



## Circular economy and consumer action: The role of apps in reducing food waste and shaping consumer behavior

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### ABSTRACT

Empirical studies on how people perceive Circular Economy (CE) concept and how they engage in circular practices are scarce. In this research, we explored the users of food waste reduction platforms, i.e., their understanding about CE, motivation for using apps that sell surplus food or close to expiry date, and opportunities for improvement. We considered two apps, which adopt circular business models (i.e., digitalization, sharing platform and resource recovery) in Brazil. The methodology included semi-structured interviews and involved 26 participants who use the apps. The results revealed mainly high-income people as consumers, indicating an opportunity to expand and promote the apps to low-income people, increasing social benefits. Regarding understanding of CE, most participants emphasised the social dimension. Novel circular behavior practices were identified including supporting small and local businesses and social-related efforts (e.g., sharing knowledge on CE strategies). The main influencing factors at purchase, either in app or in-person shopping, are price and product quality. The most frequent habit was keeping track of the food stored in the household. We concluded that the apps could enhance their contribution towards CE and sustainable consumption, by raising awareness about their benefits, evaluating the impacts avoided, and expanding publicity to attract more users.

### 1. Introduction

Circular economy (CE) encompasses a range of interpretations, and there is no consensus on an universal definition [1]. However, in most of the definitions, CE consists of a set of strategies that keep the value of resources in production and consumption systems, aiming at sustainable development [1]. It is worth to mentioning that the newer definitions have emphasized the importance of the social dimension of CE, including for example, quality of life, equity and diversity [2,3]. This shift suggests that CE should be understood not only as a technical or economic framework, but also as a socio-consumptive system in which individual practices and meanings play a central role.

CE is classified into three levels: macro, *meso*, and micro, and it involves various sectors and stakeholders, such as consumers [4]. Consumers are part of the micro dimension [5] and have an important role to play in the transition to the CE. For example, consumer behavior and decisions can cause or prevent environmental impacts related to a

product's life cycle [6]. Thus, their choices can also foster the creation of new markets and more sustainable products and practices [7]. Despite this recognized role, consumer participation in CE remains theoretically underdeveloped, particularly with respect to how consumers interpret, value, and implement circularity in practice.

Organizations can engage with individuals to understand their expectations and inform them about responsible consumption practices. This includes, for instance, actions that prolong the use of materials (e.g., maintenance, reuse, recycling) and the sharing of goods between consumers rather than acquiring the product individually. Another way for consumers to participate is through co-innovation with organizations [8]. Some examples of activities that organizations can do are periodic meetings with local consumer associations, especially those focused on sustainability and CE issues, and funding consumer initiatives on these topics [8]. However, how consumers understand and respond to these organizational efforts remains insufficiently theorized, especially in digital and platform-based contexts.

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Despite its importance, there are still many challenges related to the acceptance of circular products [9]. In a recent review article [9], the authors identified 54 factors that influence consumer behavior in relation to circularity, such as: price, income, financial return, resource scarcity, consumer age, level of environmental awareness, among others. This can still vary from one location to another.

Although the acquisition of products with high lifespan has been identified as a driver of circular behavior [10], most consumers still lack the intention to pay the premium value for these items [11]. Therefore, individuals need to be empowered into changing their consumption patterns, to start considering the products' circularity in their purchasing practices. In the long-term, it can help the individual save money and incentivize companies to adopt CE strategies, since customers start prioritizing these options [12].

These challenges are particularly salient in developing-country contexts, where CE implementation has progressed more slowly but where structural conditions also create significant opportunities. For example, Brazil, still depends heavily on landfills as solutions for the disposal of their waste. Therefore, such countries have a great potential to implement practices of CE [13], avoiding the generation of waste and valuing by-products as resources through recycling, composting, among other alternatives [14]. From a theoretical perspective, developing countries provide a critical setting for examining whether CE concepts adequately capture the social meanings and circular behavior in different socio-economic realities.

Food waste is a global issue and occurs at different points along the supply chain. At the consumer level, it is often caused by poor purchase habits and meal planning, excess buying (influenced by over-large portioning and package sizes), confusion over labels (best before and use by), and poor in-home storing [15]. Thus, household routines such as planning, shopping, storing, cooking, eating, and managing leftovers play a decisive role in food waste generation [16]. Along these different stages, the individual might adopt practices of assessing the edibility of food and deciding whether it can be redistributed or donated instead of discarded [16].

The global food system is responsible for around one-third of annual greenhouse gases (GHG) emissions, of which food waste accounts for half [17]. If the Sustainable Development Goal (SDG) target 12.3 is achieved, half of avoidable food waste is eliminated [17]. In this context, public interventions and technological innovations have a great potential to reducing food waste. Currently, there are innovative practices that contribute to the Circular Economy in the food sector, such as new business models and online marketplace platforms for food sharing, based on the circular vision, and that connect generators/sellers with food reuse groups, charities, consumers, and consequently reduce food waste [13]. Such practices can be conceptualized as intermediaries in circular systems, as they mediate consumer practices, coordinate actors, and enable circular flows of food resources.

Despite their growing relevance, empirical research examining Food Waste Reduction Platforms (FWRP) through a CE lens remains limited. Existing studies have addressed specific aspects such as platform roles in CE [18], consumer motivations for using food sharing platforms [19], and explored managerial perspectives of FWRP in this regard [20], but consumer interpretations and behaviors within FWRP remain underexplored. Overall, there is a lack of CE research focusing on the perspective of consumers [21]. Only 1 % of CE-related papers were tagged with consumer-focus, which shows this topic needs more attention [22].

Against this backdrop, this study aims to explore how users of digital platforms understand the concept of Circular Economy, how they prioritize circularity aspects in comparison with other consumption factors, and how they behave across all phases of food consumption. In doing so, the study contributes to the expansion of Circular Economy theory by examining how consumers engage with food waste reduction platforms as micro-level Circular Economy mechanisms within a developing country context.

To achieve this aim, the objectives were three. The first objective was

to identify the profile of FWRP users, as well as their perceptions and understanding of the Circular Economy, their motivations for consuming these products, and the factors influencing their purchasing decisions. The second objective was to analyze the practices and behaviors performed by participants in relation to the core elements of the Circular Economy, particularly in food consumption. Finally, the third objective was to identify and discuss potential improvements that could be implemented by these platforms to better communicate their circularity-related information, based on the findings of the previous objectives, particularly with regard to consumer awareness.

By linking consumer perceptions, decision-making criteria, and behaviors within a platform-mediated context, the study contributes to a more nuanced theoretical understanding of the social and behavioral dimensions of CE. In doing so, it extends CE toward a consumer-centered perspective on how digital intermediaries shape the enactment of circularity in everyday life. In addition, the research revealed how the consumers experience this innovation- FWRP-including the benefits they perceive to sustainability as well as the challenges faced and practical suggestions of improvements.

## 2. Theoretical background

### 2.1. Circular behavior contextualization and research gaps

One of the main challenges to the implementation of the CE is the lack of interest, knowledge and awareness of consumers in relation to the topic [23,24]. This includes consumers' understanding of the impacts generated at different stages of the product life cycle. For example, many consumers do not understand what CE means, its relevance, and what they can do to implement it [23].

Several theoretical frameworks have been used to contextualize circular behaviors, including the Theory of Planned Behavior (TPB) [25, 26], Stakeholder Theory [27], and the Unified Theory of Acceptance and Use of Technology (UTAUT) [28]. Among these, the TPB has shown a wide range of applications [29]. For example, source separation of household food waste can be linked to subjective norms and perceived behavioral control [29]. When addressing the intention to reduce food waste, Schrank et al. [30] found, through the same framework, that attitude and perceived behavioral control hold the highest explanatory power.

Consumers' environmental knowledge, awareness, and perception can impact on the purchase intention of eco-friendly products, which may impact the purchase behavior of such products [31]. However, the transformation from awareness to behavior is also affected by many factors such as perceived costs and policy incentives [32]. Besides being relevant at purchasing stage, consumers have an important role towards circular supply chain through their behavior and decision-making. Behavior includes decisions on discarding options, for example, reuse (second-hand selling or donation), recycle (return for incentives), or disposal of ordinary waste. Also, behavior integrates decisions such as, repair, buy a new or used product, or borrow/rent/lease. The adoption of CE by consumers demands changes in consumption values and patterns and includes the idea of resources optimization [33].

The scientific literature on the perception, attitude, and practices of the circular consumer started growing in 2019, suggesting a research field that can be found at an embryonic stage [9]. This includes the study of consumers' awareness and roles as CE enablers as well as the adoption and efficacy of circular consumption practices [1]. The factors that influence purchase are part of the behavior and include environmental concerns, for example, preferring products with green labels. However, there are still several knowledge gaps related to the topic of consumers and CE as presented in the following paragraphs.

Research is needed to understand the performance of circular practices by consumers, as consumer empowerment is a key part of the CE approach [3]. Piao et al. [34] highlight the need for more empirical research about community and consumers engagement in circular

practices. Other areas which remain with little research are: (i) how people perceive and understand the CE [35]; (ii) consumer behavior, habits and choices within a CE perspective [36,37]; (iii) inclusion and collaboration among stakeholders [38]; (iv) financial incentives that encourage conscious consumption [39]; and (v) how organizations communicate their circularity performance [21]. All these areas are explored in this research.

