The role of awareness of circular economy's concept in purchase of sustainable goods and access-based and collaborative consumption – Porto case

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Abstract

Purpose – *Circular economy (CE) is receiving increasing worldwide attention as a manner to overcome the challenges linked to current trends of unsustainable energy and resource consumption. This paper aims to fill this gap and analyze the adherence to sustainable, access-based and collaborative consumption practices by exploring the role of CE awareness, specifically in the context of Porto, the second-largest city of Portugal.*

Design/methodology/approach – *The methodology of choice is quantitative, based on partial least square-based structural equation modeling.*

Findings – *The result shows that there is an influence of CE awareness on subsequent sustainable consumption models.*

Research limitations/implications – *Present research contributes to the theory on CE awareness and sustainable consumption. It proposes a model that could be applied in other countries. As this research is developed within the city of Porto, it may limit generalizations of obtained results.*

Practical implications – *As CE practices are embodied into national and local policies, this research contributes to understanding local contexts of CE practices dissemination, providing practical suggestions for businesses and policymakers aiming the transition to the CE.*

Originality/value – *An original approach to measuring the awareness of CE economy is proposed, that is analyzed not only from the familiarity perspective but in six dimensions of its construction: familiarity, importance, perception or interpretation, advantages, social impact and barriers in this process. Further, the conceptual model of the impact that these dimensions have on the adoption of sustainable consumption models (purchase of sustainable products, access-based and collaborative consumption) is proposed.*

Keywords *Circular economy, Awareness, Porto, Purchase of sustainable goods, Access-based consumption, Collaborative consumption*

Paper type *Research paper*

Introduction

Sustainability became the core concern of the current socio-economic system (Plaza-Ubeda *et al.*, 2020, p. 68), as the way energy and resource consumption is managed is driving us beyond the planetary boundaries (Spangenberg and Lorek, 2019).

Over the past years, circular economy (CE) has been seen as a manner to overcome these challenges (Ghisellini *et al.*, 2016). Despite being born out of waste management, and being intrinsically linked to the "3R" principles – reduction, reusing and recycling of materials and energy (Geissdoerfer *et al.*, 2017), the scope of CE is rapidly growing toward a new economic

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system and a whole paradigm (Morea *et al.*, 2021). Additionally, CE is converging with the concept of corporate social responsibility (CSR) and putting it to practice (Mazzucchelli *et al.*, 2022). However, CSR is a concept particularly applied in the context of corporate management, as long as the implementation of CE practices is made not only by the companies but also from the consumers' perspective. And even from the consumer's perspective, the scope of CE application goes far beyond waste recycling (Bocken and Short, 2020). It fundamentally reconsiders the relation between producer and consumer (Gulserliler *et al.*, 2022), aiming to minimize the negative impact of traditional forms of production on the environment (Spangenberg and Lorek, 2019) by making fewer emissions and reducing ownership (Junnila *et al.*, 2018).

Consumers are the key in the transition to CE (Musova *et al.*, 2021), as it is possible to adopt sustainable forms of consumption, such as the purchase of sustainable goods (e.g. through reselling of secondhand goods), access-based consumption or product as service (e.g. renting and leasing) and collaborative consumption (e.g. sharing platforms) (Edbring *et al.*, 2016). New business models based on renting and servitization practices are particularly relevant in the context of CE (Mesa *et al.*, 2022). "Consumers are crucial in the success of these models" (Edbring *et al.*, 2016, p. 5). Thus, for consumers, it is all about the attitude toward consumption, the new mentality transforming infinitely growing consumption levels toward sustainable and sufficient ones (Edbring *et al.*, 2016; Kovacic *et al.*, 2019; Rotolo *et al.*, 2022; Spangenberg and Lorek, 2019). One opportunity to change our patterns of consumption toward more sustainable ones is buying used products, renting products and joining pools for co-consumption (Almefelt and Rexfelt, 2017; Edbring *et al.*, 2016).

There is the need for promoting sustainability awareness and inducing changes in consumption habits (Kohlbeck *et al.*, 2022; Smol *et al.*, 2018). However, knowledge about consumer attitudes toward alternative consumption models is scarce and research on sharing is still in its infancy (Edbring *et al.*, 2016). Social skepticism and lack of knowledge about CE is still perceived (Rotolo *et al.*, 2022). Thus, there is a need to address the level of awareness regarding the CE concept and how it is related to the purchase of sustainable goods and access-based and collaborative consumption.

Research has advanced significantly in the area of evaluating perception and awareness levels and connecting them to various sociodemographic factors, such as income or education level, specifically within certain stakeholder groups or in particular situations (Blazek, 2021; Kevin van Langen *et al.*, 2021; Liu *et al.*, 2009; Musova *et al.*, 2021; Rotolo *et al.*, 2022; Scarpellini, 2022; Smol *et al.*, 2018; Spangenberg and Lorek, 2019; Testa *et al.*, 2020; Xue *et al.*, 2010), but without exploring the link between the level of awareness on one side and purchase of sustainable goods and access-based and collaborative consumption on the other. There is some research that specifically focuses on the link between awareness and green purchase intention (Ferdousi and Qiang, 2014, 2016; Ogiemwonyi and Bin Harun, 2021; Ogiemwonyi *et al.*, 2020; Oncioiu and Ifrim, 2022; Purcarea *et al.*, 2022; Yadav *et al.*, 2022) but it lacks further development within CE framework. The link between a firm's environmental awareness and product service systems adoption is approached by Kuhl *et al.* (2022), but there is a lack of addressing consumer perspective. Edbring *et al.* (2016) examined consumption behavior concerning three consumption models (i.e. sustainable, access-based, and collaborative), by addressing their perceived advantages and barriers. However, they did not explore the connection between awareness of the concept of the CE and the adoption of these models. Additionally, a relevant question is raised by Scarpellini (2022) who analyzed the social dimension of awareness of the concept, a field that is still underexplored in the literature.

