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Green to gold: consumer circular choices may boost circular business models

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Abstract
Consumers are the true agents of transformation in the circular economy. By making conscious and sustainable choices, they drive the development of circular business models, challenging the status quo and inspiring change for a more sustainable future. The main purpose of this paper is to assess the role of consumers in the circular economy as drivers of the development of circular business models. In detail, we explore whether Portuguese citizens make circular consumption choices and what factors influence these choices. An online questionnaire was used to collect data from a sample of 826 Portuguese. The quantitative analysis was performed using the Partial Least Square (PLS) method. Overall, we found that: (i) both pro-environmental habits and environmental concerns positively influence their circular consumption choices, (ii) pro-environmental habits positively influence consumers' greenwashing perception, and (iii) greenwashing perception highlights environmental concerns. This study demonstrates that by adopting pro-environmental habits, consumers can play a central role in transforming companies' traditional business models into circular business models. Consequently, a model is proposed where consumers' motivations for adopting circular behaviors are used to convert the companies' business model from linear to circular. The model emphasizes the active participation of consumers.

Keywords Circular economy · Pro-environmental habits · Environmental concerns · Greenwashing · Circular consumption choices · Circular business model

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1 Introduction

By embracing the transition to a circular economy, the world is embarking on a journey of immense potential. This provides the chance to achieve remarkable economic growth and empowers us to make a lasting impact on our environmental and social environment. In this way, we aim to create a future where assurance and sustainability go hand in hand, inspiring the next generations. However, this implies a transformational change both in consumption and production (Ferreira et al., 2023; Meis-Harris et al., 2021). The essence of this transformation is to minimize waste. Waste minimization requires a longer useful life of resources and products (OECD, 2020). Extending the life cycle of products and materials implies that they are reused, recycled, remanufactured, and disposed of (Korhonen et al., 2018).

The transition to a circular economy is one of Europe's key priorities for fulfilling the commitment made to the United Nations 2030 Agenda for Sustainable Development and the Paris Agreement (Fetting, 2020). Although the circular material rate in the European Union has been increasing, it remains at deficient levels. In 2014 (the first year of evaluation), the rate of circular material was around 8.3% and reached 12.8% six years later (Eurostat, 2021).

Although companies progressively understand the value of a circular economy and are more aware of the opportunities that may arise, practical changes and implementing circular business models are still very incipient (Geissdoerfer et al., 2017). However, the responsibility to implement a circular economy should not fall only on companies but should be extended to consumers. According to Meis-Harris et al. (2021), the successful implementation of a circular economy depends heavily on consumers engaging in informed circular consumption behaviors. Consumers' circular purchasing choices can be an important trigger for companies to move from traditional production systems to pro-environmental production systems and to adopt circular business models. We can ask what role civil society plays in transforming consumption-based business models into circular economy models.

By recognizing the importance of consumers in structuring a circular economy, this study aims to explore the factors that influence Portuguese citizens to make circular consumption choices (CCC). Based on the study's results, a proposal was made for active consumer participation in transforming companies' traditional business models into circular business models. Thus far, few studies have addressed the importance of the role of consumers in promoting a circular economy (Gomes et al., 2022; Mostaghel & Chirumalla, 2021; Ratner et al., 2021; Testa et al., 2020; Wastling et al., 2018). Moreover, consumer participation in the circular economy is essentially based on acceptance models of circular practices (Kuah & Wang, 2020) without exploring the motivations for doing so.

Consumers' contribution to a circular economy has been studied through pro-environmental habits (Testa et al., 2020), their environmental concerns and greenwashing (Ratner et al., 2021). These items were measured with close-ended statements. However, despite the recognized contribution of these studies, these statements do not differentiate consumers' environmental concerns or environmentally friendly habits from their circular consumption choices. Thus, based on the statements explored by the authors, we created a new variable denominated "Circular Consumption Choices." From here, we examined the influence of (i) pro-environmental habits and environmental concerns in making circular consumption choices and (ii) pro-environmental habits in recognizing greenwashing and its influence on environmental concerns.

This study demonstrates consumers' relevant role in the circular economy, exploring their motivations to adopt circular consumption behaviors. This proves that consumers can actively contribute to the circular economy. Few studies have addressed consumer participation in the circular economy, focusing essentially on the part of companies, given the legal impositions they face and their contribution to green economic growth. This study contributes to the literature on the circular economy and, specifically, the literature on circular consumer behavior, demonstrating that consumers' adherence to circular consumption is encouraged by pro-environmental habits, their environmental concerns, and greater awareness of greenwashing. We believe that if society reveals a concern about pursuing circular consumption choices, this will, in the long term, pressure companies to change their business models to meet their customers' preferences. The present study, proposes a model of effective consumer participation in the circular economy.

2 Literature review

2.1 Circular consumption choices

In today's world, Consumer Circle Choices (CCC) have to be taken into account since each consumer decision can shape a better future for our planet. By embracing CCC, the consumer becomes a catalyst for change, driving a sustainable revolution that transcends traditional consumption patterns. In a linear economy—production, consumption, and disposal, a customer buys a manufactured product without any follow-up of the process. There is no concern with what the user does with the product when having it. The circular economy has been identified as a viable alternative to the traditional linear economic model (Ottelin et al., 2020; Schandl et al., 2018), and a means to fulfill the 2030 Agenda of United Nations for Sustainable Development.

From a circular business model perspective, there is already a growing interest in knowing what happens to the product after it leaves the manufacturer to be recycled and re-enter the production process. In this regard, the role of customers is crucial to the extent that consumer behavior can significantly influence the overall flow of products, components, and materials. Thus, customers' consumption choices become important to circular economy. Consumers are important actors in circular business models and can encourage them through their consumption choices (Meis-Harris et al., 2021). Two strategies for designing products and business models for a circular economy have been proposed by Bocken et al. (2016)—slowing and closing resource loops. While slowing resource cycles involves increasing product utilization through product lifespan extensions or sharing schemes, closing resource cycles, on the other hand, seeks to ensure that materials can be recycled at the end of the assets useful life (Bocken et al., 2016). In addition to entrepreneurs, consumers can (and should) undertake these strategies. In this regard, consumers can adopt a variety of behaviors. They can, for example, buy products designed for recycling or that have greater longevity, they can use repair and maintenance services to fix things instead of buying new replacement products, they can use renewable energy, they can recycle their waste (Ottelin et al., 2020), they can reuse some packaging, avoid using disposable products and/or give away clothes they do not use.

