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Promoting the Transition to a Circular Economy: A Study about Behaviour, Attitudes, and Knowledge by University Students in Portugal

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Abstract: Younger and highly skilled generations are one of the major driving forces of a successful transformation to a circular economy (CE); therefore, this paper intends to assess the prevalent behaviour, attitudes, and knowledge of the CE by university students. The study focuses specifically on Portuguese students. Some new conclusions were added to the existent literature. Our conclusions show that, although students engage in several types of CE behaviour and have positive attitudes, these mostly include actions such as reducing food waste, recycling practices, or purchasing energy-efficient products. Circular consumption habits like remanufactured products, second-hand purchases, the sharing economy, and product-as-a-service systems (PSSs) still need further implementation. However, we determine that the level of knowledge of the CE goes beyond the conventional recycling premise. Moreover, we have included an innovative part, based on a probit model, by studying how knowledge of the CE affects students' behaviour and attitudes and conclude that it positively influences them. Other variables such as age, gender, and level of education are also found to influence actions and attitudes. As a result, this study can significantly improve the overview of the current situation and provide a starting point for measuring the effectiveness of future policies to be defined.

Keywords: circular economy; university students; behaviour; attitudes; knowledge; Portugal

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1. Introduction

Increased production and consumption as a result of rising populations and economic growth have put stress on Earth's finite natural resources and have accelerated environmental problems and climate change. According to the Intergovernmental Panel on Climate Change [1], global surface temperatures will continue to rise until at least mid-century unless CO_2 and other greenhouse gas (GHG) emissions are drastically reduced in the coming decades. According to the United Nations Environment Programme (UNEP), "to get on track to limiting global warming to 1.5 °C, we would need to cut 45 percent off current GHG emissions by 2030. For 2 °C, we would need to cut 30 percent" [2].

As a result of the need to tackle environmental issues, the circular economy (CE) emerges as an alternative and much-needed model to counteract the current damaging patterns of the take–make–dispose linear model and is, therefore, at the forefront of political discussions and initiatives. For instance, in the European Union, the European Green Deal has the CE as one of its fundamental building blocks [3]. Nevertheless, there is still a long way to go to achieve the complete implementation of the CE [4,5].

The CE actively searches to reduce the use of virgin materials and waste production [6,7]. Therefore, the CE requires the redesigning of production systems to design out

waste and to retain added value from resources in the economic production chain for as long as feasible [8,9]. Moreover, moving forward with the change to CE models requires cooperation and coordination across all domains of influence, including the implementation of governmental policies and changes in business operations, societal standards, and behavioural thinking and acceptance [10,11]. Hence, consumers' perspectives on enabling the transition to a more circular future are becoming increasingly clear [12].

In fact, consumers are enablers of the CE [13] because they are the agents who control the flow of the used materials processes. Their predisposition to reuse, repair, and recycle materials will either fail or build reverse systems, which reinforces the need to educate consumers and drive a cultural shift towards circular behaviour [14,15]. Thus, consumers shift from solely individuals who consume resources to individuals who play a part in extending the life of products across the production, distribution, and consumption cycle.

Although the CE causes significant changes in consumption, current CE assessments do not provide comprehensive explanations of these challenges, accounting for a smaller portion of the work carried out so far [13,16]. For instance, according to Kirchherr et al. [17], only 19% of publications in the literature mentioned consumption while defining the CE concept, indicating that more research into the consumer's point of view could help identify strategies to improve their contribution to CE. Similarly, Ghisellini et al. [13] emphasised the importance of increasing the knowledge and understanding of European consumers and producers given their vital role in European policies. Jesus and Mendonça [18] also point to general inertia, current consumer habits, and a lack of awareness of all possible CE choices as contributing causes to the slow adoption of CE models.

This research aims to fill the aforementioned gap identified in the literature about consumers, focusing on Portuguese university students, as the establishment of a future CE-oriented society depends upon young and well-educated individuals [19]. Looking ahead, young people are key to the successful transition to a CE, and higher educational institutions (HEIs) play a crucial role in this process. It is essential to extend the fairly limited research on behaviour, attitudes, and knowledge of university students vis-à-vis CE and draw conclusions about the way forward to shape a sustainable circular mindset in students and to equip them with significant skills in the practical implementation of CE principles and initiatives such that they become change agents towards the CE and their employability in the new green economy is increased. Hence, this is the scientific relevance of this study.

Thus, we aim to understand university students' level of knowledge (knowledge embodies all information that a person possesses or accrues about a certain topic of study [20]) of the CE and their attitudes and behaviour (attitudes, as they are latent psychological constructs, cannot be directly observed. Therefore, the measurement of attitudes relies on their manifestation through observable responses [21]. Behaviour is defined as the result of an individual's engagement with their environment [22]. Essentially, it embodies a comprehensive reaction moulded by life circumstances, influenced by both environmental and cognitive stimuli, guiding the individual's visible response [23]. It functions as a crucial mechanism for individuals to convey information from their internal psychological systems to their external surroundings [24].) towards promoting the CE. We conclude that, although students engage in several types of CE behaviour and have positive attitudes, these include mostly actions such as reducing food waste, recycling practices, or purchasing energy-efficient products. Circular consumption habits like remanufactured products, second-hand purchases, the sharing economy, and product-as-a-service systems (PSSs) still need further implementation. However, we determine that the level of knowledge of the CE goes beyond the conventional recycling premise. Moreover, we have added an innovative aspect aiming to establish how attitudes and behaviour are correlated to knowledge. As a result, our work characterises knowledge, behaviour, and attitudes about the CE of higher education students; however, using a probit model, we also find a relation between knowledge and behaviour or attitudes, which enables us to complement the existent literature with some valuable conclusions: we are able to conclude that knowledge positively

influences several types of students' behaviour and attitudes as well as their perceptions of practicing CE actions. As a result, this study can significantly improve the overview of the current situation and provide a starting point for measuring the effectiveness of future policies to be defined.

The structure of this study is as follows: Section 2 provides an overview of the previous studies, evaluating the perception, awareness, and practices regarding the CE. Section 3 describes the main features of the method used for collecting the data. Section 4 summarises the results that emerged from the survey and studies the relation between behaviour, attitudes, and knowledge. Finally, Section 5 discusses the results and draws a conclusion.

2. Literature Review

Even though consumers are a vital key to the CE transition, only a few researchers have looked at consumers' understanding, attitudes, and practices towards the CE [25,26].

Hao et al. [27] conducted an empirical study in Western China aiming to research the elements affecting locals' readiness to engage in the CE and found that subjective norms, willingness to make environmental sacrifices, perceived economic benefits, and positive anticipated emotion have a major impact on citizens' readiness to engage in the CE. Also in China, Guo et al. [28] conducted research to assess CE knowledge in a Chinese city. Compared to other cities, just 41% of respondents had heard of the notion of the CE [28], possibly because of the respondents' lower educational level and cultural mindset. In contrast, inhabitants of the city displayed stronger knowledge of the concept of sustainable development and the importance of water conservation and energy efficiency due to the city's climate.

In contrast, Smol et al. [19] found that the CE model is fairly well-understood by residents in a Polish region, with the primary focus on raw material conservation and waste disposal methods. Based on the author's findings, the public's comprehension of the CE concept is linked to their educational level.

Moreover, Lakatos et al. [29] performed a survey in Romania to research young Romanians' opinions about environmental awareness and its effects, as well as their attitudes towards sustainable production and circular business models. According to the data, the respondents are highly aware of the environment and the linear model's environmental effects and have a positive attitude towards sustainable manufacturing and circular business models. However, they have a more negative attitude towards adopting sustainable consumption habits (such as taking public transportation or riding a bike to work). This last conclusion is corroborated by the European Commission's [30] research on behavioural consumer participation in the CE, which revealed that, even though consumers are generally willing to participate in CE activities, their actual involvement is modest. Szilagyi et al. [31] also studied consumers in Romania and examined the individual-level factors influencing circular purchasing behaviour. On the one hand, they find it is positively influenced by environmental concerns and that this relationship is mediated by the attitude towards circular products. On the other hand, climate scepticism has a significant positive impact on perceived greenwashing. Concerning young people from five Central and Eastern European countries, Kranjc et al. [32] assess their awareness and attitudes towards the CE and the Green Deal. They conclude that young people have already heard about the CE's goals and action plan; they believe in the principles and priorities of the CE and demonstrate responsible behaviour in their daily lives; however, they do not show significant skills in the practical implementation of CE principles. They do not see themselves as change agents towards the CE, designing, developing, and creating new business and entrepreneurial solutions towards the CE.