The CE literature has been focused on services and business models, somehow neglecting the consumer roles and behavior to accept CE [40]. In developing countries, this is a new topic and there are few studies on CE from the point of view of consumers. Most of the available publications address developed countries [41–43]). In this research, we focus on Brazil, more specifically large cities. Another new aspect is that we will address the food sector, while most research on consumers and circularity so far has been addressing the electronics sector [6] or plastics [44,45].

## 2.2. Digital technologies to avoid food waste and support circularity

Based on the food waste hierarchy, redistribution to human consumption is a priority among the options to prevent food waste [46,47]. In contrast, options like energy recovery through biogas or incineration are least preferable. Digital tools enable strategies to achieve the priority goals (prevention and minimization at the source and redistribution to human consumption) in various ways, as explored as follows.

The United Nations Environment Programme (UNEP) acknowledges the importance of technologies for food waste reduction. There is a large number of digital tools or technologies developed recently to tackle food waste [48]. These include a range of smartphone/mobile apps, as well as intelligent devices using sensors, such as smart fridges, smart packaging and smart bin [48]. The apps, for example, have different functions: (i) reminder and food storage apps help to remember consumers of the expiry date of a product; (ii) integrated food planning, shopping and recipe apps (e.g., advice around extending shelf-life and recipes with leftovers); and (iii) apps enabling food-sharing and redistribution of food surplus from restaurants, retails, restaurants [48,16]. Here, we address the last option, also known as FWRP. There are different types of FWRP: food sharing for money, food sharing for charity, and sharing for the community [49]. In this research, we focus on the first type.

The diffusion of such technological innovations to reduce food waste depends on the enabling environment needed for the technologies to work well, being influenced by regulations, institutions, infrastructure, markets, complementary technologies, and the scaling up of these businesses [48]. The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) is helpful to understanding sustainable technology acceptance and consumer behavior, especially the factors that influence the adoption of digital technologies by users, such as social influence and facilitating conditions [50]. Therefore, considering the multiple dimensions and complexity of the food waste reduction topic, a system-level perspective is required along the entire value chain [48]. Regarding regulatory aspects, for example, in Brazil, which is the case for this research, recently (January of 2022) a law (n.17755/2022) was approved in Sao Paulo city allowing the food producers and suppliers (e.g., restaurants) to donate the surplus food (including in natura, processed products and meals) that are in proper condition for consumption [51]. This is targeted at persons in vulnerability situation, and it is an important milestone towards preventing food waste. However, no national public policy or action plan related to food waste prevention was found.

## 3. Methods

### 3.1. Data collection

The exploration of the consumers' perspective allows an insight over their motivations, and behaviors, as well as the possibility to build

improvement opportunities. To this end, semi-structured interviews with open-ended and multiple-choices questions were used, enabling interviewees to develop ideas and speak freely about topics such as their motivation [52]. The semi-structured interview guide is available in the Supplementary Material 1. The questions covered pre-acquisition, acquisition, pre-use, use and post-use phases to understand consumer behavior holistically. The definition of these steps was based on [9].

Through a literature review, key aspects of product circularity in the food sector were identified, guiding the development of interview questions. In addition, the role of consumers for the CE was also explored (e.g., [53]). The searched keywords included, e.g.: circular consumption, food rescue, food waste, digital platform consumption, and food waste, searching in Scopus and Web of Science. Factors/attributes that influence consumer choice were identified based on [43]. Socioeconomic characteristics of the participants (question 1) and difficulties related to the use of the app, as well as efforts required, were based on [54] and [55]. Practices in use and post-use phases were based on [56].

We selected FWRP in Brazil as our focus because the country is paradoxical, presenting similarities with developing countries, related to post-harvest losses and similarities with developed countries, regarding food waste at the retailer and household level [57]. The increasing urbanization and dietary transition in Brazil contribute to behaviors typical of developed countries regarding food waste generation [57,58].

The main FWRP in Brazil were identified, specifically those operating in the State of São Paulo, the most populous region of the country. We contacted the responsible staff (e.g., CEO) through email, WhatsApp and LinkedIn to explain about the research and ask about their interest in collaborating with us. Three platforms responded positively and were included, but one was later discarded due to difficulty in finding participants in the recruitment phase (no users were found).

We considered the following circularity criteria for the choice of apps: (i) alignment with circular business models (e.g., resource recovery, sharing platform, digitalisation/virtualisation); (ii) working within the study area; and (iii) being a virtual platform that promotes sustainable consumption. For this context, it was assumed that a circular business model creates, captures and delivers economic value while providing social and environmental benefits [59]. Connecting consumers through digital platforms to encourage sustainable consumption is part of CE strategies [60]. Therefore, the selected FWRPs (henceforth named as apps) fit as circular business models, as they offer discounts for products that would be wasted because they are close to expiring or are leftover in restaurants, bakeries, bars, cafes, markets, or other establishments.

Initially, we analyzed each app to identify similarities and differences, and to support the design of the interview questions. For example, we noted whether the app offers delivery or pick-up/collect options, displays the establishments' rating or users rating of the product, lists available products, and allows product choice or surprise mode. App A offers surprise bags with food or meals close to expiration from bakeries and other establishments, it just specifies if it's sweet, salty or mixed. App B offers products close to expiration from supermarkets among other establishments (mainly food but not exclusively).

Inclusion and exclusion criteria were applied to refine the participant sample. To be included, participants needed to be users of at least one of the studied apps. Individuals were excluded if they did not respond within the specified time frame after the initial contact via e-mail, recruitment message, or invitation. This ensured the operationalization of the research.

The interviewees were selected through different strategies to increase recruitment success. We asked app staff to contact users and check their willingness to participate in our research (and if positive, their consent to share their contact information, i.e., name and phone number with us). However, only the team of one of the apps collaborated towards this end, providing us the contact information of 15

individuals. To recruit users of the other app and expand participation, we applied additional strategies recommended by previous research [55], including posting an invitation on social media (e.g., LinkedIn, Facebook, Instagram). Also, we identified a Facebook group of users of one of the apps and extended the invitation to them. Additionally, we searched the companies' (apps) profiles on social networks and reviewed comments on recent posts, identifying users who claimed to use the app. These users were then contacted via direct message and invited to participate. We also asked participants if they knew other users and could refer them to us (snowball method [61]).

The recruitment efforts resulted in a total of 26 participants. Although some participants mentioned that they used both apps, we considered only the app used most often for the interview (i.e., if the interviewee had a higher time usage in App A, when compared with App B, they would be interviewed as a user of App A). Therefore, no participant answered interviews for both apps.

Among the 26 interviewees, 14 were users of App A and 12 of App B. The sampling technique used was purposive sample (non-probabilistic) [62]. While purposive sampling guided the intentional selection of information-rich participants, saturation served as the criterion to determine when data collection was sufficient. Saturation was observed mainly for the open questions (e.g., question 1, 2, 5 and 12). The number of conducted interviews aligns to previous research on saturation [63] and [64] claim that saturation is usually reached with 9–17 interviews). Recruitment was therefore concluded when no new themes emerged from additional interviews and when we had a similar number of participants from each app. The interviews were conducted via video call on Whatsapp or Google Meet, based on participant preference. Permission was requested to record audio and transcribe each interview, with notes taken during the interviews. It is worth noting that 2 of the 14 App A users reported no longer using the app, but all questions were maintained as this was considered a relevant result, especially for improvement suggestions (related to the last specific objective of this research). Each interview lasted around 20 to 49 min, resulting in about 15 h of audio. The interviews were conducted between the end of October 2023 and the beginning of January 2024.

To better understand the apps and complement user experience analysis – mainly the type of information disclosed– we downloaded, installed and tested both apps. Data on food waste and sustainability indicators available in the apps are discussed in Section 4.7.

### 3.2. Ethical considerations

As required by the Brazilian law, this research proposal was submitted to ethical evaluation through Plataforma Brasil (a national platform), through the Ethics Committee of the University of São Paulo and was approved (CAAE 74844923.9.0000.5390). Before starting each interview, the consent form was shared with participants for their knowledge and approval.

### 3.3. Data analysis

To analyze the interviews' findings, thematic analysis was conducted. Each interview was transcribed, and data were analyzed by response and group of consumers, followed by identifying common patterns and differences.

Coding was conducted separately for each main topic analyzed. Atlas TI software and Microsoft Excel were used to compare data between the two apps and identify similarities and differences. Interviewees understanding of CE and perceived sustainable benefits from the use of these apps were coded inductively. For the lifestyle and circular behavior information, a hybrid approach combining deductive and inductive coding was applied. The former was used to identify the categories – based on the scientific body of literature – that integrated the findings derived from the implementation of the latter. Thus, the empirical findings were clustered into three categories: (i) Responsible acquisition [65,66]; (ii) End-of-use and lifespan extension behavior [67,65]; and (iii) Social-cultural engagement [42]. Due to the lack of literature on the social component of CE, the last category also derived from the inductive coding of the transcripts.

The dataset about problems, criticisms and suggestions for improvements were coded inductively. The remaining dataset was objective, for example, about influencing factors at purchase as well as general questions (e.g., age, gender) since they were based on multiple-choice options; in cases of "other" responses, they were included as well. All the data were summarized, and the main results represented in tables and figures.

After the coding, to enrich interpretation of results and discussion, the results were compared with other studies that addressed similar research topics. Finally, based on the results, we provided recommendations for improving the applications, such as enhancing communication of circularity to customers.