2.2 Environmental concerns

In the last three decades, societies have shown increasing environmental concerns, which has been changing consumer behaviors (Hirsh, 2010). Awareness about the importance of preserving the planet has led to a paradigm shift in the way consumers relate to the products they consume. Sustainability and circularity must stop being vague, distant, and unreachable concepts to become a real and present concern in everyone's' day-to-day life. Environmental concerns (EC) can be defined as consumers' awareness of the degradation of natural resources and pollution (Testa et al., 2020; Trivedi et al., 2018).

Consumers' environmental concerns stem from their beliefs or values, which, in turn, influence their attitudes and behaviors, from holding recycling practices to purchasing green or circular products (Fuxman et al., 2022; Schultz, 2000; Trivedi et al., 2018). Greater sensitivity toward the environment, as well as environmentally conscious behaviors has been increasing the demand for eco-friendly products made with recycled materials and reuse of waste, resulting in new green products or circular products (Bulut et al., 2021; Hamzaoui Essoussi & Linton, 2010; Yarimoglu & Binboga, 2019). Some authors (Boesen et al., 2019; Yu & Lee, 2019) claim that consumers prefer to purchase upcycle products. Upcycle products come from reusing other products (reuse), extending their useful life. These products are greener and less harmful to the environment.

There is evidence that consumer EC grow positively impacts on CCC (Camacho-Otero et al., 2018; Szilagyi et al., 2022). According to Camacho-Otero et al. (2018), consumers who hold a more favorable view toward circular products, driven by their environmental concern, tend to act accordingly when shopping. Furthermore, the authors found that EC significantly positively impacts circular buying behavior. These findings confirm that more environmentally conscious individuals are likelier to make consumption choices that follow circular principles. Thus, we hypothesize that:

H1 Greater environmental concern positively influences circular consumption choices.

2.3 Greenwashing

A raising interest has followed concerns about sustainability in greenwashing. As customers become more aware of the consequences of their consumption acts on the environment, particularly their excessive consumption, they buy more ecological products (Gomes et al., 2023). Growing consumers' concern with the environment encourages companies to develop green marketing strategies (Pickett-Baker and Ozaki, 2008) to show potential buyers their social responsibility and enhance their good corporate image. Companies from all sectors have presented themselves as environmentally responsible and involved in practices to fight climate change. However, consumers may consider these marketing strategies 'greenwashing' (GW) when they understand that companies advertise more environmental benefits than they deliver. In this context the need arises to discuss greenwashing and how it can affect conscious consumption. Despite the existence of many definitions of greenwashing (de FreitasNetto et al., 2020 for a review), we can define the phenomenon as the combination of two antagonistic corporate behaviors: weak environmental performance and positive communication about ecological performance (Delmas & Burbano, 2011). Indeed, GW is a method of highlighting a good practice while hiding all other practices with negative impacts on the environment to show itself to be more environmentally

sustainable than it is (Adamkiewicz et al., 2022; Fuxman et al., 2022; Zaidi et al., 2019). Thus, GW deliberately distorts a company's environmental practices (Ferrón-Vílchez et al., 2021) which may jeopardize fulfilling of the objectives of the United Nations 2030 Agenda for Sustainable Development and the Paris Agreement.

In recent years, the interest in GW has increased (seeZhang et al. 2018 for a review), and some studies (Bulut et al., 2021; Sun & Shi, 2022; Zhang et al., 2018) have related environmental concerns with GW. While, Zhang et al. (2018) suggest that green concern strengthens the negative relationship between GW perceptions and green purchasing intentions, Bulut et al. (2021) found that GW perception decreases the effects of environmental concern on green behavior. Recent evidence suggests that consumers' GW perception negatively influences consumers' green purchasing intentions and that environmental responsibility reinforces the negative influence of GW perception on green purchasing intentions (Sun & Shi, 2022).

Although there is evidence concerning the direct relationship between EC and GW (Bulut et al., 2021; Zhang et al., 2018), the existence of an opposite relationship (between GW and EC) remains to be proven. Actually, if consumers perceive that organizations communicate half-truths or hide information about their products or services, they may seek more product information to discover the whole reality (Leonidou & Skarmeas, 2017). This search for information to attest to the integrity of business practices can also highlight consumers' environmental concerns and increase the likelihood of making environmentally conscious choices related to purchasing circular products.

In this context, some studies point out that increased awareness of GW may influence consumers' EC (Bulut et al., 2021; Schmuck et al., 2018; Urbański & ul Haque, 2020; Zhang et al., 2018). Zhang et al. (2018) found that consumers' perception of GW is directly negative toward green purchase decisions and has an indirect negative effect via green word of mouth. Bulut et al. (2021) explained that the perception of GW mitigates the association between EC and Millennial consumer behavior. Schmuck et al. (2018) point out that false claims in green advertising harm consumer attitudes toward these ads and brands. Urbański and ul Haque (2020) documented that consumers, even those who consider themselves high environmentalists, can be seduced of identifying GW products as being sustainable, leading to a negative association between green purchasing and consumers' green behavior. Overall, the literature suggests that increased awareness of GW may lead to a greater degree of skepticism and critical evaluation of green marketing claims, which can raise more significant environmental concerns among consumers. Thus, we hypothesize that:

H2 A greater awareness of Greenwashing influences an individual's environmental concerns.

2.4 Pro-Environmental Habits

Adopting pro-environmental habits (PEH) and circular behaviors by consumers plays a fundamental role in creating a more sustainable future. By incorporating circular practices that protect and preserve the environment, consumers can make a global difference. Every choice consumers make (namely, how they buy products and use and dispose of them) has the power to impact the planet positively. Studies on pro-environmental behaviors have focused on the role of norms, values, motivations, and intentions, neglecting the role of habits (Sörqvist et al., 2016). While habits are overlooked in sustainability science, they have been recognized as a potential barrier to aligning intrinsic motivation with sustainable

behavior change (Jackson, 2004). Habits are the basis for many daily actions and can be powerful barriers to change. Once adopted, habits tend to persist without much deliberation or reconsideration (Wood & Rünger, 2016). PEH can be defined as changing from non-ecological habits to more ecological ones (e.g., energy and saving; water saving; waste management; no plastics; sustainable mobility) (Dahlstrand & Biel, 1997; Sabbir & Taufique, 2022). The adoption of PEH by consumers is essential to achieve the United Nations 2030 Agenda for Sustainable Development goals and the Paris Agreement.