In the US, Hazen et al. [11] studied consumers' opinions on remanufactured items to examine consumers' intentions to convert from buying new products to remanufactured products by incorporating macro-level aspects such as pricing, government incentives, and environmental advantages with the moderating influence of micro-level consumers'

attitudes. The results show that consumers' perception of remanufactured goods is positively associated with their decision to switch to those goods. Other literature on consumer behaviour and CE aimed to broaden knowledge about the determinants (social, psychological, and individual) of the purchase intention of specific green goods, namely refurbished smartphones [33], or about awareness and attitudes in circular fashion [34].

Some studies were also conducted on the Portuguese population. Seiça [35] directed research towards assessing attitudes and behaviour in the Portuguese population towards more circular consumer solutions. The findings show that the population's awareness of product environmental impact is still low and that circular practices, such as purchasing used or recycled products, sharing and renting goods/services, buying green products, and the techniques of disposal and eradication, are insufficient to ensure the achievement of a CE model. Additionally, another study revealed interesting results concerning the residents of Leiria, a city in central Portugal. The results show that, while participants' familiarity with the CE is limited, they are favourably inclined to participate in rental activities, reuse, item repair, and recycling [36].

Studies in higher educational institutions (HEIs) are scarce. Owojori et al. [37] studied the knowledge, attitudes, and perceptions of solid waste management at a university in rural South Africa. Their results show that the students' knowledge and awareness of solid waste management were low and students' current practices were inadequate and not in line with the CE framework. The authors also identify steps that can be taken to guide the institution closer to a CE goal. Deda et al. [38] proposed a framework that allowed an analysis to be carried out of the knowledge and understanding of CE concepts and the principles and potential of the CE to promote sustainability in HEIs based on a contest. The contest was launched by the CE Working Group of the Portuguese Sustainable Campus Network for HEI students across Portugal and the Community of Portuguese Language Countries (CPLP) HEI campuses who were challenged to create and develop innovative projects to implement a CE on their campus. The framework included CE principles and business models with sustainable indicators and was applied to the projects accepted by a jury. The results showed a misconception of the CE because of the students' perception that a CE is mainly related to recycling and waste management.

3. Method and Data

The primary goal of this research is to enable a greater understanding of Portuguese university students regarding attitudes and behaviour in promoting CE and their level of understanding of the concept as HEI students are key agents of transformation in society, and they play a crucial role in the successful implementation of a CE. The case of HEI students in Portugal presents an interesting dimension as, despite being a developed country, it still has a low level of education (the indicator for educational attainment is ranked as 37 out of 41). (Educational attainment refers to the percentage of people, aged 25 to 64, with at least an upper-secondary (high school) degree. https://www.oecdbetterlifeindex.org/topics/education/ accessed on 10 December 2023). Likewise concerning income, Portugal has a low level of income (it ranks 26 of 41 or USD 24 877 a year, lower than the OECD average of USD 30 490) (income is the average household net adjusted disposable income per capita, that is, the money available to a household for spending on goods or services. https://www.oecdbetterlifeindex.org/topics/income/ accessed on 10 December 2023). However, Portugal presents good results in terms of environmental quality (for air pollution, it ranks 11 out of 41 or 8.3 micrograms per cubic metre, below the OECD average of 14 micrograms per cubic metre; and, regarding water quality, it ranks 14 out of 41 or 89%, higher than the OECD average of 84%) (air pollution refers to the average concentration of particle matter (PM2.5) in the air. Water quality is the percentage of people reporting to be satisfied with the quality of local water. https://www.oecdbetterlifeindex.org/topics/environment/ accessed on 10 December 2023). As a result, the knowledge, attitudes, and behaviour of the more well-educated young people may have a higher impact on the path towards a greener world. Furthermore, if, even in a

country with a lower level of education, CE is known or used, this should also be replicated in countries with a higher level of education.

For the purpose of this study, survey research, using a structured questionnaire, was employed. Survey research uses a "scientific sampling and questionnaire design to measure characteristics of the population with statistical precision" [39], (p.4), and it is beneficial for a large and representative sample of respondents [40]. The sampling process was non-probability convenience sampling, where members of the target population are chosen for research if they meet a set of practical criteria, such as proximity to the research location, availability at a specific time, or accessibility [41].

The survey was designed to consider the current trends and socioeconomic context of Portugal and to meet the requirements of the research focus, and it was inspired by various previous studies (see e.g., [19,30,35,36,42,43].). As a result, it was divided into four sections: the first was concerned with behaviour, the second with attitudes, the third with knowledge, and the fourth with sociodemographic inquiries. Most of the survey's questions were closed-ended and included a 5-point Likert scale ("1" was selected when the respondent strongly disagreed with the action and "5" was chosen when the individual strongly agreed with it, suggesting that the participant carried out or had a positive attitude towards that activity), multiple-choice questions, and dichotomous (yes/no) inquiries. Only the sociodemographic questions contained open-ended responses.

The questionnaire was created using Google Forms and was made available online. It was disseminated through social media platforms such as Facebook, LinkedIn, and Instagram. In addition to using social media, several emails were sent to Portuguese universities and their students. The questionnaire was written in Portuguese as the target population was students studying in Portuguese HEIs. Nevertheless, it was translated into English for the purposes of this work.

Due to the sampling method chosen to conduct this study, it is not possible to say that the entire Portuguese HEI student population is represented.

4. Results and Discussion

4.1. Characteristics of the Sample

In total, 379 completed answers were obtained from 15 March to 11 April 2022.

In the assessment of the validity of the survey responses, specific criteria were included to ensure the reliability of the collected data. The primary factor taken into consideration was the information provided regarding the level of higher education.

This aspect was of utmost importance and was designed to exclude responses from participants who stated that they were not pursuing any university-level education. This measure was put in place to preserve the integrity of the data, focusing on the experiences and perspectives of those genuinely immersed in the higher education environment.

For this reason, two respondents, not attending an HEI, were excluded and only 377 valid answers were considered, with the aim of maintaining the accuracy and representativeness of the data obtained. This methodological rigour was essential to ensure the reliability and validity of the conclusions drawn from the survey, thereby contributing to the robustness of the research conducted.

The demographic characteristics of the sample are summarised in Table 1:

- 278 responses are from women (73.7%), whereas 99 answers are from men (26.3%).
- 55.7% of the respondents are currently pursuing a bachelor's degree, 37.7% are enrolled in a master's degree, 4% are PhD students, and 2.7% are taking a post-graduation degree.
- The respondents come from different parts of Portugal. However, northern Portugal has the largest representation. The respondents were 51.2% from Porto, 23.9% from Braga, 5.8% from Portalegre, and 4.8% from Aveiro.
- The questionnaire obtained answers from individuals from 18 to 72 years of age. The largest percentage of this sample is 22-year-olds (16.4%), which is followed by

23-year-olds (14.1%), and then 20-year-olds (10.6%). Ultimately, the sample contains a large proportion of the population between the ages of 18 and 25, totalling 78.5%.

- Most of the sample only studies (70.3%), and 29.7% are working students.

Table 1. Demographic characteristics of the sample (n = 377).

Gender		**Professional Status**	
Male	26.3%	Students	70.3%
Female	73.7%	Working Students	29.7%
Not specified	-		
Education		**Location**	
Bachelor's degree	55.7%	Porto	51.2%
Master's degree	37.7%	Braga	23.9%
PhD	4.0%	Aveiro	4.8%
Post-graduation	2.7%	Portalegre	5.8%
		Lisboa	2.7%
Age			
18	6.4%		
19	9.3%		
20	10.6%		
21	9.8%		
22	16.4%		
23	14.1%		
24	8.5%		
25	3.4%		

4.2. Students' Behaviour

Due to their potential influence and power in society, students' behaviour will play a crucial role in implementing the CE. Students were questioned about their circular behaviour, taking into account the various dimensions of the CE. The questionnaire results demonstrated that students practise and engage in several circular actions on a regular basis.

Before presenting the findings, it is necessary to emphasise that the responses "agree" and "strongly agree" are displayed together for the sake of this study since they show that students exhibit positive behaviour or attitudes.

The results for question 1 are presented in Figure 1 (Descriptive statistics are available upon request). The respondents expressed clear recycling habits (question 1.2) since 75.4% of the sample agreed and strongly agreed with the situational sentence. Those whose answers demonstrated a lack of recycling habits were able to indicate that they do not recycle because they are not in the habit of recycling or they do not have an eco-point at home or near their place of residence. Moreover, from questions 1.7 to 1.11, the students mainly agree or strongly agree with the situational assertions: 76.1% of the students frequently look for help to repair a product; 88.1% claimed to minimise food waste; 64.7% take electronic gadgets to collection centres; 60.4% of the sample use public transport/electric scooters/bicycles as their main means of transportation; and 79.5% buy energy-efficient goods for their homes.

