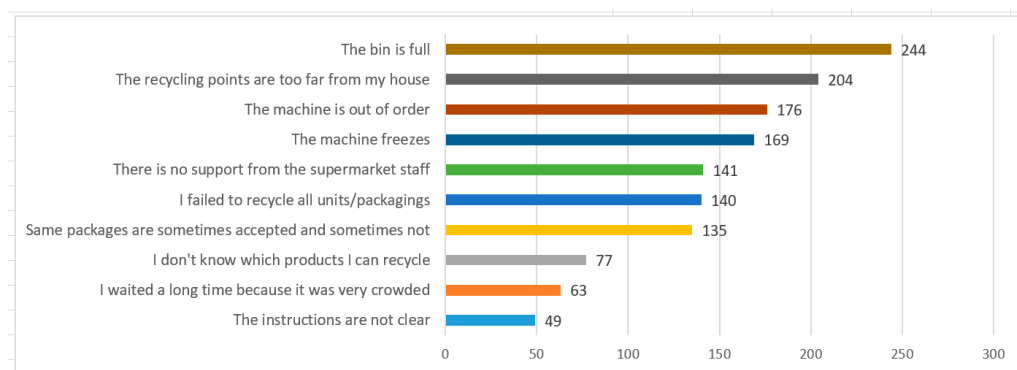
Statement (*)	1	2	3	4	5
DRS is an easy and pleasant process for me	2.1	13.7	21.1	47.8	15.4
DRS is a process that I do not encounter technical problems	2.4	13.5	29.8	44.6	9.7
DRS is a process that reflects my values about green thinking	2.1	8	30.3	49.7	10

(*) 1: I strongly disagree; 2: I disagree; 3: Neither agree nor disagree; 4: I agree; 5: I strongly agree.

Respondents were asked to rate the problems they faced during the recycling process. They were given the following options:

- The machine is out of order.
- The bin is full.
- The machine freezes.
- The instructions are not clear.
- They did not know what products can be recycled.
- They did not have the appropriate support from the supermarket staff.
- Similar packages are sometimes accepted and other times are not.
- They failed to recycle all units/packages.
- The waiting line was too long.
- The recycling/collection points are too far from my house.

The following Figure 6 presents the findings:

**Figure 6.** Common problems of DRS recycling (descending order).

As shown above, in most cases, consumers cannot complete the recycling process because of technical issues; the bins are full, the machines are out of order, or they unexpectedly freeze before the process is completed. Moreover, sometimes packages are accepted for recycling while at other times, the same packages are not. Another major problem is a lack of support from the supermarket staff. Furthermore, the small number of recycling points (“little houses”) is not enough to cover the total demand. Other, less important problems are the long waiting times, the lack of clear instructions on the use of the DRS and the fact that consumers do not know which packages can be recycled and which ones cannot.

In addition, consumers made a number of suggestions regarding the DRS process to make it more effective and efficient (they could choose more than one option). Figure 7 presents the suggestions in descending order of frequency.

DRS users emphasized the need for more recycling/collection points. Furthermore, they expect more support and information from the local authorities, the media and the retailers, and less, unexpectedly, from the DRS administrator. It is important to note that the financial incentive is not considered to be the most important to increase the use of the DRS.

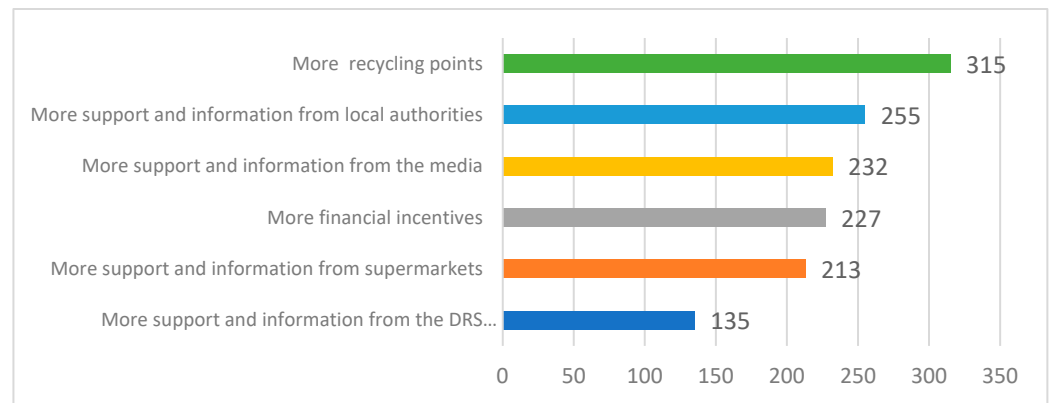


Figure 7. Suggestions by users to improve the DRS scheme.