Consequently, this paper proposes to fill this gap and analyze the adherence to the sustainable, access-based and collaborative consumption practices and explore the role of CE awareness (including the social impacts) in this process. The methodology of choice is quantitatively based on partial least square-based structural equation modeling (PLS-SEM).

Thus, from a theoretical perspective, this paper aims to contribute to the research on the relation between CE awareness and consumption models (sustainable, access-based and collaborative). And, on the other hand, as CE practices are embodied into national and local policies, from an empirical perspective, and by analyzing the second-largest city of Portugal, Porto, this research contributes to understanding local contexts of CE practices dissemination. In national Portuguese contexts, some studies evaluate the importance attributed to sustainable practices with special emphasis on waste management (Antunes *et al.*, 2022; Fonseca and Domingues, 2018), without addressing, however, sustainable consumption; approaches to policies' implementation (Henriques *et al.*, 2022; Ribeiro *et al.*, 2017) and the city's management through CE practices (Cavaleiro de Ferreira and Fuso-Nerini, 2019), and other environmental indicators within the industrial sector (Ferreira *et al.*, 2019). In the present research, awareness of CE and frequency of the sustainable models of consumption within the city of Porto are addressed.

The paper is organized as follows. Section 2 represents the theoretical background on CE, and hypothesis formulation related to awareness of CE, purchase of sustainable goods and access-based and collaborative consumption; Section 3 presents the methodology; Section 4 provides the presentation of results. Section 4 presents discussion, and the research is finalized with conclusion in Section 5.

Circular economy awareness and sustainable consumption

Circular economy concept

It is an established fact that business as usual for infinite linear growth is not conceivable, whereas CE is a sustainable alternative (Rotolo *et al.*, 2022), as it implies a reduction of the use of raw materials replaced by reusing and recycling (Kovacic *et al.*, 2019; Morea *et al.*, 2021). There may be enormous environmental advantages by using CE (Genovese *et al.*, 2017), rather than the linear one (Pine and Gilmore, 1998).

CE is rooted in the waste management (Pan *et al.*, 2015). In its basis is the "3R" principle – reduction, reusing and recycling of materials and energy (Geissdoerfer *et al.*, 2017). One of the initial political proposals for the CE emerged from the European Commission. Their focus was on shaping a fresh narrative that extended beyond its initial boundaries, aiming to conceptualize new prospects for economic growth (Kovacic *et al.*, 2019). This approach was grounded in the principles of preventive and regenerative eco-industrial development (Ghisellini *et al.*, 2016) and sought to harmonize environmental conservation with socioeconomic advantages (Morseletto, 2020).

Nowadays, CE concept goes far beyond the "3 R's" principle, becoming a basis for sustainability (Geissdoerfer *et al.*, 2017), where CE puts CSR into practice (Mazzucchelli *et al.*, 2022). In the new CE narrative, society and organizations are faced with a paradigm change; environmental problems become opportunities, waste is transformed into resources (Kovacic *et al.*, 2019) and citizens are the key to this change (Rotolo *et al.*, 2022).

Circular econom's awareness

Changing our life patterns is always disruptive (Spangenberg and Lorek, 2019), but increasing knowledge and information is important, as they are the pillars for building consumer awareness consolidated in norms and beliefs conducive to the increased adoption of sustainable consumption (Testa *et al.*, 2020).

Awareness of personal influence on the functioning of society, the planet or the environment is determinant of consumption behavior (Blazek, 2021; Rotolo *et al.*, 2022; Spangenberg and Lorek, 2019). Consequently, the awareness of circularity is expected to encourage responsible consumption (Musova *et al.*, 2021). Numerous studies have pointed out that consumers' awareness of sustainability issues has a positive impact on their adoption of

circular consumption behaviors (Ferdousi and Qiang, 2016; Gomes *et al.*, 2022; Shevchenko *et al.*, 2023; Testa *et al.*, 2020; Vidal-Ayuso *et al.*, 2023), specifically consumer understanding and consciousness regarding sustainable clothing which play a role in shaping their buying choices (Patwary *et al.*, 2023).

It is relevant also to stress that "awareness", according to the *Oxford Dictionary*, is "knowing that something exists and is important; being interested in something". That is why, when accessing awareness, citizens' familiarity with the concept of CE is accessed in literature (Liu *et al.*, 2009; Rotolo *et al.*, 2022). Further, it goes beyond familiarity, as awareness implies different issues such as something exists and is important, citizens' perception and interpretation of what CE are investigated (Rotolo *et al.*, 2022), together with perceived importance of CE adoption (Xue *et al.*, 2010), understanding of advantages/possible outcomes (Rotolo *et al.*, 2022) and perceived barriers for CE implementation (adapted from Klein *et al.*, 2022; Xue *et al.*, 2010). The new approach within this line of research on awareness is accessing the perception of social impact perceived by social impact of CE implementation (Scarpellini (2022). Therefore, in this paper, it is argued that the concept of awareness of CE should be accessed from the perspectives of familiarity, interpretation, reasons of importance, its advantages and outcomes, perceived barriers, including the assessment of perceived social impact.

Purchase of sustainable goods

By active preference for sustainable products, consumers impact production modes (Liu *et al.*, 2009); by purchasing secondhand goods, waste is reduced, on the one hand, by decreasing production volumes and, on the other hand, by prolonging their use and consequently lowering trash creation (Edbring *et al.*, 2016; Schallehn *et al.*, 2019).

Klein *et al.* (2022) analyzed purchase behavior related to CE from the point of view of organizations in Portugal, namely, purchase of recycled content of materials, potential for reparability and/or recyclability, reuse of products or components, repair/refurbishment, remanufacturing of products or equipment. This purchase behavior will be accessed according to Klein *et al.* (2022) in the consumer perspective. Concretely, it will be evaluated by the frequency of purchase in relation to: damaged products, but fit to use; reused products; products with recycled materials; products with possibility of recyclability or disassembly; bulk products; products with a return guarantee or with a takeback system; products with the highest energy efficiency (e.g. A+++). Additionally, the question of purchase of secondhand products will be evaluated according to the writings of Edbring *et al.* (2016) and Gray *et al.* (2022).

