sustainability

MDPI

Article

Understanding the Barriers to Consumer Purchasing of Zero-Waste Products

Ye Sang †, Heeseung Yu † and Eunkyoung Han *

Department of Media and Communication, Sungkyunkwan University, Seoul 03063, Republic of Korea
* Correspondence: bird24@skku.edu
† These authors contributed equally to this work.

Abstract: This study uses innovation resistance theory (IRT) to investigate why consumers are hesitant to purchase zero-waste products. Most of the existing IRT application studies have been conducted on innovation resistance to technology or devices. This study focuses on consumer innovation resistance to zero-waste products, extending the theoretical application of IRT to the field of sustainability research. We further broaden this theory by exploring the moderating role of perceived environmental responsibility (PER). Data were collected from 400 consumers through an online survey. To verify the hypothesis, structural equation modeling (SEM) was carried out using AMOS software, and the moderating effect was verified using SPSS Process Macro Model 1. The results of the study suggest that usage, value, risk and tradition barriers significantly affect the adoption of zero-waste products. Furthermore, consumer PER shows antagonistic interactions with the barriers (usage, value, risk and tradition) and zero-waste product purchase intentions; as consumer PER increases, the impacts of the barriers on zero-waste product purchase intentions also increase. These results are expected to provide a theoretical framework for future IRT research and to enable fashion brands to implement effective zero-waste practices and to manage government and corporate barriers (image, usage, value, risk and tradition) with respect to zero-waste products, thereby reaping greater profits.

Keywords: zero waste; innovation resistance theory; usage barrier; risk barrier; tradition barrier; image barrier; purchase intention

Citation: Sang, Y.; Yu, H.; Han, E. Understanding the Barriers to Consumer Purchasing of Zero-Waste Products. *Sustainability* **2022**, *14*, 16858. https://doi.org/10.3390/su142416858

Academic Editors: Ohbyung Kwon, Min-jeong Suh and Sujin Bae

Received: 29 October 2022
Accepted: 12 December 2022
Published: 15 December 2022

1. Introduction

The COVID-19 crisis has changed global waste disposal dynamics, and the concept of zero waste has received special attention. Due to the global quest for modern urban living [1], people are disposing of increasing amounts of waste. In addition, the prevalence of plastics and electronics means that the composition of waste has become more complex than ever before. Furthermore, it is estimated that total greenhouse gas (GHG) emissions from solid waste account for approximately 5% of the total GHG emissions in the atmosphere [2], making waste disposal critical to climate change.

The driving force behind the establishment of the zero-waste concept is the idea of sustainable development. Waste generation not only burdens the environment, it also, ultimately, leads to the additional economic costs of waste management [3,4], affecting the development of a circular economy. It is expected that by 2025, the annual global generation of municipal solid waste (MSW) will be approximately 2.2 billion tons, and 4.2 billion tons by 2055 [5]. This is not in line with target 12.5 proposed by the United Nations General Assembly for the 2030 Agenda for Sustainable Development [6]: to achieve a significant reduction in waste globally by 2030 [7]. Therefore, the sustainable use of materials is the preferred method for saving resources and limiting waste generation.

Originally, the most widely used methods of waste disposal included landfills, mechanical and biological treatment, incineration and recycling [8]. However, the term "zero

waste" was first introduced by Dr. Paul Palmer in 1973 with the aim of recovering resources from chemicals [9]. The focus is now on converting waste into resources without post-processing [10]. The zero-waste concept includes the 3R rules—reduce, reuse and recycle (Figure 1) [11]; for example, zero waste in production processes using natural materials from the earth and zero waste emissions into the air, water, land or other environments [12]. Renewable energy is essential for increasing GDP per capita and improving air quality [13]; therefore, the valorization of waste can yield many economic, environmental and social advantages [14].

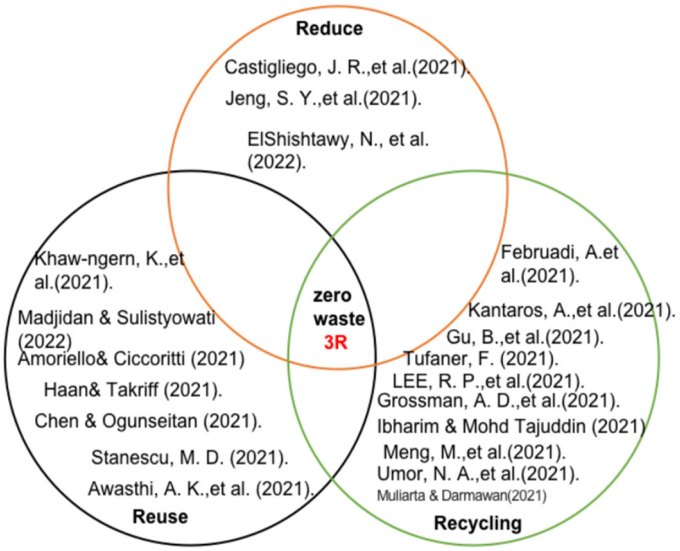

Figure 1. The 3Rs of zero waste [15–34].

There is no doubt that many cities, organizations, individuals and waste recycling industries around the world are researching and developing "greener" technologies in order to develop a circular economy [35]. The basic goal is to avoid and limit the use of products and assets through different material cycles [36,37]. For example, according to the Zero Waste Coalition, the zero-waste philosophy is based on a closed-loop system in which waste is used as a potential source of raw materials [38]; it is also known as the cradle-to-cradle philosophy [39,40]. Therefore, this paper will analyze the impact of zero-waste products on waste management.

However, existing research on zero waste has focused on manufacturing innovation [41], zero-waste city building [42–46], zero-waste community creation [47,48], zero-waste living [49], zero-waste campuses [50,51] and zero-waste recycling programs [52–54]. Research on zero-waste products has concentrated on stakeholders, such as governments, businesses and institutions, with little research related to consumers (Figure 1). Consumers are an important link in the distribution of zero-waste products and an important participant in circular economies, ignoring the fundamental macroeconomic aspects of national waste resource recovery operations that can be achieved with zero waste and the fact that reliable data on the consumer adoption of zero-waste purchases are not yet available. Therefore, this study addresses the barriers to consumer purchasing of zero-waste products as the primary research objective, to shed light on the commencement of a circular economy for businesses.

Additionally, the zero-waste concept has been implemented in several countries (e.g., South Africa, New Zealand, China and India), provinces (e.g., Nova Scotia (Canada), California) and organizations (e.g., DuPont, Fuji Xerox, Toyota) [55–57]. Europe and the United States have developed a consumer culture around zero-waste stores that promote a plastic-free environment to customers who bring their own containers to refill their food and to purchase cleaning products and personal care products [58]. South Korea introduced thepicker, a zero-waste product concept store, in 2016 and subsequently combined zero

waste with K-beauty in an attempt to create a business that both satisfies consumers and protects the environment. From a consumer perspective, organizations currently lack reasons to reject zero-waste products; therefore, this paper's exploration of factors from basic functions to emotional values will assist brands to develop zero-waste products.

Moreover, zero waste is no longer an option but a necessity that has become widespread among conscious consumers. Thus, we note that perceived environmental responsibility (PER) has been further expanded and conceptualized in various studies as another necessary factor in the promotion of selfless behavior [59]. According to Johri and Sahasakmontri [60], PER implies that individuals' intentions can reduce harm to the environment and help them become conscious purchasers. Furthermore, Piligrimenė et al. [61] explained that consumers' PER positively influences their involvement in sustainable consumption and purchasing behavior. They further suggested examining the association between PER and perceived environmental behavior in different contextual settings. Therefore, this study examines PER as a moderator to explore whether it moderates the association between zero-waste product purchase intentions and barriers, thus allowing high levels of environmental responsibility to curb the negative effects of zero-waste barriers.

2. Theoretical Background

2.1. Innovation Resistance Theory

Innovation resistance theory (IRT) was first proposed by Ram and Sheth [62,63] as a valid framework for studying consumer resistance or barriers. Prior research has shown that the adoption and use of innovation that leads to deviation from the status quo and from current beliefs is likely to create resistance. Customer resistance is an important variable in determining the success or failure of a new technological innovation [64,65]; in other words, IRT helps us to understand user resistance to innovation. Resistance to change is a normal consumer response [66]; however, some scholars have previously tended to categorize late adopters as "laggards" [67]. Resistance to innovation is not the opposite of innovation adoption but rather the process of behavioral change that occurs when consumers are exposed to innovative products. Consumers often delay their decisions to innovate until the innovation evolves into a generic product or until the product or service improves [68].

In the past, IRT was extensively tested for technology-based products, such as internet banking [69], mobile phone banking [70], online travel agencies [71,72], mobile phone payment solutions [64], mobile phone social travel [73], online purchasing of cars [74], smart lighting products and services [75] and food delivery services [76]. In addition, we found attempts to explain the barriers to the adoption of organic agro-cosmetics in pro-environmental terms [77], so we believe that IRT will be a reliable tool for measuring zero-waste adoption barriers.

According to IRT, consumer resistance is divided into active and passive resistances [78]. Active resistance creates barriers [79] when a key characteristic of an innovation that has received an undesirable evaluation [80] falls short of expectations. Passive resistance arises from the rejection of an evaluation of an innovation [81], resisting immediately without evaluating the innovation, in order to be satisfied and to maintain the status quo [82]. In other words, passive resistance is determined at the knowledge stage before the persuasion stage, without a sufficient evaluation of the innovation [83]. Active resistance represents barriers to the adoption and use of an innovation due to the conflicts caused by behavioral contradictions arising from the use, value and risk of the innovation. On the other hand, passive resistance appears as a conflict with existing beliefs [84]. Active resistance is studied through functional barriers (e.g., use, value and risk), whereas passive resistance is studied through psychological barriers, such as image and tradition [84].

This study considers functional barriers (use, value and risk) and psychological barriers (tradition and image) in examining consumer resistance. There have been multiple controversies regarding zero waste, and in response to the differences in the practical (our behaviors as individuals/consumers) and conceptual (related to system design and

functionality) aspects, we argue that consumer resistance may be spontaneous or reactive because of external factors, such as the products.

