

Consumer Perception of the Zero-Waste Concept: a Hungarian Case Study

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Sustainability is a concept that many people are familiar with, but it also seems elusive and difficult to generalize. Part of this concept is the Zero Waste mindset, which exists in equally diverse forms in people's minds. The research uses the 7R approach of the Zero Waste framework, adapted to consumers, to analyze which consumer groups can be distinguished from each other in terms of Zero Waste thinking. The methodology is based on a questionnaire analysis with the use of an HSD test. The results show that rethinking is the most widespread within the 7R concept, as the effects of most moderating variables (generation, gender, information gathering, product purchase, knowledge of the 7R concept, perceived income) can be measured in its case. In addition, 3 groups (Perfectionists, Adopters, and Rejecters) were created based on the consumers' mindset of Zero Waste and named according to the means of the variables associated with the 7Rs. The present research is a Hungarian case study, which illustrates the existence of Zero Waste awareness and activities and should be extended to other nations as well.

1. Introduction

Nowadays, humanity's greatest challenges are related to environmental protection and climate change. It has become clear that the modern development of humankind is leading to environmental changes that could seriously endanger the lives of future generations on the planet. The concept of sustainability and sustainable development was created to solve this process. In 2015, the UN announced the goals of the "2030 Agenda for Sustainable Development", which defines all the focus areas necessary for sustainable development by 2030. Among the 17 sustainable development goals, the 12th (Responsible Consumption and Production) deals with the aspects of sustainable production, consumption, and waste management (Sachs et al., 2023).

Since the economic, environmental, and social processes currently prevailing in the world are not suitable for achieving the goals of sustainable development, radical changes are needed in all of these aspects on a global level. The concept of the circular economy (CE) offers a solution to these problems by replacing the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes (Kirchherr et al., 2017). CE has been gaining significant attention in minimizing the life cycle environmental footprint of a product (Fan et al., 2022). One of the key elements of this concept is sustainable waste management, which is used to realize the recycling and reusing of products otherwise destined to be thrown away (Hrabec et al., 2018). As a result, products, as well as their components which already fulfilled their primary purpose, do not end up in landfills (cradle-to-grave model) but are reused as materials for other products (cradle-to-cradle model) (Balwan et al., 2022). This concept is otherwise called Zero Waste management. As formulated by the Zero Waste Alliance (ZWIA), „Zero Waste is the conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health” (ZWIA, 2023). This approach encourages manufacturers to adopt new methods, e.g., to introduce production technologies and processes that generate as little waste as possible during production and to develop products that can be recycled or reused (Balwan et al., 2022). Since companies deal with the creation of products following the Zero Waste (ZW) concept, the vast majority of ZW research focuses on these organizations (Jestratijevic et al., 2022). However, the role of consumers should not be underestimated either,

as they can indicate their need for ZW products to manufacturers through their purchasing decisions (Badowska, 2019).

CE is often characterized by reference to hierarchically ranked R-imperatives as an important operationalization principle where the range of R-principles starts from 3Rs and ends at 10Rs (Reike et al., 2018). Having reviewed the literature on the R frameworks, the 7R framework (Table 1) of Jestratijevic et al. (2022) was applied.

Table 1: Definitions of 7Rs

7Rs	Definition	Source
Rethink	Find better solutions for products by exploring alternatives and rethinking problems.	Harmsen et al. (2021)
Refuse	Make a product redundant by abandoning its function or by offering the same function with a radically different product.	Potting et al. (2017)
Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources or materials.	Potting et al. (2017)
Reuse	Re-use product that is still in good condition and fulfills its original function.	Potting et al. (2017)
Repurpose	Use a discarded product or its parts in a new product with a different function.	Potting et al. (2017)
Recycle	Disassembling components and separating parts or materials to create new ones.	Harmsen et al. (2021)
Rot	Valorization of household food and other biodegradable wastes.	Kunuszabó et al. (2022)