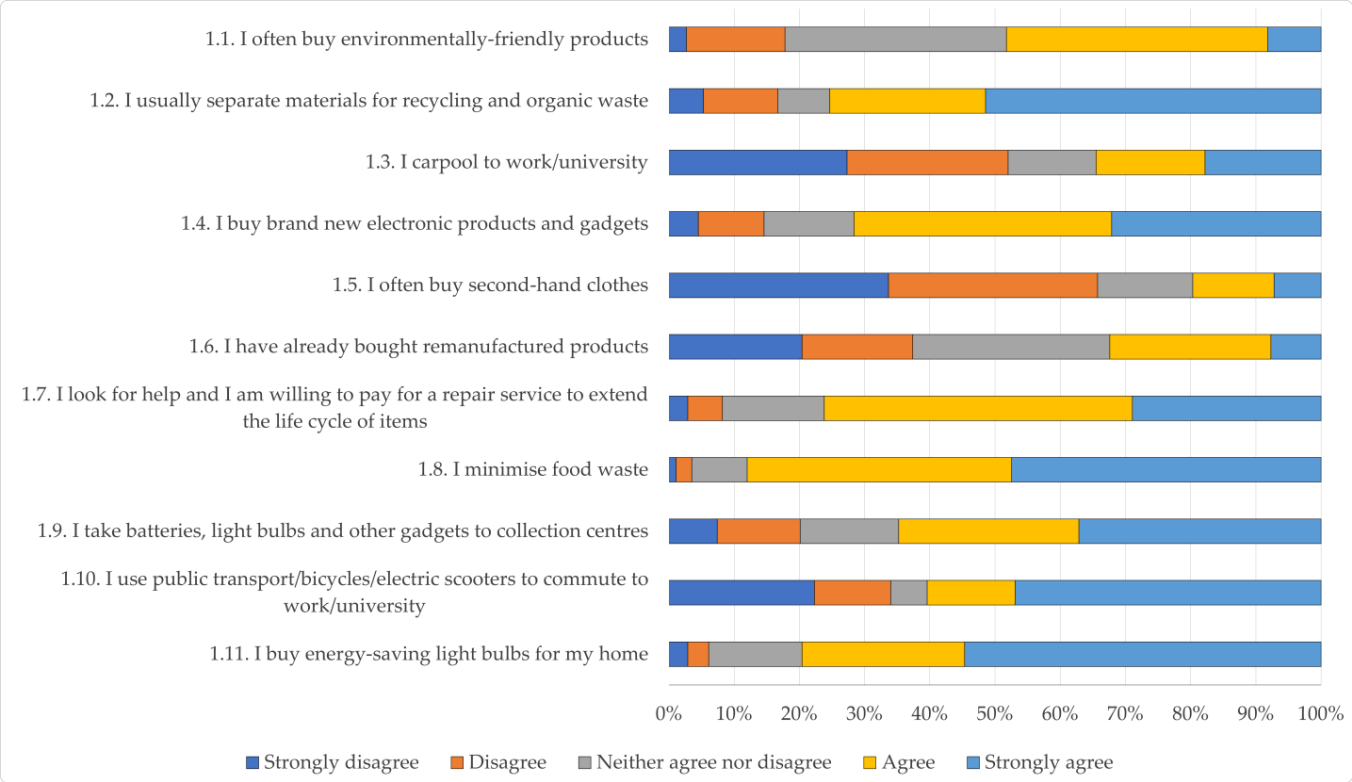

Figure 1. Results distribution of the sample per behavioural question.

In contrast to the aforementioned findings, the students also expressed an absence of some circular habits, such as carpooling and purchasing second-hand clothing. Concerning the practice of carpooling, 27.3% confirm that they do not practise this action and 24.7% do not practise it on a daily basis, indicating an absence of behaviour. This may be related to security reasons, driver experience, and concerns about increased time and trip costs [44]. There is a lack of second-hand purchasing habits since 65.8% of the respondents to some extent or completely disagree with the statement. The average of 2.28 obtained in this statement confirms this outcome. This is confirmed by a previous study conducted in Portugal, where 88% of the participants declared that they buy new apparel from fast-fashion retailers [45]. According to the EC report [30], this opposition stems from concerns about product quality.

In addition, results on the purchase of environmentally friendly products are not very encouraging: 40.1% agreed with the sentence and 34% neither agreed nor disagreed, which yielded a mean of 3.36. Moreover, the answer to question 1.6, regarding the purchase of remanufactured goods, does not provide a clear indication of behaviour. It yields a mean of 2.82 and a standard deviation of 1.234, suggesting a negative attitude towards buying remanufactured goods. This result is supported by question 1.4 in which 71.6% of the sample said they purchase brand-new technological devices and gadgets. Based on previous studies, several reasons can explain this behaviour, including the uncertainty inherent in the remanufacturing process and their lack of awareness and understanding of these products [46].

The first section of the survey regarding behaviour included other multiple-choice questions (questions 2 to 6). The students were asked about which factors they take into consideration when making sustainable product purchases (question 2): 29.2% look for products made of recycled materials and plastic-free; 22.8% look for information on whether the product is easily recyclable; 38.5% of students do not usually check any environmental aspect; and 9.5% do not look at any of the previous options (Figure 2). These findings tend to be in line with those previously obtained in question 1.1. However, 28.3% of the students

who answered the survey often buy green and organic food, 26.1% buy plastic-free goods, 23.1% buy items with environmental labels, and 15.8% buy items that use less energy and water (question 3). The results are described in Figure 3. Thus, it is possible to confirm the existence of some incongruent results regarding the purchase of these types of goods. Price, income barriers, lack of time to digest information or look at green alternatives, and muddled marketing communication were all listed by consumers as barriers to buying green products [47]. Moreover, younger generations manifest an "all or nothing" approach, in which they "opt to do nothing because they do not believe their small actions can make a difference" [48], p. 816.

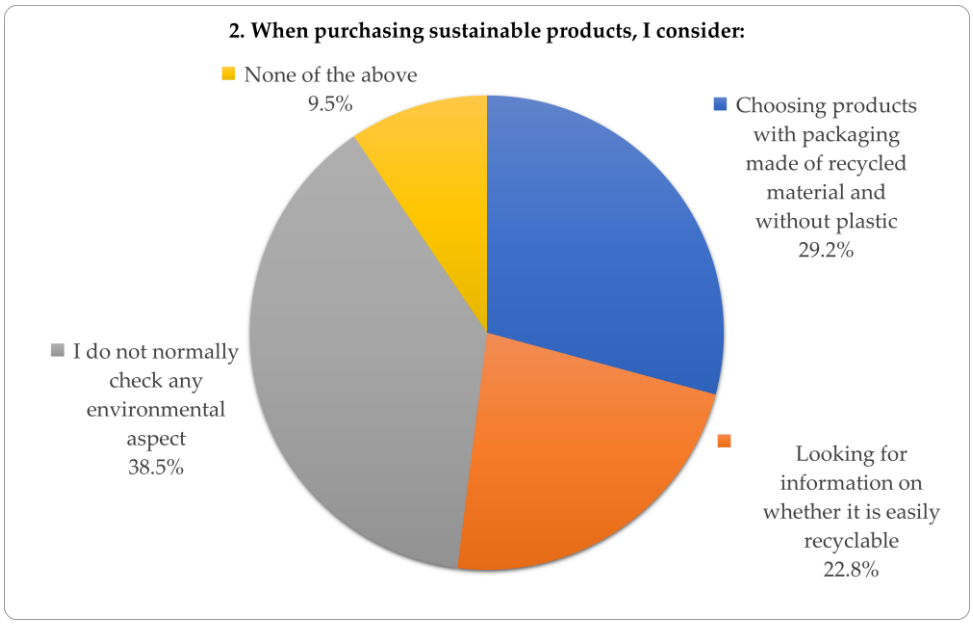

Figure 2. Results distribution on what students pay attention to when purchasing sustainable products.