2.2. Usage Barriers and Purchase Intention

Usage barriers emerge in response to changes in the consumer status quo for accommodating new innovations [63,67]. It was earlier shown that the intention to use mobile phone banking services was significantly influenced by the perceived ease of use [85,86]. The small size of mobile phone devices, compared with banks, make the text and graphics more difficult to understand [87], and the complexities of using such services prevent some consumers from adopting them. The concept promoted by zero waste, while assuming an alternative vision of shared responsibility among the government, product manufacturers, retailers and consumers [88], is a challenge for all participants because, even as people understand the concept of innovation, their consumption habits do not change. Previous studies on zero-waste products have emphasized that zero waste focuses on innovations in the chemical ingredients, or on new ingredients, and advances in product technology but does not actually enhance consumer convenience. For example, Kushwah et al. [89] noted that environmentally friendly products are more convenient for consumers than traditional products. Similarly, Tandon et al. [90] showed that usage barriers may be important disincentives for consuming unfamiliar products, such as zero-waste products. Therefore, we argue that barriers to using zero-waste products may result in low purchase rates. This leads to the derivation of Hypothesis 1:

Hypothesis 1 (H1). *Usage barriers significantly inhibit consumer zero-waste product purchase intentions.*

2.3. Value Barriers and Purchase Intention

The second functional barrier concerns value and occurs when the innovation deviates from the existing value system [67]. This can be simply understood as the value that one is willing to pay for an innovation compared with the alternatives [91]. The value of price as perceived by consumers is defined as the balance between the perceived benefits of new technology and the cost of acquiring the latest technology [92]. Focusing mainly on the perceived value of a product in terms of performance [93], such as the advantages of mobile phone banking where users can check their account balances and transactions regardless of location [94], would increase the adoption intent. Regarding the choice of organic produce, customers reject adoption when their expectations are not met in terms of the relevant parameters, such as food quality [89]. Previous studies have shown that customers may refuse to use mobile phone banking apps [84] or shop online [95] when they encounter value barriers, and there is a negative relationship between the value barrier and the intention to use in a service innovation environment. Thus, the level of consumers' perceived benefits in response to an innovative product determines its adoption or rejection. We therefore argue that value barriers for zero-waste products lead to low purchase rates. This leads to the formation of Hypothesis 2:

Hypothesis 2 (H2). *Value barriers significantly inhibit consumer zero-waste product purchase intentions.*

2.4. Risk Barriers and Purchase Intention

Risk barriers arise when there is a high level of uncertainty regarding the innovation, which can be considered a fixed perceived risk in the innovation. The higher the level of uncertainty, the higher the perceived risk, which acts as a barrier [96]. Previous studies have highlighted that risk barriers are negatively correlated with innovation adoption in various contexts. For example, in organic food delivery services, unprofessional behavior of delivery personnel or the disclosure of personal addresses are often considered risk barriers [77]; in online banking, some consumers fear losing connectivity during their

online transactions [86,97,98] or errors may occur [99] when an online purchase differs from the actual item [95]. These studies suggest that uncertainty and perceived risk can cause the rejection of innovation adoption. Similarly, there may be adverse effects on purchase intentions owing to customer doubts about the authenticity and trust regarding zero waste. Therefore, we propose Hypothesis 3 as follows:

Hypothesis 3 (H3). *Risk barriers significantly inhibit consumer zero-waste product purchase intentions.*

2.5. Tradition Barriers and Purchase Intention

Tradition barriers arise when innovative products go against consumer values and established social norms [67], such as when the adoption of a new innovation changes consumer habits and lifestyles [91] or when new product adoption conflicts with existing belief systems [99]. Tradition barriers fall under the category of psychological barriers. Past studies—looking at things such as online banking, wherein bill payments are stored differently to paper bills [100]; online services, where there is no physical access to sales clerks resulting in a lack of engagement [101]; and organically farmed foods, with short shelf lives [102] and lower satisfaction drawbacks [89], which are not in line with consumer psychology—have shown that there are negative correlations between tradition barriers and intention to use. In recent years, given the technological advances, zero-waste products have been made of materials, such as marine litter [103] and human feces as alternative biological zero-waste energy sources [104], causing consumers to resist the ingredients; therefore, tradition barriers may negatively affect purchase intention, and Hypothesis 4 is proposed as follows:

Hypothesis 4 (H4). *Tradition barriers significantly inhibit consumer zero-waste product purchase intentions.*

2.6. Image Barriers and Purchase Intention

Image barriers arise when consumers compare innovative products or technologies with generic products in terms of the "category, brand name and country of origin" [105], which may create negative impressions of the innovations owing to changes in the image or nature of the product [69]. Previous studies have shown that, when people question the authenticity of the quality of a green product and its originality for environmental friendliness [106], or they suspect greenwashing owing to the need for corporate social responsibility (CSR)-based innovations [107,108], then an image crisis in the country of origin may affect the intention to purchase an innovative product [109,110], resulting in image barriers. In addition, product image barriers can occur in terms of the quality of the product being excellent [111,112], the packaging being environmentally friendly [113,114], the value for money being high [115] and the brand's own satisfaction with its reputation [116]. Consumers who do not purchase environmentally friendly products have trust issues [117], which can be interpreted as the consumers reasonably suspecting the aforementioned zero-waste product issues that in turn lead to a negative image of the product claims [76]. Therefore, we argue that image barriers can deter consumers from adopting zero-waste products. Therefore, this study proposes Hypothesis 5 as follows:

Hypothesis 5 (H5). *Image barriers significantly inhibit consumer zero-waste product purchase intentions.*

2.7. Perceived Environmental Responsibility as a Moderator

In addition to the direct effects of consumption barriers on zero-waste product purchase intention, we considered the moderating effects of PER on the proposed associations (Figure 1). PER is defined as an individual's intent to protect the environment by maintaining awareness while causing minimal harm to society in the purchasing process [60];

because PER is considered morally right and required by law [118], it serves as an expectation to motivate personal achievement. However, egoism is a universal feature of human nature [119]; on one hand, the general public expects the government to adopt more aggressive public policies to eliminate environmental problems, while on the other hand, society is reluctant to make personal sacrifices to cooperate with governmental policies [120,121]. Based on the ideal society theory, knowledgeable people exhibit responsible behaviors to maintain the values of the ideal society around them [122]. Greater environmental knowledge inspires more responsible environmental attitudes and intentions [123,124], while citizens who show a higher awareness of environmental damage tend to practice more sustainable consumption habits and accordingly consider themselves responsible [59]. We can infer then that the more consumers are aware of their environmental responsibilities, the more they may be willing to participate in environment-related solutions.

PER is an important factor that influences consumer purchasing behaviors [98]. The level of environmental concern among consumers may differ significantly based on the negative impacts of consumer barriers on purchase intentions [89]. Therefore, it is expected that PER will reduce the negative impacts of barriers (use, value, risk, tradition and image) on the zero-waste product purchase intentions of consumers by changing their existing beliefs and status quo. Previously, PER has been associated with various environmental issues, such as green purchase intentions [125] and environmental activism [79]. To the best of the authors' knowledge, no studies have tested the moderating role of PER in a theoretical framework of resistance to innovation in the context of zero-waste adoption behaviors. Therefore, based on the above arguments and theory, the following hypotheses are proposed:

Hypothesis 6 (H6a–e). *Perceived environmental responsibility moderates the relationship between barriers ((a) usage, (b) value, (c) risk, (d) tradition, (e) image) and zero-waste product purchase intentions.*

3. Methods

This study was conducted through an online survey company. Referring to existing studies applying IRT [65,99,126,127], this study conducted a survey targeting people who had never purchased zero-waste products to clearly examine their resistance to the innovation of zero-waste products. Through screening questions, the survey was aimed at people who had no experience purchasing zero-waste products, and gender and age were equally collected through assigned sampling. In addition, the online survey program was programmed to forcibly close the survey to respondents who repeated the same score in order to process the data as outliers, while gender and age were equally allocated for generalization of the analysis results and normality of data distribution.

We designed a questionnaire to collect data, and the measurement scales of the research model constructs were based on previous related research. The survey was conducted on people in the age range of 20–50 years who had never purchased zero-waste products, and responses from 400 people were selected for the final analysis (excluding poor responses). The number of samples relating to the respondents' gender (male: 200, female: 200) and age (20s: 100, 30s: 100, 40s: 100, 50s: 100) were all controlled equally. Confirmatory factorial analysis and structural equation modeling were performed using AMOS, and moderation analysis was performed using SPSS Process Macro (Model 1).

3.1. Research Model

In this study, the effects of functional barriers (usage, value and risk) and psychological barriers (tradition and image) on zero-waste product purchasing intentions were analyzed through a survey of respondents who had never purchased zero-waste products. In addition, the relationship between the barriers and zero-waste product purchase intentions was analyzed with regard to the role of PER as a moderator. To this end, a research model, as shown in Figure 2, is presented.

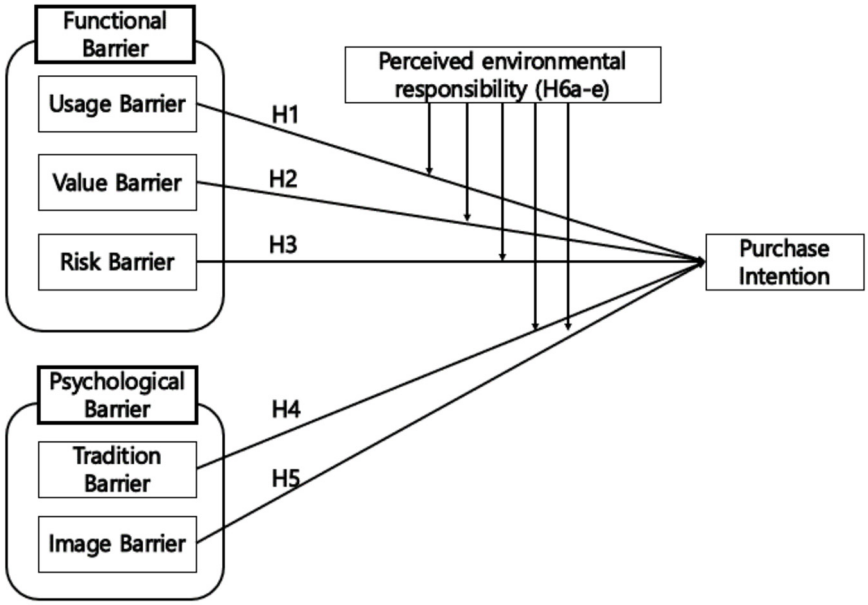

Figure 2. Research model.