Source: Own elaboration based on Jestratijevic et al. (2022)

The concept of ZW is slowly gaining worldwide recognition, not only for businesses but also for consumers who are incorporating sustainable consumption practices into their daily lives, changing their lifestyles, and becoming more environmentally conscious (Pietzsch et al., 2017). The corporate and government viewpoints that are the subject of the majority of research and knowledge of the population's general practice (e.g., at home, at work, on holiday) are also essential, and the analysis of this research will help to fill this important research gap. The following research question was determined based on the review literature: How does the 7R approach to ZW in business differ from the practice of the general public?

2. Methodology

The present study examines the public acceptance of the ZW approach from several perspectives (e.g., generation, income level, education level). A questionnaire was identified as the appropriate data collection method to implement the primary research. In addition to demographic data, the questionnaire included 5-point Likert-Scale (Strongly disagree, Disagree, Undecided, Agree, Strongly Agree) questions. The online questionnaire was shared with potential respondents using the Snowball Method through social media platforms (Facebook). Before distribution, the questionnaire was reviewed by 25 random test respondents, mainly students/lecturers of Széchenyi István University. Their insight made it necessary to reformulate some of the questions. The final questionnaire, which received 200 responses, was open to potential respondents from 08/06/2023 to 03/07/2023. The research method was chosen with the limitations of the data collection in mind, so a non-representative, Cross-Sectional Analysis was carried out using IBM SPSS Statistics 25 statistical software. The statements were assigned to the following keywords in the questionnaire based on the 7Rs definition system: Rethink, Refuse, Reduce, Reuse, Repurpose, Recycle, Rot. The Likert-Scale variables used in the questionnaire were as follows: Rot (R1): I am familiar with the importance and benefits of composting in households. (R1_1); I compost organic waste from my household (e.g., vegetable and fruit peels). (R1_2); I use household compost to care for my plants (flowers, vegetables, weeds). (R1_3); Recycle (R2): I collect my household waste separately. (R2_1); I dispose of hazardous waste (e.g., batteries, accumulators, medicines) at the designated collection points. (R2_2); I do not throw away the bottles that can be recycled, I return them to the reverse vending machine. (R2_3); I take advantage of the opportunities offered by the separate waste collection islands. (R2_4) Repurpose (R3): I turn old, used clothes into bags and cleaning cloths. (R3_1); I often use containers (e.g., jars, tins) for creative purposes (e.g., decoration, lantern, and screw storage). (R3_2); I often use leftovers from the previous day in the next day's cooking (e.g., cook goulash from pork stew). (R3_3); Using pallet furniture is a good idea. (R3_4) Reuse (R4): I keep the wrapping paper and boxes to use them up again. (R4_1); I use old jars to store food. (R4_2); I sew my torn clothes. (R4_3); I try to use recyclable products (e.g., textile pads instead of cotton pads). (R4_4) Reduce (R5): I donate or sell things I no longer use. (R5_1); I reduce my energy consumption. (R5_2); I buy in bulk/batch to use less packaging material. (R5_3); I only add new items to my wardrobe when necessary. (R5_4); I have reduced my food waste. (R5_5) Refuse (R6): I do