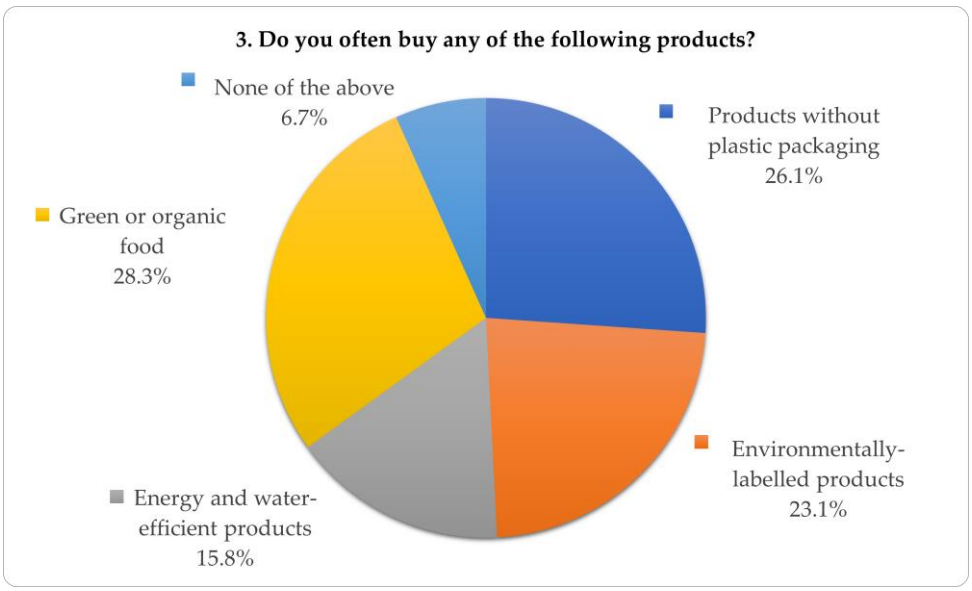

Figure 3. Results distribution on purchasing habits.

Also, to examine other elements of the CE, such as product-as-a-service systems (PSSs) and the sharing economy, question 5 was devised. The participants were questioned about which actions they had already taken, such as booking a room on Airbnb, renting clothes,

sharing a trip (through apps like BlaBlaCar), and renting a room in their home to tourists. The most prevalent answer to this query was booking a room or apartment on Airbnb, with 38.9% of students selecting that choice, while 39.2% chose the "None of the above" option. Moreover, 9.2% have shared a trip, 9.2% have rented clothes, and 3.6% have rented a room to tourists (Figure 4). Here, it is possible to confirm that PSSs have notable challenges to consumer acceptance that may be related to the loss of personal ownership [49], especially important in the context of clothing. Indeed, dematerialisation through rental, sharing, or other means may be objectionable due to the emotional aspect of personal ownership of objects that confer status, and a sense of control, self-expression, or memory keeping [49]. Furthermore, we must be very careful when drawing conclusions about sharing economy practices because there has been a distortion of the initial Airbnb concept, where there was a consumer-to-consumer (C2C) interaction, where consumers allowed temporary access to a physical asset they owned (a house, in this case) with idle capacity, possibly for money [50].

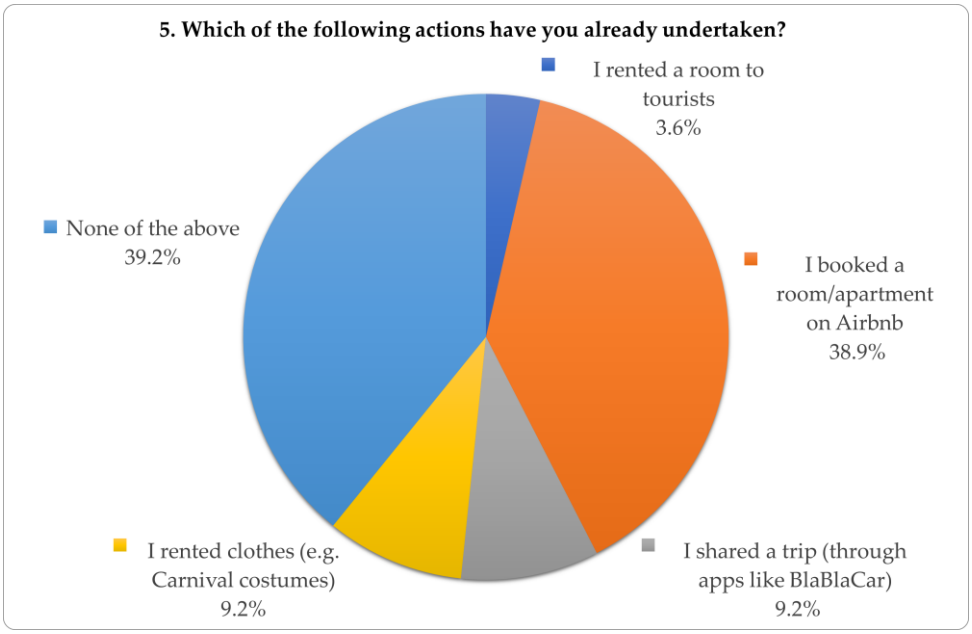

Figure 4. Results on consumption habits related to shared resources.

Additionally, when given the choice between buying a new or used phone, 82.8% of the respondents are more likely to choose the former than the latter (question 4). This result is consistent with question 1.4 referred to previously (Figure 5).

Lastly, people behaved positively towards their belongings as they approached the end of their lifespan: 39.4% of the students stated they typically donate their unwanted items, 25.1% said they frequently fix them, and 19% said they sell their unwanted items. Keeping things at home is the choice that was the least chosen (Figure 6). As shown later, their behaviour is consistent with the attitude demonstrated in question 8.5 of the attitudinal question (see Figure 7 below).

Overall, it becomes clear that the behaviour adopted by students tends to be more 'conventional', such as reducing food waste, recycling practices, including organic and e-waste, and purchasing resource-efficient products. In fact, students demonstrate a greater aversion to changing their behaviour regarding new CE consumption trends like the sharing economy, PSSs, remanufacturing, and second-hand purchases.

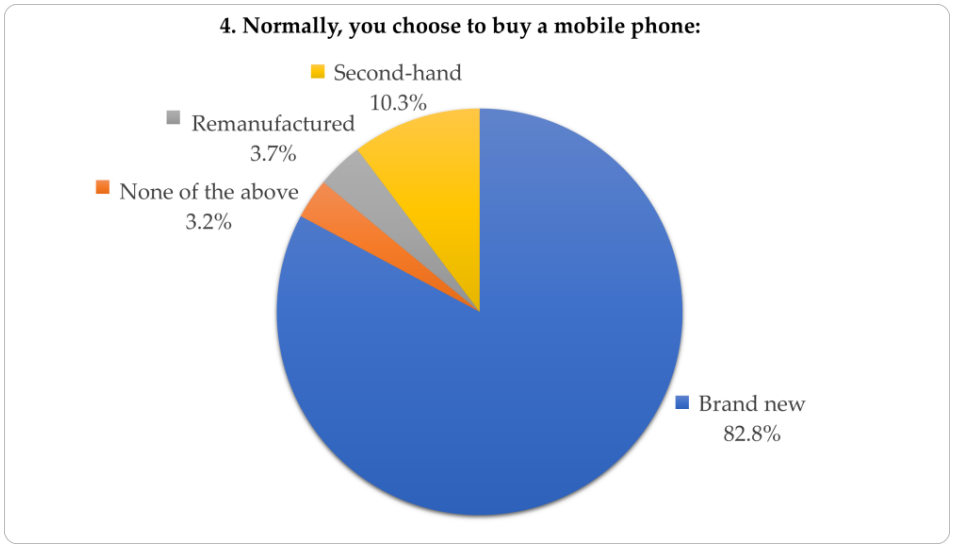

Figure 5. Results on the purchasing of brand new, second-hand, or refurbished mobile phones.

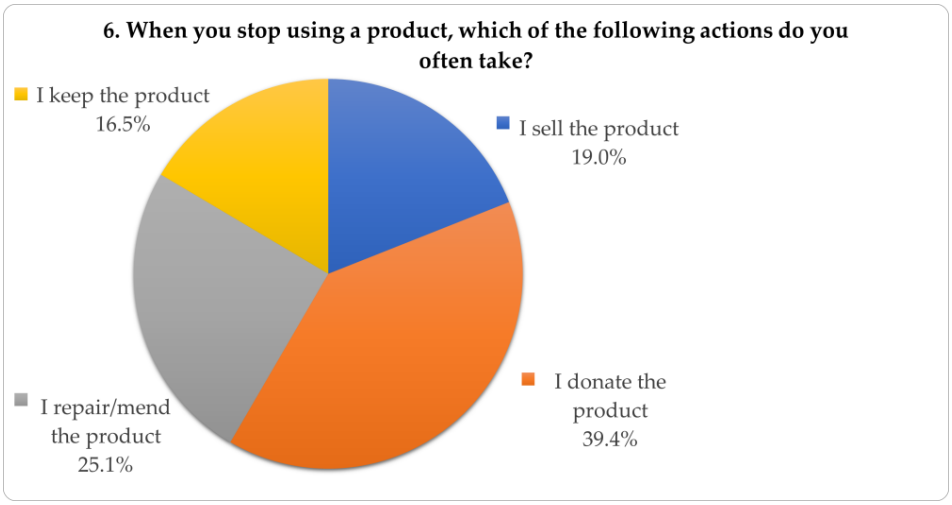

Figure 6. Results on consumer habits when stopping using a product.