3.2. Measures

The barriers for zero-waste products were measured on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) by modifying the measurement items of existing research using the IRT model [128–130] to fit this research (see Appendix A for details). The tendency to purchase zero-waste products was measured by referring to the research of Lee [120] for the PER as well as to the studies by Mackenzie and Lutz [131] and Hsu et al. [132] for the purchase intention.

4. Results

4.1. Descriptive Statistics

In this work, frequency verification was performed to confirm that there were no missing values in the collected data. The results verified this, and we used Cook's distance to test for the data outliers. Finally, by confirming the normality of the data through skewness and kurtosis tests, the data were shown to be close to a normal distribution between +3 and −3.

4.2. Confirmatory Factorial Analysis (CFA)

We conducted CFA on the constituent elements to secure the convergent validity, construct validity and discriminant validity of the research model. Construct reliability (CR) indicates the degree of consistency between the measured variables and can be calculated from the values of factor loading and error variance; in general, these values should be 0.7 or higher. In addition, it is determined that the construct validity exists if the average variation extracted (AVE) is greater than or equal to 0.5 [133]. The AVE of the corresponding latent variable must be greater than the square of the correlation with all other factors; if this is satisfied, discriminant validity is secured [134].

The CFA result was χ^2 = 103.124 (df = 44, χ^2/df = 2.344, p = 0.000). The statistics of χ^2, which is a goodness-of-fit test in the structural equation model, are sensitive to the sample size. In general, when the number of samples is large (more than 200), $p < 0.05$ is indicated, and the chi-square goodness-of-fit test rejects the null hypothesis that the "model is appropriate." However, if there are a sufficient number of samples, the p-value is 0.000 in the chi-square test result, so even if the null hypothesis is rejected [135], it is judged that "the goodness of fit of the model is not acceptable." Rather, it is considered that there is a significant difference and that it is necessary to check whether other goodness-of-fit criteria are met. To determine the goodness of fit, the adjusted goodness-of-fit index (AGFI),

goodness-of-fit index (GFI) and root mean square error of approximation (RMSEA), which are absolute indices of fit, and the Tucker–Lewis index (TLI) and comparative fit index (CFI), which are incremental fit indices, were evaluated and found to meet the criteria and acceptable overall goodness of fit (Table 1).

Table 1. Goodness of fit for confirmatory factorial analysis (CFA).

Classification	χ^2/df	RMSEA	AGFI	GFI	TLI	CFI
Criterion	<3	<0.08	>0.80	>0.90	>0.90	>0.90
Structural model	2.344	0.058	0.907	0.959	0.939	0.959

Note: Absolute fit indices: RMSEA, AGFI, GFI; incremental fit indices: TLI, CFI.

Next, the CR and AVE were calculated, through which the convergent validity and discriminant validity were verified. As shown in Table 2, the CR and AVE for the constituent elements of the research model of this study are: usage barrier (CR: 0.8, AVE: 0.6); value barrier (CR: 0.8, AVE: 0.6); risk barrier (CR: 0.5, AVE: 0.4); tradition barrier (CR: 0.4, AVE: 0.2); and image barrier (CR: 0.5, AVE: 0.4).

Table 2. Confirmatory factorial analysis.

Variables			Estimate	Standardized Estimate	SE	CR	AVE	CR
Usage barrier	→	Q1	1.000	0.454				
	→	Q2	2.054	0.9	0.238	8.646	0.6	0.8
	→	Q3	1.814	0.836	0.206	8.813		
Value barrier	→	Q4	1.000	0.776				
	→	Q5	0.804	0.675	0.064	12.527	0.6	0.8
	→	Q6	0.999	0.800	0.070	14.315		
Risk barrier	→	Q7	1.000	0.567			0.4	0.5
	→	Q8	1.031	0.637	0.125	8.26		
Tradition barrier	→	Q9	1.000	0.388			0.2	0.4
	→	Q10	1.504	0.577	0.19	7.913		
Image barrier	→	Q11	1.000	0.763			0.4	0.5
	→	Q12	0.586	0.466	0.076	7.679		

To verify the discriminant validity among the constituent elements of the barrier measurement items, the root AVE, coefficient of correlation and squared coefficient of correlation were derived. As shown in Table 3, the squared coefficient of the correlation value excluding risk barrier was 0.000–0.29, which was lower than the root AVE.

Table 3. Test of discriminant validity.

	UB	VB	RB	TB	IB
UB	**0.76**	0.00	0.25	0.05	0.15
VB	0.01	**0.75**	0.11	0.00	0.29
RB	0.50	0.33	**0.60**	0.79	0.76
TB	0.22	0.04	0.89	**0.49**	0.00
IB	0.39	0.54	0.87	0.06	**0.62**

Note: Bold text: root AVE; diagonal bottom: coefficient of correlation; diagonal top: squared coefficient of correlation. UB: usage barrier; VB: value barrier; RB: risk barrier; TB: tradition barrier.

4.3. Structural Model

Structural equation modeling was used to verify the proposed hypothesis. Similar to the measurement model, we assessed that the structural model has a good fit (CMIN/df = 2.603, TLI = 0.913, GFI = 0.945, AGFI = 0.907, CFI = 0.941, RMSEA = 0.063). From the results of the

hypothesis verification (Table 4), it was found that usage barrier ($\beta = -0.11$, $p < 0.05$), value barrier ($\beta = -0.35$, $p < 0.001$), risk barrier ($\beta = -0.14$, $p < 0.05$) and tradition barrier ($\beta = -0.36$, $p < 0.001$), with the exception of image barrier, were negatively related to the intention to purchase zero-waste products. Among all the barriers, tradition barrier had the strongest influence on the intention to purchase zero-waste products.

Table 4. Hypothesis results.

Hypothesis	Path	β	*p*	Support
H1	Usage barrier → Zero-waste product purchase intention	–0.11	<0.05 *	Yes
H2	Value barrier → Zero-waste product purchase intention	–0.35	<0.001 ***	Yes
H3	Risk barrier → Zero-waste product purchase intention	–0.14	<0.05 *	Yes
H4	Tradition barrier→ Zero-waste product purchase intention	–0.36	<0.001 ***	Yes
H5	Image barrier → Zero-waste product purchase intention	0.43	<0.001 ***	No

* $p < 0.05$, *** $p < 0.001$.

4.4. Moderation Analysis

We used the Process Macro (Model 1) in SPSS to test the moderating effects of PER (high versus mid versus low). From the analysis, we found that PER moderates the relationships between the remaining barriers (usage, value, risk, tradition) and zero-waste product purchase intention, except for the image barrier. The image barrier showed a positive (+) effect in structural equation modeling and was excluded from the analysis because the corresponding hypothesis was rejected. The moderating effects include an enhancing interaction effect, a buffering interaction effect and an antagonistic interaction effect. When the coefficient of the independent and moderator variables in Table 5 is positive (+), the coefficient of the interaction term is negative (−); conversely, when the coefficient of the independent and moderator variables is negative (−), the coefficient of the interaction term that is positive (+) is interpreted to have an antagonistic interaction effect. Therefore, PER represents the antagonistic interaction effect between all barriers and zero-waste product purchase intention in the proposed research model.

Table 5. Results of moderation analysis.

Moderator Variable: Perceived Environmental Responsibility								
Hypothesis	**Moderation**	**Classification**	**Coeff.**	**S.E.**	***t***	***p***	**LLCI**	**ULCI**
UB → ZPPI (H6a)	Support	Constant	0.161	0.348	0.463	0.643	−0.523	0.846
		Independent variable	0.279	0.201	1.389	0.165	−0.116	0.674
		Moderator variable	0.213	0.049	4.332	0.000 ***	0.116	0.309
		Interaction term	−0.081	0.039	−2.059	0.040 *	−0.158	−0.004
		F = 31.993 ***, R^2 = 0.603, $\triangle R^2$ = 0.007 *						
VB → ZPPI (H6b)	Support	Constant	−0.917	0.717	−1.279	0.202	−2.327	0.493
		Independent variable	0.305	0.200	1.522	0.129	−0.089	0.699
		Moderator variable	0.514	0.129	3.986	0.000 ***	0.260	0.768
		Interaction term	−0.087	0.040	−2.160	0.031 *	−0.166	−0.008
		F = 29.579 ***, R^2 = 0.346, $\triangle R^2$ = 0.008 *						
RB → ZPPI (H6c)	Support	Constant	0.152	0.339	0.447	0.655	−0.516	0.819
		Independent variable	0.971	0.260	3.735	0.000 ***	0.460	1.482
		Moderator variable	0.198	0.048	4.110	0.000 ***	0.013	0.293
		Interaction term	−0.215	0.048	−4.456	0.000 ***	−0.309	−0.120
		F = 35.46 2 ***, R^2 = 0.388, $\triangle R^2$ = 0.031 ***						
TB → ZPPI (H6d)	Support	Constant	−1.832	0.879	−2.084	0.038 *	−3.560	−0.103
		Independent variable	0.175	0.213	0.822	0.411	−0.244	0.594
		Moderator variable	0.582	0.160	3.635	0.000 ***	0.267	0.897
		Interaction term	−0.094	0.040	−2.360	0.019 *	−0.172	−0.016
		F = 32.288 ***, R^2 = 0.366, $\triangle R^2$ = 0.009 *						

* $p < 0.05$, *** $p < 0.001$; UB: usage barrier; VB: value barrier; RB: risk barrier; TB: tradition barrier; ZPPI: zero-waste product purchase intention.