PEH can be planned and adjusted to the daily routines of each individual (Huang et al., 2020). Indeed, families with PEH invest more in energy-efficient appliances (Busic-Sontic et al., 2017; Ramos et al., 2015); larger families with children are more likely to save water (Berk et al., 1993; Martínez-Espiñeira et al., 2014). Some authors (Gould et al., 2016) argued that individuals had successfully adopted waste management. The transition to zero plastics depends not only on consumers' adoption of this attitude but also on suppliers that need to change their current practices. However, on the supply side of the market, there is a significant dependence on the industry for plastic packaging (Beitzen-Heineke et al., 2017), which will undoubtedly delay the reduction in the use of plastics. Further, although, in general, individuals seem to value sustainable mobility, it does not translate into sustainable attitudes, as there is a perception that sustainable mobility entails more significant financial expenses (Herberz et al., 2020; Rezvani et al., 2018).

The PEH approach might be an effective way to promote pro-environmental attitudes and promote CCC. Zeng et al. (2023) found that PEH positively relates to sustainable consumption behavior. Thus we will confine ourselves to the PEH used by Ratner et al. (2021)—energy and water saving, waste management, avoiding plastic, and sustainable mobility—to explore their role in circular consumption choices and greenwashing perception. Thus, we hypothesize that:

H3a Pro-environmental habits have a positive association with circular consumption choices.

$H3_{a1}$ The pro-environmental energy saving habit has a positive association with circular consumption choices.

$H3_{a2}$ The pro-environmental habit of water saving positively correlates with circular consumption choices.

$H3_{a3}$ The pro-environmental habit of waste management has a positively associates with circular consumption choices.

$H3_{a4}$ The pro-environmental habit of zero plastic has a positive association with circular consumption choices.

$H3_{a5}$ The pro-environmental habit of sustainable mobility positively associates with circular consumption choices.

Regarding the association between PEH and GW, Lyon and Montgomery (2015) provide evidence that companies often use GW to reach consumers concerned about the environment. This shows that individual pro-environment behaviors can promote the company's environmental reputation. Conversely, PEH also has the potential to

mitigate GW. Parguel et al. (2011) show that consumers with PEH are more likely to denounce bad environmental practices by companies and, as such, help expose GW. Thus, while pro-environmental behaviors can be misused to promote GW, they can also play a significant role in its mitigation. Therefore, we hypothesize that:

H3b Pro-environmental habits have a positive association with greenwashing.

$H3_{b1}$ The pro-environmental habit of energy saving has a positive association with greenwashing.

$H3_{b2}$ The pro-environmental habit of water saving has a positive association with greenwashing.

$H3_{b3}$ The pro-environmental habit of waste management positively associates with greenwashing.

$H3_{b4}$ The pro-environmental habit of zero plastic has a positive association with greenwashing.

$H3_{b5}$ The pro-environmental habit of sustainable mobility positively associates with greenwashing.

Figure 1 describes the reduced (Fig. 1A) and the developed (Fig. 1B) structural model.

3 Methods

3.1 Sample

Data from this study were collected through a questionnaire constructed in google forms and made available online for two months (September and October, 2022). The link to the questionnaire was published on social networks, which is why it is a convenience sample, not a probabilistic one. The criteria for inclusion in the sample were Portuguese citizenship and being a consumer over 18 years old. The questionnaire was anonymous, and participants were informed about the academic purpose of the data. Written consent of the participants was obtained. A pre-test was conducted with 20 participants to assess their understanding of the questions.

A total of 826 valid responses were obtained from the available questionnaire. Most respondents were women (69.9%), and the average age of participants was 33.8 years (minimum age 18 years and maximum age 78 years). The majority of respondents (73.6%) reside in the central region of Portugal. Regarding education, 39.2% of respondents have completed secondary education, and 47.7% were licensed. The rest have a master's degree (11.9%) and a doctorate (1.2%). As for professional occupation, 46.4% were employees, 28.9% were students, and 10.2% were self-employed. Most respondents had a net monthly income of less than €1000 (63.9%).

