



Research article

Measuring consumer effort in circular economy initiatives in the food domain: An exploratory analysis

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ABSTRACT

The transition towards a Circular Economy (CE) system requires a change in consumers' behavioural pattern that implies a certain level of effort which, in turn, could affect initiatives' success. Although consumers' role in CE is increasingly drawing the attention of scholars, limited knowledge is available on the evaluation of consumer's effort in CE initiatives. The current research provides an identification and measurement of the core parameters affecting consumer effort, offering a comprehensive Effort Index applied to 20 CE companies operating in food domain. Companies were classified in 5 categories (Quantity of food, Appearance of food, Edibility of food, Living with food and Local and sustainable food); the analysis of the companies revealed 14 parameters building the Effort Index. Results showed that initiatives ascribable to the category "Local and sustainable food" require higher levels of consumer effort; in contrast, case studies belonging to "Edibility of food" group are less effort-requiring.

1. Introduction

Circular economy (CE) promotes a model in which the concept of waste is phased out by transforming it as nutrients circulating within infinite technical and biological loops [1,2]. Put differently, CE takes inspiration from natural processes where biological and organic materials complete continuously their cycles: what an organism or process wastes becomes a nutrient for another one [3].

The implementation of CE in the agro-food sector represents a great opportunity for transitioning into a food system that may help to achieve sustainable models of production and consumption [4–9]. As for the latter, the most frequent circular initiatives in the food sector are those aiming at reducing the amount of waste by recycling food as nutrients, and making by-products out of them [4,10]. To illustrate, a recent stream of literature is mostly focusing on topics investigating food waste in food supply chains [4,11,12]. The issue of food waste is at the centre of the scientific debate because data reveals that an amount between 30 and 50% of food intended for human consumption is wasted, with a global cost that is estimated to be around a trillion US dollars [4,9,13,14].

Even though the interest in CE in the food sector has upsurged recently, most of the attention has been focused on the production side [15]. According to Kirchherr and colleagues [16], less than 20% of scientific publications tackle consumer role in CE transition, highlighting the urgent need for a deep understanding of consumers' engagement in circular initiatives [17–20]. Previous literature on consumer's side, in fact, has been focusing the attention mainly on the understanding of factors influencing individuals' participation in CE initiatives instead of analysing how consumers are practically involved in circular processes, what is their role, and what is requested to them in these processes. Specifically, a detailed review conducted by Camacho Otero and colleagues [18] classified

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studies on consumers showing that the themes mainly investigated by researchers were: *barriers, drivers and motivation of consumers participation in CE* [21,22]; *consumers attitudes towards circular solutions* [23,24]; *consumers typology* (showing typologies of consumers linked circular solutions) [25] and *incentives for acceptance* (external strategies aiming to improve consumers acceptance of CE) [26]. Gomes and colleagues [20], in a more recent literature review, analysed consumers' circular mindsets, circular behaviour (the realization of circular mindset), and influencing factors emerging when consumers decide to be involved in circular consumption systems. Results showed that, driving by mindset as starting point and pre-disposition, consumers make their circular behaviour (e.g. acquire recycled products, maintenance of products, tacking back products, reusing goods [...]) which can be affected by several factors (political, economic, demographic [...]). The outcome is a comprehensive investigation on circular consumption system. However, what is still unclear is the perceptions of practical involvement and effort required to individuals when they decide to embrace circular behaviours. The transition towards a CE system and the success of related initiatives, indeed, depends on consumers' willingness to change their routinized behaviour at different stages of their everyday life, such as decision-making at purchase and/or end of life management moments [19,27–29]. Consequently, the theoretical precepts of circular economy have brought to light an innovative image of consumers strongly involved in new practices, such as participation and sharing practices, new ways of recycling, taking back systems or returning products that clearly imply an active engagement and a certain level of effort [19,30,31]. Nevertheless, how to explore and measure this effort, and understand what kind of companies/organizations - following circular principles - require higher levels of consumer effort are relevant aspects that, to the best of our knowledge, are scantily investigated in the scientific literature.