Access-based and collaborative consumption

Access-based consumption. Access-based business models are seen as a way to align customer needs, business success and sustainability, as products are rented rather than purchased (Baden and Frei, 2022). That in turn would reduce production and environmental pressure (Liu *et al.*, 2009). Within these business models (access-based, or pay-per-use or product-as-a-service), consumers pay for the unit off without gaining product ownership (Bocken *et al.*, 2018), which is seen as a fundamental aspect of CE (Kerdlap *et al.*, 2021). Thus, frequency of renting a machine and a product rather than buying it will be analyzed.

Renting of houses, cars or industry equipment is already something quite common, but renting of small equipment for personal use, such as clothes, is still something just on the rise. In particular, the business models linked to fashion renting are on the rise, prolonging the life cycle of each garment and decreasing the production of one of the most pollutant industries (Gray *et al.*, 2022). Consequently, the unit of renting a party outfit instead of buying it is included.

Collaborative consumption. In recent years, the notion of collaborative consumption has gained great popularity as a form of sustainable consumption (Arrigo, 2021). In this model, renting is replaced by sharing products, for example, clothing, cars, apartments and tools, as well as skills, time, finances and services (Edbring *et al.*, 2016). Thus, frequency of the shared housing and sharing of goods with others is accessed.

In addition, there is a special relevance of automatic laundries within CE, as the use of commercial laundry leads to a reduction in total carbon emissions (Hu *et al.*, 2012) together with a diminution of the number of privately owned washing machines by households (Bressanelli *et al.*, 2019). Thus, owing to it is relevance, the frequency of using the automatic laundry service is analyzed.

Theoretical framework

The awareness of CE is analyzed along six dimensions (Table 1): citizens' familiarity with the concept of CE (adapted from Liu *et al.*, 2009 and Rotolo *et al.*, 2022); their perception/ interpretation of what CE is (adapted from Rotolo *et al.*, 2022); perceived importance of CE adoption (adapted from Xue *et al.*, 2010); citizens understanding of advantages/possible outcomes of CE implementation (adapted from Rotolo *et al.*, 2022); perceived barriers for CE implementation (adapted from Klein *et al.*, 2022; Xue *et al.*, 2010); and perceived social impact of CE implementation (adapted from Scarpellini, 2022).

Sustainable consumption models within CE are as follows: purchase of sustainable products (adapted from Edbring *et al.*, 2016; Gray *et al.*, 2022 and Klein *et al.*, 2022); access-based consumption (adapted from Arrigo, 2021; Edbring *et al.*, 2016; Fani *et al.*, 2022; Gray *et al.*, 2022; Musova *et al.*, 2021); and collaborative consumption (adapted from Belk (2014), Bressanelli *et al.* (2019); Bressanelli *et al.* (2020), Edbring *et al.* (2016) and Hu *et al.*, 2012).

Methodology

Method

The questionnaire was specifically developed according to the objectives of the present research based on the sources indicated in Table 1.

For data collection, the non-probabilistic convenience sampling technique was used. The questionnaires were applied through direct and personal interviews. The interviews were conducted in strategic popular areas in the City of Porto, such as Trindade, with special emphasis, on the area of Metro da Trindade; entrance of the Norte Shopping, Via Catarina and La Vie shopping centers; São Bento Station (train and metro); Santa Catarina Street; Bolhão Market; Aliados street.

Model

This study applied PLS-based SEM (Smart PLS 4.0), which is one of the most important data analysis tools in the fields of management, information systems, marketing and social sciences (Hair *et al.*, 2019). It is a multivariate statistical technique used for analyzing complex relationships between variables (Hair *et al.*, 2019).

To analyze individuals' sustainable consumption models toward CE, the study applied a two-stage approach. First, the measurement model was analyzed and then, the structural equation model was used to test the relations between familiarity of CE (A1), Perception/ Interpretation of what CE is (A2), importance of CE (A3), advantages of CE (A4), barriers of CE (A5), CE social impact (A6) and two outcome variables – purchase of sustainable products (B1) and access-based and collaborative consumption (B2) resulting in formulation of 12 hypotheses:

Table 1 Theoretical framework (units of analysis)

Topic/variable	*Source*	*Units*	*Reason for selection*
Public familiarity with the concept of CE	*Adapted from* Liu *et al.* (2009) *and* Rotolo *et al.* (2022)	• I understand circular economy very well • I have some knowledge • Heard of it, but don't have knowledge • Had never heard of it	✓ To verify the level of awareness regarding to CE concept. ✓ Does familiarity with the concept influence the behavior?
Perception/Interpretation of what CE is	*Adapted from* Rotolo *et al.* (2022)	• A new economic model • A new way of production • An economy capable of regenerating • An economy without residues • A more sustainable production and consumption model • Reduce-reuse-recycle • I don't know • Other	✓ Is the scope of CE, understood in its narrow sense, linked to the management, or as whole new economic model? ✓ Does this perception have implications on the behavior?
Perceived importance of CE adoption	*Adapted from* Xue *et al.* (2010)	• To save energy • To protect the environment • To reduce costs • It is one of the national policy requirements • Public appealing • I don't know • Other	✓ How do citizens see the importance for CE implementation? ✓ Verify, if there is some relation between the interpretations of the reasons for CE and subsequent consumer behavior.
Understanding of advantages/possible outcomes of CE implementation	*Adapted from* Rotolo *et al.* (2022)	• Drastic reduction of raw material consumption • New business and jobs opportunities • Reduction of pollutant emissions • Waste reduction • Food waste reduction • Other	✓ How do citizens see the advantages/possible outcomes of CE implementation? ✓ Verify, if there is some relation between the interpretations of the outcomes for CE and subsequent consumer behavior.
Perceived barriers for CE implementation	*Adapted from* Klein *et al.* (2022); Xue *et al.* (2010)	• Lack of public awareness • Lack of financial support • Lack of available budget • Lack of legislation • Lack of technology • Lack of supervision • Lack of encouragement • Other	✓ To understand perceived barriers ✓ and its relationship with subsequent behavior