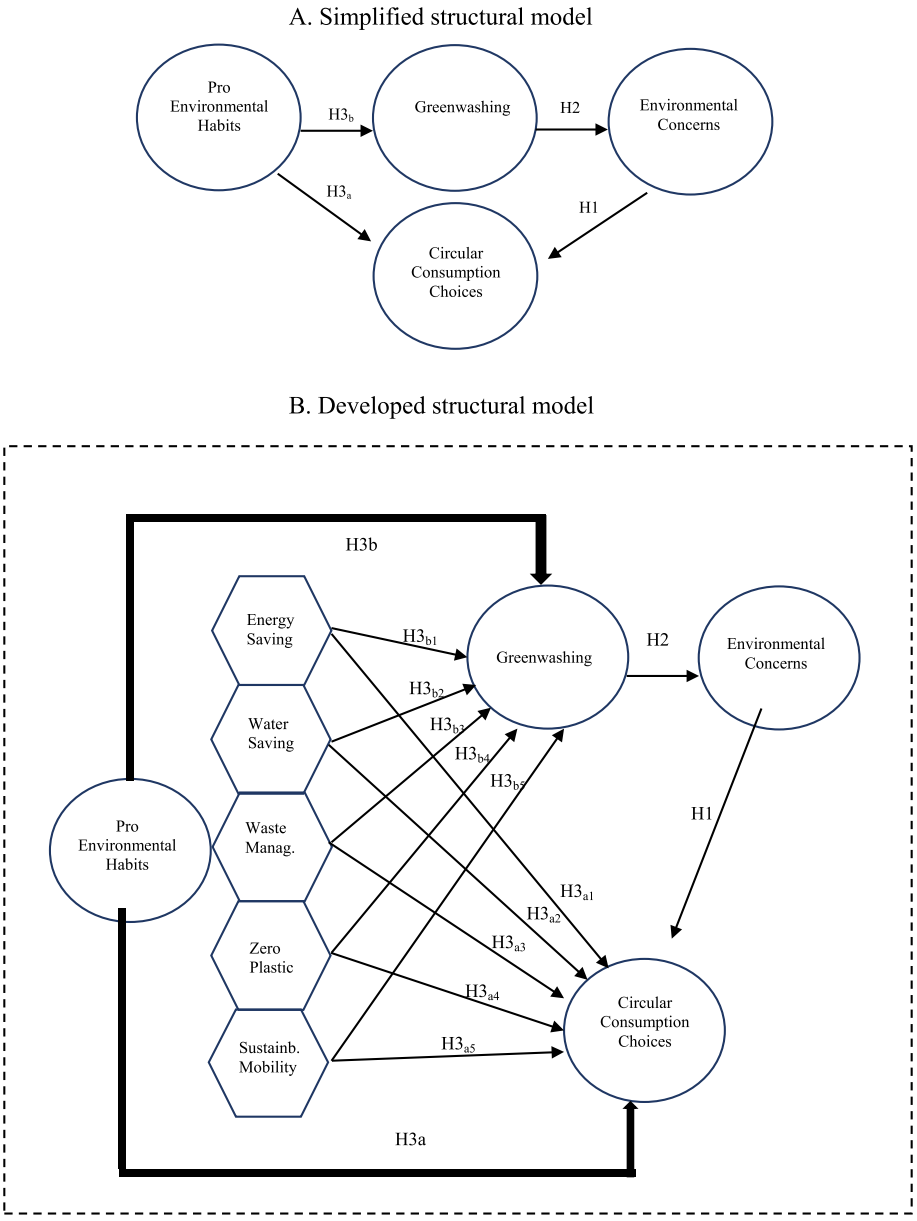

Fig. 1 **a** Simplified structural model. **b** Developed structural model

3.2 Measurement of the constructs

The questionnaire comprises five sections. The first section collected information regarding respondents' sociodemographic characteristics. The remaining sections collected the

opinion of participants about their circular consumption choices (CCC), their environmental concerns (EC), their awareness of greenwashing (GW) and their pro-environmental habits (PEH). This information was collected through close-ended statements used elsewhere (Ratner et al., 2021; Testa et al., 2020).

In section two, eight statements were presented to evaluate CCC related attitudes. These statements represent the five dimensions of the circular economy: (i) reuse—three statements: CCC1, CCC2 and CCC7; (ii) recycle—one statement: CCC3; (iii) reduce—two statements: CCC4 and CCC5; (iv) repair—one statement: CCC6 and (v) minimal take—one statement: CCC8.

The third and fourth sections comprised four statements related to EC and GW, respectively. Respondents' PEH were collected in the last section through 31 statements, of which ten statements related to energy saving, six statements related to water saving, five statements related to waste management, three statements related to plastic avoidance and six statements related to sustainable mobility.

The answers to statements presented in sections two to four were measured on a 5-point Likert scale ranging from 1—Strongly Disagree to 5—Strongly Agree. The PEH presented in section five was also measured on a 5-point Likert scale ranging from 1—never and 5—whenever/whenever I can. The statements are detailed in the first column of Table A1, in the Appendix.

3.3 Data analysis

This study performed a quantitative approach. First, a descriptive statistical analysis of the structural model constructs—CCC, EC, GW and PEH, was performed. Then, a factor analysis was performed, and an exploratory factor analysis (EFA) was implemented to factor the items. A confirmatory factor analysis (CFA) was implemented to validate the reflective nature of the structural model. The relationships established in the structural model (hypotheses) were tested by the Partial Least Square (PLS) method in the Smart PLS 4.0 software (Ringle et al., 2020). This method allows combining a factorial analysis with simple linear regressions estimated by the Ordinary Least Square (OLS) method and does not require the data to follow a normal distribution. The PLS method allows for multivariate data analysis and is widely used in topics related to the social and behavioral sciences (Hair et al., 2019). This method has still been widely used to measure variables such as environmental concerns and sustainable consumption behavior (Antonetti and Maklan (2014); Saari et al., 2021). The PLS is also a suitable method for modeling data for forecasting purposes, in which the investigation focuses on a target construct, such as the circular consumption choices construct in our study (Calvo-Mora et al., 2020).

The PLS method has advantages over the OLS method, which is most commonly used for estimating simple and multiple linear regressions. The PLS method allows modeling regressions with numerous variables and indicators without being affected by multicollinearity problems. Then it produces factors with high covariances and, as such, factors with high predictive power (Jørgensen et al., 2004). However, the PLS method, compared to the OLS method, has more difficult interpreting the factor loadings. Since the estimators of the regression coefficients do not have known distributions, their significance test can only

Table 1 Evaluation of the PLS model

	Cα	CR	AVE	CCC	EC	GW	ES	WS	WM	ZP	SM
Circular Consumption Choices (CCC)	0.774	0.836	0.599	**0.774**							
Environmental Concerns (EC)	0.791	0.813	0.525	0.571	**0.724**						
Greenwashing (GW)	0.900	0.930	0.768	0.276	0.322	**0.877**					
Energy Saving (ES)	0.844	0.878	0.521	0.631	0.316	0.163	**0.722**				
Water Saving (WS)	0.743	0.824	0.552	0.604	0.311	0.177	0.618	**0.743**			
Waste Management (WM)	0.714	0.815	0.581	0.571	0.253	0.182	0.502	0.502	**0.762**		
Zero Plastic (ZP)	0.715	0.840	0.637	0.729	0.327	0.238	0.526	0.525	0.494	**0.798**	
Sustainable Mobility (SM)	0.727	0.807	0.520	0.556	0.187	0.198	0.444	0.389	0.389	0.440	**0.721**

AVE Square Root in bold

be performed through resampling methods (Jørgensen et al., 2004). The model obtained after applying the PLS method to the structural model was evaluated using three measures proposed by Hair et al. (2019): (i) Cronbach's Alpha measurements ($C\alpha \geq 0.70$); (ii) Average Variance Extracted ($AVE \geq 0.50$) and (iii) discriminant validity tested by the Fornell–Larcker criterion (comparison between the squared construct correlations and AVE). The model obtained after applying the PLS method was also validated regarding coefficient of determination (R2) and predictive relevance using the Stone–Geisser measure (Q2), which is based on the cross-validated redundancy approach. Finally, the hypotheses contained in the structural model were tested through a bootstrap analysis in Smart PLS 4.0.

4 Results

4.1 Descriptive analysis

Table A1 in the Appendix summarizes the descriptive statistics of the CCC, EC and GW constructs. Respondents agreed with all statements presented. The results show that respondents, in general, exhibit a circular behavior mainly in terms of reuse—they value especially products with a longer shelf life (M = 4.65), those whose packaging can be reused for other purposes (M = 3.67) and, recycling—they do not throw clothes in the trash, they recycle them through donating (M = 3.42). Concerning EC, respondents were worried about wasting resources (M = 4.86), the consumption of natural resources, and the consequences for future generations (M = 4.67). Regarding GW, the most valued item was related to the absence or concealment of important information about the actual environmental characteristics of the products (M = 4.03).