4.2. Model Estimation

The following model (Figure 8) has emerged with the use of the Smart-PLS software 4:

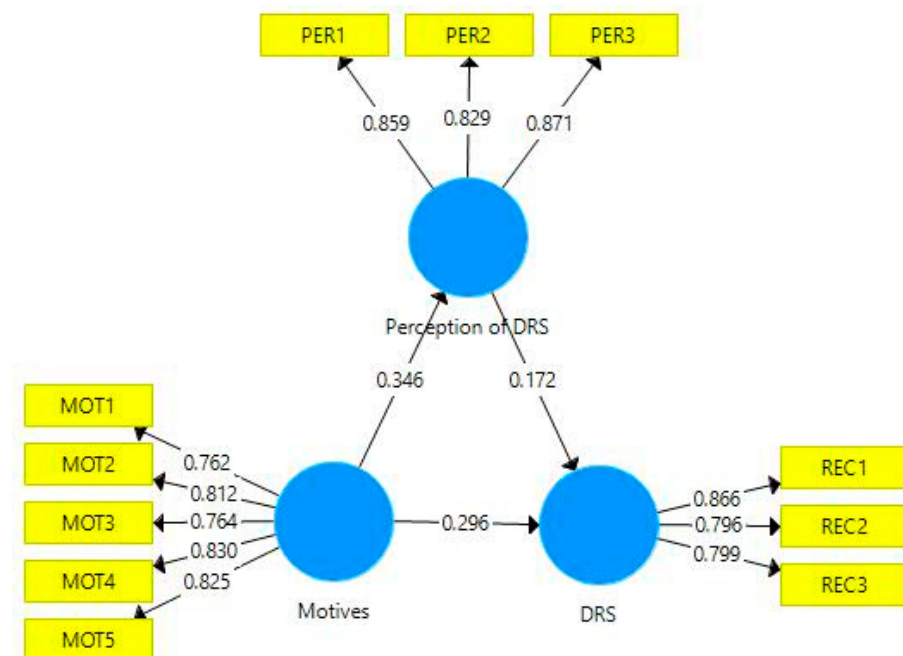


Figure 8. Model representation.

The PLS algorithm executed 5000 iterations. Firstly, the data fit was examined through the Standardized Root-Mean-Square Residual (SRMR) index, which should be less than 0.08 [48]. The model meets this condition, as the estimated model SRMR index is 0.074. Then, the path coefficients are checked. The effect of incentives on citizens' perception of refundable recycling stands out, with a path coefficient of 0.346. The next strongest effect is that of motives for remunerative recycling with 0.296, followed by the effect of citizens' perception of refundable recycling on its use, with a path coefficient of 0.172.

4.3. Reflective Measurement Model Assessment

In this subsection, firstly, the internal consistency and reliability are evaluated by Cronbach's Alpha, ρ and Composite reliability. Secondly, the convergent validity of the model is examined through the outer loadings and the Average Variance Extracted (AVE). In addition, the discriminant validity is examined through the Heterotrait Monotrait criterion (HTMT). For this purpose, bootstrapping with 5000 subsamples is performed. In this criterion, a matrix is produced, where each element must have a value of less than 0.85. As

shown in the tables below, all the required conditions apply, ensuring internal consistency, reliability, convergent validity and discriminant validity for the model (Tables 4 and 5).

Table 4. HTMT values.

	Perception of Refund System	Deposit Refund Recycling	Motives
Perception of refund system			
Deposit refund recycling	0.316		
Motives	0.408	0.412	

Table 5. Path Coefficients of the structural model and significance testing results.