(*continued*)

Table 1

Topic/variable	*Source*	*Units*	*Reason for selection*
Perceived social impact	*Adapted from* Scarpellini (2022)	• It creates new jobs • It will need new professional profiles • It positively impacts society in general • It increases citizens' awareness of sustainability and transparency • It contributes to the environment education of young people • It improves public health (due to environmental improvements) • It increases collaboration between people in sharing goods and services	✓ How do citizens perceive the social impact? ✓ Verify, if there is some relation between the interpretations of the of the social impact of CE and subsequent consumer behavior.
Frequency of purchase of sustainable products	*Adapted from* Klein *et al.* (2022); *Adapted from* Edbring *et al.* (2016) *and* Gray *et al.* (2022)	• Damaged products but fit to use • Reused products • Products with recycled materials • Products with possibility of recyclability or disassembly • Bulk products • Products with a return guarantee or with a takeback system • Products with the highest energy efficiency (e.g. A+++) • Second-hand products	✓ Verify the frequency of purchase of sustainable products and its relation to awareness
Access-based consumption	*Adapted from* Edbring *et al.* (2016) *Adapted from* Fani *et al.* (2022), Musova *et al.* (2021), Gray *et al.* (2022), Arrigo (2021)	• Rent a machine instead of buying it • Rent a product instead of buying it • Rent a party outfit instead of buying it	✓ Verify the frequency of access-based and collaborative consumption and its relation to awareness
Frequency of collaborative consumption	*Adapted from* Belk (2014); Edbring *et al.* (2016) *Adapted from* Bressanelli *et al.* (2019); Bressanelli *et al.* (2020); Hu *et al.* (2012)	• Shared housing • Sharing your goods with others • Automatic laundry service	

Source: Authors' own elaboration

H1. Public familiarity with the concept of CE positively influences the frequency of purchase of sustainable products.

H2. Public familiarity with the concept of CE positively influences the frequency of access-based and collaborative consumption.

H3. Perception/interpretation of what CE is positively influences the frequency of purchase of sustainable products.

H4. Perception/interpretation of what CE is positively influences the frequency of access-based and collaborative consumption.

H5. Perceived importance of CE adoption positively influences the frequency of purchase of sustainable products.

H6. Perceived importance of CE adoption positively influences the frequency of access-based and collaborative consumption.

H7. Understanding of advantages/possible outcomes of CE implementation positively influences the frequency of purchase of sustainable products.

H8. Understanding of advantages/possible outcomes of CE implementation positively influences the frequency of access-based and collaborative consumption.

H9. Perceived barriers for CE implementation negatively influence the frequency of purchase of sustainable products.

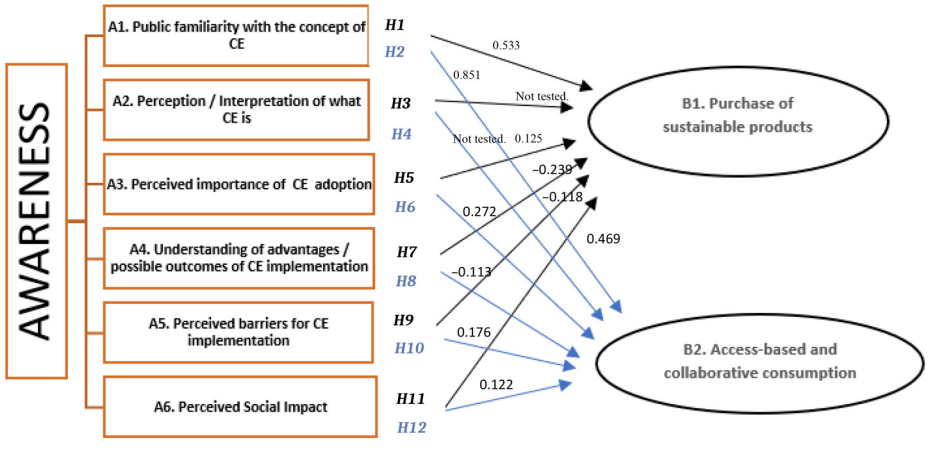
H10. Perceived barriers for CE implementation negatively influence frequency of access-based and collaborative consumption.

H11. Perceived social impact positively influences the frequency of purchase of sustainable products.

H12. Perceived social impact positively influences the frequency of access-based and collaborative consumption.

Sustainable consumption was measured using two questions; one question was directed to the purchase of products and other to consumption models, and this justifies why access-based consumption and collaborative consumption are combined in one block (i.e. one question) (Figure 1).

Figure 1 Conceptual model (CE awareness)



Source: Authors' own elaboration

Sample

The total number of respondents is 1,011 with diverse characteristics regarding gender, age, marital status, education, employment and nationality (Table 2). Predominant age group is between 18 and 25 years (34.7%), and cumulatively, the respondents from 18 up to 45 years old constitute most of the sample (74.7%). Regarding the level of education, it is evident that the relationship of this variable was with the predominance of public belonging to the younger generations. Most of the respondents are Portuguese (80.6%), residing in Portugal (88.5%) and most of them in Porto Metropolitan Area (84.0%). Although other

Table 2 Sociodemographic characteristics of the sample

Variable	*%*
1. Gender	
Female	54.1
Male	44.2
Prefers not to say	1.7
2. Age = average 35.22 years	
18–25	34.7
26–35	23.1
36–45	16.9
46–55	13.3
>55	12.0
3. Marital status	
Single	54.5
Married	36.8
Divorced	6.8
Widower	1.9
4. Education (complete)	
Basic	10.6
Secondary	37.6
Bachelor	37.2
Master's or PhD	14.6
5. Employment	
Self-employed	17.0
Employee	53.1
Looking for the first job	2.2
Student	19.0
Unemployed	3.7
Retired	4.6
Domestic	0.4
6. Nationality	
Portuguese	80.6
Spanish	5.2
English	2.2
German	0.3
French	1.6
Brazilian	6.6
American	0.3
Other	3.2
7. Residence	
Portugal	88.5
Other	11.7
7.1. City in Portugal	N = 875
Porto metropolitan area	84.0
Others	16.0

Source: Authors' own elaboration

nationalities are also represented, such as Brazilian (6.6%), Spanish (5.2%), English (2.2%), French (1.6%) and others (3.2%).