On average, the PEH most followed by participants were saving energy (M = 3.19) followed by not using plastic (3.06), managing wastes (M = 2.86), and sustainable mobility (M = 2.55). Water saving was the least frequent PEH (M = 2.48).

Concerning energy saving, respondents showed that they often turn off the lights in empty spaces (M = 3.65) and turn off the TV when no one is watching (M = 3.49). The most frequent habits engaged by respondents to save water were turning off the water while washing their face or brushing their teeth (M = 3.42) and taking short showers (M = 3.17). Concerning waste management, respondents most often follow garbage separation rules (M = 3.19) and avoid throwing away used cooking oil (M = 3.15). Finally, regarding sustainable mobility, respondents' most frequent habit was maintaining correct tire air pressure (M = 3.24).

4.2 Factor analysis

Table A2 in the Appendix, contains the results of the EFA and the CFA. The 46 items initially collected were divided into eight factors corresponding to each of the constructs included in the structural model. None of the items was removed. Eight factors present an accumulated variance of 72.55%, and none explain more than 50% of the variance. All items have commonalities greater than 0.70, enough to proceed with the rotation of the factor matrix. Regarding CFA results, all items have high confirmatory factor loads (0.70),

Table 2 Results of Gaussian copula approach

	Original model		Gaussian Copula results		Difference of β
	β	P value	β	P value	
Environmental Concerns (EC)	0.127	0.000	0.124	0.000	0.003
Energy Saving (ES)	0.181	0.000	0.168	0.000	0.013
Water Saving (WS)	0.094	0.032	0.094	0.011	0.000
Waste Management (WM)	0.143	0.000	0.143	0.000	0.000
Plastic Zero (ZP)	0.393	0.000	0.393	0.000	0.000
Sustainable Mobility (SM)	0.183	0.000	0.169	0.000	0.014
Gaussian Copula term for EC			0.054	0.332	
Gaussian Copula term for ES			0.054	0.245	
Gaussian Copula term for WS			0.045	0.108	
Gaussian Copula term for WM			0.032	0.298	
Gaussian Copula term for ZP			0.012	0.398	
Gaussian Copula term for SM			0.045	0.156	

confirming the reflective nature of the items in the model, and thus, no item has to be deleted.

4.3 Assessment of the measurement model

Table 1 presents the values for the individual reliability indicators of each research model construct (Cα and CR), convergent validity (AVE) and discriminant validity (square root of the AVE). The PLS model reveals high levels of reliability (Cα > 0.70 and CR > 0.70) and convergent (AVE > 0.50), and discriminant validity. The measures proposed by Hair (2019) were used to assess the quality of the model's fit, such as the Chi-Square (p = 0.081), Goodness-of-Fit (0.92), Comparative Fit Index (0.91) and Standard Root Mean Square Residual (0.095). Fulfilling the reference values, the estimated PLS model presents a good fit.

4.4 Assessment of the structural model

According to Hair et al. (2021), the assessment of the structural model implies verifying i) collinearity problems using the variance inflation factor (VIF), ii) the predictive power of the models with the determination coefficient (R^2) and the predictive relevance (Stone–Geisser Q^2) based on the approach of cross-validated redundancy, and iii) the endogeneity problems with the Gaussian copula approach.

Regarding collinearity, the largest inner VIF is 1.389, so collinearity is not a critical issue. According to Cohen (1988), the latent variables CCC (R^2 adjusted = 0.691) and GW (R^2 adjusted = 0.650) have a "substantial effect," and the latent variable EC (R^2 adjusted = 0.102) has a "moderate effect." The estimated model reveals predictive relevance for predicting CCC, EC and GW since Q^2 is greater than zero ($Q^2 = 0.267$; $Q^2 = 0.510$ and $Q^2 = 0.520$, respectively).

We apply the Gaussian copula approach to ensure that the estimated coefficients are not affected by endogeneity problems, according to Park and Gupta (2012). The structural model focuses on the relationships between the EC independent variables and the CCC pro-environmental habits (ES, WS, WM, ZP and SM). GW is considered in the structural model a variable dependent on pro-environmental habits. According to the Gaussian copula approach, independent variables cannot have a normal distribution. We apply the Shapiro–Wilk test and Kolmogorov–Smirnov test with Lilliefors correction and verify that EC and the pro-environmental habits have a $p < 0.01$. As such, we confirm that they do not have a normal distribution. The Gaussian copula analysis was performed in Smart PLS 4.0 as described by Hult et al. (2018), and the results are shown in Table 2. None of the Gaussian copula terms of EC and pro-environmental habits are significant for a 1% or 5% probability of the error terms, and the differences of the β between the original model and the results of Gaussian copula are reduced. In this way, the PLS results are robust and are not affected by endogeneity problems.

Table 3 PLS model estimation results

Effects on Endogenous Variables	Path (β)	*t* Value (Bootstrap)	Confidence Interval (2,5%; 97,5%)	Hypothesis Support
Circular Consumption Choice (R^2 adjusted: 0.691; Q^2: 0.267)				
H1: Environmental Concerns → Circular Consumption	0.127	4.573*	Sig. (0.072; 0.179)	Yes
$H3_{a1}$: Energy Saving → Circular Consumption	0.181	6.551*	Sig. (0.124; 0.231)	Yes
$H3_{a2}$: Water Saving → Circular Consumption	0.094	3.482**	Sig. (0.039; 0.145)	Yes
$H3_{a3}$: Waste Management → Circular Consumption	0.143	5.661*	Sig. (0.093; 0.187)	Yes
$H3_{a4}$: Plastic Zero → Circular Consumption	0.393	12.825*	Sig. (0.331; 0.452)	Yes
$H3_{a5}$: Sustainable Mobility → Circular Consumption	0.183	7.308*	Sig. (0.128; 0.228)	Yes
Greenwashing (R^2adjusted: 0.650; Q^2: 0.510)				
$H3_{b1}$: Energy Saving → Greenwashing	-0.004	0.071	Sig. (-0.109; 0.114)	No
$H3_{b2:}$Water Saving → Greenwashing	0.026	0.539	Sig. (-0.062; 0.127)	No
$H3_{b3}$: Waste Management → Greenwashing	0.055	1.230	Sig. (-0.031; 0.145)	No
$H3_{b4}$: Plastic Zero → Greenwashing	0.156	3.192**	Sig. (0.062; 0.244)	Yes
$H3_{b5}$: Sustainable Mobility → Greenwashing	0.098	2.211**	Sig. (0.013; 0.188)	Yes
Environmental Concerns (R^2adjusted: 0.102; Q^2: 0.520)				
H2: Greenwashing → Environmental concerns	0.322	7.680*	Sig. (0.235; 0.400)	Yes

*$p < 0.001$; **$p < 0.005$

4.5 PLS model

Table 3 presents the results of the bootstrap analysis carried out in Smart PLS 4.0, intending to estimate the relationships established in the structural model using the PLS method.