	Path Coefficient	95% Bca Confidence Interval	Significant ($p < 0.05$)?	f^2 Effect Size
Motives → Perception of contributory recycling	0.346	[0.259, 0.426]	Yes	0.136
Motives → Contributory recycling	0.296	[0.220, 0.365]	Yes	0.091
Perception of contributory recycling → Contributory recycling	0.172	[0.079, 0.255]	Yes	0.031
Motives → Perception of contributory recycling → Contributory recycling	0.059	N/A	Yes	N/A

4.4. Structural Model Assessment

In this sub-section, the first step is the collinearity test between the latent variables. The Variance Inflation Factor (VIF) index is used, which must have a value of less than three. This applies to all the latent variables of the model, so there is no issue of collinearity (Table 6). Secondly, with the use of bootstrapping, a non-parametric technique, the statistical significance of the effects is tested. At a statistical significance of 5%, the p -value must have a value of less than 0.05 for an effect to be considered statistically significant. This applies to all the studied effects of the model, both direct and indirect. Beyond the statistical significance of the effect, the f^2 index is used to investigate the size of each effect examined. All effects are considered small as they lie between 0.02 and 0.15 (Table 5). Then, the model is assessed for its predictive accuracy and the PLS Predict and Blindfolding techniques are used respectively [44]. In regard to the PLS technique, the Root-Mean-Square Error (RMSE) and Mean Absolute Error (MAE) are utilized to assess the endogenous construct predictive relevance. The RMSE and MAE values are checked for each indicator on the PLS and on the linear model (Table 7). The majority of the linear model indicators extract higher prediction errors than the PLS model. This indicates a medium predictive relevance of endogenous constructs [38]. The Blindfolding Technique used shows that Q^2 values are higher than 0, so the model has predictive relevance. Specifically, PER and REC are 0.085 and 0.090, respectively. As they do not exceed 0.25, the model's predictive accuracy is small.

Table 6. PLS Predict.

	PLS Model		Linear Model	
	RMSE	MAE	RMSE	MAE
PER1	0.929	0.737	0.926	0.730
PER2	0.820	0.652	0.821	0.647
PER3	0.890	0.720	0.893	0.723
REC1	1.049	0.875	1.052	0.877
REC2	1.231	1.023	1.230	1.029
REC3	1.187	1.001	1.186	1.003

Table 7. Assessment of measurement model.

Latent Variable	Indicators	Convergent Validity		Internal Consistency Reliability		
		Loadings	AVE	Composite Reliability	ρ_A	Cronbach's Alpha
		>0.7	>0.5	>0.7	>0.7	0.7–0.9
Motives	MOT1	0.762	0.728	0.925	0.864	0.868
	MOT2	0.825				
	MOT3	0.812				
	MOT4	0.764				
	MOT5	0.762				
Perception of contributory recycling	PER1	0.871	0.728	0.889	0.822	0.814
	PER2	0.858				
	PER3	0.829				
Contributory Recycling	REC1	0.868	0.674	0.861	0.864	0.768
	REC2	0.797				
	REC3	0.797				

5. Conclusions

The Deposit Refund System (DRS) aims to increase the quantities of used packaging consumers return to recycling/collection points (Rewarding Recycling Centers). This practice will in turn increase the reuse of packaging products and the recycling of packaging material. Moreover, it may help prevent littering, as it gives consumers an incentive to return empty packaging [34,49].

According to EU policy, effective from 1 January 2022, large sellers (enterprises and retailers) of beverages are required to have the necessary equipment for the deposit of packages. The State is financing the equipment and the overall objective is to recycle 70% of all packaging waste by 2030 [50]. The DRS ensures the appropriate means to recycle and consumers are rewarded with a coupon. The value of this coupon depends on the capacity of the package returned. Overall, citizens in most EU countries have embraced this green practice.

This study analyzes consumers' perceptions of the DRS initiative in Greece. The aim is to measure the effectiveness of the DRS in Greece, and to identify the motives of DRS users and how these motives affect DRS usage and perception. The results of descriptive statistics show that refundable recycling is primarily carried out with plastic food packaging and secondly, with glass or metal packaging. This is very important as it is estimated that 42% of the total production of plastic globally is used for food packaging [51].

In regard to the quantity recycled (plastic, glass and metal), the number of items is no larger than 50 per visit. The majority of respondents agree with the statements: (a) "DRS

is an easy and pleasant process for me", (b) *"DRS is a process where I do not encounter technical problems"*, and c) *"DRS is a process that reflects my values about green thinking"*.

With respect to the challenges related to refundable recycling and the actions needed to increase the consumers' engagement in recycling, Figures 6 and 7 show that the number of recycling points is limited, and as a result, their use is time consuming for the customers. Furthermore, appropriate management of the system is needed, as the issue of full bins is rated as the most important by the respondents.