Results

Circular economy awareness

Most of the respondents (63.40%) stated that they had never heard of the concept of CE (Table 3). These results reflect the fact that the CE is still a fairly recent concept with regard to public knowledge because the total respondents who have some familiarity with the concept are only 36.60%.

Interpretation of what CE is and evaluating its importance is evident and consensual among the public, demonstrating that the concept of CE is associated with sustainability and circularity, which are indeed the objectives of CE. In addition, it should be noted that the interpretations of the CE in its broadest sense, as a new and alternative economic and production model, also have a relevant expression that reflects the metamorphoses that are in place with the concept of CE. It is relevant for the economic context to point out that there is a significant percentage of people who recognize an entrepreneurial aspect of the CE. However, among the barriers perceived, a large majority considers the lack of knowledge of the population as the main barrier to the implementation of CE, along with the need of financial and legislative support in transition to CE.

Perceived social impact demonstrates an acceptance and appreciation of CE practices which is important for the development of society in general, together with the need of developing professional profiles with a specific skill that meet the circular and more sustainable economic model, namely, specialization on waste management, knowledge and preference of sustainable product purchase, access-based and collaborative consumption patterns within organizations and helping organizations to adopt more sustainable models.

Sustainable models of consumption

Purchase of products with a guarantee of return and/or exchange as well as products with high energy efficiency (e.g. A+++) seem to be the most rooted in the consumption, and accompanied by the concern of recycling and reuse (Table 4). The demand for secondhand products and consumption based on access and sharing are growing trends. Sharing goods with other people and sharing a house have the highest incidence.

Influence of awareness on sustainable consumption models

Measurement model. The measurement model confirms the reliability of the model constructs of purchase of sustainable goods (B1) and access-base and collaborative consumption (B2). All the construct items' loading exceeds the threshold value of 0.70, ensuring construct reliability (Sarstedt *et al.*, 2019). Also, composite reliability scores of the constructs are above 0.70, showing them adequate.

The value of the average variance extracted (AVE) of the constructs is above 0.50 (Hair *et al.*, 2017). The detailed results are presenting in Table 4. The results also confirm discriminant validity which refers to the extent to which distinct constructs or variables, theoretically expected to be unrelated, do not show strong correlations when measured, and this demonstrates that they are indeed measuring separate and unique concepts (Hair *et al.*, 2017).

Table 5 shows that the heterotrait–monotrait ratio (HTMT) values are significantly lower than 0.85. The variance inflation factor (VIF) quantifies the severity of multicollinearity in a regression model. Multicollinearity occurs when predictor variables in a regression model are highly correlated with each other, which can lead to issues with the interpretation of coefficients and predictions. VIF values are between 1.203 and 2.009, meeting the

Table 3 Awareness of CE

Question		*%*
A1. Have you heard about the concept of circular economy?		
Yes, and I understand very well		9.50
Yes, and I have some knowledge		18.69
Yes, but I have no knowledge		8.41
No, I've never heard of		63.40
A2. Which of the following best defines what is circular economy?		
An economy capable of regenerating		31.1
A more sustainable production and consumption model		28.1
A new economic model		11.4
Reduce-reuse-recycle		10.5
A new form of production		9.2
An economy without waste		5.1
I do not know		4.6
Other		0.0
A3. Why do you think it' s important to implement circular economy practices? [multi-response]		
Protecting the environment		57.8
Awareness of society		27.8
Reduce expenses		26.5
Save energy		23.8
It is one of the requirements of national policy		3.8
I do not know		3.2
Other		0
A4. In your opinion, what is the main advantage of implementing circular economy practices?		
Drastic reduction of the consumption of natural resources		43.8
Reduction of pollutant emissions		19.7
New business opportunities and jobs		17.0
Waste reduction		11.4
Reduction of food waste		6.2
Other		1.9
A5. The main barrier to the implementation of the CE		
Lack of knowledge of the population		48.1
Lack of financial support from public bodies		17.8
Lack of incentives		9.2
Lack of available budget		8.9
Lack of legislation		8.4
Lack of supervision or control		3.2
Other		2.4
Lack of technology		1.9
A6. To what extent do you consider the following statements relevant in relation to the implementation of circular economy practices? (1 - Extremely irrelevant;. . .; 5 - Extremely relevant)	*Mean*	*Relevant and extremely relevant*
Contributes positively to society	4.40	83.8
Increases society's awareness of the issue of sustainability	4.33	83.2
Contributes to the environmental education of the youngest	4.24	80.5
Improves public health (due to improvements in the environment)	4.23	79.2
Increases collaboration and exchange of services and products between people	3.98	70.3
Creates the need for specialized professionals	3.82	64.3
Generate new jobs	3.63	54.3

Source: Authors' own elaboration

criteria ≤ 3 (please see Appendix 1 – VIF Values). When VIF values are below 3, it indicates that there is a relatively low level of multicollinearity among the predictor variables. This implies that the predictor variables are relatively independent and do not duplicate information in the model (Podsakoff *et al.*, 2003).