not use single-use products. (R6_1); I don't use plastic bags, instead, I carry my canvas bag. (R6_2); I do not request printed advertising material. (R6_3); I unsubscribe from any newsletters that trigger impulse buying. (R6_4) Rethink (R7): I would like to be a consumer who eliminates waste from every aspect of life. (R7_1); When I make my purchases, I am conscious of the impact they will have on my environment. (R7_2); When I make my purchases, I am conscious of buying products that can be used in the long term. (R7_3); I make sure that trends do not influence my consumption. (R7_4); I promote ZW awareness among my friends. (R7_5). The analysis uses Two-Step and K-Means for clustering. Neither method requires a target field to be defined as they attempt to explore patterns in a set of input fields rather than predicting the outcome. The two-step method clusters the elements (records) of a sample in such a way that they tend to be similar within a cluster, but this is not the case for records in different groups. The two steps of the method are: create manageable sub-clusters from the data after a single run and progressively merge sub-clusters into larger and larger clusters using a hierarchical clustering method. The steps of K-mean clustering are slightly different: a cluster centre (K-point) is randomly initialized, each element is categorized to the nearest mean, the mean coordinate is updated, and the process is repeated until the final clusters are formed. The idea of this paper was based on the principle of calculating the HSD between means using a statistical procedure. Among the various methods that have been developed, the most popular method for comparing the means between pairs or groups in a sample is Tukey's HSD test (Toothaker, 1993). Considering this, Tukey's HSD test was used to determine the significance levels in the analyses. This method is recommended for the continuous measurement level (Sepanek et al., 2022), so the results of the present study are discussed with this limit in mind. For this research, the significance values of HSD tests could be used to conclude the ability of the nominal variables included in the test to be correlated with the values of the ordinal variables. HSD tests were used to determine which specific groups' responses differ significantly from each other in terms of nominal variables in the case of more than two choices in the questionnaire. Overall, the method tested the possibility of clustering the ordinal variables with nominal variables. Nominal variables were included in the analysis: gender, age, number of people in a household, income level, educational level, online ZW information collection for orientation, and knowledge of ZW.

3. Results

The questionnaire consisted of 6 demographic questions (1-6) and 3 questions (7-9) based on ZW knowledge and knowledge transfer. As a first step in descriptive statistics, it is important to understand the distribution of responses to the questions used as nominal variables in the analysis (Table 2).

Table 2: Descriptive statistics

Variables		N	%	Variables		N	%
(1) gender	male	40	20.0	(5) educational level	secondary	49	24.5
	female	160	80.0		higher	151	75.5
	village	39	19.5		no income	17	8.5
(2) settlement type	city	98	49.0	(6) perceived income category	below average	20	10.0
	county seat	40	20.0		average	119	59.5
	capital	23	11.5		above average	20	10.0
(3) date of birth	1946-1964	21	10.5	(7) online information collection on ZW	yes	112	56.0
	1965-1979	50	25.0		no	88	44.0
	1980-1994	70	35.0	(8) ZW product purchase	yes	116	58.0
	1995-2009	59	29.5		no	84	42.0
(4) number of people living in a household	1-2 persons	81	40.5	(9) knowledge of ZW concept	yes	169	84.5
	3 persons	44	22.0		no	31	15.5
	4 persons	46	23.0				
	5 persons or more	29	14.5				

The first step in cluster creation is the use of the Two-Step method, which automatically determines the appropriate number of clusters on a statistical basis (Hiziroglu, 2013). After describing the distributions of the respondents, which resulted in 3 clusters, the second step is to explore the differences between them by K-Means clustering (Table 3). In the process of applying the clustering method, the following criteria were considered based on the literature: the use of standardized values in the case of different scales; outlier treatment; verification of the representativeness of the sample (where possible); the correlations of the variables included in the analysis must be, less than 0.9 (variables suitable for clustering); included variables have to be relevant to the analysis (Sajtos and Mitev, 2007). Data clustering is a statistical method that is an unsupervised