Circular consumption choices (CCC) can be explained by pro-environmental habits (PEH) or environmental concerns, although the PEH are more explanatory. Among the PEH, not using plastic is the practice most explanatory of CCC (β = 0.393). Engaging in sustainable mobility is the second most explanatory habit for CCC (β = 0.183), followed by the habit of saving energy (β = 0.181) and waste management (β = 0.143). Finally, water savings is the PEH that least explains the CCC (β = 0.094). Moreover, respondents with more significant environmental concerns tend to have a more circular consumption and, as such, to make a greater contribution to developing a more circular economy (β = 0.127). Thus, hypotheses H1 and all H3a were confirmed.

PEH only partially explained the awareness of greenwashing. Participants who did not use plastic (β = 0.156) and those who followed sustainable mobility (β = 0.098) proved to be more sensitive and attentive to GW. The daily habit of saving energy and water and waste management did not explain GW significantly. This result is not surprising since these habits are separate from the production practices of companies. Thus, hypotheses $H3_{b4}$ and $H3_{b5}$ were confirmed.

Finally, the results indicate that greenwashing was statistically significant in explaining EC (β = 0.322), confirming hypothesis H2.

5 Discussion and implications

5.1 Discussion

The transition to a circular economy is essential for developing a more sustainable world and meeting the priorities imposed by the 2030 Agenda (Fetting, 2020). While playing the role of consumer, society must pressure companies to adopt sustainable production methods, implying changes in their business models. This study investigates whether Portuguese society may play a role in companies' construction of circular business models. To this end, we explored the impact of Portuguese pro-environmental routines and ecological concerns on circular consumption choices. Additionally, we explored the influence of Portuguese daily pro-environmental habits on their perception of greenwashing and whether this perception influences their environmental concerns.

In general, the results confirmed the formulated hypotheses. We find evidence that the environmental concerns of Portuguese respondents' positively influenced their circular consumption choices, as seen in studies by Camacho-Otero et al. (2018) and Szilagyi et al. (2022). Consumers with greater environmental awareness are more sensitive to environmental problems and, as such, are more likely to value circular products and to engage in circular behaviors, namely in their circular consumption choices (Camacho-Otero et al., 2018; Yarimoglu & Binboga, 2019). Moreover, the findings show that Portuguese respondents revealed significant environmental concerns, which

translated into protecting future generations. They seemed to be especially worried about wasting resources and using natural resources. Analogous findings were found elsewhere (Trivedi et al., 2018; Yarimoglu & Binboga, 2019).

Also, our findings indicate that Portuguese respondents' pro-environmental habits positively influenced their circular consumption choices. From these habits, reducing plastic use, engaging in sustainable mobility, and energy saving had the most significant influence. These results corroborate the findings of Sabbir and Taufique (2022) and Huang et al. (2020), who demonstrate that pro-environmental habits result from planning and transforming conventional daily practices into ecological ones. This adjustment of individual practices essentially involves the more efficient use of energy (Busic-Sontic et al., 2017), water saving (Martínez-Espiñeira et al., 2014), waste management (Gould et al., 2016), plastic reduction (Beitzen-Heineke et al., 2017) and greener mobility (Herberz et al., 2020). Our findings suggest that respondents follow a circular consumption materialized mainly on reusing and recycling products. This finding aligns with international evidence that consumers prefer to upcycle products because they are more beneficial to the environment (Boesen et al., 2019; Wilson, 2016; Yu & Lee, 2019). Adopting pro-sustainable habits awakens individuals to a greater environmental awareness and to adopt sustainable consumption choices (Zeng et al., 2023). Despite the environmental concerns expressed by respondents, their daily contribution to preserving the environment leaves much to be desired. Their effective contribution is materialized in saving energy and avoiding plastics, in line with previous studies (Arı & Yılmaz, 2017; Liu et al., 2020; Ratner et al., 2021). Waste management practice, saving water and resorting to more sustainable means of mobility were daily routines least followed by the respondents. Safeguarding the due methodological differences, our respondents seem aligned with Russian respondents (Ratner et al., 2021). We can only speculate about the reasons for these findings. The lack of concern of participants with saving water can be explained by the water price, which, in Portugal, is one of the lowest in Europe. Indeed, empirical evidence demonstrates that a higher water price enhances water conservation (Grafton et al., 2011; Worthington & Hoffman, 2008). Further, the low adherence to sustainable mobility may be due to the lack of an appropriate public transport infrastructure network and or for hedonic reasons such as status, independence and security (Herberz et al., 2020; Rezvani et al., 2018).

On the other hand, we found evidence that being aware of greenwashing increases environmental concerns, corroborating the findings of several studies (Bulut et al., 2021; Schmuck et al., 2018; Urbański & ul Haque, 2020; Zhang et al., 2018). This result demonstrates that greater awareness of greenwashing actions promoted by companies' increases consumers' skepticism and arouses greater environmental concern (Bulut et al., 2021). However, it was shown that participants' greenwashing perception was positively linked to the practice of not using plastic and sustainable means of transport, with no statistical evidence for the relationship between the perception of greenwashing and the remaining pro-sustainable habits. These results can be explained by the fact that these habits, unlike the other three, involve greater contact with companies that try to demonstrate to consumers that the organization has implemented environmentally essential procedures and that the products and services sold meet the ecological requirements they promote through their marketing campaigns (Mohr et al., 2022; Wahab, 2018).