Tunn and colleagues [32] defined consumer effort in CE as one of the four business model elements relevant for the achievement of CE and sustainable consumption patterns, together with resource strategy, revenue model and objective at consumption level. Moreover, when a new system of supply is developed, it is crucial to consider the level of effort required by consumers, as they compare "the new with the old way" in terms of effort required [15].

The relevance of consumers effort in the CE debate is already highlighted in recent literature. Hoffman and colleagues [33] stressed how the evaluation of effort required in CE initiatives could determine the failure of circular practices. Authors highlighted that, at consumption level, business models, that have the ability to reduce the amount of effort required to consumers, are evaluated as the most promising for transitioning towards CE models. To illustrate, CE solutions push consumers to move away from traditional habits bringing them in a new and different experience that require, almost always, more involvement. A more recent work conducted by Guyader et al. [34] tried to analyse consumers' evaluation when involved in a CE experience; results have underlined the main role of effort, indicating that consumers' assessment was negatively influenced by the superior level of effort required compared to the traditional one. This aspect reinforces the trade-off between consumers' acceptance of CE initiatives and the "amount of extra effort required" that may compromise the success of circular business initiatives [33,34]. Another relevant issue relates with the wide range of literature that has focused the attention mainly on recycling activities as the core CE practice conducted by consumers, not considering that there are an extensive range of circular sustainable behaviors proposed by circular initiatives that, in turn, require extensive time and effort. Therefore, evaluating consumer effort starting from the analysis of CE initiatives operating in the market is clearly a core concern for practitioners and policy makers interested in fostering CE. Nevertheless, to the best of our knowledge, no research has attempted to define effort considering real-world business initiatives.

The objective of current research is to fill the gap regarding the analysis of effort in circular initiatives and provide a broad definition of the core parameters of consumer effort in CE companies operating in the food domain. These parameters, declare or "dimensionalize" effort and seek to generate, for the first time, an effort index throughout an inductive process starting from a set of observations of CE real enterprises. The innovative contribution of the current research, as compared to previous scientific studies, is the "case studies centric approach" adopted, that tries to define how consumers embrace CE practices and how to decompose the effort spent [34,35]. To do so, several recently born circular companies have been analysed; in detail, we selected twenty western companies mainly operating in tackling food waste issues and applying CE principles. Using the method validated by Narvanen et al. [36], we classified the case studies in five groups according to the circular practices they developed. For the analysis of effort, we took the classification provided by Howie and colleagues [37] according to whom cost associated with personal effort can be examined in terms of four dimensions: *physical energy, distress, money, and time*. Throughout the deep analysis of the twenty case studies in terms of their organization, the way they operate and, especially, how the organization involves consumers in the process, we have extrapolated 14 core parameters necessary to measure the amount of effort required to consumers; each of the 14 parameters describe and represent a peculiar aspect related to one of the four effort categories. The novel result of current research lies in providing, for the first time, a measure of consumer's effort to be used as a tool to classify circular initiatives and companies according to the level of effort required to consumers. Findings could foster these circular initiatives development and promote their up-scaling. As for the latter, it is important to reiterate that, the understanding of consumers' effort is relevant because it also impacts individuals' evaluation of the underlining product [38–41].

Current study is based on a qualitative research methodology with multiple-case study approach [42]. Case study research is well suited in the attempt of digging into a phenomenon rather than in the context of testing established frameworks [36].

The paper is organized as follows. In the next paragraph each step of analysis is described together with the methodology applied for the measurement of consumer effort. In paragraph 3 the concept of consumer effort is defined, and how it is operationalized in the academic debate. Moreover, the classification of effort dimensions according to Howie and colleagues [37] are depicted. Paragraph 4 is dedicated to the description of the origin of the parameters, that measure the level of effort in our case studies. Subsequently, results are presented and discussed; finally, concluding remarks and future research avenues are provided.