technique in data analysis that involves grouping or categorizing various data sources into a coherent and homogeneous group (Cruz et al., 2008). Clustering - by calculating cluster centers and accounting for demographics - provides a way to estimate the ZW practices of the respondents. The clustering was based on Likert-Scale questions, so standardization of the scores was not necessary due to the similarity of the scale type. The outlier problem was also not a relevant issue in the analysis for the same reason. The sample presented in this paper is not representative. However, in contrast to most published research typically analyzing corporations, it identifies consumers' ZW practices and perceptions. A general disadvantage of questionnaire surveys is that the use of this range of ordinal scales involves subjective value judgments by respondents. Therefore, as opposed to continuous scales, the distances between numerical values are not uniform. In terms of relevance, it is important to note again that the 7R concept was used in the wording of the questions in the questionnaire. Correlation analysis was performed using Kendall's tau-b correlation coefficients (a non-parametric alternative to Pearson Correlation) due to the use of ordinal scales. In all cases, Kendall's tau-b values were between 0.07 and 0.77. Hence, the variables were suitable for clustering. Since there are significant differences, the groups were named based on the means of the variables related to the 7Rs. Based on the F-score, the most important clustering elements belong to the following elements of the 7R concept: Rethink (R7_1, R7_3) and Recycle (R2_4).

Table 3: Results of K-Mean clustering (Average values of 7R variables)

Variable groups	Perfectionists n=113	Adopters n=73	Rejecters n=14
R1	4.38	2.97	1.33
R2	4.67	3.94	1.27
R3	4.21	3.07	1.38
R4	4.21	3.31	1.54
R5	4.42	3.73	1.50
R6	4.19	3.42	1.50
R7	4.35	3.23	1.17

The applied clustering method shows that there are significant differences in the perceptions of ZW, but the Rejecters have a small sample size, which can be considered positive from a sustainability point of view. However, public perception may differ as the 7R ranking does not appear to be reflected in the averages of the groups. After clustering, HSD tests were used to determine significant correlations between nominal (demographics) and ordinal (Likert-Scale questions) variables (Figure 1).

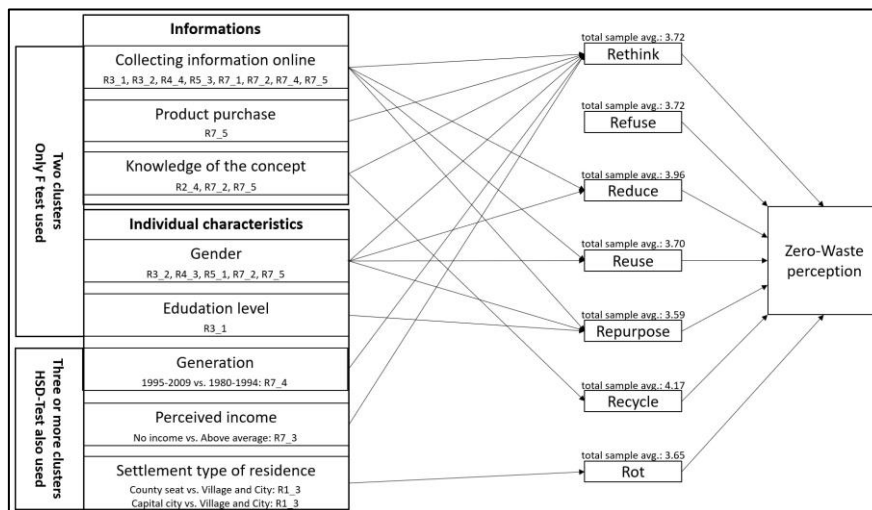


Figure 1: Impact of demographic and information variables on the perception of Zero Waste

Before the HSD tests, Levene tests for homogeneity of variance and ANOVA tests (F-tests) were performed to detect significant differences between clusters. The homogeneity of variance condition ($p > 0.05$) and the F-test acceptance criterion ($p < 0.05$) were taken into account when including the variables in the analyses. The HSD tests could have only been run on more than three clusters, so F tests were performed for the nominal variables