**Table 1**  
Sociodemographic and lifestyle characteristics of the participants ( $n = 26$ ).

Variable	Options	Relative frequency
<b>Gender</b>	Female	73 %
	Male	27 %
<b>Age</b>	18–30	19 %
	31–40	39 %
	41–50	12 %
	51–60	15 %
	61 or more	15 %
<b>Monthly income</b>	Up to 1320 BRL	4 %
	2640–3960BRL	11.5 %
	3960–6600BRL	11.5 %
	6600–13200BRL	27 %
	Above than 13200BRL	46 %
<b>Education level</b>	Elementary school	8 %
	High school	11 %
	Higher education (bachelor)	54 %
	Post-graduate	27 %
<b>Diet preference</b>	Not vegetarian nor vegan	92 %
	Flexitarian	8 %
<b>Household composition</b>	1 (live alone)	19 %
	2	27 %
	3 or more	54 %
<b>Place of residence</b>	São Paulo city or metropolitan region	96 %
	Rio de Janeiro city	4 %

Notes: The decimals values were rounded. In the case of monthly income category, we kept the decimal values 11.5 to totalize 100 %. 1BRL = 0.16€.

### 3.4. Limitations

For the question on how frequently participants performed such practices (Question 6- Supplementary Material 1), there were three missing responses (i.e., use of leftover for other recipes, integral use of food, avoiding acquire more food than needed) from two participants. These cases were considered “not applicable”; however, the participants answered all other questions. In terms of scope, this research focused on circular behavior related to food consumption, and no other areas of lifestyle (e.g., housing, transport, consumption of other resources, such as electricity or water).

## 4. Results and discussion

### 4.1. Profile of the users of the two circular apps: who are they?

The results (Table 1) reveal that the main users of these apps are women, aged between 31 and 40 years old, with high income, completed higher education, nor vegetarian or vegan, living with 2 people or more and mainly in Sao Paulo city or its metropolitan area. Pandey et al. [68] investigated the profile of consumers of surplus meals at reduced price from Danish canteens. Similar results were obtained regarding gender and level of education, i.e., the vast majority were female users. Other studies have found that women are more likely to engage in circular behavior such as to purchase green products and participate in actions that demand behavior change than men [69,70].

Based on the income data, we could raise the question whether the apps have not reached enough the low-income communities who could benefit from the discounts and get affordable and quality food, as stressed by one of the low-income interviewees: *"There are products that I have never bought in the grocery store and already bought in the app because of the price"* (#AppB-1). In this context, strategies to promote these apps among low-income population would be important and are further discussed in Sections 4.6 and 4.7.

In response to the question about how they found the app, most answered that they discovered it through ads on social media or TV (e.g. facebook group, neighborhood page, influencer post, video on Youtube, news), followed by suggestions of friends or relatives, and own initiative. One different response was from an interviewee who learned about the app during a lecture in the job. Regarding those who found by own initiative (6 persons), 4 have completed higher education or post-graduate while two persons have lower education level (elementary school and high school). For the income variable, 3 people have more than 10 minimum wages while 3 show a salary between 3 and 10 units (minimum wage), which may indicate that this behavior of search by

themselves could be more frequent in high-income people. However, it is difficult to draw clear relationships considering the nature of this exploratory study, and the inherent limitations associated with the sample size and main characteristics of the participants.

In general, the main reasons identified by the interviewees for using the apps are to: (i) avoid food waste; (ii) save money; and (iii) convenience (Fig. 1). However, when we analyze separately per app, there are some differences. For app A "it is funny" is considered the third main reason for using, while for the app B is "convenience". Regarding the latter (convenience), one of the interviewees highlighted: *"It is practical because it is delivered to you, you don't need to go to the place"* (#AppA-10). Whereas the former "fun" was reflected as a couple activity, as stressed by another participant: *"It is a lot of fun! My partner always asks what came today, and, whenever it comes, we open it together"* (#AppA-11). This is due to the surprise element of app A which is not available in App B. The possibility to save money and convenience are similar results to findings of previous research. For example, [71] found that the main attributes perceived by the consumers are access to affordable food, access to quality food, and ease of use. Regarding convenience of such apps, some participants mentioned that after pandemic they got the habit of purchasing mainly via apps. The least reported motivation was "it is popular, current trend", which could be connected to the social influence variable of the UTAUT2, for example, the findings indicate that the opinion of relatives, such as friends and family of the participants regarding use the app was not perceived as an important motivator for them to use it in the assessed context. This aligns with findings from [50], who likewise reported that social influence was not a significant factor.

The purchase frequency varies between the apps, since it depends on product availability, user interest and need. For the app A (surprise bag of meals and snacks), most of regular users buy once or twice per month (42 %) or less than once per month (42 %). In another study with a similar app in Sweden [55], the frequency of use was similar. In this app that is also based on surplus food (e.g., from coffee shops, restaurants and retailers), very few informants used it on a daily basis, mainly due to the limited supply of restaurants, cafes and stores connected to the app and the unpredictable offers available by the app. In our study, the frequency of purchase of users of the app B (grocery shops) is higher likely because of the type of the product (e.g., food for everyday needs). Most of App B users (83 %) make purchases more than once per week, including two that buy daily and work as resellers of these products, as mentioned by one of them: *"I started to resell because I got unemployed and currently the use of this app is the main income of my household"* (#AppB-1). Interestingly, some participants also reported that they use other similar apps (which fit in FWRP too), including some that sell products close to

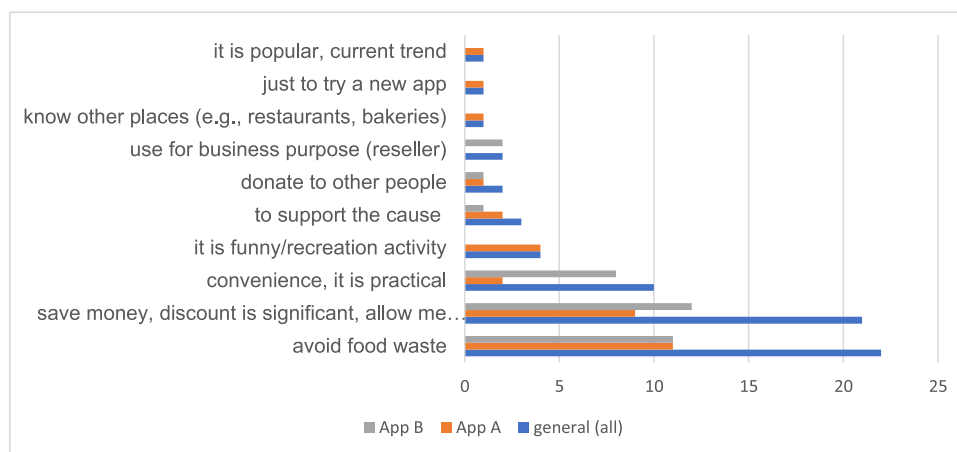


Fig. 1. Motivations identified by the interviewees for using the apps A or B. The general (in blue) means both (A and B). Continuation of "allow me...": to buy quality food at a low price. For detailed information about all the options please consult the Supplementary Material 1, question 8b of the interview guide. The data (x axis) refer to the number of participants who mentioned this motivation. Note that the participants could choose up to 3 options.

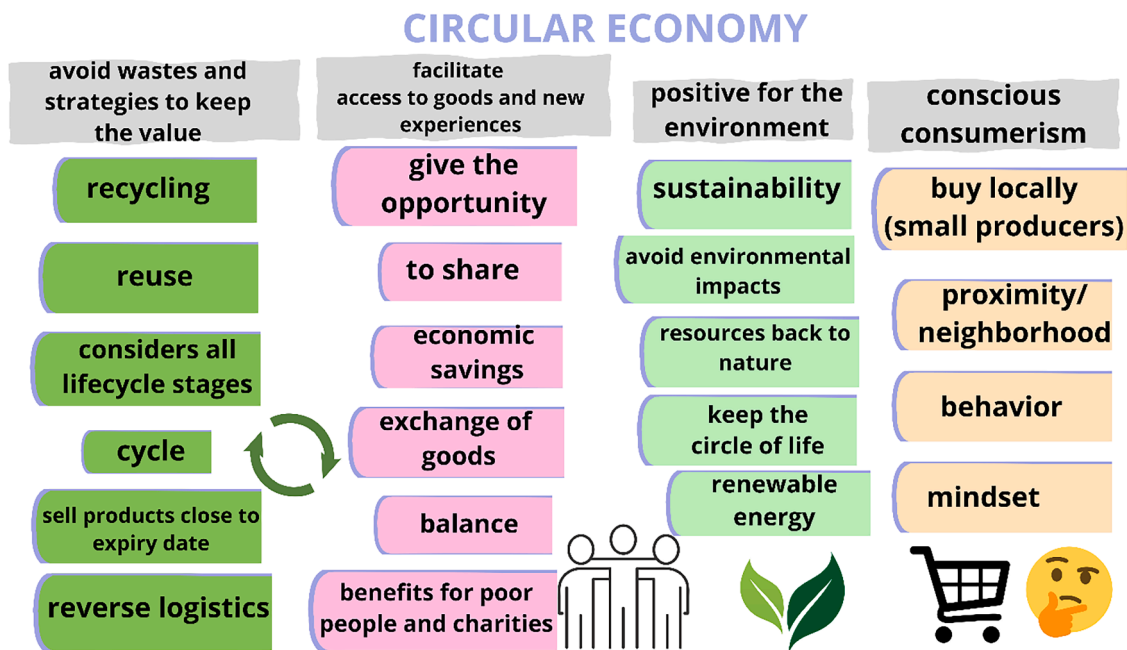


Fig. 2. Affinity diagram summarizing the responses about their CE understanding (considering 24 responses, including guesses). The themes are in grey. The text in dark and light green, pink and light orange boxes represent the codes in the same theme.

expire, surprise bags, and fruits and vegetables out of aesthetic standards.