The construct A2 was removed from the model because of the missing data. Removing a construct due to a high number of missing values in a PLS estimation is a methodological

Table 4 Sustainable models of consumption

Question	*Mean*	*Very often and always*
B1. Purchase sustainable products (1 - Never;. . .; 5 - Always)		
Products with return and/or exchange guarantee	4.14	76.8%
High energy efficient products (e.g. A+++)	3.96	67.8%
Products that can be recycled or dismantled	3.75	66.2%
Products containing recycled materials	3.80	60.8%
Reused products	3.39	50.3%
Second-hand products	3.08	40.3%
Bulk products	3.01	34.3%
Products defective but fit for use	2.65	27.3%
B2. How often do you choose to? (1 - Never;. . .; 5 - Very often)		
Share goods with others	3.08	43.1%
Shared housing	2.10	22.4%
Renting a product instead of comparing it	1.96	18.3%
Renting a party outfit instead of buying it	1.74	15.1%
Laundries	1.94	14.0%
Renting a machine instead of buying it	1.80	13.2%

Source: Authors' own elaboration

Table 5 Construct reliability

Reflective construct	*Items*	*Loading*	*Cronbach's alpha*	*CR/CR_rho*	*AVE*
B1	B1.1	0.749	0.838	0.854/0.872	0.533
	B1.2	0.785			
	B1.3	0.751			
	B2.4	0.713			
B2	B2.1	0.705	0.801	0.874	0.698
	B2.2	0.791			
	B2.3	0.835			

Source: Authors' own elaboration

decision aimed at maintaining the integrity and reliability of the analysis (Hair *et al.*, 2019). When a construct has a substantial proportion of missing data, it introduces uncertainty and reduces the precision of estimates. This can lead to biased or unreliable results, undermining the validity of the model. Furthermore, in the context of PLS estimation, the presence of missing data can hinder the identification of the model (Sarstedt *et al.*, 2019). This is because PLS relies on covariance structures between latent constructs and observed indicators. When a substantial portion of data is missing, the estimation algorithm may struggle to establish these relationships, potentially resulting in an ill-posed or under-identified model. By removing constructs with high levels of missing data, researchers aim to improve the overall quality and robustness of the analysis (Sarstedt *et al.*, 2019). This enables more accurate parameter estimates and ensures that the model is identifiable, allowing for meaningful and reliable conclusions to be drawn from the data (Hair *et al.*, 2019).

Structural model. Using 5,000 sub-samples in bootstrapping, the structural model and the test of hypotheses were accessed. The using 5,000 bootstrap iterations can lead to more accurate and robust estimates, especially in scenarios where traditional assumptions and methods may be less appropriate or reliable (Hair *et al.*, 2017). It provides a powerful tool for statistical inference and estimation in a wide range of applications.

The model's explanatory capacity is evaluated using R^2 value, which indicates the explained variance of the dependent constructs (Hair *et al.*, 2019).

The model presents a good level of predictive power (R^2), with a percent of (35.2%) for R^2 concerning the purchase of sustainable products intention (B1) and 12.5% for frequency of access-based and collaborative consumption (B2) (Table 6).

The familiarity of CE positively affects the purchase intention ($\beta = 0.533$, $p < 0.001$) and frequency of access-based and collaborative consumption ($\beta = 0.851$, $p < 0.001$) which supports *H1* and *H2*.

The importance of CE also positively affects the purchase intention ($\beta = 0.125$, $p < 0.001$) and frequency of access-based and collaborative consumption ($\beta = 0.272$, $p < 0.001$) which supports *H5* and *H6*.

However, the advantage of CE negatively affects the purchase intention ($\beta = -0.239$, $p < 0.001$) while frequency of access-based and collaborative consumption ($\beta = -0.113$, $p < 0.001$) does not support *H7* and *H8*.

The barrier of CE negatively affects the purchase intention ($\beta = -0.118$, $p < 0.001$) and positively affects the frequency of access-based and collaborative consumption ($\beta = 0.176$, $p < 0.001$) which supports *H9* and does not support *H10*.

Finally, CE implementation positively affects the purchase intention ($\beta = 0.469$, $p < 0.001$) and frequency of access-based and collaborative consumption ($\beta = 0.122$, $p < 0.001$) which supports *H11* and does not support *H12* (see Appendix 2 – Figure Smart PLS-SEM).

Most of the hypotheses received statistically significant influence, with the exception of *H3* and *H4* which have not been tested, demonstrating that the interpretation of what the CE entails does not impact sustainable consumption models, whereas the perception of its importance, advantages and barriers does (Table 7).

Table 6 Discriminant validity – HTMT ratios

	A1	*A3*	*A4*	*A5*	*A6*	*B1*	*B2*
A1							
A3	0.014						
A4	0.087	0.140					
A5	0.006	0.040	0.187				
A6	0.046	0.088	0.268	0.219			
B1	0.094	0.173	0.382	0.197	0.574		
B2	0.134	0.278	0.084	0.145	0.222	0.429	

Source: Authors' own elaboration

Table 7 Results of hypothesis testing

Hypothesis	*Relationship*	*Path coefficient*	*Standard error*	*t-statistic*
H1	A1 → B1	0.533	0.000	12.324
H2	A1 → B2	0.851	0.000	15.623
H3	A2 → B1	*It has not been tested*		
H4	A2 → B2	*It has not been tested*		
H5	A3 → B1	0.125	0.000	9.436
H6	A3 → B2	0.272	0.000	10.213
H7	A4 → B1	−0.239	0.000	−9.827
H8	A4 → B2	−0.113	0.000	−8.997
H9	A5 → B1	−0.118	0.000	−9.023
H10	A5 → B2	0.176	0.000	10.864
H11	A6 → B1	0.469	0.000	11.652
H12	A6 → B2	0.122	0.000	10.028

Indicators
R^2 B1 = 35.2%; R^2 B2 = 12.5%

Source: Authors' own elaboration

Discussion

CE is a concept with growing importance, but according to Rotolo *et al.* (2022), there is still lack of general knowledge on what CE is. This statement supports the findings of the present study, as most of the respondents have never heard of the concept (63.40%), as observed by Antunes *et al.* (2022) in the city of Leiria.

Among those who have some familiarity with CE, the economy capable of regenerating was the most frequent understanding of CE (31.1%). This contradicts the findings of Rotolo *et al.* (2022), where the interpretation of CE as more sustainable production and consumption model was the most common response. Generally, the interpretation among the respondents is still linked to the initial "3R" principle – reduction, reusing and recycling of materials and energy (Geissdoerfer *et al.*, 2017). However, it is notable that the growing scope of CE toward a new paradigm (Bocken and Short, 2020; Morea *et al.*, 2021) is reflected in the answers, as there is a part of the respondents who reveal an understanding of CE as a new economic model (11.4%).