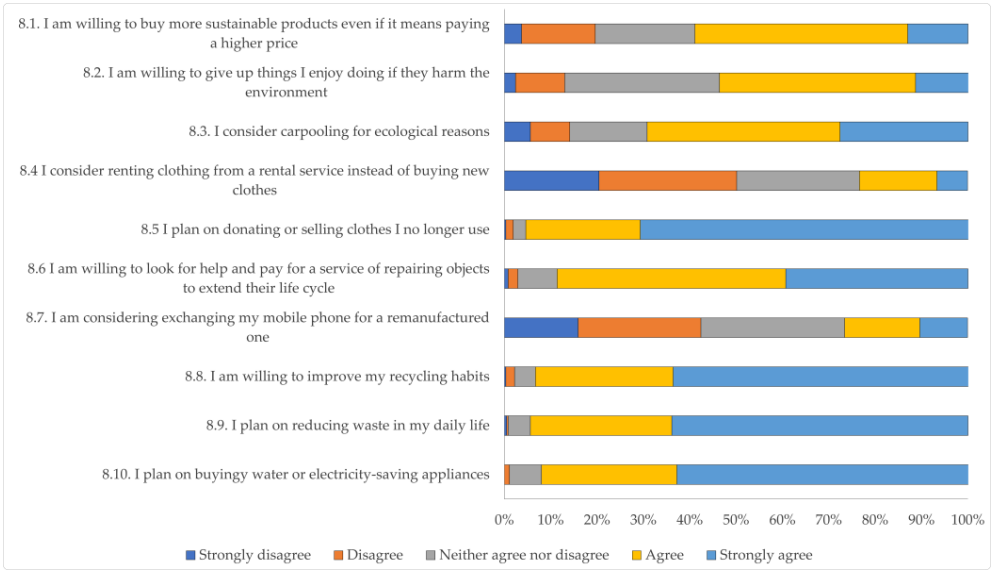

Figure 7. The results of the sample concerning attitudes.

4.3. Students' Attitudes

In the second section of the questionnaire, students' attitudes were assessed as to whether there was an attitude–behaviour gap based on a 5-point Likert scale as it is considered the best measurement scale to assess an individual's attitude towards an issue [51]. The findings revealed opposed attitudes: considerable negativity and significant positivity. The results are shown in Figure 7. (Descriptive statistics are available upon request.)

On the one hand, favourable attitudes towards circular practices were found. Concerning the intention to donate or sell items that are no longer used, 95.5% of the respondents show an encouraging attitude towards this action, and this was validated by the mean of 4.64 (question 8.5). Following this positive result is the question about reducing waste, where 94.4% of the students also express a positive tendency to reduce waste (question 8.9). Similarly, the willingness to improve recycling habits (question 8.8) and buy water- and electricity-saving appliances (question 8.10) also shows strong results, 93.4% and 92.1%, respectively. Also, the willingness to pay for repair services is 88.6% (question 8.6).

On the other hand, other results demonstrate unfavourable attitudes. Students revealed a low willingness to rent clothing (50.1%) (question 8.4). Likewise, they also show a negative position towards purchasing a refurbished mobile phone since 42.4% are unwilling to buy one and 31% do not have a definite position on this subject, resulting in a mean of 2.79 (question 8.7).

More divided stances were also found. The willingness to buy sustainable products even if that means paying more reveals a mean of 3.49, reflecting the position of respondents as 58.9% of the sample agreed and strongly agreed with the statement and 21.5% neither agreed nor disagreed (question 8.1). Furthermore, the willingness to give up things on behalf of environmental improvement shows that 53.7% express a desire to purchase and 33.4% of the sample neither agree nor disagree with the statement, not knowing if they would do it or not (M = 3.50) (question 8.2).

With a mean of 3.77, the participants show a slight interest in carpooling to work/university facilities, in contrast to the behaviour shown in question 1.3 in the behavioural section. Thus, an attitude–behaviour gap was found as students say that they do not carpool despite their positive attitude towards it.

Overall, attitudes tend to be in line with the actual CE practices described in the previous section, although students usually have more favourable attitudes than behaviour. Yet, students also demonstrated a more 'traditional' mindset, displaying a dislike for more modern circular consumption habits (e.g., remanufactured and second-hand products, PSSs, and the sharing economy).

4.4. Students' Knowledge

Lastly, the participants were asked about their awareness and understanding of the CE. The results are presented in Figures 8–12.

Question 9 was a filter query, where the students assessed their level of knowledge of the CE. Most of the respondents, 28.6%, used the term "moderately" to define their level of understanding of the CE. This result is followed by students who have "never heard of it" (23.9%) and those who have heard "little" (20.2%) about the concept. The two least selected options are related to significant knowledge about the CE, with only 13.5% confirming that they are "well informed" about the CE, and another 13.8% say that they know "quite a lot" about the CE (Figure 8) (only students with some knowledge of the concept answered questions 10 to 13).

Thus, it is possible to say that students in Portugal have a low to moderate degree of understanding of this concept, which is in line with other research studies, such as Gelder's [52] research on the population in the Netherlands. This lack of awareness and in-depth understanding of the subject may relate to the lack of consensus on the definition of CE [36], as well as to the lack of consumer interest since citizens do not believe they are accountable for that transition as the responsibility lies with governments and businesses.

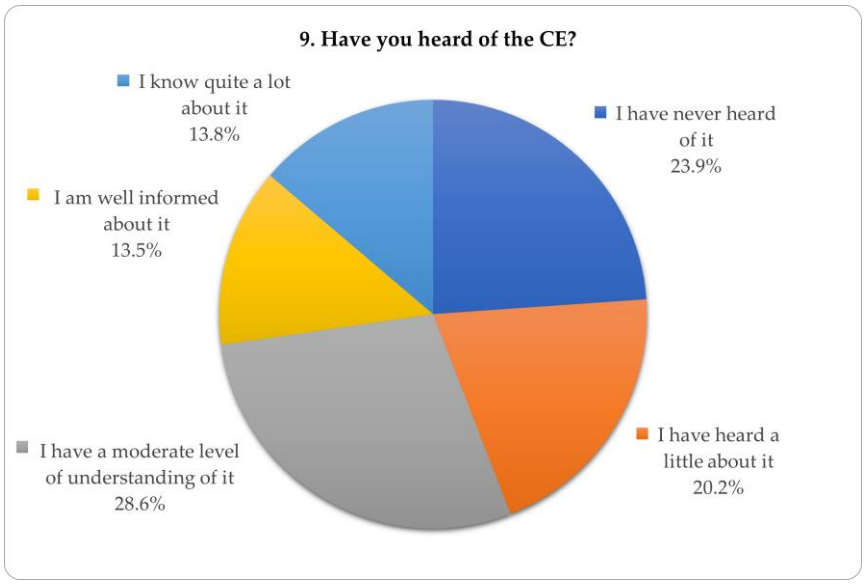

Figure 8. The results of the sample concerning the level of awareness of CE.

The second question was designed to assess what the CE meant for the target group. The largest percentage of students in question 10 said that the CE relates to the 4Rs "reduce, reuse, remanufacture, recycle" (37.5%). Moreover, 28.6% responded that the CE is "an economy that is able to regenerate by itself", 22.3% "a more sustainable way of producing and consuming", and 10.5% said that the CE is "an economy marked by zero waste". The least chosen answer by students was "recycling waste" with 1%, as presented in Figure 9 below.

When it comes to those who have heard of the CE, it is fair to say that their knowledge extends beyond the conventional recycling premise because students also associate the CE with other ideas, such as zero waste, shared resources, sustainable production and consumption methods, and an economy capable of self-regeneration.

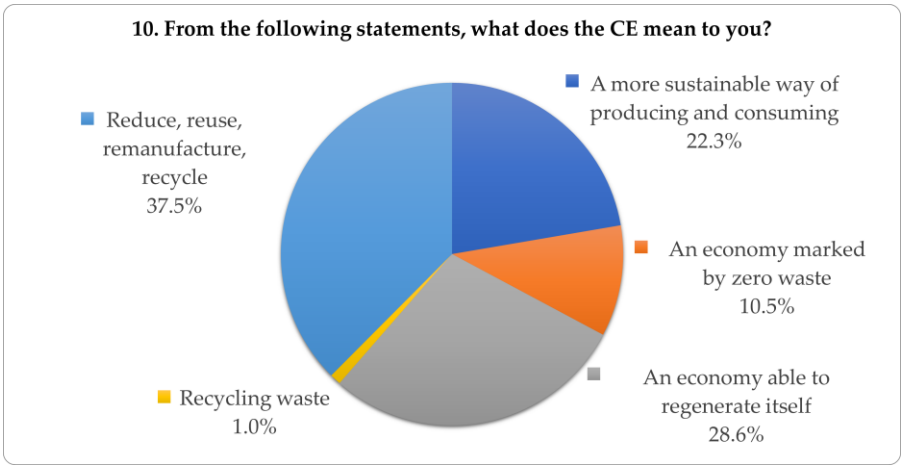

Figure 9. The results of the sample concerning the meaning of CE.