To determine how the influence of the independent variable on the dependent variable is specifically moderated by the level of the moderator variable, the moderator variable is divided into three groups, namely the mean and ±1 standard deviation (SD), and the regression equation is calculated to verify the significance of the simple slope. These results are shown in Table 6. To better understand the moderating role of PER in the antagonistic interaction effect of the barriers on zero-waste product purchase intention, see Figure 3.

Table 6. Moderating effect of influence relationship between independent and dependent variables according to the level of the moderator variable.

Moderator	**Classification**	**Classification**	**Effect**	**S.E.**	***t***	**LLCI**	**ULCI**
Perceived environmental responsibility	UB → ZPPI (H6a)	M − 1SD	−0.059	0.058	−1.021	−0.172	0.055
		Mean	−0.131	0.049	−2.672	−0.227	−0.035
		M + 1SD	−0.203	0.063	−3.238	−0.327	−0.080
	VB → ZPPI (H6b)	M − 1SD	−0.059	0.056	−1.056	−0.168	0.051
		Mean	−0.136	0.050	−2.715	−0.235	−0.038
		M + 1SD	−0.214	0.067	−3.177	−0.346	−0.082
	RB → ZPPI (H6b)	M − 1SD	0.073	0.082	0.890	−0.088	0.234
		Mean	−0.118	0.065	−1.815	−0.247	0.010
		M + 1SD	−0.310	0.074	−4.188	−0.456	−0.164
	TB → ZPPI (H6d)	M − 1SD	−0.218	0.065	−3.372	−0.345	−0.091
		Mean	−0.302	0.051	−5.971	−0.401	−0.202
		M + 1SD	−0.386	0.059	−6.554	−0.501	−0.270

UB: usage barrier; VB: value barrier; RB: risk barrier; TB: tradition barrier; ZPPI: zero-waste product purchase intention.

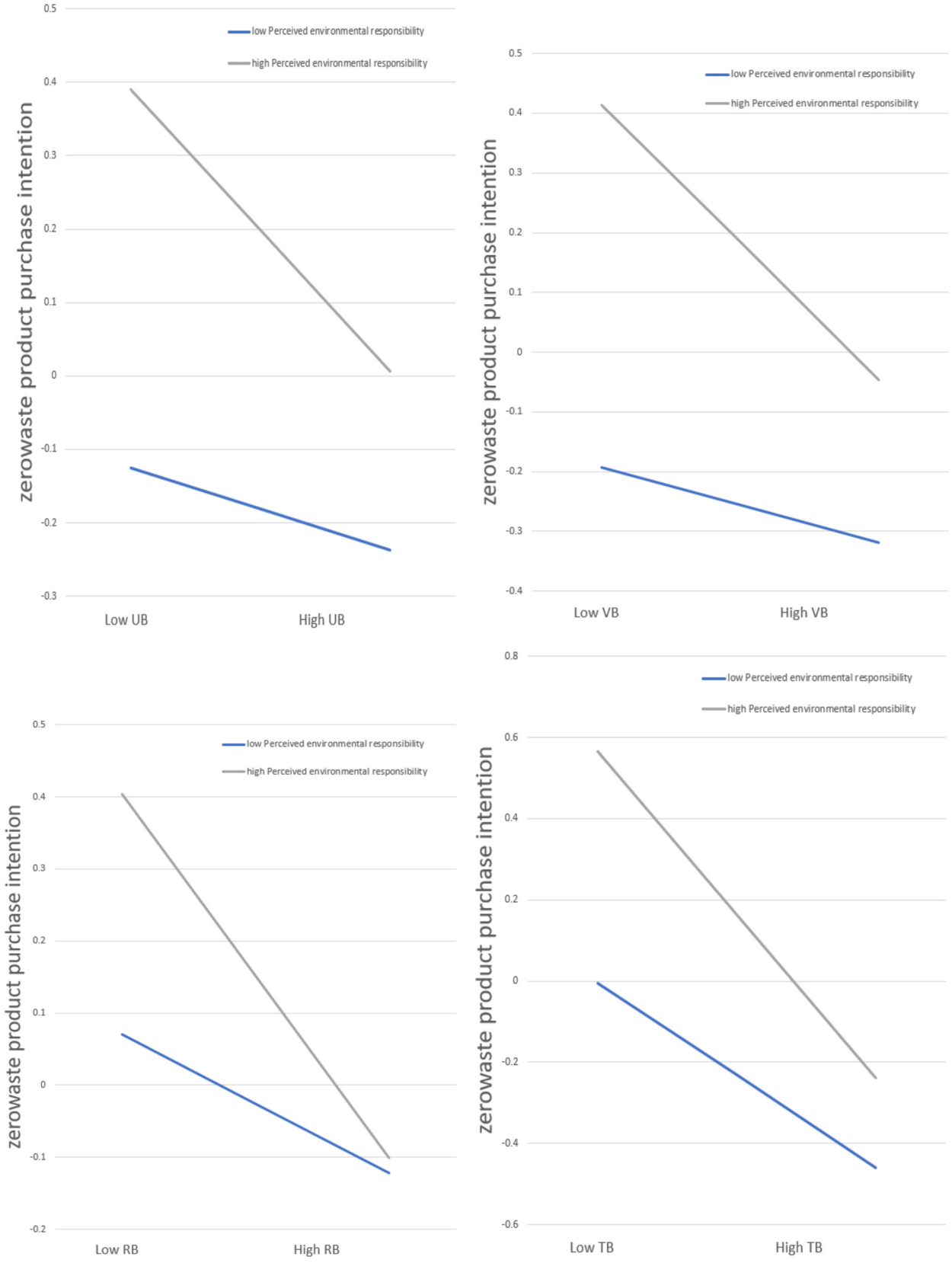

Figure 3. Moderating effect of perceived environmental responsibility on the link between the barriers (usage, value, risk, tradition) and zero-waste product purchase intention.

5. Discussion

In order to address some ecological issues and to develop a circular economy, this paper examines consumer resistance to waste reuse/zero-waste products with the aim of identifying the role of IRT in addressing the causes of consumer reluctance to purchase zero-waste products. Innovation resistance is an emerging area of marketing research [136], and applications of IRT to date have been almost exclusively related to the measurement of the causes of resistance to electronic products [65,105,137–140]. However, it is clear that there is subconscious consumer resistance to zero-waste products as an innovative approach to waste management, so this study makes a practical contribution to the enrichment and expansion of IRT by identifying the barriers to zero-waste product adoption.

In this study, three functional barriers and two psychological barriers were considered in analyzing zero-waste product purchase intention. First, we verified H1, that usage barriers negatively affect the intention to purchase zero-waste products. Unlike usage barriers for electronic products, barriers to the use of zero-waste products are mainly focused on factors related to purchase difficulty, such as "limited choice of zero-waste products," "narrow product types and range of zero-waste products," and "limited choice of zero-waste products." Zero-waste products are not yet common in the market due to their technical requirements and production difficulties [141]. Reducing the barriers to consumer use necessitates providing them with the opportunity to choose from a wide range of products as well as expanding the product categories, not only concentrating on the household goods category.

Second, H2 is consistent with previous studies verifying that value barriers negatively affect zero-waste product purchase intention [77,84,89,95]. Where the value of the zero-waste products lies in their positive impact on environmental protection, one study showed that plastic waste exposed to sunlight and degraded in the environment emits a variety of greenhouse gases, including methane and ethylene [142]; therefore, when measuring value barriers such as "I see no advantage of zero-waste products compared to existing products" and "zero-waste products do not contribute much to environmental protection" can influence consumers' expectations of zero-waste products. If there is no advantage in terms of environmental protection and product quality, the value barrier will affect the intention to purchase zero-waste products; therefore, companies should focus on the environmental value to guide consumer behavior when promoting zero-waste products.

Third, H3 verifies that risk barriers negatively affect zero-waste product purchase intention. Risk barriers are measured by factors such as "I am concerned that all zero-waste products that claim to be environmentally friendly are not actually zero-waste products" and "I am concerned that I will pay more for zero-waste products than existing products." As can be seen, the risks perceived by consumers are mainly related to zero-waste ingredients and value for money, and there is often a lack of data on zero-waste products because the market share is still small. Sadiq et al. [77] examined consumer barriers to eco-friendly cosmetics, similar to zero-waste products, and concluded that misinformation and exaggerated claims in advertising exacerbate the lack of trust among consumers, leading to a lower adoption of eco-friendly products. Therefore, the most important way to reduce consumer risk barriers for zero-waste products is to have comparative advantages and reliability with existing products, while avoiding excessive or false advertising.

Fourth, H4 verifies that tradition barriers negatively affect the intention to purchase zero-waste products. As the concept of tradition is deeply embedded in the consumer consciousness, any conflict with tradition can lead to strong consumer opposition in the form of poor word-of-mouth, bad publicity and boycotts [143]. Measures of the traditional barriers to zero-waste products are related to reliability and the comparison between existing products and zero-waste products. For example, items such as "I don't think I need a zero-waste product because I am satisfied with the existing product" and "I don't believe in zero-waste products" are measured. When comparing zero-waste products with existing products, for example, the reality that zero-waste supermarket customers now need to provide their own bottles actually causes inconvenience to consumers, and

may raise questions about packaging compared with the existence of general products. Therefore, when faced with innovations that go against tradition, zero-waste products should enhance their comparability with ordinary products.

However, among the five barriers, image barrier, which is a psychological barrier, does not have a negative effect on the willingness to purchase zero-waste products. Similar results were reported by Kaur et al. [76]. There are few negative reports on the image of zero-waste products, so items such as "I have questions about the labeling of zero-waste products" in the questionnaire did not become a barrier to consumers purchasing zero-waste products. It can be seen that Korean consumers have fewer doubts about the labels of products certified by certification bodies and generally trust them.