Similarly, to Xue *et al.* (2010), the importance of CE in a sense of protecting the environment and saving energy are among the most perceived values (57.8% and 23.8%). This is linked, in its turn, with the perceived advantage of implementation of CE as a drastic reduction of the consumption of natural resources. In line with Scarpellini (2022), the majority of the respondents consider that CE-related activities positively impact society as a whole. Although, in Scarpellini (2022), the second item that received the biggest expression is creation of new professional profiles, in the present research, this item did not obtain the same relevance. Contrastingly, increasing society's awareness of the issue of sustainability and contribution to the environmental education of the youngest are the most considered impacts. These differences may be related to the context of the study, as Scarpellini's (2022) research addresses firms' context, that is reflected in the bias toward professional perspective. However, in the present research the context is a general public residing in the city of Porto. Therefore, more broader impact of society's awareness of the issue of sustainability and contribution to the environmental education of the youngest are considered. It emphasizes the dynamic nature of public perceptions and the need to consider the specific context when interpreting research findings on this topic.

Among the most perceived barriers to CE implementation is lack of knowledge of the population and lack of finance support, thus corroborating the findings of Xue *et al.* (2010). The answers show the importance that is given to the awareness of the need to transition from a linear production to a circular one, as consciousness dictates behaviors (Spangenberg and Lorek, 2019). In addition, great relevance is credited to financial, legislative and technological support, namely, by the state. This seems to be justified by the fact that sustainable practices are perceived as requiring an investment in appropriate technology and structural changes, which have higher costs than their possible applications (or the trade-off considered), especially for smaller companies. Regarding individual consumption models, it seems to be related to the indicated barriers of lack of incentives and budget. Indeed, sustainable products/choices often have higher prices or are more time-consuming, which leads people to see with difficulty their adoption in their daily life. Within this context, the results regarding sustainable consumption models reflect a growing trend, especially the demand for secondhand products, which are, according to Edbring *et al.* (2016), the main drivers of decisions that are not environmental but economic.

Concerning the purchase of sustainable products, among the most frequent ones are those with high energy efficiency, as previously shown by the results obtained by Klein *et al.* (2022) within organizational context. However, there are some differences; as for consumers, the most frequent purchase is the products with guarantee of return and/or exchange, which was not among the most relevant in the study of Klein *et al.* (2022). This aspect is more valued by consumers for their household consumption rather than the

possibility to rent or lease which is valued more within the organizational context. Within the organizational context renting or leasing products and purchasing the service rather than the product are far more frequent than in consumer context, similarly to the findings of Edbring *et al.* (2016). On the other hand, concern with recycling and reuse is emphasized by consumers at the time of purchase.

The most frequent behavior within access-based and collaborative consumption is sharing goods and housing. And even though it is considered that fewer purchases increase sustainability (Belk, 2014), the reason behind this choice is still seen primarily as economic, rather than environmental (Edbring *et al.*, 2016). The option of sharing a house is more imposed by difficulties in the real estate market, lack of supply and unaffordable prices, than a voluntary choice.

Growing relevance of rent a party outfit instead of buying it is acknowledged, which corroborates the research of Arrigo (2021), Fani *et al.* (2022), Gray *et al.* (2022) and Musova *et al.* (2021). Party clothes are usually bought and used only once or a few times, generating consumerism and thus influencing the environment nefariously due to the great pollution generated by the textile industry. Although adherence to this type of model is not yet high, it creates a promising future in the field of sustainability.

The frequency of use of automatic laundry is not very high yet, but it is expected to increase, especially if the consumer is informed not only about the practical use and advantages that the laundry presents for its own use, but in the sense of its positive influence on the environment, as is referred by Bressanelli *et al.* (2019), Bressanelli *et al.* (2020); Hu *et al.* (2012).

And the most important finding of the present research is the fact that higher awareness is positively related with purchase of sustainable products, as well as the access-based and collaborative consumption which is highlighted. Higher understanding of the advantage of CE as drastic reduction of the consumption of natural resources and reduction of pollutant emissions influences less consumerist behavior. These results reinforce previous studies in the fields of green purchase intention (Ferdousi and Qiang, 2014, 2016; Ogiemwonyi and Bin Harun, 2021; Ogiemwonyi *et al.*, 2020; Oncioiu and Ifrim, 2022; Purcarea *et al.*, 2022; Yadav *et al.*, 2022) and product service systems adoption (Kuhl *et al.*, 2022). Even though, there are economic constraints acknowledged in the analysis, as the higher perceived barriers which negatively influence the frequency of sustainable purchase, it is evident that CE awareness impacts adoption of sustainable consumption models, as it is pointed out by Blazek (2021), Ferdousi and Qiang (2016), Gomes *et al.* (2022), Musova *et al.* (2021), Patwary *et al.* (2023), Testa *et al.* (2020), Rotolo *et al.* (2022), Spangenberg and Lorek (2019), Vidal-Ayuso *et al.* (2023).

Conclusion

The result shows that there is an influence of CE awareness on subsequent sustainable consumption models. However, there is still a great need to increase familiarity with the concept of CE, which is a promising new economic model that aims to meet the goals of the 2030 Agenda for Sustainable Development outlined by the United Nations. Education belongs to the external antecedents of need awareness and, therefore, is positively related to participation in the CE (Vidal-Ayuso *et al.*, 2023), and municipalities should continue to invest in the extension and promotion of CE initiatives (Antunes *et al.*, 2022). Thus, more dissemination and awareness actions that lead to increased knowledge of practices and the importance of CE by the population are suggested.

Furthermore, as CE is in a process of increasing its range of action, becoming a new paradigm of production and consumption, this broader aspect should be reinforced in the education of citizens.

However, even though the awareness regarding CE is still below what is desirable among the respondents in the city of Porto; environmental awareness and awareness of waste reduction stand out and grow significantly which is a positive note. Given that consumers place a high value on certain aspects of the consumption process, businesses should place more emphasis on recycling, reusing and recycling products, as well as providing consumers with information about them, as these factors have been shown to be significant determinants of consumer preference for purchases.