As for the main principles of CE, the respondents selected a variety of options to identify the primary CE principles, from recycling and closing the product/material's life cycle (Figure 10). The most selected principle was the "recycling" principle (23.6%), followed by "zero waste" (21.6%), "shared resources" (18.7%), "using more renewable energy" (17.2%), with "closing the product/material's lifecycle"(8.0%) being the least selected option. Although "recycling waste" was the least selected option in question 10, students' behaviour and attitudes are overall more aligned with the recycling principle.

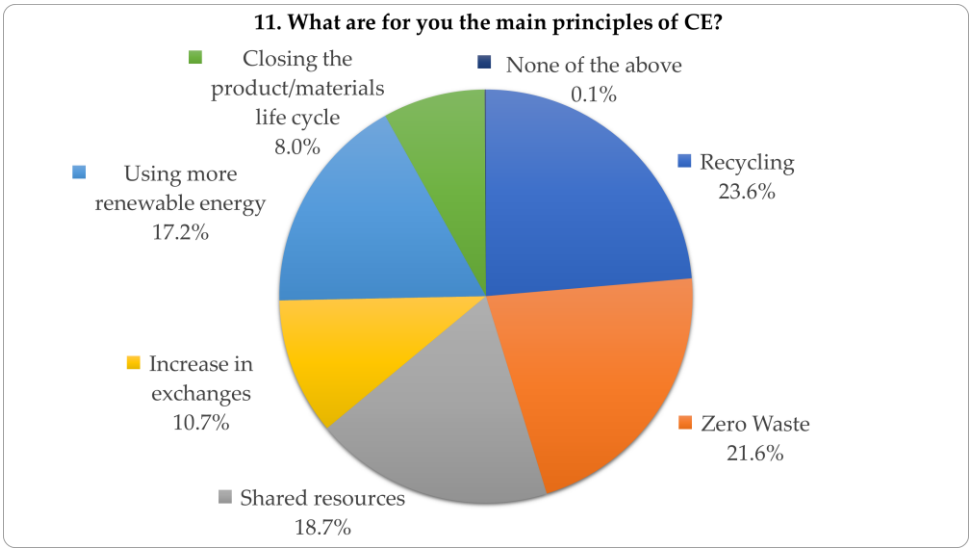

Figure 10. The results of the sample concerning the principles of CE.

The students were asked how they obtained information on the CE. The majority have mostly heard of the CE through "social media" (22%), followed by "in a university context (classes)" (20.4%), "in conversation with friends and family" (14.3%), and "traditional media" (12.5%). Marketing campaigns were the least selected option by this target group (Figure 11).

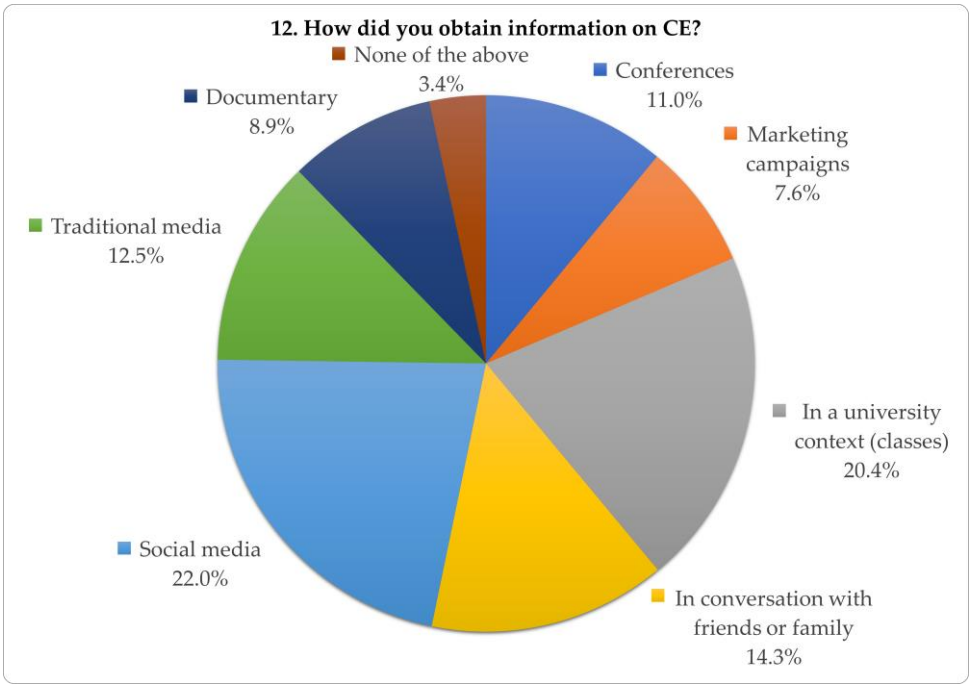

Figure 11. Results on how the students learnt about CE.

Finally, the respondents also assessed their perception of the practice of circular actions through a dichotomous question. Indeed, 81.5% of the sample population consider that they engage in CE-related actions, in contrast with the 18.5% who do not think they practise circular actions (Figure 12).

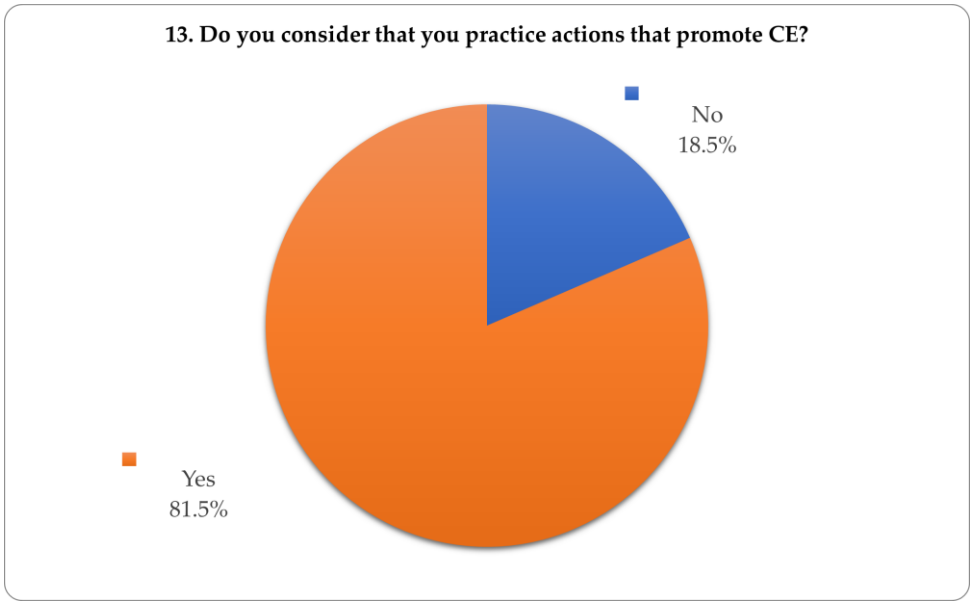

Figure 12. Results on college students' perception of practising CE-related actions.

Thus, respondents' knowledge of the circular economy tends to be satisfactory among those who are familiar with the concept, and a majority consider that they carry out practices that promote the circular economy.

4.5. Relation between Behaviour, Attitudes, and Knowledge

In this section, we study whether there is some correlation and causality between knowing what CE is and the actual behaviour and attitudes. For the purposes of this study, we run a binary regression, which estimates a relationship between one or more explanatory variables and a single output binary variable. In this case, we are going to use the probit model.

4.5.1. Behaviour and Knowledge

To establish the relationship between knowledge and behaviour, we consider as an outcome/dependent variable the answer to question 13 ("Do you consider that you practise actions that promote CE?"), where "Yes" assumes the value 1 and "No" the value 0. This question allows the measurement of the perceived behaviour of the respondents. The independent variable is the answer to question 9 ("Have you heard of the CE?"). On a scale of 1 to 5, 5 measures a higher degree of knowledge of the CE. (those students who answered that they had never heard of the concept were not considered in the regression since they cannot determine if they are taking CE actions). However, other sociodemographic factors may also influence this relation, so we control for some of those characteristics: age (in years); gender (1—male; 0—female); education (1—masters/PhD/post-graduation; 0 undergraduate); professional status (1—working student; 0—student); location (1 to 20 considering all the districts and autonomous regions in Portugal). The estimation results are shown in Table 2. In model (1), we only use the dependent and independent variable, and, in model (2), we add the sociodemographic factors.