with two clusters. In this case, the 7R ranking is not valid, as most of the clustering criteria have an impact on Rethink. This may be due to a lack of knowledge about the definition of ZW, as evidenced by the open question in the questionnaire regarding the type of ZW product (very different perceptions represented by respondents) included in the survey. In terms of gender, the results show that women have a more positive perception of ZW for all variables included in this part of the study (R3, R4, R5, R7). Considering the level of education, lower education (secondary education) is closer to ZW, at least for the reuse of used clothes. There is a link between perceived income and generation, as people with higher income (presumably older people) pay more attention to long-term product use, while people without income (presumably university students) with parental contribution attach less importance to this perspective (R7_4: fashion effect). Rot plays an important role in cluster formation only for the settlement type but also in the case of the use of compost for plant nutrition. Probably because of its utility, the following ranking is developed based on averages: village (3.87), city (3.82), county seat (3.03), and capital city (2.78). Regarding information gathering (this is especially true for online information collection), it can be said that their use can positively influence the perception of many elements (R3, R4, R5, R7) of the ZW concept. Regarding refuse, generation and income categories have differences in mean squares, but these are significant only through the F test, and the differences between the concrete groups are not detectable by HSD tests. However, for more than two clusters, Figure 1 shows only group effects with significant differences explained by both tests. The variables causing significant cluster differences, as well as the means calculated for the entire sample, consistently indicate that consumer behavior differs from the 7R concept ranking (hierarchy), as shown in Table 4.

Table 4: The difference between the concept of the 7Rs and consumers' practice (Rank)

Concept	Rot	Recycle	Repurpose	Reuse	Reduce	Refuse	Rethink
Original 7R ranking	1	2	3	4	5	6	7
Modified 7R ranking	5	1	6	4	2	3	3

The reason for the difference from the original ranking is probably that people have to think differently than businesses. Consumers try to prioritize the solutions that are easiest for them, so recycling and reducing come first. The differences in the demographic and information-gathering components of the 7R support the ranking of Rot at the bottom of the modified version, as the type of settlement in which people live has a significant impact on their ability to take advantage of these opportunities.

4. Discussion and conclusions

Overall, in answering the research question, the study concludes that online information collection, which is part of today's digitization and important in almost all areas, has a positive impact on most parts of the ZW hierarchy. This is because there is a wealth of information about this aspect of sustainability on the internet in many different places/modes. However, the misleading and misinforming effects of websites and social media have been described by several researchers (Kumar and Shah, 2018), so the ZW approach should not be judged too hastily. The impact appears to be positive, but in the absence of adequate expertise, it can misleadingly change people's attitudes towards ZW. Some research (Sang et al., 2022) shows that the information-sharing nature of social media has a significant positive impact on green purchasing intentions. Therefore, it can be improved by sharing and viewing positive information about the environment/sustainability. The division of knowledge on ZW, known as the so-called Innovation Resistance Theory (IRT), may contribute to the divisiveness caused by information sharing on the Internet, where deviations from the status quo and current beliefs may reduce the likelihood of innovation adoption and acceptance. Obviously, it is not an easy task for the consumer to avoid the effects of misinformation from digital spaces, but it is advisable to collect a number of sources that appear to be credible in order to obtain valid information. Another important aspect of ZW consumption identified by Badowska (2019) is gender motivational differences, as men are more likely to be influenced by environmental benefits and women by economic benefits. Given the similar findings of the present study, gender should also be considered when implementing ZW principles as a new way of consuming. It is important to note that in line with the present research, the analysis of Brand et al. (2022) indicates that members of Generation Y are particularly open to practicing more sustainable habits and are more aware of environmental responsibility, while Generation Z has the lowest level of unnecessary consumption in an age group comparison. Overall, the consumer approach differs from the original 7R concept on several points, and there are differences between clusters formed by demographic and informational variables. The differences in the specific ZW population types identified should be considered, and in the future, deeper statistical analysis using multivariate techniques may be worthwhile to complement and confirm the results of this study. However, the limitations of the methodology (e.g., non-representative sample, ordinal scales) require some cautiousness with the observations. The analysis

reveals that consumers think differently about the 7R concept and provides insights into the demographics that distinguish these ideas. The results of the present study can be seen as a possible new direction of research that will allow researchers to develop a theoretical framework through the further development of the methodology described in this paper, including the use of a structural model.

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