#### 4.2. Understanding of CE concept and its scope

When asked if they have already heard about CE, 14 participants answered yes while 12 have never heard about it. However, among those who answered yes, one didn't remember what it meant. In addition, two participants from App B mentioned that they might have already heard about CE but do not know what it means. One, for example, mentioned that she might have heard but with another word. Half of the participants answered that they know what CE means and half answered that not. Interestingly, this outcome diverges between apps. The majority of the users of app A (11) are aware of the meaning of CE, while only two users of app B show this knowledge. The main participants' views regarding CE are summarized in Fig. 2.

Several interviewees mentioned sustainability as a keyword to represent CE. Two participants highlighted that CE depends on the mindset and awareness of people. In the "don't know" group, most participants (except 2) guessed about CE meaning. The guesses were more generic but presented connections with CE, mainly with social benefits and waste prevention. Examples of generic answers are "something that turns to avoid waste", "something that will provide benefits for several people, a common good", "something that benefits charities and schools". Two participants, among those who guessed, cited the example of the apps as part of CE. One of the guesses was that CE is a group of people buying together to share. Two participants reported that had no idea about the CE meaning and preferred not to guess.

Mindset was mentioned as part of CE, for example, as an influencing factor. According to the literature, mindset expresses a pre-disposition to new and innovative forms of consumption. This could include the preference for digital and shared circular services, value multi-functional products, favor acquisition and utilization of circular products [9].

The most complete answer came from a participant who works as a sustainability consultant, stating that CE is the alternative and contrast to the linear economy and mentioning some of the CE strategies, such as

to reuse, remanufacture or recycle. She also adds that it is to keep the loop, that the raw materials should have everlasting life or often should return to the cycle. Other participant who worked in environmental related job is a retired biology teacher, but she never heard about CE. The other participants do not work with jobs directly related to sustainability. All the individuals who answered that they know the CE meaning have at least higher education completed, which might indicate that education level could be an important factor. Part of our participants (almost 20 %) are less educated (i.e., one has elementary school incomplete, one has elementary school complete and three have high school complete), and all are in the "don't know group". In contrast, there are also some of the participants with post-graduate level who did not comprehend what CE means too. Previous research in the Nordic Region showed that the awareness and knowledge about the circular economy is higher in people with university degree [72], but there still no consensus since this is still an underexplored research topic.

Regarding income, there is not a clear connection between income and awareness, especially considering that the sample includes mainly people with high income. Among the participants who answered they know CE, only 2 earned less than 5 times the minimum wage. On the other hand, analyzing answers from the interviewees who affirm to be unfamiliar with the concept ("don't know group"), 5 earned less than 5 times the minimum wage, which is slightly more participants with a low-income than in the previous group (who answered that they know CE). However, quantitative studies with big samples are needed to explore further this and related implications.

Previous studies found a lower level of understanding about CE concept [73]. For example, in another study in Brazil, 11 % of participants never heard about CE, 35 % had a basic understanding of the concept and only 7 % a complete understanding [73]. Building on the findings of a previous survey, Brazilians associated CE mainly with recycling and reuse while few link CE with repair, zero waste and sharing [74]. The same study in Latin America found that Brazil is the second country where people are the least familiar with the CE concept meaning, ranked after Argentina [74]. Further efforts are needed to promote CE among people and encourage circular behaviors.

Our results indicate that the overall understanding of CE mainly relates with the CE definitions from the literature, which are discussed

**Table 2**  
Lifestyle practices adopted by the participants that are part of circular behavior ( $n = 13$ ).

Category	Code	Representative Quotation
<b>Responsible acquisition</b>	<i>Conscious consumerism</i>	"I started to think a lot before buying something, like, do I really need this, a new outfit, new shoes? Or even when I go to events with giveaways, let's take a new pen, do I need to take this giveaway if I already have several pens at home?" (#AppA-10)
	<i>Second-hand shopping</i>	"I prefer to buy things from other people who won't use them anymore than buying new things and thus stimulate factories and everything else." (#AppA-06)
	<i>Supporting small and local businesses</i>	"I seek out small producers [and] buy directly from the person who produces." (#AppB-08)
<b>End-of-use and lifespan extension behavior</b>	<i>Waste reduction</i>	"People usually throw away rotten mangoes. I put the rotten mango out for birds. Then, the birds eat the rotten mango, which isn't rotten (bad) for them." (#AppA-11)
	<i>Donations</i>	"Since there's a lot of good quality food, not spoiled or unfit for consumption, what do I do? I buy a lot and help several people... I'm constantly making bags for them, for their needs." (#AppB-04)
	<i>Second-hand selling</i>	"I live in a condominium of buildings, so there's the official condominium group for communications [...]. So, people post what they no longer want and the price." "The decluttering groups, it's another way we find to give a new purpose to things, and I've been doing that a lot in my family as well." (#AppA-07)
	<i>Waste sorting and disposal for recycling</i>	"Oh, here at home, we do selective waste sorting, as in the building, there's a specific place to dispose of recyclable items." (#AppA-12)
<b>Social-cultural engagement</b>	<i>Teaching others</i>	"For example, I teach people how to restore wooden furniture, which is a hobby of mine [...]" (#AppB-04)
	<i>Proactivity and education</i>	"Yes, in 1990, I took a very interesting course [...] on food waste reduction (culinary course)." (#AppB-04)

Notes: The codebook with the definitions of each code and other quotations per code are in the Supplementary material 2. In parentheses, the app and the corresponding participant number for each quotation are provided.

by [1,75]. However, an unexpected result is that both groups of participants, i.e., the ones who know CE meaning and those who guessed, emphasised the social dimension of CE. This should be considered particularly relevant because the social dimension is usually a neglected element of CE [3,76]. Awareness is important to encourage circular behavior. However, it is worth noting that a higher awareness and knowledge of the CE concept does not necessarily imply a larger adoption of circular economy practices in everyday life. This is explored in the next section.

#### 4.3. Behavior: CE as part of their lifestyle, everyday life, and in food consumption

##### 4.3.1. CE as part of the participant's lifestyle

Among the 26 interviewees, 13 were further questioned on the CE practices they adopted on a daily basis. This iteration resulted from a positive affirmation, when asked about the meaning of CE. As shown in Table 2, the empirical findings were coded, and clustered into three categories [67,42,65,66]: (i) Responsible acquisition, encompassing practices implemented during the procurement phase of the consumption process and reflecting circular consumption-related efforts; (ii) End-of-use and lifespan extension behavior, outlining practices aligned with careful maintaining, and selling or donating products when no longer needed, as well as timely and correctly discarding the product at its end-of-life; and (iii) Social-cultural engagement, including initiatives that share knowledge on CE strategies.

The participants implement on a regular basis three CE-related practices – grounded on responsible acquisition principles [66]–, when procuring new products: (i) Conscious consumerism; (ii) Second-hand shopping; and (iii) Supporting small and local businesses. The first action (i) implies the thoughtful consideration before purchasing a new item, while prioritizing needs and products with a better environmental performance. This is aligned with the results of [42], where young Finnish adults also refuse to buy non-recyclable or unnecessary products. This approach towards consumption can be linked with environmental values, and financial benefits. Our second finding (ii) suggests a focus on second-hand markets, where the stock – which should still be in a good condition and capable of fulfilling its original function – was previously owned by another individual. Despite being connected to the same theory, the drivers include, among environmental awareness and economic advantages, the desire to be unique, as certain products may only be found in second-hand stores [77]. The third output (iii) indicates an interest in supporting small and local businesses. This initiative is still relatively underexplored in the scientific literature. Da Silva and Ramos

[78], for example, found localism, i.e., "to ensure that we contribute to the local economy by investing in products that were made locally" as a driver for adoption of circular household practices in Portugal. This practice of supporting local and small business can derive from the values within the consumer or from the proximity to the stores and feeling of inclusion in the business activities, and as stressed by one of our interviewees (#AppA-13): " [...] I felt more part of a smaller consumption ecosystem, especially (with) food. I was already very close to a farm that produced vegetables, eggs, and so on. So, there was not as much stimulus to buy in a less sustainable chain".

Most of the actions adopted by the interviewees are guided by the intention to extend the lifespan of the product. In the context of donations, the findings are aligned with the conclusions of [42] and [9], where consumers may, first, desire to perform a good deed by supporting a social cause, and/or, second, free up space for new items. These drivers extend into the action of selling products in second-hand markets with the addition of a financial benefit, while disposing their used items [79]. The attitude towards reducing their waste production can be compared to the results on the drivers of food waste reduction of the questionnaire survey conducted by [80], which include: (i) anticipated guilt; (ii) sense of community; (iii) awareness of consequences; and (iv) environmental knowledge. For instance, one interviewee who is aware of the impact of the amount of waste produced on a daily basis claimed: "I stopped ordering delivery a bit because I found it expensive, an economic factor, but also because one week I ordered a lot of delivery and I got really shocked by the amount of packaging I was throwing away, and many of them would not be recycled or used for anything" (#AppA-10). On the other hand, individuals sort their waste for recycling, likely due to a sense of responsibility and convenience (i.e., if it is easier to sort waste for recycling, consumers will prioritize that option). These insights match the conclusions of [42] and [81], where, among other socio-demographic attributes, the perceived convenience and effort, moral norms, and environmental concern represent drivers for recycling. This is also aligned with the findings of [29], where source separation of household food waste can be explained by subjective norms under the TPB.