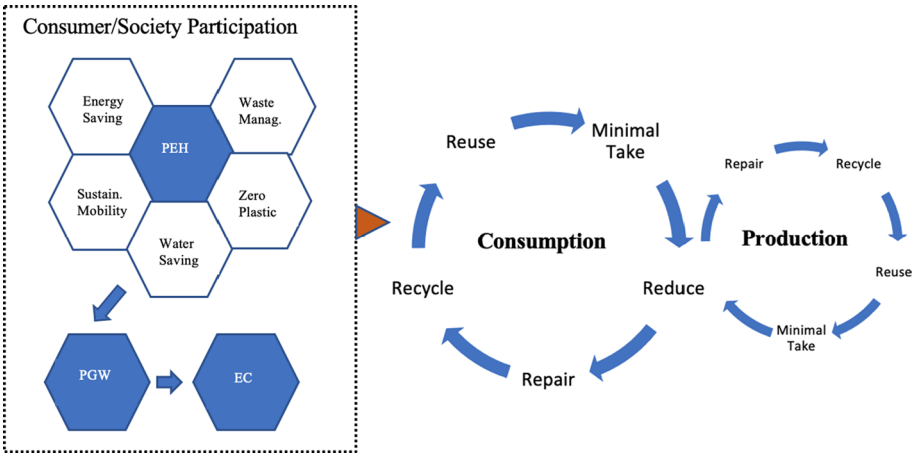

Fig. 2 Circular consumption and business model. *PEH* pro-environmental habits, *PGW* perceived greenwashing, *EC* environmental concerns

In sum, we found that CCC was explained by EC and by PEH. Given the results of our study, we propose a model of consumer participation in the companies' circular business model (Fig. 2).

The Circular Consumption and Business Model assume the interaction between three dimensions: (i) drivers to consumer involvement in the circular economy; (ii) circular consumption choices, and (iii) circular business model. The drivers of consumer involvement are their PEH, their perceived GW, and their EC. Consumers more endowed with PEH, with greater GW perception and more concerned with the environment, make a more significant contribution to the circular economy by engaging in circular consumer choices, which, in turn, will push companies to follow circular business models. The consumer's circular choices translate into avoiding buying unnecessary disposable products (minimal take), reducing the consumption of disposable products (reduce), trying to conserve products before buying new ones (repair), recycling products (recycle) and looking for rechargeable products whose packaging can be used for other functions (reuse). In response to this consumption pattern, firms must formulate new production models that become increasingly circular.

5.2 Theoretical implications

Our study provides significant contributions to some dimensions of the circular economy. Despite the recent but growing attention that researchers have directed toward the circular economy, studies that analyze the participation of consumers in the circular economy are still scarce and focus essentially on models of consumer acceptance of circular consumption practices (Kuah & Wang, 2020). This study makes an

essential contribution to the literature because it explores the factors influencing circular consumption choices. Our model lets us conclude that daily pro-environmental habits followed by environmental concerns determine of circular consumption choices. Furthermore, pro-environmental habits trigger a greater awareness of greenwashing, positively influencing ecological accountability.

5.3 Practical implications

The present study allows inferring a set of practical implications. First, greater consumer participation in the circular economy requires the intervention of several actors. Governments must be genuinely committed to helping implement a circular strategy for consumers and businesses. They should promote greater public awareness campaigns to pursue more sustainable habits. Second, governments should monitor companies' marketing campaigns by punishing those who practice greenwashing as people increasingly perceive it. Third, governments should provide tax incentives for sustainable products so that they become more competitive. Fourth, governments should provide greater financial support to companies to facilitate and encourage the transition from traditional production to circular business models. In this regard, companies must change or restructure their product portfolio to offer products with a longer life, reusable, recyclable and repairable, that is, to encourage collaborative consumption. Finally, the current energy crisis can be an opportunity to drive the transition from a linear economy to a circular economy, as it will force consumers and companies to save energy and, as such, to be more aware of the exhaustibility of resources.

5.4 Limitations and future lines of investigation

The present paper presents some limitations and new avenues for future studies. First, regarding the sample, it is a convenience sample and not probabilistic and, as such, the sample is not representative of Portuguese consumers and may be biased. The pretest performed may need to be increased, and including more participants in the sample pre-test would be beneficial. Despite the acceptable sample size, it is still insufficient to explore the differences in circular consumption at the Portuguese national level (North, Lisbon, Centre, Alentejo, Algarve, Madeira, and Azores). Thus, it would be beneficial that future studies use a larger sample covering the seven Portuguese regions. By increasing the sample, it would be relevant to study the circular consumption from the perspective of generations X, Y and Z. Furthermore, sociodemographic variables, such as age, gender and net income, were not used as mediating variables. The results of this study may be different when considering sociodemographic characteristics. Second, this paper did not consider the role of social norms and cultural values and their influence on pro-environmental habits, which could be included in future studies. Third, the findings of this study are limited to Portuguese consumers. Since the cultural context can influence circular consumption choices, it would be interesting to design a cross sectional questionnaire to be applied in regions of

different economies (either developed or developing). The responses may have been influenced by commercial and economic factors specific to Portugal, making it advisable to conduct further studies in other countries to complement and strengthen the present study's findings. It would also be interesting to consider in future studies whether non-cognitive and cognitive factors are different by considering demographic characteristics (e.g., age, gender, level of education, marital status, and ethnicity). Finally, as this study does not include companies' perspectives regarding circular consumption, it would be important that other studies have the viewpoint of companies concerning circular consumption.

6 Conclusion

Transitioning to the circular economy is one of the main challenges for companies, society and policymakers. The circular economy is considered a giant step toward sustainable development. However, this step must be taken jointly by companies and societies. Therefore, it is important to know what role customers and or civil society play in transforming economic systems based on linear 'take-make-consume-dispose' models into circular models. To this end, this study evaluated the potential role of society/consumers in building circular business models.

Respondents revealed a pattern of circular consumption, particularly concerning reuse and recycling. These choices are strongly conditioned by the pro-environmental habits they engage in daily (especially energy saving and avoiding plastics) and (albeit to a lesser extent) by their environmental concerns, which fall heavily on the waste of resources and intergenerational commitment. These environmental concerns are, in turn, driven by their perception of greenwashing, which is more commonly perceived by respondents who do not use plastic and by those who resort to more sustainable mobility.

This study contributes, in general, to the literature on circular economy and, in particular, to the literature on circular consumer behavior. The few existing studies on consumer participation in the circular economy have demonstrated a passive role for these agents, centered on models of acceptance of circular practices. This study indicates that it is necessary to understand consumers' motivations, and that consumers can contribute to transforming companies' business models. The Circular Consumption and Business Model is an integrated model that includes consumers' participation in the companies' circular business model. We believe that if society reveals circular consumption, there will be more pressure on companies, "forcing" them to transform their traditional business models into circular ones. This transformation will be faster the faster civil society follows circular consumption. Change toward sustainable development, in general, or toward a circular economy, can only be successful with everyone's contribution.

Appendix

See Tables 4 and 5.