Finally, PER shows an opposing interaction between use, value, risk and traditional barriers and the willingness to purchase zero-waste products. This indicates that the higher the consumer PER, the greater the impact of the barriers (use, value, risk and tradition) on the willingness to purchase zero-waste products. As shown in Figure 2, respondents with a high PER have a greater willingness to purchase zero-waste products than respondents with a low PER. However, as the barriers (use, value, risk, tradition) increase, it can be seen that the slope of purchase intention is significantly lower for the high PER group than for the low PER group. These results suggest the need for strategic consideration of consumer PER when encouraging governments and the consumption of zero-waste products, or when motivating companies to produce zero-waste products. With this in mind, identifying consumer altruism with respect to environmental protection can help strengthen waste management operations, such as spontaneous collection, disposal, recovery and recycling. Globally, there are an increasing number of national regulations and policies related to environmental protection, and consumers are often exposed to discussions about the importance of environmental protection activities through the media and social media. As a result, it is expected that consumer PER levels will naturally increase over time.

Theoretical and Practical Implications

The important theoretical implications of our study are as follows: First, it adds to the literature on consumer boycotts of environmentally innovative products. In the past, scholars have shown a growing interest in better understanding consumer boycotts. Thus, the findings of this paper will contribute to the emerging, but limited, area of research on zero-waste products.

Second, the current study contributes to an understanding of the causes of resistance to environmentally friendly product innovation by testing the applicability of IRT in the emerging market of zero-waste products in Korea while explaining the relationship between the different barriers to purchase intention and IRT, as well as extending PER within IRT.

In terms of practical contributions, firstly, although the sustainable consumption practices of the brand in the past were mainly focused on distribution and sustainable production of product packaging, the research results of this paper for Zero waste will contribute to the solution of waste management and the innovation of related technology as well as promoting the development of sustainable practices in the product production chain Zero waste has become one of the major trends today. If the associated technologies develop further, they will exert a strong influence enough to change the form of human life significantly by reducing the carbon footprint. The opening of Zero waste offline concept stores and flash stores will help to better understand real-life consumer choices in terms of sustainable consumption and will deepen understanding of brands' green choices, sustainable decision-making and pro-social behavior, while continuously improving the image of brand services.

Second, current research findings suggest that, to increase the purchase intention, Zero waste should focus on expanding the type and range of zero-waste products while improving the convenience and cost-effectiveness of purchases. At the same time, brands should create more channels to push Zero waste-related information and continuously update and optimize Zero waste products to after-sales. Brand marketers should be

aware that there is little negative publicity about Zero waste, and maintaining brand trustworthiness is the best approach at this time. This study recommends integrating Zero waste into more product lines and programs, which allows them to be maximized in real-world settings, such as brands offering multiple incentives to develop membership economies to change sustainable consumption habits. Service providers should also focus on reducing user perceptions of barriers to using and value, using advertising to promote the value of Zero waste, and reinforcing environmental responsibility, thereby increasing consumer willingness to consume Zero waste products, and maximizing the ease of use and purchase flexibility of Zero waste.

6. Limitations and Future Research

In this study, the effects of functional barriers (usage, value and risk) and psychological barriers (tradition and image) on zero-waste product purchase intention were verified by applying IRT. Furthermore, we explored the moderating effect of consumer PER. This research provides the following conclusions.

First, in situations where the importance of environmental protection activities, such as ESG, CSR and zero waste, are emphasized and academic discussions are active, this study contributes to the literature regarding consumer resistance to ecofriendly products. In addition, IRT, which has mainly been used in reference to the latest technologies, mobile phones and applications, was extended to consumer product consumption pattern analysis.

Second, through the results of this study, it can be seen that barriers to zero-waste products significantly reduce purchase intention, and high levels of PER are associated with stronger negative impacts of barriers. Accordingly, governments and organizations should systematically establish strategies for managing these barriers to encourage consumers toward the zero-waste philosophy and products, in addition to considering consumer PER through products and product marketing.

The present study, however, has the following limitations and future research directions. First, as each barrier set as an independent variable comprises two or three measurement items, the question of whether reliability and validity have been secured may arise. Therefore, in the future, efforts to increase the reliability are needed through the development of various measurement variables via the Delphi technique. Second, it will be necessary in the future to explore the relationships between different variables in addition to purchase intention. Hence, it may be possible to establish a foundation for sustainable consumption and to use behaviors by identifying the roles of the consumer barriers and reducing user resistance.

This study did not sufficiently secure the CR and AVE of the measured items in the CFA. As the previous studies in which IRT was applied mainly focused on technological innovations, many items were removed without securing reliability in the process of modifying the items to fit the subject of this research. Based on the results of this work, it is expected that empirical studies securing higher validity could be conducted in follow-up research by adding new measurement items along with an expansion of the research topic.

Third, this study was conducted as a sample survey of Asian people. The functional and psychological barriers, as well as PER, may vary by country and by culture. Future studies are therefore expected to yield significant results if the model can be validated using consumer data from different age groups across different geographical and cultural boundaries.

Author Contributions: Y.S., H.Y. and E.H. conceived and designed the initial research idea; Y.S., H.Y. and E.H. performed the literature review and analyzed the data; Y.S, H.Y. and E.H. wrote the paper. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Due to the nature of this study, no formal approval of the institutional review board of the local ethics committee was required. Nonetheless, all subjects were informed about the study, and participation was fully on a voluntary basis. Participants were ensured

of the confidentiality and anonymity of the information associated with the surveys. This study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Barrier Measurement Questions.

Variable Name	Item Code	Items
Usage barriers (Sadiq et al., [77]; Nandi et al., [129])	UB1	I think zero-waste products have a narrow range of choices.
	UB2	I think zero-waste products have a narrow range of types and products.
	UB3	The reason I don't buy zero-waste products is that they're not readily available in stores.
Value barriers (Sadiq et al., [77]; Kushwaha et al., [89])	VB1	I don't think zero-waste products have any advantages compared to existing products.
	VB2	I think the quality of zero-waste products is lower than that of existing products.
	VB3	I don't think zero-waste products are very helpful for environmental protection.
	VB4	I think zero-waste products also contain pesticides and other harmful chemicals.
Risk barriers (Sadiq et al., [77]; Kushwaha et al., [89])	RB1	I am afraid that zero-waste products that claim to be environmentally friendly are not actually zero-waste products.
	RB2	I am afraid to pay more for zero-waste products than for existing products.
Traditional barriers (Sadiq et al., [77]; Torres-Ruiz et al., [130])	TB1	Even if it's not a zero-waste product, the existing product is enough.
	TB2	I don't trust zero-waste products.
Image barriers (Sadiq et al., [77]; Kushwaha et al., [89])	IB1	I have doubts about the labels of zero-waste products (e.g., eco-friendly certification marks on product packaging).
	IB2	I don't think the zero-waste products currently on the market are actually zero-waste.
	IB3	I have an image of a high barrier to use zero-waste products.

References

1. Islam, K.M. Municipal Solid Waste to Energy Generation in Bangladesh: Possible Scenarios to Generate Renewable Electricity in Dhaka and Chittagong City. *J. Renew. Energy* **2016**, *2016*, 1712370. [CrossRef]
2. Gautam, M.; Agrawal, M. Greenhouse Gas Emissions from Municipal Solid Waste Management: A Review of Global Scenario. In *Carbon Footprint Case Studies*; Muthu, S.S., Ed.; Environmental Footprints and Eco-Design of Products and Processes; Springer: Singapore, 2021; pp. 123–160. [CrossRef]
3. Lehmann, S.; Zaman, A.U.; Devlin, J.; Holyoak, N. Supporting Urban Planning of Low-Carbon Precincts: Integrated Demand Forecasting. *Sustainability* **2013**, *5*, 5289–5318. [CrossRef]
4. Zaman, A.; Lehmann, S. The zero waste index: A performance measurement tool for waste management systems in a 'zero waste city'. *J. Clean. Prod.* **2013**, *50*, 123–132. [CrossRef]
5. Ibikunle, R.; Titiladunayo, I.; Akinnuli, B.; Dahunsi, S.; Olayanju, T. Estimation of power generation from municipal solid wastes: A case Study of Ilorin metropolis, Nigeria. *Energy Rep.* **2019**, *5*, 126–135. [CrossRef]
6. Connor, R. *The United Nations World Water Development Report 2015: Water for a Sustainable World*; UNESCO: Paris, France, 2015; Volume 1.
7. Romano, G.; Rapposelli, A.; Marrucci, L. Improving waste production and recycling through zero-waste strategy and privatization: An empirical investigation. *Resour. Conserv. Recycl.* **2019**, *146*, 256–263. [CrossRef]
8. Yu, Z.; Khan, S.A.R.; Ponce, P.; Zia-Ul-Haq, H.M.; Ponce, K. Exploring essential factors to improve waste-to-resource recovery: A roadmap towards sustainability. *J. Clean. Prod.* **2022**, *350*, 131305. [CrossRef]