Lastly, the participants linked the adoption of CE practices with social-related efforts. In this case, this comprises the act of sharing knowledge on CE strategies (e.g., repairing), and of searching education and trainings on this topic. These actions have been documented in the scientific body of literature as a pair and remain relatively underexplored. According to [82], it represents one of the main roles of the consumers to reduce food waste, underlining the need to educate, learn, develop new competencies and communicate these to other individuals.

In fact, one participant shared skills on repairing wooden furniture, as a measure for other people to reduce waste. Although this participant highlighted "avoiding waste" as the motivation for it, this behavior could also be related to "upgrade" as defined by [67], that extends a product useful life. Thus, some circular behavior practices are connected. Several participants told us that they share knowledge about these apps with people they know and staff/owners of places from where they buy from (and which are not yet partners of the apps), so we could also include this within social-related efforts. Korsunova et al. [42] further expands on the role of social engagement, by indicating that people aim – due to curiosity – to learn more about how they can actively participate in the system.

It is also possible to compare our findings with other studies on circular behavior. The donation of unused products, recycling or reusing objects, and sorting waste for recycling were the 3 main circular behaviors found in Brazil, respectively [74]. The most predominant practice among our participants (considering this question) is waste sorting for recycling. This agrees with results from other countries, such as Sweden, Denmark and Norway, where delivering materials to a recycling centre is the main CE activity that people take part [72]. In the Netherlands, the most common circular behavior and with high willingness of participants are hand in broken products for recycling and give away their most recently replaced product for possible re-uses [83].

While the most common practice is sorting waste for recycling there are other seldom actions, such as buying second-hand or refurbished products, as mentioned by one participant (#AppB-8): "Only if there's something very specific that I can only find second-hand, yes, but it's an exception". However, this might be different in other countries and depending on local conditions, for example, in a low-income region of England, the frequency of second-hand shopping was high [43].

4.3.2. Adoption of circular practices related to food consumption

The empirical findings enabled the assessment of the frequency of the food waste reduction practices adopted by the participants – and divided between apps (i.e., A and B) -, where eight possible actions were pre-established: i) Shopping list; (ii) Avoid acquiring excessive amounts

of food; (iii) Food storage tracking; (iv) Adoption of reusable bags; (v) Integral use of food; (vi) Leftovers use for other recipes; (vii) Food waste monitoring; and (viii) Food donation. The most frequent habit (i.e., considering "always" an "often" responses) was keeping track of the food stored in the household (stock), the second was adoption of reusable bags/boxes, followed by using leftovers for other recipes and avoid acquiring excessive amounts of food, both at third place. This ranking can be linked with the attitudes underlying these actions, which will be explored in next paragraphs.

Regarding the habits which can be implemented throughout the circular customer role (Fig. 3), for the four options, there is a significant variation between the frequency of the practices adopted by the users of the different apps. This could derive from a difference in the awareness of the CE concept, since the majority of the App A interviewees showed more knowledge of this topic. The elaboration of a shopping list and tracking the food storage are, on the one hand, convenient, and, on the other hand, can help the consumer budget their expenses [84]. Although planning-oriented actions, such as preparing a shopping list, do not necessarily reduce household food waste, food storage tracking and management can induce a significant improvement in this regard [85]. The "adoption of reusable bag" shows a similar trend, where a positive perceived behavioral control (i.e., the perceived ease or difficulty of using reusable bags) has a direct correspondence to the intention of the userholder in performing this action [86].

For the practices that can be implemented in the customer role (Fig. 3), a variation between the apps is shown; shopping list and "avoiding excessive amounts of food" are more frequent in users of App A, while "food storage tracking" and "adoption of reusable bags" are more often in App B users. Regarding the "avoid excessive amounts of food" some participants that do not adopt this practice explained that it results from a desire to donate food, as outlined by interviewee #AppB-4: "I buy a lot (of food), and I help several people". Also, some highlighted that if the price is good, they buy big amounts, prepare the meals and freeze them to preserve the food, which would also avoid waste. However, in most situations, as discussed by [87], it connects with an impulse towards taking advantage of discounts, as well as oversized



Fig. 3. Adoption of food waste reduction practices implemented by the participants during the customer role. The "Not applicable" option may result from a situation where the participant found that the practice is not relevant to their lifestyle (3 participants), or the question was not responded (1 participant).

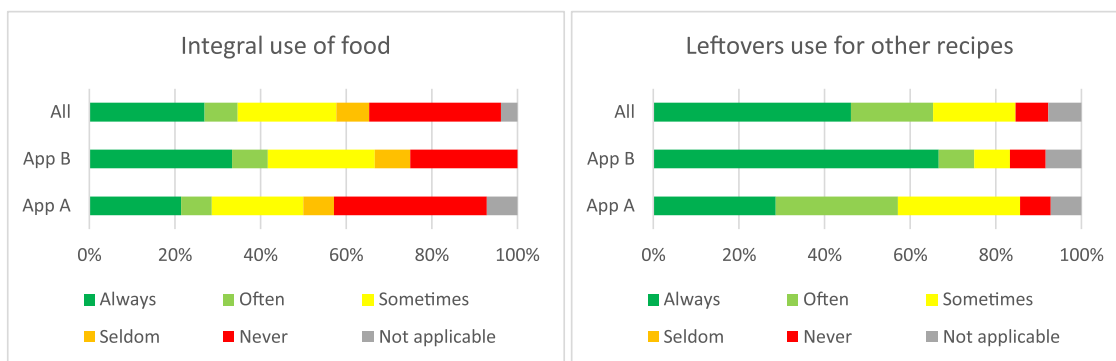


Fig. 4. Adoption of food waste reduction practices implemented by the participants during the circular user role "Not applicable" option may result from a situation where the participant found that the practice is not relevant to their lifestyle (1 participant), or the question was not answered (1 participant).

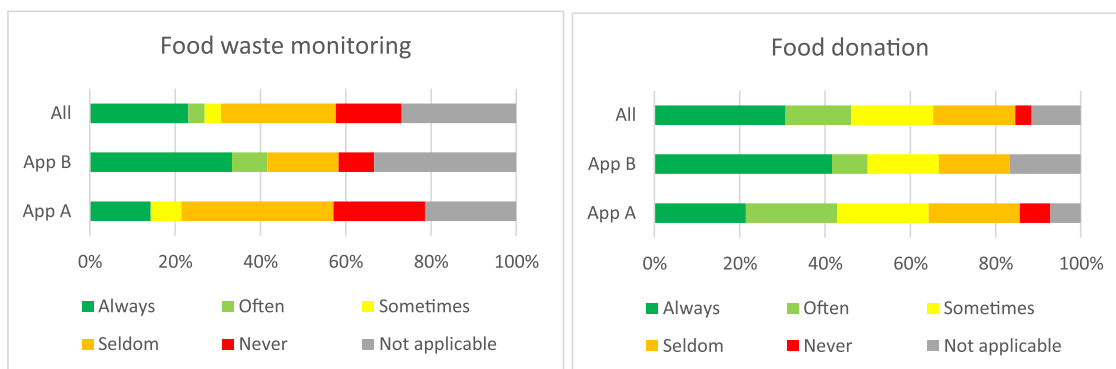


Fig. 5. Adoption of food waste reduction practices implemented by the participants during the *EoU product holder* role. The "Not applicable" option result from a situation where the participant found that the practice is not relevant to their lifestyle. The sorting and disposal practices are also within *EoU product holder* role but as they were open questions they are addressed in the text.

packaging.

Regarding the *circular user role* practices (Fig. 4), some of the interviewees always use leftovers for other recipes, whereas the counterpart, "integral use of food", shows a less consistent behavior. This is partially aligned with the findings of [88], who found that the practice of preparing recipes with stalks, leaves and peel is among the less frequent attitudes. The preference of using leftovers for other recipes may derive, nevertheless, from two factors [89]: (i) Overcooking (i.e., the householder cooks excessive amounts food, and needs to find a method to reduce waste); and (ii) Convenience (i.e., the use of leftovers for other recipes can help the individual save money and time).

In the context of the practices that can be carried out during the *EoU (end of use) product holder role* (Fig. 5), the same pattern found in the previous role repeats. The users of the app B are more likely to implement food waste reduction practices in their role as an *EoU product holder* than App A users. Food donation was reported as a common practice, except for four participants that claimed they consume all their groceries. This result is aligned with the results of [90], where, in the Australian context, the majority of the householders donate their food, as a method to reduce their organic waste. Another finding of our study was that monitoring the household food waste represented the action with the lowest frequency. There are recent apps created for this purpose, such as Food waste tracker, but this is something new and not known by the participants. Some participants answered that they monitor but it was done mentally, as indicated by interviewee #AppB-5 "Always (do it), but it is a mental control". In other cases, the low frequency of monitoring resulted from a lack of reason (e.g., "not applicable"), as stressed by interviewee #AppB-2 "It is really rare that I waste (any food)".