Table 4 Descript statistics of CCC, EC, GW and pro-environmental habits

	Mean (M)	SD
Circular Consumption Choice (CCC)	3.41	0.779
Reuse*		
CCC1—Increasing the useful life of the products we use must be a priority to preserve the balance of nature	4.65	0.638
CCC2—When I buy food products. I look for those with packaging that can also be used for other functions (e.g., glass packaging that can be reused as a cup)	3.67	1.167
Recycle**		
CCC3—I give used clothes to other people or use a recycling box	3.42	0.711
Reduce**		
CCC4—I use my own bottle or glass of water	3.33	0.764
CCC5—I reduce the use of disposable products	3.04	0.722
Repair**		
CCC6—I try to fix things before buying replacement parts	3.09	0.765
CCC7—I use recharge products	3.04	0.711
Minimal Take**		
CCC8—I do not buy unnecessary products	3.06	0.753
Environmental Concerns (EC)*	4.62	0.661
EC1—I am concerned about the consumption of natural resources and the consequences for generations	4.67	0.634
EC2—Waste of resources is a serious problem	4.86	0.448
EC3—In our country we are not doing enough to encourage waste recycling	4.32	0.884
EC4—Protecting the natural environment is one of the most important issues facing the world	4.62	0.679
Greenwashing (GW)*	3.88	0.929
GW1—Most companies use misleading words about the environmental characteristics of their products	3.88	0.908
GW2—Most companies use misleading pictures or graphics about features	3.80	0.935
GW3—Most companies provide vague or seemingly improbable environmental claims for their products	3.81	0.931
GW4—Most companies leave out or hide important information about the actual environmental characteristics of their products	4.03	0.945

Table 4 (continued)

	Mean (M)	SD
Pro-Environmental Habits (PEH)**		
Energy Saving (ES)	3.19	0.785
ES1—I avoid overloading the refrigerator	2.91	0.803
ES2—I reduce the opening and closing of the refrigerator door	3.19	0.776
ES3—I use stairs instead of elevators	2.84	0.834
ES4—I adjust the air conditioning temperature	3.06	0.956
ES5—I turn off the lights in empty rooms	3.65	0.619
ES6—I turn off devices that are not in use	3.46	0.716
ES7—I turn off the TV when people are not watching	3.49	0.721
ES8—I set a lower shower temperature	2.63	0.929
ES9—I buy energy-efficient appliances	3.24	0.765
ES10—I use LED lamp instead of fluorescent lamps	3.46	0.728
Water Saving (WS)	2.48	0.686
WS1—I use the toothbrush cup	2.31	1.128
WS2—I turn off the water when washing my face or brushing my teeth	3.42	0.762
WS3—I take short showers	3.17	0.707
WS4—I reduce the use of detergent	3.05	0.746
WS5—I reduce the frequency of washing clothes	2.95	0.775
WS6—Dishwasher safe	2.96	0.897
Waste Management (WM)	2.86	0.939
WM1—I avoid throwing away used cooking oil	3.15	0.860
WM2—I follow the garbage separation rules	3.19	0.845
WM3—I separate the garbage	3.18	0.866
WM4—I compost kitchen waste	2.24	1.082
WM5—Dispose of kitchen waste after drying	2.53	1.046

Table 4 (continued)

	Mean (M)	SD
Zero Plastic (ZP)	3.06	0.777
ZP1—I use a container instead of a plastic bag	2.89	0.843
ZP2—I use my own bag/purse to go shopping	3.38	0.714
ZP3—I do not buy over packaged products	2.92	0.773
Sustainable Mobility (SM)	2.56	0.924
SM1—I use a bicycle or a path to get around	2.15	0.922
SM2—I use public transport	2.15	0.949
SM3—I join the car-free day program	2.10	1.063
SM4—I avoid overloading the car	2.81	0.935
SM5—I use recharge products	2.82	0.913
SM6—I maintain correct tire air pressure	3.24	0.764

*Statements retrieved from Testa et al. (2020); **Statements retrieved from Ratner et al. (2021)

Table 5 EFA and CFA results

	Confirmatory factor loads	Varimax-rotated loadings factor								
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Communality
Circular Consumption Choice (CCC)										
CCC1	0.758	0.638								0.741
CCC2	0.729	0.767								0.773
CCC3	0.731	0.711								0.717
CCC4	0.713	0.764								0.743
CCC5	0.875	0.722								0.703
CCC6	0.705	0.765								0.786
CCC7	0.789	0.711								0.768
CCC8	0.801	0.753								0.765
Environmental Concerns (EC)										
EC1	0.790		0.734							0.744
EC2	0.840		0.748							0.735
EC3	0.740		0.884							0.778
EC4	0.799		0.779							0.740
Greenwashing (GW)										
GW1	0.878			0.908						0.895
GW2	0.895			0.935						0.712
GW3	0.882			0.931						0.872
GW4	0.850			0.945						0.745
Pro-Environmental Habits (PEH)										
Energy Saving (ES)										
ES1	0.744				0.803					0.764
ES2	0.754				0.776					0.799
ES3	0.796				0.834					0.766

Table 5 (continued)

	Confirmatory factor loads	Varimax-rotated loadings factor								
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Communality
ES4	0.732				0.956					0.772
ES5	0.717				0.719					0.763
ES6	0.748				0.716					0.715
ES7	0.701				0.721					0.776
ES8	0.789				0.929					0.727
ES9	0.762				0.765					0.729
ES10	0.703				0.728					0.731
Water Saving (WS)										
WS1	0.708					0.728				0.726
WS2	0.768					0.762				0.763
WS3	0.714					0.707				0.812
WS4	0.835					0.746				0.776
WS5	0.795					0.775				0.799
WS6	0.710					0.897				0.777
Waste Management (WM)										
WM1	0.761						0.860			
WM2	0.869						0.845			0.721
WM3	0.852						0.866			0.792
WM4	0.795						0.782			0.795
WM5	0.794						0.746			0.761
Zero Plastic (ZP)										
ZP1	0.730							0.843		0.737
ZP2	0.731							0.714		0.751
ZP3	0.777							0.773		0.715

Table 5 (continued)

	Confirmatory factor loads	Varimax-rotated loadings factor								
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Communality
Sustainable Mobility (SM)										
SM1	0.777								0.922	0.824
SM2	0.729								0.949	0.823
SM3	0.713								0.763	0.815
SM4	0.731								0.935	0.824
SM5	0.705								0.913	0.866
SM6	0.724								0.764	0.812

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Declarations

Conflict of interest The authors declare no potential conflicts of interest.

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