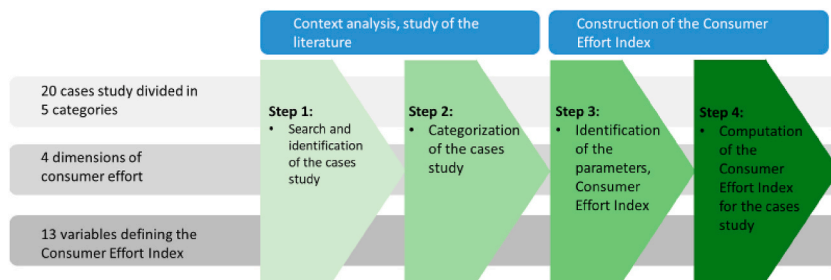


Fig. 1. Graphical representation of each step of analysis.

2. Analysis development

In this paragraph we illustrate each step of analysis of the present study from the beginning of the data generating process to the application of the methodology applied to build and measure the effort index proposed (Fig. 1).

In the first step the selection of case studies was performed. Recently a growing number of sustainable and circular companies have flourished. Most of them act considering the CE principles according to which, what is perceived as waste for one firm may become a resource by another [43]. Therefore, in this phase we were continuously concentrated on monitoring and observing several sources of information such as online websites and media/social sources, to find active circular businesses in the food sector. Particularly, we focused our attention on the search of companies operating in Western Countries with the objective of preventing food waste as well as fostering the reuse of it for human consumption, and more in general of companies that operate within circular economy principles. Moreover, we referred to recent literature reviews to retrieve scientific papers that have presented circular real case studies [36,44]. Results of this search provided 20 circular companies which constitute our sample of case studies; through their websites, web news and scientific papers we understood how companies operate, the rules of their organization, how they addressed the issue of circular practices and how the organization involved consumers in the process or put differently, which are the set of activities, decisions, and behaviours required to consumers. Table 1 briefly describes the 20 case studies analysed.

Table 1
Country of operation - Year of establishment and description of case studies.

N° Cases	Description
Case Study 1	(Denmark – 2015) it is an on line app that connects costumers to restaurant and shops to sell leftover of food products.
Case Study 2	(Finland - 2015) A start-up company, born in 2015 that to sell on line food services leftovers meals to consumers at a discount.
Case Study 3	(UK- 2015) This company, established in 2015, allows shops to offer, throughout a mobile application, their surplus food that is redistributed to consumers. Consumers could be active in the process using the same app to share their leftover food.
Case Study 4	(Finland – 2016) Online discount selling packaged groceries at waste risk from other Finnish food industries, importers and wholesalers.
Case Study 5	(the Netherlands – 2014) A company that uses surplus food from local supermarkets and other producers to cook dishes to serve in their restaurants or food truck.
Case Study 6	(Portugal –Not available) This company delivers fresh fruit and vegetable boxes containing surplus and out-of-spec produce that is rescued directly from farms via a weekly subscription service.
Case Study 7	(The Netherlands – 2012) A social company that produces soups from misshapen vegetables collected from growers.
Case Study 8	(Germany – 2014) This company uses ‘deformed’ organic fruit and vegetables from farmers to resell them to business customers.
Case Study 9	(France – 2015) A start-up that produces jams from surplus fruits and vegetables from shops.
Case Study 10	(Italy – 2000) A start- up with an on line platform that redistributes leftover and misshapen veggies and fruits to costumers. The initiative works with a subscription of big or small boxes that are delivered directly to home.
Case Study 11	(The Netherlands -Not available) A company that produces veggie soup with leftovers of producers and wholesalers.
Case Study 12	(United States – 2018) This start-up, this company offers a Smarterware system, a stock management app for the home, that helps consumers to avert food waste.
Case Study 13	(Italy – 2015) application for sellers to offer products about to expire. Also, the company offer a waste management system to monitor their stock.
Case Study 14	(Bulgaria – 2017) A mobile application that helps consumers to manage their shopping and stocks.
Case Study 15	(Germany -Not available) The company sells food that can be visually unappealing, mislabelled, or close to the best-before date. Products are sold on line and in dedicated supermarkets.
Case Study 16	(Italy -Not available) the initiative has the scope of promoting a different model respectful of biodiversity and health. The work condition of farmers, the rights of consumers have a leading role in the initiative, indeed consumers are considered as co-producers and are involved in the certification of products and in the projects.
Case Study 17	(The Netherlands -Not available) A CSA with approximately 200 families members. Members decide what they want to eat from their farm; they employ a farm and, in case the families want to help with harvesting, this is possible.
Case Study 18	(The Netherlands -Not available) A farm near to or in a city where pigs are fed with residuals products from breweries. Pigs eat (food) waste from the city (bakeries, supermarkets and cheese farmers). Residents also help to keep the pigs. In the end, when the pigs are slaughtered, the pig meat could be eaten during activity.
Case Study 19	(Canada - 2011) It is a local urban farm that delivers directly to customers thousands of food baskets filled with our rooftop-grown veggies. The vision is to create a better food system, promoting rooftop farms and local agriculture (farmers and food makers) in all shapes and sizes and creating a community of pick-up points to deliver all this food as directly as possible.
Case Study 20	(Germany – 2012) Initiative against food waste. The scope is to save “unwanted” food and in excess food from families and firms. The sharing of food works throughout an on line platform and members are volunteers and for free.