How individuals sort and dispose the rests of food and packaging is also part of *EoU product holder* role. Among the aforementioned

household waste treatment strategies in Section 4.3.1, in this component, the interviewees further outline the use of composting ( $n = 4$ ) and pet feeding ( $n = 3$ ), whereas the remaining either sort and dispose for recycling ( $n = 25$ ) or discard everything mixed ( $n = 1$ ). The sum of the values is superior to the number of participants in the sample, since each individual may adopt, in certain situations, more than one waste disposal practice.

Furthermore, each treatment or disposal habit is paired with challenges. For instance, when trying to compost, health and hygiene was a concern, as stressed by interviewee #AppA-1 "So, I had a composter, but I got tired of living with bug infestations all the time". Also, the lack of space was mentioned by some interviewees who live in apartments. This agrees with a previous study in Brazil which revealed low willingness of participants in adopting home composting (16 %) when compared with other circular practices such as recycling with higher willingness (87 %) (the participants may select multiple practices) [74]. When feeding the pet with food leftovers, certain ingredients should be avoided, as emphasized by one participant (#AppA-11) "No, because they (the pets) would have diarrhoea". Lastly, even when the householder aims to recycle, they face infrastructure-based limitations, such as the lack of a recycled waste collection vehicle, according to interviewee #AppA-10: "Where I live, they do not collect separately, so everything goes together, and I do not take it anywhere else". The lack of recycling wastes collection was reported by several participants, which highlights the need for government to offer this service to the population, increasing the coverage/accessibility of recycling collection to all the neighborhoods of the city. Structural changes play an important role to enable sustainable lifestyle choices and behavior, as addressed by [91]. However, some participants who live in the regions without public recycling collection service, underlined they donate to neighbors or other waste

pickers that come to collect and then reuse or recycle these materials (e.g., plastic bottles, metal cans). In addition, there are no take-back systems in Brazil which often occurs in European countries (e.g., for PET bottles, cans), and are an important motivator for people participating in the recycling at end of life [92].

#### 4.4. Factors influencing their food purchases

The evolution of e-commerce and shopping apps has redefined the landscape of global retail, offering consumers a variety of options and unprecedented convenience. However, behind consumers' choices in using shopping apps lies a complex interaction of various factors shaping their decisions [93]. The consumers interviewed in our study chose brand, price, product or service quality, appearance, environmental concerns (e.g., related to packaging, labels), produced locally, reputation of selling establishment (e.g., rating and classification by others), animal wellbeing and social issues.

Our results indicate that knowing the concept of CE doesn't seem to alter the determinants of the purchasing decision. According to our findings, price is considered the main factor that influences purchase via app. Among the 26 interviewed customers, 24 respondents considered price amidst the main 3 factors that influence their choices. But price is not considered alone. Usually, the respondents select product quality as a factor to be deemed together with price. Consumers claim that it's pointless to pay less if the quality is compromised. Two interviewees revealed that they purchase for resale, stating that they cannot pass on expired or damaged products to customers, even if the price is low. One of the resellers mentioned (#AppB-1): *"The app has the part about damaged goods, you know. This part about damaged goods is a bit complicated because "damaged", I understand as dented, torn, right? However, 't's not always like that, sometimes it happens... It happened to me, okay? It was actually last week. The heart of palm, it came with all rusty lids and already with bugs"*.

The interaction between price and quality often dictates the product's perceived value, guiding consumer choice, and remaining a key determinant in the consumer's perception of product value [94]. In-person purchase experience, there were no major differences in the influencing factors at acquisition. In both cases (app and in-person shopping), price and product quality are the main factors that influence their purchase, followed by brand. Also, there was no difference considering the main 3 influencing factors among those that know CE and the ones that don't know.

Although price and quality are also central in-person shopping, their interaction may acquire a different meaning when considering the FWRPs context. As consumers cannot inspect the products by touching them before purchase, the evaluation of quality becomes dependent on the information provided by the platform and on its reliability. In addition to these dynamics of risk-reduction, convenience also plays an important role in app-based purchases, as the platforms reduce search effort and simplify access to discounted products.

In accordance with [94], our findings suggest that perceived value emerges from how consumers balance expected quality, convenience and prices under contexts of information asymmetry and risk. FWRPs appear to mediate this relationship reducing uncertainty by informing product conditions, which supports consumers to evaluate whether the discounted price remains compatible with acceptable quality standards. Thus, in spite of the fact that price-quality factor is relevant in both contexts, in the app-based purchases it becomes particularly relevant in shaping trust, facilitating convenience and reducing uncertainty.

Previous studies also have found that price is the attribute that usually weighs to the greatest extent on respondents' choices [41]. One example is research about consumer demand on reused and remanufactured products, which showed that price was the factor with the highest importance [41].

Brand plays a central role in the purchase decision, providing consumers with a point of reference for trust and quality, for the confidence

of receiving something within expectations as discussed by [95], or even because the brand will meet a specific need, (in the case of people with specific diets, such as gluten intolerance): *"Since my daughter is celiac, then for me, the brand is important. So, looking at the brand, the price, because since it's gluten-free, everything is very expensive (#AppA-3)"*.

Furthermore, the reputation of the selling establishment and the quality of service offered play a crucial role in the consumer's shopping experience. Positive reviews from other users and a satisfactory service experience contribute to consumer trust and brand loyalty [96]. This (classification from other users) was mentioned by the participants when buying via apps.

Some interviewees expressed their preference for local products, which reflects their desire to support the community and reduce environmental impacts. Consumer preference for local food can be considered as a sustainable practice [97]. The motives for buying locally may vary and include freshness, taste, food safety, as well as support of the local economy [97]. One example of trust in quality is given by this interviewee: *"If I really need it and can't buy it through the app, I prefer to buy from local places in my neighborhood. So, my passion fruit, my banana, my tangerine are without pesticides. So, I'm a bit picky when I have to make this choice, so I try to buy from a certain shop, which doesn't have it for sale every day" (#AppA-11)*.

Consumer's decisions are also influenced by environmental concerns, changing their preference for products with environmental certifications and/or eco-friendly packaging. The integration of these aspects reflects an ethical stance aligned with sustainability values, winning over conscious consumers' preference [98]. However, in our sample, few participants (only 5 out of 26, and 3 of them in the group that knows CE) chose the presence of sustainability related labels (e.g., organic or animals well-being) as the main factor when purchasing. On the other hand, one participant contested the label value: *"Label, it's nice, but you know, there are many small producers who don't have it, and we know that a quality seal isn't synonymous, a quality label is paid for, right? Sure, there's a quality prerequisite, but along the way we know that Brazil doesn't have 100 % enforcement. So, I don't really believe in it much, to be very honest" (#AppA-2)*. Buying organic is not yet a common practice across all geographies and socio-cultural contexts, as highlighted by previous literature [83]. One reason for this might be that the sustainability related labels are not well-known by the population, so most people find difficulty recognizing, evaluating and using these labels in their habitual purchasing practices [99].

Other important considerations for consumer's choice are social issues such as child labor and modern slavery labor, reflecting companies' commitment to corporate social responsibility. Additionally, concern for animal welfare influences the choice of animal-origin products, highlighting the importance of ethical practices in the supply chain [100]. One participant for example mentioned she prefers to buy eggs of free-range chicken, but that sometimes she doesn't buy because the price is too high.

Other factors that were mentioned as influencing their purchase choice are nearby location, recommendation by friends, variety of products, expiry date, items of daily consumption and easy to sell (these two latter mentioned by one of the resellers). When we asked the participants if they seek for some attribute related to sustainability when buying via the app, most answered "no". Some justified they don't have time to do it. One participant also highlighted that the app is very limited and doesn't disclose criteria of sustainability, so he could not check environmental impacts, because this information is not available. In addition, some people who answered "no" added that if there was such information (e.g., if the package is 100 % recyclable, sustainable practices that the seller shop adopts) disclosed by the app they would consider this aspect in their purchase decision. Among those who answered "yes", one mentioned the free-range chicken eggs labels which she prefers, other example was if there was a label stating that the product was made by women's collective, another participant mentioned the involvement of the brand with social causes (support

**Table 3**  
Benefits caused by the apps according to the participants' view.

Category	Benefits	Representative quotation
<b>Don't know/not sure</b>	do not know about the practices of the restaurants/sellers; social benefits are not clear; the available stores do not attract all income levels; information is missing to know how the app helps	"I don't think these apps achieve all the income classes" (#AppA-7)"It is not clear for me where the donations go" (#AppA-4)" the information is missing to know how we are really helping" (#AppA-9)
<b>Environmental</b>	avoid food wastes; <u>less environmental impacts in the production and disposal</u> (use of resources, carbon emissions, odor); <u>avoid inappropriate disposal of wastes</u> ; less plastic and packaging use; save natural resources (e.g., energy).	"I think I help to reduce waste generation and consequently it decreases the inappropriate disposal of them" (#AppA-8). "The environmental benefit is to avoid the disposal of this product, all the energy and emissions in its production, so make this food to be consumed" (#AppB-5)".
<b>Economic</b>	financial benefits for sellers and consumers; revenue for sellers, income generation (e.g., reseller); job creation; reduce the costs in meals preparation and disposal costs; <u>improve economy</u> ; <u>benefits the whole value chain</u> ; encourage the restaurants to rethink the amounts (e.g., more efficient planning of demand).	"The products are more expensive due to the losses (food waste). Perishable goods are more expensive because there is a greater risk that the market assumes which is the risk of loss/disposal. So, if we reduce the losses, automatically this value should return back to us" (#AppB-5).
<b>Social</b>	<u>allow access to cheaper and quality food (healthier)</u> ; please my children (e.g., products that don't buy often); support small and local businesses; better well-being for the seller and everyone; <u>better distribution of food (food security)</u> , considering the social inequality and hunger problems in Brazil; more practical (home delivery)	"Social because give us access to buy organic food, which is difficult in Brazil due to very expensive prices. So, we have access to organic and better products" (#AppB-12). "I am a person with a better income level, but there are people who found out the app whose children did not eat yogurt and now they can thanks to the app, it is more accessible" (#AppB-2).