9. Palmer, P. *Getting to Zero Waste*; Purple Sky Press: Sebastopol, CA, USA, 2004.
10. Fudala-Ksiazek, S.; Pierpaoli, M.; Kulbat, E.; Luczkiewicz, A. A modern solid waste management strategy—The generation of new by-products. *Waste Manag.* **2016**, *49*, 516–529. [CrossRef]
11. Bressanelli, G.; Adrodegari, F.; Pigosso, D.C.A.; Parida, V. Towards the Smart Circular Economy Paradigm: A Definition, Conceptualization, and Research Agenda. *Sustainability* **2022**, *14*, 4960. [CrossRef]
12. Lehmann, S. Optimizing Urban Material Flows and Waste Streams in Urban Development through Principles of Zero Waste and Sustainable Consumption. *Sustainability* **2011**, *3*, 155–183. [CrossRef]
13. Ali, S.; Akter, S.; Ymeri, P.; Fogarassy, C. How the Use of Biomass for Green Energy and Waste Incineration Practice Will Affect GDP Growth in the Less Developed Countries of the EU (A Case Study with Visegrad and Balkan Countries). *Energies* **2022**, *15*, 2308. [CrossRef]
14. Ali, S.; Akter, S.; Fogarassy, C. Analysis of Circular Thinking in Consumer Purchase Intention to Buy Sustainable Waste-To-Value (WTV) Foods. *Sustainability* **2021**, *13*, 5390. [CrossRef]
15. Castigliego, J.R.; Pollack, A.; Cleveland, C.J.; Walsh, M.J. Evaluating emissions reductions from zero waste strategies under dynamic conditions: A case study from Boston. *J. Waste Manag.* **2021**, *126*, 170–179. [CrossRef] [PubMed]
16. Jeng, S.Y.; Lin, C.W.; Tseng, M.L.; Jantarakolica, K.; Tan, R. Resource efficiency improvement: Zero waste discharge planning in a pulp-and-paper firm under uncertainties. *Manag. Environ. Qual.* **2021**, *32*, 646–664. [CrossRef]
17. ElShishtawy, N.; Sinha, P.; Bennell, J.A. A comparative review of zero-waste fashion design thinking and operational research on cutting and packing optimisation. *Int. J. Fash. Des. Technol. Educ.* **2022**, *15*, 187–199. [CrossRef]
18. Khaw-ngern, K.; Peuchthonglang, P.; Klomkul, L.; Khaw-ngern, C. The 9Rs strategies for the circular economy 3.0. *Psychol. Educ. J.* **2021**, *58*, 1440–1446.
19. Madjidan, N.L.; Sulistyowati, R. Pengaruh Green Marketing dan Green Product terhadap Green Purchase Intention pada Alang Alang Zero Waste Shop. *J. Ecogen.* **2022**, *5*, 294–305. [CrossRef]
20. Adedeji, A.A. Agri-food waste reduction and utilization: A sustainability perspective. *J. ASABE* **2022**, *65*, 471–479. [CrossRef]
21. Haan, T.Y.; Takriff, M.S. Tecnologías de residuos cero para el desarrollo sostenible en las plantas de beneficio de aceite de palma. *Palmas* **2022**, *43*, 40–55.
22. Chen, M.; Ogunseitan, O.A. Zero E-waste: Regulatory impediments and blockchain imperatives. *Front. Environ. Sci. Eng.* **2021**, *15*, 114. [CrossRef]
23. Stanescu, M.D. State of the art of post-consumer textile waste upcycling to reach the zero waste milestone. *Environ. Sci. Pollut. Res.* **2021**, *28*, 14253–14270. [CrossRef]
24. Awasthi, A.K.; Tan, Q.; Li, J. Biotechnological potential for microplastic waste. *Trends Biotechnol.* **2020**, *38*, 1196–1199. [CrossRef] [PubMed]
25. Gu, B.; Tang, X.; Liu, L.; Li, Y.; Fujiwara, T.; Sun, H.; Gu, A.; Yao, Y.; Duan, R.; Song, J.; et al. The recyclable waste recycling potential towards zero waste cities-A comparison of three cities in China. *J. Clean. Prod.* **2021**, *295*, 126358. [CrossRef]
26. Kantaros, A.; Laskaris, N.; Piromalis, D.; Ganetsos, T. Manufacturing zero-waste COVID-19 personal protection equipment: A case study of utilizing 3D printing while employing waste material recycling. *Circ. Econ. Sustain.* **2021**, *1*, 851–869. [CrossRef] [PubMed]
27. Gu, B.; Zhang, L.; Van Dingenen, R.; Vieno, M.; Van Grinsven, H.J.; Zhang, X.; Zhang, S.; Chen, Y.; Wang, S.; Ren, C.; et al. Abating ammonia is more cost-effective than nitrogen oxides for mitigating $PM_{2.5}$ air pollution. *Science* **2021**, *374*, 758–762. [CrossRef] [PubMed]
28. Wahyudi, S.; Efendi, F.N.; Faizal, A. The effects of adsorbent mass using red brick powder on the results of biogas purification. *J. Appl. Sci. Eng.* **2021**, *19*, 17–23. [CrossRef]
29. Lee, R.P.; Tschoepe, M.; Voss, R. Perception of chemical recycling and its role in the transition towards a circular carbon economy: A case study in Germany. *J. Waste Manag.* **2021**, *125*, 280–292. [CrossRef]
30. Grossman, A.D.; Belete, Y.Z.; Boussiba, S.; Yogev, U.; Posten, C.; Tena, F.O.; Thomsen, L.; Wang, S.; Gross, A.; Leu, S.; et al. Advanced near-zero waste treatment of food processing wastewater with water, carbon, and nutrient recovery. *Sci. Total Environ.* **2021**, *779*, 146373. [CrossRef]
31. Ibharim, M.S.R.; Mohd Tajuddin, R. A zero-waste concept of multifunctional clothing design. *ESTEEM J. Soc. Sci. Humanit.* **2021**, *5*, 76–87.
32. Wan, M.C.; Qin, W.; Lei, C.; Li, Q.H.; Meng, M.; Fang, M.; Song, W.; Chen, J.H.; Tay, F.; Niu, L.N. Biomaterials from the sea: Future building blocks for biomedical applications. *Bioact. Mater.* **2021**, *6*, 4255–4285. [CrossRef]
33. Umor, N.A.; Ismail, S.; Abdullah, S.; Huzaifah, M.H.R.; Huzir, N.M.; Mahmood, N.A.N.; Zahrim, A.Y. Zero waste management of spent mushroom compost. *J. Mater. Cycles Waste Manag.* **2021**, *23*, 1726–1736. [CrossRef]
34. Muliarta, I.N.; Darmawan, I.K. Processing Household Organic Waste into Eco-Enzyme as an Effort to Realize Zero Waste. *Agriwar J.* **2021**, *1*, 6–11.
35. Arevalo-Gallegos, A.; Ahmad, Z.; Asgher, M.; Parra-Saldivar, R.; Iqbal, H.M. Lignocellulose: A sustainable material to produce value-added products with a zero waste approach—A review. *Int. J. Biol. Macromol.* **2017**, *99*, 308–318. [CrossRef] [PubMed]
36. Kirchherr, J.; Reike, D.; Hekkert, M. Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.* **2017**, *127*, 221–232. [CrossRef]

37. AAli, S.; Akter, S.; Fogarassy, C. The role of the key components of renewable energy (combustible renewables and waste) in the context of CO_2 emissions and economic growth of selected countries in Europe. *Energies* **2021**, *14*, 2034. [CrossRef]
38. Chalfan, L. *Zero Waste Key to Our Future*; Zero Waste Alliance: Portland, OR, USA, 2001.
39. Zaman, A.; Newman, P. Plastics: Are they part of the zero-waste agenda or the toxic-waste agenda? *Sustain. Earth* **2021**, *4*, 4. [CrossRef]
40. Zaman, A. Zero-Waste: A New Sustainability Paradigm for Addressing the Global Waste Problem. In *The Vision Zero Handbook: Theory, Technology and Management for a Zero Casualty Policy*; Springer: Cham, Switzerland, 2022; pp. 1–24.
41. Singh, S.; Ramakrishna, S.; Gupta, M.K. Towards zero waste manufacturing: A multidisciplinary review. *J. Clean. Prod.* **2017**, *168*, 1230–1243. [CrossRef]
42. Bartl, A. Barriers towards achieving a zero waste society. *Waste Manag.* **2011**, *31*, 2369–2370. [CrossRef]
43. Fujita, K.; Hill, R.C. The zero waste city: Tokyo's quest for a sustainable environment. *J. Comp. Policy Anal.* **2007**, *9*, 405–425. [CrossRef]
44. Lehmann, S. Urban metabolism and the zero-waste city: Transforming cities through sustainable design and behavior change. *Green Cities* **2012**, *2012*, 108–135.
45. Premalatha, M.; Tauseef, S.M.; Abbasi, T.; Abbasi, S.A. The promise and the performance of the world's first two zero carbon eco-cities. Renew. Sustain. *Energy Rev.* **2013**, *25*, 660–669.
46. Zaman, A.U.; Lehmann, S. Urban growth and waste management optimization towards 'zero waste city'. *City Cult. Soc.* **2011**, *2*, 177–187. [CrossRef]
47. Connett, P. *The Zero Waste Solution: Untrashing the Planet One Community at a Time*; Chelsea Green Publishing: White River Junction, VT, USA, 2013.
48. Dileep, M.R. Tourism and waste management: A review of implementation of "zero waste" at Kovalam. *Asia Pac. J. Tour. Res.* **2007**, *12*, 377–392. [CrossRef]
49. Khan, M.M.; Rafiqul Islam, M. *Zero Waste Engineering: A New Era of Sustainable Technology Development*; John Wiley & Sons: Hoboken, NJ, USA, 2016.
50. Kelly, T.; Mason, I.; Leiss, M.; Ganesh, S. University community responses to on-campus resource recycling. *Resour. Conserv. Recycl.* **2006**, *47*, 42–55. [CrossRef]
51. Mason, I.; Brooking, A.; Oberender, A.; Harford, J.; Horsley, P. Implementation of a zero waste program at a university campus. *Resour. Conserv. Recycl.* **2003**, *38*, 257–269. [CrossRef]
52. Cole, C.; Osmani, M.; Quddus, M.; Wheatley, A.; Kay, K. Towards a Zero Waste Strategy for an English Local Authority. *Resour. Conserv. Recycl.* **2014**, *89*, 64–75. [CrossRef]
53. Connett, P.; Sheehan, B. *A citizen's Agenda for Zero Waste*; GrassRoots Recycling Network: Sebastopol, CA, USA, 2001.
54. Young, C.-Y.; Ni, S.-P.; Fan, K.-S. Working towards a zero waste environment in Taiwan. *Waste Manag. Res. J. A Sustain. Circ. Econ.* **2009**, *28*, 236–244. [CrossRef] [PubMed]
55. Greyson, J. An economic instrument for zero waste, economic growth and sustainability. *J. Clean. Prod.* **2007**, *15*, 1382–1390. [CrossRef]
56. Song, Q.; Li, J.; Zeng, X. Minimizing the increasing solid waste through zero waste strategy. *J. Clean. Prod.* **2015**, *104*, 199–210. [CrossRef]
57. Matete, N.; Trois, C. Towards zero waste in emerging countries—A South African experience. *J. Waste Manag.* **2008**, *28*, 1480–1492. [CrossRef]
58. Bagui, B.E.; Arellano, L.R.A.C. Zero Waste Store: A Way to Promote Environment-friendly Living. *Int. J. Qual. Res.* **2021**, *1*, 150–155. [CrossRef]
59. Paço, A. Gouveia Rodrigues R. Environmental activism and consumers' perceived responsibility. *Int. J. Consum. Stud.* **2016**, *40*, 466–474. [CrossRef]
60. Johri, L.M.; Sahasakmontri, K. Green marketing of cosmetics and toiletries in Thailand. *J. Consum. Mark.* **1998**, *15*, 265–281. [CrossRef]
61. Piligrimienė, Ž.; Žukauskaitė, A.; Korzilius, H.; Banytė, J.; Dovalienė, A. Internal and External Determinants of Consumer Engagement in Sustainable Consumption. *Sustainability* **2020**, *12*, 1349. [CrossRef]
62. Ma, L.; Lee, C.S. Understanding the Barriers to the Use of MOOCs in a Developing Country: An Innovation Resistance Perspective. *J. Educ. Comput. Res.* **2018**, *57*, 571–590. [CrossRef]
63. Seth, H.; Talwar, S.; Bhatia, A.; Saxena, A.; Dhir, A. Consumer resistance and inertia of retail investors: Development of the resistance adoption inertia continuance (RAIC) framework. *J. Retail. Consum. Serv.* **2020**, *55*, 102071. [CrossRef]
64. Kaur, P.; Dhir, A.; Singh, N.; Sahu, G.; Almotairi, M. An innovation resistance theory perspective on mobile payment solutions. *J. Retail. Consum. Serv.* **2020**, *55*, 102059. [CrossRef]
65. Talwar, S.; Talwar, M.; Kaur, P.; Dhir, A. Consumers' resistance to digital innovations: A systematic review and framework development. *Australas. Mark. J.* **2020**, *28*, 286–299. [CrossRef]
66. Ram, S. A model of innovation resistance. *ACR N. Am. Adv.* **1987**, *14*, 208–212.
67. Ram, S.; Sheth, J.N. Consumer resistance to innovations: The marketing problem and its solutions. *J. Consum. Mark.* **1989**, *6*, 5–14. [CrossRef]