As can be observed, the fact that the respondents have a higher degree of knowledge of CE leads them to consider that they practise more CE actions, and this is confirmed when we control this result by considering sociodemographic factors. From this table, it is also possible to conclude that the level of education also positively influences the respondents to perceive that they practise a greater number of CE actions, which is an easy result to accept from an intuitive point of view as they are more well-educated. Regarding the other variables, no significance has been found between them and the perceived behaviour of the respondents.

Table 2. Perceived behaviour of the CE as a function of knowledge of the CE.

	(1)	(2)
Variables	**Behaviour**	**Behaviour**
Knowledge	0.345 ***	0.420 ***
	(0.0932)	(0.113)
Age		0.00321
		(0.0142)
Sex		−0.162
		(0.207)
Education		0.498 **
		(0.202)
Professional Status		0.349
		(0.230)
Constant	−0.174	−1.962 *
	(0.294)	(1.175)
Location		✔
Observations	287	287

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ✔ means that location was added into the regression.

However, we must understand whether knowledge merely influences the perception that respondents have about their practice of CE actions or if they actually carry them out. In order to study this, we run the same regressions, but the dependent variables now relate to the behaviour represented in questions 1.1 to 1.11. (for this reason, all the observations are considered in the regression). We assume that those who answer "totally agree" and "agree" practise that specific action and we attribute the value 1 to those answers. In the remaining answers, we assume that the respondents do not practise the action and the value 0 is attributed.

The results are presented in the Appendix A, Table A1. Only recycling increases with knowledge when we consider both the variable knowledge as the single independent variable or knowledge together with the control variables as independent variables. Moreover, when the variable knowledge is the single independent variable, other behaviour seems to be positively affected: the purchase of environmentally friendly and remanufactured products and energy-saving light bulbs; and depositing batteries, light bulbs, and other devices at collection centres. However, these results do not hold when we introduce the remaining control variables. This result is consistent with earlier studies, which show that purchasing decisions were influenced by knowledge of environmental issues [53]. Likewise, according to Zheng et al. [54] and Shujahat et al. [55], knowledge can be an external agent of change that influences the adoption of new practices, processes, and structures.

From the table, it is also possible to conclude that older students are more likely to buy environmentally friendly and remanufactured products, second-hand clothes, look for repair services, deposit batteries and other devices at collection centres, and buy energy-efficient lighting. This might occur as a result of older students being more aware of the effects of human activity on the ecosystem over the course of their lifetimes, and thus they have higher environmental concerns. Additionally, they have benefitted from more formal education or training related to sustainability and environmental issues, either through their academic studies or professional development opportunities, which provides them with the knowledge and skills to make more environmentally conscious choices. In contrast, younger students have a higher probability of using public transport or smooth mobility, which may be related to the lack of driving licence or car at the youngest ages.

Furthermore, males are less likely to use carpooling or second-hand clothes. Based on studies by Delhomme and Gheorghiu [56] and de Luca and Di Pace [57], males are, in fact, less likely than females to use carpooling, which can be attributed to females' lower rate of car ownership (or access to the household's car), and services such as carpooling provide them access to what equates to private use of a car. As for second-hand clothes,

this result can be explained by the gendered expectations surrounding these activities as they are perceived as being more feminine.

Finally, students with a higher level of education, on the one hand, are more likely to use battery collection centres and buy energy-efficient lighting, but, on the other hand, they are less likely to use carpooling or public transport/smooth mobility. This could be related to the fact that they may have a higher income and already work, which means they have their own car.

The other control variables do not have an impact on these different types of CE behaviour.

4.5.2. Attitudes and Knowledge

It may also be of interest to study whether the willingness to adopt some attitudes related to the CE is also affected by the knowledge the respondents have about it. In order to study this, we run the same regressions, but the dependent variables are the attitudes represented by questions 8.1 to 8.10. (As with behaviour, we assume that those who answer "totally agree" and "agree" have a positive attitude towards those actions and are willing to adopt them. We attribute the value 1 to those answers. In the other answers, we assume that the respondents do not intend to do so and we attribute the value 0.)

The results are presented in Table A2 in the Appendix A. From the table, we can conclude that a higher degree of knowledge of the CE makes respondents more likely to be willing to pay a higher price for more sustainable products, consider renting clothes from a rental service, and consider using a refurbished phone and buying water/electricity-saving appliances. Liu et al.'s [58] study corroborates these results since it was proven that environmental knowledge significantly positively affects environmental attitudes. Other studies like Oreg and Katz-Gerro [59] and Zsóka et al. [60] find similar results. However, a higher degree of knowledge makes respondents less likely to be willing to carpool. There are a few factors related to the person's preferences that can ultimately explain this result. People who prioritise flexibility in their transportation choices, for instance, might be less prone to participate in carpooling if they discover that it can be less flexible than driving alone. Similarly, if someone prioritises ease or comfort and discovers that carpooling occasionally involves longer travel times and/or less comfortable conditions, they might be less willing to participate.

It is also possible to conclude that older respondents are more likely to be willing to give up products that harm the environment, repair objects, and use water/electricity-saving appliances.

Moreover, males are more likely than females to be willing to use refurbished phones but are less likely to be willing to carpool, rent clothes, donate/sell clothes, reduce waste and use water/electricity-saving appliances.

Finally, working students are more likely than students to give up things that harm the environment, rent clothes from a rental service, and repair objects; and less likely to donate or sell clothes. This last result may be because working students are often more financially independent than non-working students, making them more conscious of their spending habits and more likely to prioritise saving money. Repairing and renting items can be cost-effective. Also, working students often have limited free time due to their job responsibilities and academic workload, making them prioritise their time differently and choose to spend less time shopping for new clothes and more time repairing or renting items they already have. Lastly, they may also be more focused on their career goals and professional and personal development, which can influence their decisionmaking in other areas of their lives. They may prioritise behaviour that aligns with their values and goals, such as sustainability and financial responsibility, and choose activities that support those values.

5. Discussion and Conclusions

The goal of this paper is to assess the behaviour and attitudes of university students towards promoting the CE and their level of knowledge of the concept, focusing specifically

on Portuguese students. Data collection from the target audience was carried out using an online questionnaire, disseminated through social media and e-mail, and 377 valid answers were obtained.

The data collected demonstrated that students display several types of circular behaviour and have positive views towards the CE, although their attitudes are usually more favourable than their behaviour. However, these are intrinsic to the most 'traditional' actions, such as reducing food waste, recycling practices, including organic and e-waste, and purchasing energy-efficient products. Indeed, they are resistant to emerging consumer trends such as the purchase of second-hand and remanufactured products, and circular business models like the sharing economy and PSSs. Also, data showed an attitude–behaviour gap: despite the students' positive attitude towards carpooling, they do not implement this action in their daily lives, confirming resistance to this practice. Furthermore, the data revealed some contradictions as students exhibit inconsistent behaviour when it comes to purchasing environmentally friendly products, responding to both buying and not paying attention to the environmental features of products.

Regarding the level of knowledge of the CE, it tends to be satisfactory among those who are familiar with the concept. Students associate the CE not just with recycling but also with zero waste, shared resources, and renewable energy, which goes beyond the conventional recycling premise.

Finally, based on a probit model, we also study the relation between behaviour, attitudes, and knowledge and find knowledge positively influences several students' behaviour and attitudes as well as their perceptions of practicing CE actions. Other variables influencing the perception of practicing CE actions, effective actions, and attitudes are also identified, like age, gender, and level of education. Interestingly, but also of some concern, is that, the higher the level of education and the older the student, the lower the use of public transport or smooth mobility.

Based on our results, we can infer that HEIs can generate the essential knowledge and tools to facilitate the transition to a CE. Their role can be organised: in the dissemination of the CE through teaching; in knowledge creation regarding the CE through research and in students' involvement in the innovation process; community development leading local change towards a CE and campus management [61]. HEIs mobilise stakeholders, policymakers, and business leaders in the private sector to learn, think, and act differently. They are critical to the acceptance of circular initiatives as they can influence people's views, ideas, and behaviour, all of which are necessary for a successful CE transformation.