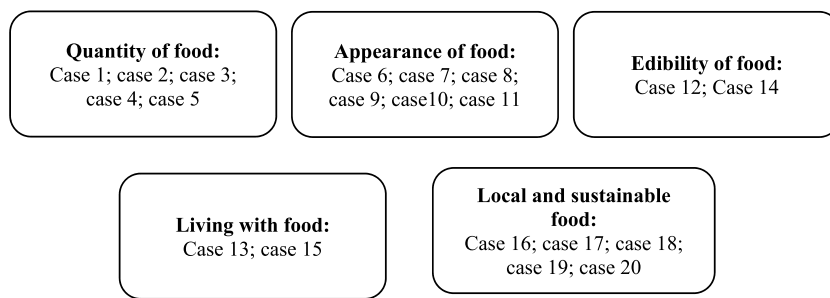


Fig. 2. Categorization of cases studies (adapted from Narvanen et al. [36]).

In the second step of analysis each case study was categorized applying a method adapted from Narvanen et al. [36]; authors defined four categories capable to classify all circular food case studies according to circular practices developed: *i. Quantity of food*, *ii. Appearance of food*, *iii. Edibility of food* and *iv. Living with food*. To increase the scope of initiatives to these categories we added a fifth category, named *local and sustainable food* that includes initiatives of Alternative Food Networks or sharing local food communities. Practice of food provisioning participating in Alternative Food Networks, such as Community Supported Agriculture or Short food chains (e.g. farmers markets), have been defined in recent literature as examples of circular food initiatives due to the benefits that implementation of these peculiar organizations of food production and consumption generate in defining patterns of sustainable development [4,31,45,46]. Hereafter we shortly describe each of the five identified categories.

Quantity of food: in this category we insert companies that induce the circular behaviour of “purchasing innovative products or up cycled food products”, “digital platforms and e-commerce fighting food waste” and “purchasing waste to value food” [46,47]. More specifically, companies in this group use surplus of food and food waste at different stages to sell them and to create new products. Some of them also use digital platforms to connect different stakeholders in the process [36,48].

Appearance of food: the aim of these initiatives is to address the circular practice of “purchasing food with a non-standard aesthetics or surplus food” [46]. The scope is to sell products rejected by retailers due to the anaesthetic aspect of foods (for example misshapen fruits and vegetables).

Edibility of food: this category is devoted to reducing waste by extending the life of food products through technological devices. Initiatives in this group specify the edibility of products to manage rationally stocks at home. An example of circular practice conducted by consumers in this group of companies is “the monitoring/storing food in specific and particular container” [49]; the scope is related to the need of redesigning some food provisioning practices that lead to high food waste, such as storing and serving food [50,51].

Living with food: companies included in this group act considering consumers’ circular food practice of “purchasing soon-to-expire food” [49] helping retailers to collect potential food waste and products that are near to expiration date, to resell them to final consumers.