68. Szmigin, I.; Foxall, G. Three forms of innovation resistance: The case of retail payment methods. *Technovation* **1998**, *18*, 459–468. [CrossRef]
69. Lian, J.W.; Yen, D.C. To buy or not to buy experience goods online: Perspective of innovation adoption barriers. *Comput. Hum. Behav.* **2013**, *29*, 665–672. [CrossRef]
70. Chaouali, W.; Souiden, N. The role of cognitive age in explaining mobile banking resistance among elderly people. *J. Retail. Consum. Serv.* **2019**, *50*, 342–350. [CrossRef]
71. Talwar, S.; Dhir, A.; Singh, D.; Virk, G.S.; Salo, J. Sharing of fake news on social media: Application of the honeycomb framework and the third-person effect hypothesis. *J. Retail. Consum. Serv.* **2020**, *57*, 102197. [CrossRef]
72. Talwar, S.; Dhir, A.; Kaur, P.; Mäntymäki, M. Barriers toward purchasing from online travel agencies. *Int. J. Hosp. Manag.* **2020**, *89*, 102593. [CrossRef]
73. Jansukpum, K.; Kettem, S. Applying innovation resistance theory to understand consumer resistance of using online travel in Thailand. In Proceedings of the 2015 14th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES), Guiyang, China, 18–24 August 2015; pp. 139–142.
74. Molesworth, M.; Suortti, J.P. Buying cars online: The adoption of the web for high-involvement, high-cost purchases. *J. Consum. Behav. Int. Res. Rev.* **2002**, *2*, 155–168. [CrossRef]
75. Juric, J.; Lindenmeier, J. An empirical analysis of consumer resistance to smart-lighting products. *Light. Res. Technol.* **2019**, *51*, 489–512. [CrossRef]
76. Kaur, P.; Dhir, A.; Ray, A.; Bala, P.K.; Khalil, A. Innovation resistance theory perspective on the use of food delivery applications. *J. Enterp. Inf. Manag.* **2020**, *34*, 1746–1768. [CrossRef]
77. Sadiq, M.; Adil, M.; Paul, J. An innovation resistance theory perspective on purchase of eco-friendly cosmetics. *J. Retail. Consum. Serv.* **2021**, *59*, 102369. [CrossRef]
78. Heidenreich, S.; Handrich, M. What about passive innovation resistance? Investigating adoption-related behavior from a resistance perspective. *J. Prod. Innov. Manag.* **2015**, *32*, 878–903. [CrossRef]
79. Laukkanen, P.; Sinkkonen, S.; Laukkanen, T. Consumer resistance to internet banking: Postponers, opponents and rejectors. *Int. J. Bank Mark.* **2008**, *26*, 440–455. [CrossRef]
80. Nabih, M.I.; Poiesz, T.B. Conceptual issues in the study of innovation adoption behavior. *ACR N. Am. Adv.* **1997**, *24*, 190–196.
81. Bagozzi, R.P.; Lee, K.H. Consumer resistance to, and acceptance of, innovations. *Adv. Consum. Res.* **1999**, *26*, 218–225.
82. Sheth, J.N. *An Integrative Theory of Patronage Preference and Behavior*; College of Commerce and Business Administration, Bureau of Economic and Business Research, University of Illinois: Urbana, IL, USA, 1981.
83. Heidenreich, S.; Kraemer, T. Innovations-Doomed to Fail? Investigating Strategies to Overcome Passive Innovation Resistance. *J. Prod. Innov. Manag.* **2015**, *33*, 277–297. [CrossRef]
84. Yu, C.S.; Chantatub, W. Consumersâ€™ resistance to using mobile banking: Evidence from Thailand and Taiwan. *Int. J. Electron. Commer. Stud.* **2015**, *7*, 21–38. [CrossRef]
85. Lee, C.; Coughlin, J.F. PERSPECTIVE: Older adults' adoption of technology: An integrated approach to identifying determinants and barriers. *J. Prod. Innov. Manag.* **2015**, *32*, 747–759. [CrossRef]
86. Kuisma, T.; Laukkanen, T.; Hiltunen, M. Mapping the reasons for resistance to Internet banking: A means-end approach. *Int. J. Inf. Manag.* **2007**, *27*, 75–85. [CrossRef]
87. Bruner, G.C., II; Kumar, A. Explaining consumer acceptance of handheld Internet devices. *J. Bus. Res.* **2005**, *58*, 553–558. [CrossRef]
88. Phillips, P.S.; Tudor, T.; Bird, H.; Bates, M. A critical review of a key waste strategy initiative in England: Zero waste places projects 2008–2009. *Resour. Conserv. Recycl.* **2011**, *55*, 335–343. [CrossRef]
89. Kushwah, S.; Dhir, A.; Sagar, M.; Gupta, B. Determinants of organic food consumption. A systematic literature review on motives and barriers. *Appetite* **2019**, *143*, 104402. [CrossRef]
90. Tandon, A.; Dhir, A.; Kaur, P.; Kushwah, S.; Salo, J. Why do people buy organic food? The moderating role of environmental concerns and trust. *J. Retail. Consum. Serv.* **2020**, *57*, 102247. [CrossRef]
91. Mani, Z.; Chouk, I. Consumer resistance to innovation in services: Challenges and barriers in the internet of things era. *J. Prod. Innov. Manag.* **2018**, *35*, 780–807. [CrossRef]
92. Vafaei-Zadeh, A.; Wong, T.K.; Hanifah, H.; Teoh, A.P.; Nawaser, K. Modelling electric vehicle purchase intention among generation Y consumers in Malaysia. *Res. Transp. Bus. Manag.* **2022**, *43*, 100784. [CrossRef]
93. Samudro, A.; Sumarwan, U.; Simanjuntak, M.; Yusuf, E. Assessing the effects of perceived quality and perceived value on customer satisfaction. *Manag. Sci. Lett.* **2020**, *10*, 1077–1084. [CrossRef]
94. Laukkanen, T.; Lauronen, J. Consumer value creation in mobile banking services. *Int. J. Mob. Commun.* **2005**, *3*, 325–338. [CrossRef]
95. Lian, J.W.; Yen, D.C. Online shopping drivers and barriers for older adults: Age and gender differences. *Comput. Hum. Behav.* **2014**, *37*, 133–143. [CrossRef]
96. Kuo, C.M.; Chen, L.C.; Tseng, C.Y. Investigating an innovative service with hospitality robots. *Int. J. Contemp. Hosp. Manag.* **2017**, *29*, 1305–1321. [CrossRef]
97. Poon, W.C. Users' adoption of e-banking services: The Malaysian perspective. *J. Bus. Ind. Mark.* **2008**, *23*, 59–69. [CrossRef]
98. Yiu, C.S.; Grant, K.; Edgar, D. Factors affecting the adoption of Internet Banking in Hong Kong—Implications for the banking sector. *J. Inf. Manag.* **2007**, *27*, 336–351. [CrossRef]