Notes: The quotation illustrated the highlighted benefit text.

cancer child organizations), and another interviewee expressed that she wished to know what the app does with what is left and not sold or after the expiry date. This is further discussed in Section 4.7 as a suggestion for improvement.

#### 4.5. Awareness about environmental, economic and social benefits from using the FWRP

The benefits that the participants perceive in using the apps are also related to their motivation for using them and their understanding about CE. As the environmental, social and economic dimensions are interconnected under the umbrella of sustainability, distinguishing them separately proves to be challenging. Table 3 provides all the benefits mentioned by the participants.

Most people believe that these apps provide environmental or economic benefits. However, in the case of App A, some users are not sure whether the apps provide advantages, mainly regarding to social aspects. Eight participants were not sure about the benefits or whether the app provides it. For example, as illustrated by the following quotations: "it is hard to answer this question, I would like that yes, but I am not sure" (#AppA-13). Then, this participant added that she believes that the app may cause food waste criticizing the surprise element model. She thinks the app contributes to environmental benefits only if the people consume what they buy. Three participants questioned about the social

benefits (examples in the row "don't know" of Table 3).

In the App B group, the users are more convinced about the benefits, all replied yes, some answered "Sure, absolutely". Interestingly, some users of App B don't know the environmental benefits provided by it, which could be linked with the less awareness and knowledge about CE when compared to the users of App A. Social benefits were highlighted by the users of App B, stating: (i) "There is a great impact in money savings of poor people" (#AppB-1); (ii) "This app allows people to experiment food that they would never be able to buy (afford). The cleaning lady who works for my relative told me that she made her Christmas dinner with all the products she bought from the app. She told me that she bought wonderful pies and invited her whole family to have dinner with her, because she could buy via this app" (#AppB-4). In both apps, people perceive economic benefits mainly due to the affordable prices of the products. One more specific example of economic benefit is to the value chain which was given by one participant (Table 3). A previous empirical study in Norway with FWRP did not find statistically significant differences in food expenses before and after the app trials [101]. Also, there was no statistically significant change in the healthy diet index in their participants [101]. Therefore, profiling the benefits is still complex and may vary depending on individual behavior.

One of the main issues with FWRP pointed by previous research is delivering more than economic benefits [18]. The identified environmental benefits are similar to previous finding by [102] such as more efficient use of resources and the lower emission of GHG by reducing organic waste disposal in landfills. The main social benefit found by [102] was the increase access of quality food at reduced prices, especially achieving low-income people. Consequently, this promotes social balance and societal well-being [102]. Social impact can also be achieved in social institutions with a tight purchasing budget to buy quality food such as organic [20]. However, such social benefits are achieved only if the apps prioritize these consumers in their business models [18]. This point could be related to the doubts raised by some of our participants about the existence of social benefits (Table 3, "don't know/not sure"), especially the claim that the stores available at one of the apps do not attract low-income people.

The low perception of economic, social and environmental benefits is one barrier to people use these apps [18]. We assessed only the users, but perhaps if they were more aware about the benefits, they would increase their use (frequency of purchase). Therefore, the assessed apps could contribute to disseminating information about the environmental, social and economic benefits of their activities to their users and public in general, thus attracting new users. These FWRP are often startups and have an untapped potential to influence the behaviors of individuals by facilitating and driving social and institutional changes towards a CE, for example, raising awareness [20]. Also, these FWRP bring more visibility to the food waste problem and could encourage the actors in the entire food system to take action, create strategies to avoid waste, and make changes [18].

Other benefits that were not mentioned by our participants are: the participating shops/restaurants could gain new customers; it is a tool for marketing their responsible and sustainable actions in a positive way; save time, since the user does not need to cook (for App A) [102]; and reduce GHG emissions due to less waste [17]. However, it is worth adding that the save time could be linked to the social benefit of the app being more practical, and the reduction of emissions were mentioned as part of environmental benefits, but in a more general way.

#### 4.6. Criticism: what could be improved in these initiatives?

Except for 1 participant (which was very satisfied with the app), all the others reported their main problems in using the app and highlighted some measures to improve them (Table 4). These results indicate barriers for using the apps since these are factors that the users do not like or wish could be improved. One of the participants, for example, mentioned the limited availability of product offers and shops in the app

**Table 4**  
Main problems with the apps and suggestions of improvement identified by the interviewees.

Category	Problem	Possible solution
<b>Availability related</b>	limited variability of options (offers and partner shops) incl. variability of items within the bag	when the customer buy two bags or more, diversify the items of the content of bags: offer more diverse products
	restricted days or times for ordering	-
	limited geographical coverage of the app (e.g., mainly in capitals)*	expand the app to other Brazilian States
<b>Price and delivery related</b>	long waiting time for the delivery or related issues	give a better prediction about the expected time for delivery, offer the possibility to choose a time range for delivery (e.g., morning, afternoon)
	have to collect (without delivery option)	offer more delivery options
	high fee of delivery or minimum purchase to have free delivery*	-
	high price of products/meals (e.g., if compared to a similar physical shop that sells product close to expiry date)*	decrease the price of products
<b>Environmental related</b>	packaging (e.g., be recyclable, use less plastic)	adopt a more resistant packaging that is recyclable (e.g., biobased plastic, biodegradable).
	environmental impacts of whole value chain (waste, pollution avoided/caused) are unknown*	disclose more info about the app concept, and how much waste is avoided.
<b>Product and quality concern</b>	product quality (i.e., could be better, ugly appearance), it also includes the service of staff* when collecting	more care with handling the product, e.g., offer to warm up the snack or meal.
	handling and conditions of transportation of the products (e.g., frozen food and safe/health concerns)*	improve the storage and transportation system, e.g., the food arrives defrost and the buyer has to refreeze, pack better delicate fruits, use boxes or more resistant materials for packaging
	too close to expiry day (sometimes at the same day)*	offer products at least one or two days before their expiry day
<b>Information related</b>	don't know exactly what will come in the bag (surprise element)	provide a better and more accurate description of what is in the surprise box (e.g., it is an appetizer, main course or desert), more diverse content, a picture of the item; offer 2 options-the surprise box and not surprise, offer a bigger discount in the surprise one
	inaccurate or incomplete information (i.e., product photo, description, quantity-product not available after order, expiry date)*	better description of the product ingredients or product conditions including those with "damages/defects"; better control of the stock
<b>Technology and technical support</b>	weak usability of the app (not easy the flow to order, edit order, limited options)*	add a filter option (e.g., type of offer, location), improve user experience
	temporary errors/crash in the app* customer support*	- quicker responses via chat

Notes: asterisk (\*) means when the problem was not listed in the question options, i.e., it was added by the participant. The two following options were not chosen: app instructions (e.g., how to pay, where to collect...); and it demands more time than if I go directly in the place to buy. The categories (in bold in the rows) were created by the authors based on coding and thematic analysis. The solutions in green were mentioned to contribute to CE based on participant opinion.

as an issue, and complemented: "I think this is one of the main reasons for me not buying more frequently with this app". In addition, some people prefer to make purchases in-person, for instance, one participant said: "I am not very much a consumer by apps, so I prefer to go to grocery shops to choose my food and so on, I have a street fair nearby home so I have this privilege of having it besides me" (#AppA-6).

The two participants who reported that no longer use the app (App A) shared the common point "do not know what will come in the surprise bag" as an issue. One of them highlighted that she has financial conditions to pay for the normal price visiting the restaurant, so she claimed she doesn't need the app, and as she had an inconvenient experience using the app she prefers to pay more (than the offered by the app) to buy at the time she prefers (e.g., criticism about the restricted time and days to order). The surprise element of App A was also criticized by some participants: "The surprise bag may contain several stuff that are not interesting for your use and it will end up as a new waste" (#AppA-13). Another participant mentioned she gave a break in using app B because of the

high fee of delivery. Regarding the high fee of delivery, other participant mentioned: "There is a shop you must buy over 500 BRL to get free delivery. Spending 500 BRL in products close to expiry date is a high risk" (#AppB-11). The solutions that the participants presented are available only in some cases.

As highlighted in Table 4 (marked with \*) some problems were added by the participants (i.e., besides the options already available as this was a multiple option question and, in such cases, they chose "other" and specified). For example, the complaints about care in handling and transportation: "I started to get upset because the fruits came packed like a tomato below the papaya, and then tomato arrived mashed. So, I got tired of complaining. I have to stop, take a picture and send it to the app, so I started to get a bit discouraged" (#AppB-6).

Problems in the category "technology and technical support" (Table 4) can be related to the effort expectancy component of the theory UTAUT2, which refers to the perception of the consumer of how difficult is using sustainable technologies, in this case the apps (FWRP).

For example, if the app is easier, the intention to use will be higher, as also usually found by other studies which assessed other sustainable technologies (e.g., for solar PV or smart-home/energy tech- [103]).