Local and sustainable food: the last group of companies include examples of CSA, community of food sharing, farmers market that represent approaches to stimulate the transition towards CE. Circular practices carrying out by case studies in this group are “purchasing local and seasonable food”, “participating in alternative food network or Short supply chain” and “sharing food and in excess food within a community” [46,49]. Reconnecting the place of production and the place of consumption, these companies present several advantages including reduced packaging, reduced waste, enhanced product freshness and a shorter supply chain [4]. The categorization applied allows each case study to fit only into one of the five categories of circular food initiatives (Fig. 2).

The third step of research represents the core of the present study with the construction of the Consumer Effort Index (CEI) throughout the identification of the parameters that better describe and decline effort in our circular case studies. The fourth step consists in the data analysis with the evaluation of the CEI for each case study.

3. Consumer effort: definition and classification of components

Consumer effort is a broad concept, and it is subject of several fields of scientific research. In order to better define, and size to our scope the concept of consumer effort, we focused on scientific literature coming primarily from economics. Nonetheless, notably important insights regarding the same concept have been brought also from psychology [52], and neuroscience [53]. The first of the two disciplines in particular, provided an initial, general definition of effort. In accordance with Eisenberger [54], effort can be seen as an intensification of activity, that individuals apply toward some outcomes. In our case, we intend consumer effort as the intensity of work that consumers, apply to engage in circular initiatives in the agro-food sector. Different studies specifically focused on consumers, have shown the negative reflection effort has in terms of willingness to buy or to participate in consumer-related activities [55,56]. For instance, Howie et al. [37] illustrate how consumers may apply defensive denial, a psychological defence, in order to avoid effort. However, to some extent, consumers’ effort can also be perceived as a value, and not as a cost. An example of this unusual case is documented by Norton et al. [57], where the “Ikea effect” is described. This underlines how coproduction, hence effort required by the consumers, has become one of the peculiar and extensively accepted characteristics of the company Ikea in which consumers often need to complete the assembly of their goods. Consumer effort, related to CE activities, can arise in different moments and distinct

situations. Consumers can be asked to recollect their product from the producer or to acquire second-choice food. These are only two examples of how consumers may experience very different types of effort. In the first case, effort can be intended as the consumption of time and fatigue deriving from the transfer to the producer. In the latter, consumers are faced with the intangible effort of renouncing the first-choice food. Thus, consumer effort can be further described by identifying all the important dimensions that jointly compose it. We, therefore, will use these to “dimensionalize” the consumer effort. Several researchers have already identified these dimensions leading to similar results. While there is a certain agreement on the physical dimension of effort [58,59], Cardozo in 1965 [58] included a financial (money) dimension. Finally, Piliavin and colleagues [59] identified other two dimensions: time and distress. Howie and colleagues [37] used the four dimensions of effort jointly: physical, time, money, and distress.

These dimensions can be seen as the principal resources invested by consumers in participating in CE activities in the food sector. We choose to consider the four dimensions of effort together (physical, time, money and distress), as suggested by Howie and colleagues [37], with the aim to better classify the effort required to consumers in the circular businesses of the sample. Going into details of each dimension, the physical dimension includes physical actions needed to participate in a specific CE activity, such as transfer to a specific place or simply cleaning vegetables. The time dimension encloses all the necessary amount of time spent in the CE activity, this can be due to taking part in the organization of the CE activity or just due to participate in the activity, such as time spent in the learning processes. The money dimension, instead, refers to the monetary expenditure required by individuals besides the purchase, as the subscription cost; often these expenditures are meant as consumers’ risk sharing. Finally, the distress dimension includes all the uncertainty and anxiety that can be caused by the CE activity, for example in some CE activity participants do not precisely know the quality and quantity of the product purchased. Each of these dimensions of effort has been investigated using a list of parameters emerging from the analysis of the set of activities, decisions, and behaviours required to consumers in the case studies (more deeply explained in the next paragraph).