99. Laukkanen, T. Consumer adoption versus rejection decisions in seemingly similar service innovations: The case of the Internet and mobile banking. *J. Bus. Res.* **2016**, *69*, 2432–2439. [CrossRef]
100. Fain, D.; Roberts, M.L. Technology vs. consumer behavior: The battle for the financial services customer. *J. Direct Mark.* **1997**, *11*, 44–54. [CrossRef]
101. Marr, N.E.; Prendergast, G.P. Consumer adoption of self-service technologies in retail banking: Is expert opinion supported by consumer research? *Int. J. Bank Mark.* **1993**, *11*, 3–10. [CrossRef]
102. Bryła, P. Organic food consumption in Poland: Motives and barriers. *Appetite* **2016**, *105*, 737–746. [CrossRef] [PubMed]
103. Deselnicu, D.C.; Militāru, G.; Deselnicu, V.; Zăinescu, G.; Albu, L. Towards a circular economy—A zero waste programme for Europe. In Proceedings of the International Conference on Advanced Materials and Systems (ICAMS), Bucharest, Romania, 18–20 October 201; The National Research & Development Institute for Textiles and Leather-INCDTP: Bucharest, Romania, 2018; pp. 563–568.
104. Pratiwi, N.; Saputri, M.; Okwisan, S.; Atifah, Y. Pup Pump: Processing of Human Feces as a Alternative Bioenergy Power Plant Zero Waste. *Int. J. Ethnosci. Bio-Inform. Trans. Innov. Sci. Technol.* **2022**, *1*, v1i1.4. [CrossRef]
105. Laukkanen, T.; Sinkkonen, S.; Laukkanen, P. Communication strategies to overcome functional and psychological resistance to Internet banking. *Int. J. Inf. Manag.* **2009**, *29*, 111–118. [CrossRef]
106. Misra, R.; Singh, D. An analysis of factors affecting growth of organic food: Perception of consumers in Delhi-NCR (India). *Br. Food J.* **2016**, *118*, 2308–2325. [CrossRef]
107. Yu, E.P.; Van Luu, B.; Chen, C.H. Greenwashing in environmental, social and governance disclosures. *Res. Int. Bus. Financ.* **2020**, *52*, 101192. [CrossRef]
108. Szewczyk, M. Corporate Social Responsibility in the Textile and Apparel Industry: Barriers and Challenges. *J. Corp. Responsib. Leadersh.* **2016**, *3*, 67–81. [CrossRef]
109. Pham, L.; Williamson, S.; Lane, P.; Limbu, Y.; Nguyen, P.T.H.; Coomer, T. Technology readiness and purchase intention: Role of perceived value and online sat-isfaction in the context of luxury hotels. *Int. J. Manag. Decis. Mak.* **2020**, *19*, 91–117. [CrossRef]
110. Wang, C.L.; Li, D.; Barnes, B.R.; Ahn, J. Country image, product image and consumer purchase intention: Evidence from an emerging economy. *Int. Bus. Rev.* **2012**, *21*, 1041–1051. [CrossRef]
111. Psarommatis, F.; Prouvost, S.; May, G.; Kiritsis, D. Product Quality Improvement Policies in Industry 4.0: Characteristics, Enabling Factors, Barriers, and Evolution Toward Zero Defect Manufacturing. *Front. Comput. Sci.* **2020**, *2*, 26. [CrossRef]
112. Kerdlap, P.; Low JS, C.; Ramakrishna, S. Zero waste manufacturing: A framework and review of technology, research, and implementation barriers for enabling a circular economy transition in Singapore. *Resour. Conserv. Recycl.* **2019**, *151*, 104438. [CrossRef]
113. Habel, C.; Schöttle, M.; Daab, M.; Eichstaedt, N.J.; Wagner, D.; Bakhshi, H.; Agarwal, S.; Horn, M.A.; Breu, J. High-Barrier, Biodegradable Food Packaging. *Macromol. Mater. Eng.* **2018**, *303*, 1800333. [CrossRef]
114. Wu, F.; Misra, M.; Mohanty, A.K. Challenges and new opportunities on barrier performance of biodegradable polymers for sustainable packaging. *Prog. Polym. Sci.* **2021**, *117*, 101395. [CrossRef]
115. Bodenheimer, M.; Schuler, J.; Wilkening, T. Drivers and barriers to fashion rental for everyday garments: An empirical analysis of a former fashion-rental company. *Sustain. Sci. Pract. Policy* **2022**, *18*, 344–356. [CrossRef]
116. Chao, S.L.; Tsao, C.F. Influence of Brand Reputation and Switching Barrier on Customer Loyalty for International Express Carriers. In Proceedings of the International Forum on Shipping, Ports and Airports (IFSPA) 2015: Empowering Excellence in Maritime and Air Logistics: Innovation Management and Technology, Hong Kong, China, 29 November–2 December 2015; Hong Kong Polytechnic University: Hong Kong, China, 2016.
117. Ricci, E.C.; Banterle, A.; Stranieri, S. Trust to go green: An exploration of consumer intentions for eco-friendly convenience food. *Ecol. Econ.* **2018**, *148*, 54–65. [CrossRef]
118. Bamberg, S. Changing environmentally harmful behaviors: A stage model of self-regulated behavioral change. *J. Environ. Psychol.* **2013**, *34*, 151–159. [CrossRef]
119. Kaplan, H.S.; Hooper, P.L.; Gurven, M. The evolutionary and ecological roots of human social organization. *Philos. Trans. R. Soc. B Biol. Sci.* **2009**, *364*, 3289–3299. [CrossRef]
120. Lee, K. Gender differences in Hong Kong adolescent consumers' green purchasing behavior. *J. Consum. Mark.* **2009**, *26*, 87–96. [CrossRef]
121. Lai, O.K. Greening of Hong Kong? Forms of manifestation of environmental movements. In *The Dynamics of Social Movements in Hong Kong*; Hong Kong University Press: Hong Kong, China, 2000; pp. 259–295.
122. Tang, Y.; Hinsch, C. Going green to be morally clean: An examination of environmental behavior among materialistic consumers. *Psychol. Mark.* **2018**, *35*, 845–862. [CrossRef]
123. Ernst, J.; Blood, N.; Beery, T. Environmental action and student environmental leaders: Exploring the influence of environmental attitudes, locus of control, and sense of personal responsibility. *Environ. Educ. Res.* **2017**, *23*, 149–175. [CrossRef]
124. Patwary, A.K.; Rasoolimanesh, S.M.; Rabiul, M.K.; Aziz, R.C.; Hanafiah, M.H. Linking environmental knowledge, environmental responsibility, altruism, and intention toward green hotels through ecocentric and anthropocentric attitudes. *Int. J. Contemp. Hosp. Manag.* **2022**, *34*, 4653–4673. [CrossRef]
125. Afzaal, M.; Gohar, M.A.; Zahid, Z. Green Marketing Effect on Consumer's Purchasing Behavior/intention and Brand Equity. *Int. J. Bus. Econ. Aff.* **2021**, *6*, 106–117.

126. Billig, M.; Badwan, A.; Ankona, E.; Anker, Y. Charcoal Production in Palestinian villages-The Paradox of resistance to innovation driving rural development. *J. Rural Stud.* **2022**, *89*, 25–34. [CrossRef]
127. Prakash, A.V.; Das, S. Explaining citizens' resistance to use digital contact tracing apps: A mixed-methods study. *Int. J. Inf. Manag.* **2022**, *63*, 102468. [CrossRef]
128. Kushwah, S.; Dhir, A.; Sagar, M. Understanding consumer resistance to the consumption of organic food. A study of ethical consumption, purchasing, and choice behaviour. *Food Qual. Prefer.* **2019**, *77*, 1–14. [CrossRef]
129. Nandi, R.; Bokelmann, W.; Gowdru, N.V.; Dias, G. Factors Influencing Consumers' Willingness to Pay for Organic Fruits and Vegetables: Empirical Evidence from a Consumer Survey in India. *J. Food Prod. Mark.* **2016**, *23*, 430–451. [CrossRef]
130. Torres-Ruiz, F.J.; Vega-Zamora, M.; Parras-Rosa, M. False barriers in the purchase of organic foods. The case of extra virgin olive oil in Spain. *Sustainability* **2018**, *10*, 461. [CrossRef]
131. MacKenzie, S.B.; Lutz, R.J. An empirical examination of the structural antecedents of attitude toward the ad in an advertising pretesting context. *J. Mark.* **1989**, *53*, 48–65. [CrossRef]
132. Hsu, C.-L.; Chang, C.-Y.; Yansritakul, C. Exploring purchase intention of green skincare products using the theory of planned behavior: Testing the moderating effects of country of origin and price sensitivity. *J. Retail. Consum. Serv.* **2017**, *34*, 145–152. [CrossRef]
133. Netemeyer, R.G.; Bearden, W.O.; Sharma, S. *Scaling Procedures: Issues and Applications*; Sage Publications: Thousand Oaks, CA, USA, 2003.
134. Yu, H.; Han, E. Developing a Measure for Online Shopping Mall Reputation (OSMR). *Sustainability* **2021**, *13*, 3818. [CrossRef]
135. Hu, L.T.; Bentler, P.M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model. Multidiscip. J.* **1999**, *6*, 1–55. [CrossRef]
136. Huang, D.; Jin, X.; Coghlan, A. Advances in consumer innovation resistance research: A review and research agenda. *Technol. Forecast. Soc. Chang.* **2021**, *166*, 120594. [CrossRef]
137. Roy, S.K.; Shekhar, V.; Lassar, W.M.; Chen, T. Customer engagement behaviors: The role of service convenience, fairness and quality. *J. Retail. Consum. Serv.* **2018**, *44*, 293–304. [CrossRef]
138. Claudy, M.C.; Garcia, R.; O'Driscoll, A. Consumer resistance to innovation—A behavioral reasoning perspective. *J. Acad. Mark. Sci.* **2015**, *43*, 528–544. [CrossRef]
139. Mainardes, E.W.; de Souza, I.M.; Correia, R.D. Antecedents and consequents of consumers not adopting ecommerce. *J. Retail. Consum. Serv.* **2020**, *55*, 102138. [CrossRef]
140. Nel, J.; Boshoff, C. Status quo bias and shoppers' mobile website purchasing resistance. *Eur. J. Mark.* **2020**, *54*, 1433–1466. [CrossRef]
141. Ullah, H.I.; Dickson, R.; Mancini, E.; Malanca, A.A.; Pinelo, M.; Mansouri, S.S. An integrated sustainable biorefinery concept towards achieving zero-waste production. *J. Clean. Prod.* **2022**, *336*, 130317. [CrossRef]
142. Royer, S.-J.; Ferrón, S.; Wilson, S.T.; Karl, D.M. Production of methane and ethylene from plastic in the environment. *PLoS ONE* **2018**, *13*, e0200574. [CrossRef]
143. Kleijnen, M.; Lee, N.; Wetzels, M. An exploration of consumer resistance to innovation and its antecedents. *J. Econ. Psychol.* **2009**, *30*, 344–357. [CrossRef]