This study shows that consumers are willing to participate in refundable recycling initiatives due to their environmental concerns, and they regard the DRS as an easy and simple process. However, in order to enhance their overall participation, a greater number of Rewarding Recycling Centers are needed. Furthermore, according to the findings, all effects examined are statistically significant and confirm all research hypotheses. More specifically, we found that:

DRS motives positively and statistically significantly affect the adoption of DRS. This finding is encouraging because it shows that existing motives are working in favor of refundable recycling. The challenge is to extend the motives and to increase their impact on deposit refund recycling.

DRS motives positively and statistically significantly affect the users' perception of DRS. DRS motives have a positive effect not only on the adoption of DRS, but also on citizens' perception of it. This finding is important, because it shows that motives have an impact on a fundamental factor of citizens' participation in DRS adoption. Policymakers and the organization which is in charge of the DRS should add motives to increase consumer participation in DRS.

DRS perception positively and statistically significantly affects the adoption of DRS. The results confirmed that the citizens' opinion on refundable recycling affects their participation in it. This impact is positive. Ways to improve consumer's perception of refundable recycling should be further examined. Certain marketing actions should be applied to promote DRS, explaining to consumers why they should participate and how they will benefit from this process.

DRS users' perception complementary mediates the effect of motives of DRS adoption. As both the direct and the indirect effects of DRS motives to DRS are statistically significant, the intermediary variable of consumers' perception of DRS emerges as a complementary partial mediator. This result actually demonstrates that consumers' perception of DRS enhances the impact of DRS motives to the adoption of DRS. In summary, a series of targeted actions by policymakers and the organization which is responsible for DRS could add motives and improve consumers' perception of DRS. Thus, participation in the DRS will increase, benefiting both the environment and people's well-being and prosperity.

The model examined three direct effects, through to the hypotheses testing (H1, H2, and H3). The values of path coefficients showed the quantitative importance of the motives. Utilizing the normalized model, it is shown that an increase in motives by 1 unit will increase the perception of consumers for the refundable recycling by 0.346 units. Similarly, the increase in motives by 1 unit will increase the use of refundable recycling by 0.296 units.

From the above findings it becomes evident that policymakers should provide more incentives to consumers and improve their perception of DRS to increase their participation in it. Furthermore, the fee that consumers receive per recycled item could be increased to make DRS more attractive.

In addition, information and awareness campaigns on remunerative recycling could strengthen the existing incentives, but also further improve the perceptions of citizens about the process.

The study has significant implications. Firstly, it contributes to current relevant research by providing an overview of the current state of refundable recycling in Greece. Secondly, it examines the perception of Greek consumers on refundable recycling and analyzes the impact of several factors on their engagement in refundable recycling. A limitation of this study is that it focuses only on perceptions of DRS users and neglects

to examine the perceptions of non-users. It will be useful for future research to compare the perceptions between the two groups. In addition it will be useful to examine other factors and their impact on the consumers' decisions to adopt refundable recycling. Lastly, the perceptions of other stakeholders (food processors, retailers, companies and state agencies/organizations) should be examined.

Moreover, it will be useful to compare the perceptions of DRS users and non-users. Furthermore, it should be noted that additional policies are needed in Greece to provide incentives to consumers to recycle more, in order to close the existing gap with other EU countries and achieve the EU targets. Moreover, the DRS examined mostly on the retailers. They oversee the placing of the adhesive labels on the bottles and they are responsible for managing the data of the system and the money corresponding to the unclaimed deposit to the administration. These tasks need to be conducted in a reliable manner, otherwise the system will not perform as expected.

Therefore, it is necessary to closely control this step in the DRS process. Given this, it is suggested to make registration to the system mandatory for all retailers. Furthermore, the store (where the bottle/package is purchased) should be indicated on the bottle label. As Rossetti [52] argues "From a free-market perspective, a DRS can be a superior waste management policy to government mandates because individuals respond to price incentives, which the DRS provides" [52].

Finally, local authorities that have understood that waste management is a public good should play the critical role of the supporter and enabler of the DRS paradigm. In conclusion, recycling mitigates pollution and appears to be a viable response to the current environmental crisis. Strong support is needed to change the current recycling practices in Greece and refundable recycling can be a solution to this challenge, as it motivates consumers and may lead to an increase in food packaging recycling rates.

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