To achieve that, HEIs must develop a unified educational management system to meet today's socio-technical challenges. It is within this framework that HEIs must effectively reform their curricula to engage students in real-world environments for applied learning. Students should also be included in research-based CE projects through the development of university–industry–government collaboration projects that might serve as CE incubators [61]. This transformation must be complemented by an investment in teacher training given their role in spreading the CE as a new paradigm to students. HEIs must also improve their efforts to address sustainability in campus operations (e.g., the development of a shared cycling scheme on the university campus), which are imperative to foster more circular behaviour in students' life beyond the campus grounds [62].

Furthermore, policymakers can promote educational awareness programmes disseminated through different social media outlets, like social networks, television, online newspapers, etc, which may also shape consumers' knowledge, attitudes, and behaviour towards environmental issues or place particular emphasis on youth-related policies, training, and programmes associated with the CE and sustainable environmental development. The Portuguese government, like other European governments, is very committed to adapting to a CE within the framework of the European Green Deal.

The most relevant limitations of this work derive from the methodology employed. As this is a convenience sample, it does not represent the population as a whole. Another drawback is the number of answers gathered, which was likewise limited and does not reflect

the entire target population. Moreover, as one of the key disadvantages of questionnaires is the lack of responses due to the time necessary for completion, the current questionnaire was not exhaustive, addressing all the types of circular behaviour and attitudes.

Finally, there is a wide range of opportunities for future research in this area. First, it would be interesting to study the same research questions for other target groups (adolescents or middle-aged people) and possibly identify generational disparities. Second, despite the compelling case Portugal represents, the replication of the study in HEIs in other countries with different cultural and economic backgrounds would allow the implications of cultural, social, and economic aspects to be verified. Third, it would be fascinating to incorporate psychology into these studies to examine students' motivations and barriers to adopting more circular consumption patterns. Finally, a map of all HEI initiatives could be assembled in order to create a more effective action plan for transforming students' perceptions and behaviour.

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

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflicts of Interest: The authors report there are no competing interests to declare.

Appendix A

Table A1. Behaviour of different types of CE-related actions as a function of knowledge of CE.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
VARIABLES	**Environmentally Friendly Products**	**Environmentally Friendly Products**	**Recycling**	**Recycling**	**Carpooling**	**Carpooling**	**New Electronic**	**New Electronic**	**Second-Hand Clothes**	**Second-Hand Clothes**	**Remanufactured Products**	**Remanufactured Products**	**Repair**	**Repair**	**Minimise Food Waste**	**Minimise Food Waste**	**Batteries Collection Centres**	**Batteries Collection Centres**	**Public Transport**	**Public Transport**	**Energy-Saving Light Bulbs**	**Energy-Saving Light Bulbs**
Knowledge	0.0957 *	0.0898	0.112 **	0.124 **	−0.0816	−0.0175	0.0819	0.0988A	−0.0255	−0.0130	0.130 **	0.0932	0.0226	0.00674	−0.0246	−0.00686	0.163 ***	0.0925	−0.0600	−0.00927	0.136 **	0.0762
	(0.0489)	(0.0553)	(0.0542)	(0.0629)	(0.0504)	(0.0586)	(0.0524)	(0.0594)	(0.0557)	(0.0635)	(0.0509)	(0.0578)	(0.0534)	(0.0612)	(0.0639)	(0.0751)	(0.0514)	(0.0595)	(0.0493)	(0.0594)	(0.0565)	(0.0665)
Age		0.0226 **		0.00672		−0.0141		0.0102		0.0202 **		0.0216 **		0.0282 **		0.00762		0.0317 ***		−0.0228 **		0.0299 **
		(0.0100)		(0.0107)		(0.0105)		(0.0111)		(0.0101)		(0.00986)		(0.0132)		(0.0134)		(0.0116)		(0.00991)		(0.0147)
Sex		− 0.129		0.0789		−0.315 *		−0.112		−0.409 **		0.223		−0.134		−0.307		−0.224		−0.224		−0.285
		(0.153)		(0.170)		(0.165)		(0.161)		(0.188)		(0.159)		(0.166)		(0.193)		(0.160)		(0.160)		(0.179)
Education		0.159		0.0588		−0.424 ***		−0.0114		−0.228		−0.0167		0.0872		0.0616		0.360 **		−0.578 ***		0.449 **
		(0.146)		(0.163)		(0.156)		(0.157)		(0.168)		(0.154)		(0.163)		(0.196)		(0.155)		(0.154)		(0.181)
Professional Status		0.0458		−0.0120		0.0634		0.138		−0.0352		−0.181		0.194		0.0429		−0.0456		0.254		−0.228
		(0.162)		(0.179)		(0.172)		(0.172)		(0.182)		(0.167)		(0.179)		(0.2117)		(0.175)		(0.165)		(0.206)
Constant	−0.305 **	0.134	0.387 **	−0.170	−0.179	0.315	0.351 **	0.396	−0.776 ***	−1.116	−0.820 ***	−1.533 **	0.649 ***	−0.124	1.246 ***	0.521	−0.0586	−1.245 *	0.430 ***	0.456	0.468 ***	−0.556
	(0.148)	(0.709)	(0.159)	(0.643)	(0.151)	(0.629)	(0.156)	(0.707)	(0.168)	(0.713)	(0.158)	(0.716)	(0.161)	(0.627)	(0.196)	(0.806)	(0.151)	(0.668)	(0.151)	(0.627)	(0.163)	(0.718)
Location		✔		✔		✔		✔		✔		✔		✔		✔		✔		✔		✔
Observations	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ✔ means that location was added into the regression.

Table A2. Attitudes about CE as a function of knowledge of CE.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
VARIABLES	**Sustainable Products**	**Sustainable Products**	**Give up Things That Harm the Environment**	**Give up Things That Harm the Environment**	**Carpooling**	**Carpooling**	**Clothes Rental Service**	**Clothes Rental Service**	**Donate or Sell Clothes**	**Donate or Sell Clothes**	**Repairing Objects**	**Repairing Objects**	**Remanufactured Phone**	**Remanufactured Phone**	**More Recycling**	**More Recycling**	**Reduce Waste**	**Reduce Waste**	**Water or Electricity-Saving Appliances**	**Water or Electricity-Saving Appliances**
Knowledge	0.146 ***	0.139 **	0.0709	0.0690	−0.181 ***	−0.169 ***	0.112 **	0.164 ***	−0.0252	0.00713	0.0104	0.0106	0.147 ***	0.128 **	0.111	0.172	0.117	0.131	0.135 *	0.105
	(0.0499)	(0.0562)	(0.0489)	(0.0558)	(0.0520)	(0.0593)	(0.0537)	(0.0619)	(0.0844)	(0.108)	(0.0631)	(0.0746)	(0.0526)	(0.0611)	(0.0774)	(0.0922)	(0.0829)	(0.102)	(0.0738)	(0.0909)
Age		0.0172		0.0510 ***		−0.0132		0.0151		−0.0124		0.0360 *		0.000734		−0.0166		0.0306		0.0591 *
		(0.0105)		(0.0134)		(0.00984)		(0.0102)		(0.0152)		(0.0200)		(0.0101)		(0.0130)		(0.0280)		(0.0341)
Sex		0.239		−0.126		−0.269 *		−0.537 ***		−1.001 ***		0.0270		0.347 **		−0.280		−0.470 *		−0.445 **
		(0.156)		(0.155)		(0.161)		(0.185)		(0.271)		(0.206)		(0.163)		(0.234)		(0.254)		(0.223)
Education		0.0500		−0.0931		−0.166		−0.0568		−0.130		0.0909		0.161		−0.121		0.0852		−0.0655
		(0.149)		(0.150)		(0.156)		(0.165)		(0.267)		(0.202)		(0.161)		(0.232)		(0.267)		(0.236)
Professional Status		0.0678		0.332 *		−0.0494		0.310 *		−0.655 *		0.401 *		−0.0482		−0.278		0.295		−0.241
		(0.166)		(0.171)		(0.172)		(0.183)		(0.368)		(0.222)		(0.174)		(0.275)		(0.304)		(0.313)
Constant	−0.168	−0.209	−0.103	−1.612 **	1.010 ***	1.695 **	−1.042 ***	−1.553 **	1.764 ***	2.143 ***	1.177 ***	0.0461	−1.042 ***	0.742	1.218 ***	0.872	1.292 ***	−0.0868	1.062 ***	−0.0941
	(0.149)	(0.607)	(0.148)	(0.669)	(0.163)	(0.726)	(0.168)	(0.717)	(0.261)	(0.795)	(0.191)	(0.792)	(0.165)	(0.690)	(0.218)	(0.706)	(0.231)	(0.963)	(0.205)	(1.001)
Location		✔		✔		✔		✔		✔		✔		✔		✔		✔		✔
Observations	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377	377

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ✔ means that location was added into the regression.

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