Overall, the main problems were the limited variability of options (offers and partner shops) including variability of items within the bag (12 responses), followed by high fee of delivery or minimum purchase to free delivery (8), product quality (7) and don't know what will come in the surprise bag (7). In App A, half of the interviewees mentioned the surprise element (i.e., "don't know exactly what will come in the bag") as one of the main issues. The other 2 main issues were limited availability, and product quality. In App B, limited availability, high fee of delivery

fee, and packaging were the main issues raised by the users.

Overall, the findings are consistent with those of [54], who assessed the consumer efforts in 20 apps in Europe and North America, including physical efforts, time, money and distress. Examples of physical efforts are the delivery problems, such as having to go out to collect the product. The technology and technical problems, the information related problems and product quality concerns could be linked to the distress dimension. These authors also found that the consumers of apps with similar characteristic face mainly distress and physical efforts. The possible solutions (Table 4) could help to reduce the consume efforts and mitigate the problems. Our findings on environmental related problems

**Table 5**

Suggestions to increase the contribution of the apps towards CE and sustainable consumption (by the participants who answered they knew CE) and the connection with problems and expected benefits.

Suggestion	Possible problems that will be reduced	Expected benefit to circular and sustainable consumption
Make partnerships with big brands (e.g., Carrefour, Pao de acucar...), increase the network of the app	Availability issues	Expand the coverage of the apps, with more partners and more customers.
Asking the customer to suggest a new partner shop		App gets <b>more inclusive</b> for people with dietary requirements
Include more brands and offers of products for people with diet restrictions (e.g., celiac disease, lactose intolerance)		Better <b>promotion</b> of the app, more awareness about the topic
Make partnership with neighborhood communication channels (e.g., instagram pages)	App is not well-known by most people	App could reach more people, <b>including</b> those who do not understand English (e.g., <b>low-income</b> )
App names are in English is not helpful to achieve everyone (people don't speak English), choose a Portuguese word and related to Brazil		Better <b>promotion</b> of the app, more awareness about the topic
Better promotion of the app mainly in social media		
Organize meetings in squares and public parks to promote awareness of people about sustainable consumption and Circular Economy, including info about the app	Environmental concerns	
Partner with bike delivery services and prioritize it, except for higher distances (e.g., above 5km)		<b>Reduce environmental impacts</b> , promote more <b>awareness</b> about the topic
Monitor their performance on environmental benefits involving their suppliers		
Provide the data about their environmental benefits to the customers (how many tons of waste avoided, impact to improve wellbeing...)	Social concerns	The user <b>can understand better</b> (it could be an option for user who wishes to know more information)
Share knowledge about the benefits of the app, highlight within the app what CE means, the goals of CE and how this could achieve more people, sharing this information		Better <b>work conditions</b> for delivery staff
Make partnership with a delivery app that has social concern and fair work conditions for delivery staff		<b>Help population</b> , providing food and avoiding waste
Donate products that couldn't be sold to avoid waste, e.g., during meetings within the communities	Price issues	<b>Attract more customers</b> and keep the existing ones
Offer advantages and memberships for customers who buy often (e.g., gift or discount), establish customer loyalty programmes/measures (e.g., rewards)		
The app could control/follow better the partner shops by visiting them (e.g., check how they are packaging, quality standards)	Product quality concerns	Ensure a <b>good service</b>
Have an assessment of the quality, asking the customers to rate the partner sellers based on criteria		
Accept payment with meal allowances	People don't buy via the app frequently	<b>Encourage</b> the regular use and to attract new users

add to the previous empirical findings in the field of consumers and CE and indicate the critical view of the participants about the environmental benefits of the Apps (this point is further discussed in the next section).

#### 4.7. Suggestions for enhancing the contribution of these apps towards CE and sustainable consumption

Several suggestions were made by the participants who claimed that they know what CE means; this was a question only for such participants (Table 5). One participant did not have suggestions to improve CE and expressed his opinion that considering the nature of the app and its business model he didn't think the app could do other actions such as including local producers, and that this would be another app and with different target users.

The name of the app being in English was mentioned by some as an issue, one participant claimed (#AppA-8): *"There are many more people who don't speak English than those who speak, so the app becomes very niched. Because you would offer the opportunity to buy of nice restaurants for affordable prices it could include other people. Sometimes the app will not achieve those group of people because its name is in English"* (referring to low-income people and that would not buy for the normal price).

Some of the suggestions to improve the impact to CE are related to promote awareness and environmental education, as illustrated by this participant: *"They could tell us what is the purpose of the app, not that I have to discover about the app through and influencer in social media. I saw it by chance... The app could tell me what its impact is to keeping the environmental quality or reduction of damages or whatever, but that this app does besides selling"* (#AppA-11).

The need for improvements in the apps was also raised by similar research in the literature, for example, Jesus and Jugend [104] highlight the importance of consumer awareness of CE. This could happen through more interaction between companies and consumers and may empower the sense of responsibility consumers share, as well as contributing to a better planning of environmentally sustainable product lifecycle. Both apps do not provide more information about food waste and what people can do to reduce it. App A when is installed and open for the first time mention the general information of how much of the food is wasted and that by using the app the user can contribute to save surplus food and avoid waste. Also, App A shows two indicators: number of bags saved and kg of avoided CO<sub>2</sub>. These are updated after every purchase. However, there is no information explaining how this (emissions saved) are calculated. Another feature also by App A is that the bag contains a QR for information on recipes generator (so the person can have ideas on what to cook with the ingredients which came in the bag). App B informs that the customer contributes to avoid food waste when he/she install it, but no information about the topic is provided during the purchasing process. It is worth to noting that this was based on our experience using the apps to complement the data about available information. So, the users did not mention these two features, which might indicate that this is something more recent or not easily perceived/findable in the apps.

Our results are novel and allow to better understand the social impact of initiatives considered circular, such as the apps (FWRP) and how they help to raise consumer awareness. This is called by [105] the cultural impact of CE, i.e., transferring knowledge and raising customer awareness. Some of the suggestions made by our interviewees are about the apps improving communication and offering more channels for the consumers to participate. This is aligned with what is mentioned by the literature, where is often highlighted that more consumer awareness of CE contributes to facilitate the transition towards CE (e.g., [103]).

## 5. Conclusions

This research examined how consumers of FWRP interpret and implement CE in their lifestyle, especially regarding food consumption,

which factors influence their purchasing decisions, and which circular practices they adopt across consumption stages. The results show that FWRP users are predominantly women, aged 30–40, with higher education and higher household income. Regarding knowledge of CE, only half of the participants reported being familiar with the term and its meaning. However, even those who made guesses, mentioned elements related to CE. Most participants primarily associate CE with social issues, viewing it as something that contributes positively. Price, product quality, and brand emerged as the main determinants of purchasing decisions (either via app or in person), indicating that environmental and social considerations remain secondary. Participants, nonetheless, reported engaging in multiple circular practices throughout food planning, purchasing, storage, consumption, and disposal. Finally, several communication and operational improvement opportunities for the FWRP were identified, including raising awareness about the benefits of the apps, evaluating the impacts avoided through app usage, expanding publicity to attract more users, and increasing the network of partners and coverage throughout Brazil. These results underscore the role of FWRPs as intermediaries that enable circular practices even in the absence of strong conceptual engagement with CE.

In addition to the empirical insights, this study contributes theoretically by advancing a consumer-centered perspective on CE. By exploring FWRPs as intermediaries within CE systems, the findings highlight how digital platforms mediate the translation of abstract CE principles into everyday practices. The strong association between CE and social benefits identified among consumers suggests that the social dimension of CE may be more salient and accessible than its environmental or economic dimensions, particularly in developing-country contexts. This challenges dominant CE narratives that prioritize efficiency and resource optimization and points to the importance of social framing in fostering consumer engagement. For policymakers, these findings indicate that CE-related interventions may gain greater traction when aligned with social outcomes such as inclusion, food access, and community benefits. For practitioners and platform developers, the results offer guidance on how communication strategies, platform design, and outreach efforts can strengthen user engagement and expand participation, especially among currently underrepresented groups, such as low-income people. Our findings on consumption motivations and perceived benefits and challenges of the apps can guide food waste reduction efforts and consumer engagement in countries with similar development levels.

This study is, however, limited by its sample composition and focus on current FWRP users, which may not represent perceptions and behaviors of non-users and former users. Future research could, for example, compare these groups, explore motivations for adoption and discontinuation, and examine whether the social framing of CE holds across other developing and developed countries. Quantitative studies with larger samples and user clustering could refine the understanding of consumer segments. Additionally, studies involving FWRP staff could provide complementary insights into platform operations, impacts (e.g., increasing reputation), and scalability. Broader investigations into circular behaviors, beyond food consumption – such as mobility, household resource use, and lifestyle practices – would further enrich understanding of consumer contributions to the CE.

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## Ethical approval

As required by the Brazilian law, this research proposal was initially submitted to ethical evaluation by Plataforma Brasil (a national platform), through the Ethics Committee of EACH/USP (School of Arts, Sciences and Humanities of the University of Sao Paulo) and was

approved (CAAE 74844923.9.0000.5390). Before starting each interview, the consent form was shared with each participant for their knowledge and approval.

### CRedit authorship contribution statement

**Mariana Cardoso Chrispim:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Alexandre Rodrigues da Silva:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis. **Tania Pereira Christopoulos:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Conceptualization. **Tomás B. Ramos:** Writing – review & editing, Validation, Methodology, Formal analysis, Conceptualization.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.sfr.2026.101742](https://doi.org/10.1016/j.sfr.2026.101742).

### Data availability

Data will be made available on request.

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