Thus, consumption choices increasingly reflect an awareness of the impacts on the environment (Edbring *et al.*, 2016). This trend supports and drives new forms of economically sustainable action (Scarpellini, 2022). There is a great consensus on the opportunities that the transition to CE represents, both on the supply side and on the demand side. Therefore, there is a need to create new business models that can respond to the new circular reality in line with the suggestion of Mesa *et al.* (2022). The attention should be directed to the creation of business models based on access, both by large companies and for platform businesses working as mediators and controllers of product rental processes. Sharing goods with other people is a frequent behavior, so it is considered as having economic viability for platform businesses that aim to connect consumers in meeting the aforementioned needs. Self-service laundries are a growing business that lacks further environmental education on their sustainability aspects. Considering that the pieces of party clothing have a very punctual and often unique use, it is seen as a business opportunity still to be explored, given the size of the market not covered and the quick loyalty of those who experience the service. Additionally, as new professions may emerge in the face of changes in the productive system, educational establishments must be prepared to respond to this new reality, being important agents that focus on the concrete aspects of this change.

Thus, present research contributes to the theory of development CE awareness and sustainable consumption models, confirming the relevance of awareness of CE concept along its six dimensions (i.e. familiarity, interpretation, importance, advantages, social impact and barriers) for the adoption of sustainable consumption models (purchase of sustainable goods, access-based and collaborative consumption). Moreover, it provides practical suggestions for business and policymakers aiming at the transition to the CE.

Recommendations

Based on the findings, it is advisable to focus on raising awareness and understanding of the CE concept among the population. This includes promoting CE practices, the importance of CE in achieving sustainability goals, and its alignment with the United Nations' 2030 Agenda for Sustainable Development. Moreover, efforts should be directed toward increasing education as an external antecedent to boost CE participation. Municipalities are encouraged to continue investing in CE initiatives. To enhance public knowledge and emphasize the significance of CE, more awareness campaigns and educational initiatives are recommended.

Further research

Considering the research's location within Porto and its specific findings, it is recommended to expand the scope through further comparative studies in various cities and countries. These comparative studies should investigate the behaviors and attitudes of individuals with differing levels of CE awareness. Additionally, there is a need for in-depth exploration of the motivations behind consumers' choices regarding sustainable consumption models. Future research could delve into the factors driving decisions related to sustainable goods, access-based consumption and collaborative consumption.

Limitations

While this research provides valuable insights into the relationship between CE awareness and sustainable consumption models in the context of Porto, it is essential to acknowledge certain limitations. First, the study's findings may not be universally applicable, as they are based on a specific geographical location. The research might not encompass the full diversity of perspectives and behaviors seen in other regions or cultural contexts. Additionally, this study's scope primarily focused on CE awareness and its links to sustainable consumption, potentially overlooking other influential factors. It is vital to recognize that public awareness regarding CE in Porto is below ideal levels, indicating a potential limitation in generalizability.

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Appendix 1

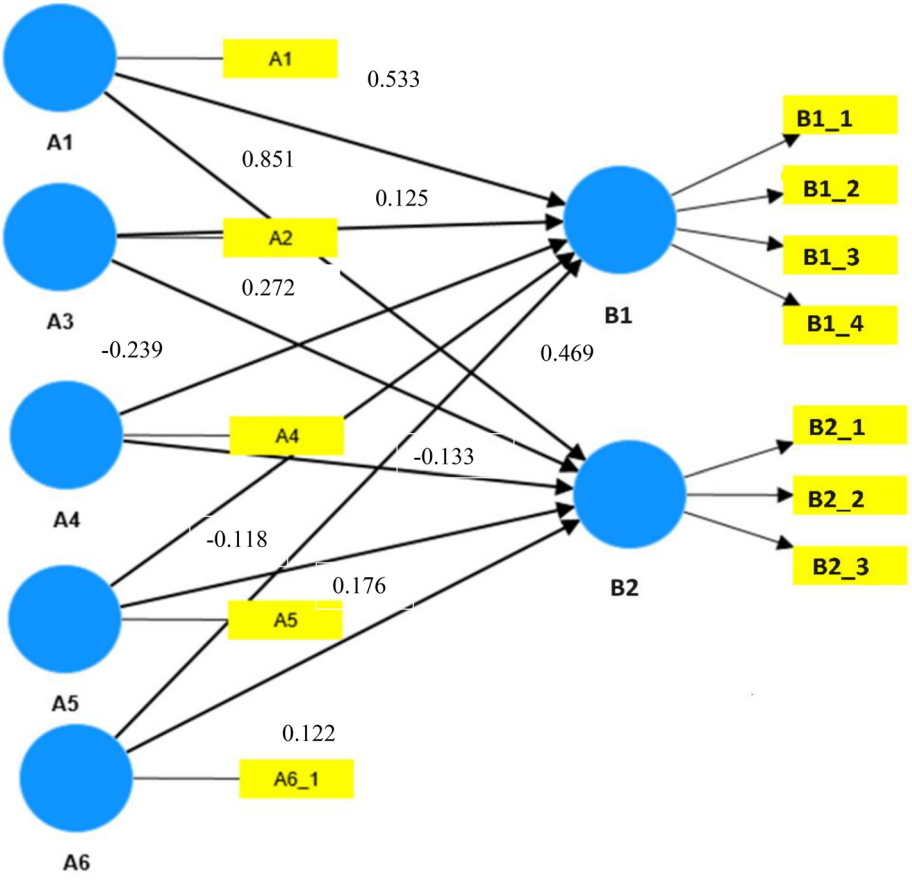
Table A1 VIF Values

Items	*VIF*
A1	1.345
A2	1.627
A4	2.003
A5	1.285
B4_1	1.293
B4_2	1.911
B4_3	1.546
B4_4	1.400
B5_1	1.458
B5_2	1.350
B5_3	1.136
A6_1	1.203

Source: Authors' own elaboration

Appendix 2

Figure A1 Conceptual model SmartPLS



Source: Authors' own elaboration

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