4. Methodology: the construction of a Consumer Effort Index and its measurement in CE initiatives in the food sector

The lack of a validated direct measure of consumer effort in CE initiatives in the food sector highlights the need of an exploration of the concept. For that reason, a conceptual thinking and theory-building approach fits best the aim of the current study. Our analysis led primarily to the construction of a CEI and, subsequently, to a first assessment of it. The formulation of the CEI followed two consequential, complementary paths. The first led to the identification of statements, parameters that contained all the important facets concerning consumer effort in participating in circular economy initiatives, emerging from the analysis of the initiatives themselves. The second path involved the application of this statement-formed index to the cases study identified, to verify whether the parameters effectively described all the selected initiatives. The identification of the statements involved the group of researchers’ authors of the current paper who, independently, analysed the cases study selected and proposed, for each of the four dimensions of the consumer effort, a list of sentences that described the effort-producing factors characterizing the case studies. Researchers, in this step, worked individually to produce a personal list of parameters. Subsequently, these parameters were discussed collegially, grouped, and cleaned from redundancies. Moreover, the sentences were rewritten in order to obtain dichotomous possible answers, *i.e.*: every sentence could (or could not) apply completely to each case study. Then, a second round, in which researchers reviewed the group of sentences, was performed. This first path ended with a list of 14 parameters divided throughout the consumer effort dimensions as follows: 3 parameters regarding the physical dimension, 2 the time dimension, 2 the money dimension, 6 the distress dimension. The full list of parameters is reported in Table 2.

The sub-categories are differently represented, 3 parameters are sub-categorized as Physical, 2 as Time, 2 as Money, and 7 as Distress. Given the innovative and explorative nature of the present study, the authors decided not to assign specific weights to single parameters, excluding an order of importance or differentiation in the level of effort required per each. Therefore, all the parameters are dichotomous; the majority of these indicate an increase of effort, while three of these (*i.e.*, *Incentives such as discounts or promotions and discounted prices*, *Possibility of obtaining complete information about the purchased product* and *Possibility to decide the exact quantity of the product*) have an opposite direction in terms of required effort. Hence, while for the latter three parameters, the CEI increases by one point if these are not applicable to the activity being studied, for all the remaining parameters, the CEI increases by one point if these are applicable. A first assessment of the CEI was the subsequent step. Researchers evaluated the case studies through the list of effort parameters previously identified (Table 2). Authors once again worked independently from each other and produced a personal evaluation of the case studies. This step led to evaluate whether or not the constructs were easily applicable, comprehensible and if it led to consistent results if applied by different individuals.

Finally, parameters that do not apply to any case studies, were removed leaving only those that apply at least to one case study. The definitive CEI applicable to Circular Economy initiatives in the food sector goes from 0 to 14 (where 0 means minimum effort, and 14 maximum effort) and is divided into four sub-categories, according to Physical, Time, Money and Distress dimensions.

5. Results and discussion

New consumption practices falling inside the circular economy expect consumers to adapt their behaviors towards a more sustainable act of consumption that involves extensive time and effort [34]. As stated by Hoffman and colleagues [33], consumers’ evaluation of effort in CE initiative is a fundamental aspect that could determine the failure of circular practices. This paper responds to the call of recent literature to enhance understanding of circular economy practices in terms of consumers’ effort, offering a measure of an effort index applied to twenty examples of Circular economy initiatives operating in the agro-food system. Findings presented hereafter, provide a rank of the 20 business initiatives in terms of the highest and the lowest level of effort; outcomes should represent a

Table 2
Parameters building the CEI.

Parameter	Dimension	Description
A transfer is necessary to take the product/use the service.	Physical	Product delivery is not organized, hence physical movement is required. This could end up being time and money consuming e.g. farmer's market in a particular place far from the house.
A transfer is necessary to return part of the product.	Physical	Once the product is consumed, or used, part of it has to be taken back to the seller. e.g. Reusable packaging such as cans.
Product cleaning, washing or inspection required.	Physical	Before use, food products may need an inspection to remove non-edible part, for example when dealing with raw food or second choice vegetables.
Time dedicated to the project, besides purchasing.	Time	Total time consumed in activities related to the product (e.g., harvesting vegetables in community-supported agriculture).
Moments of sharing, lessons involved in the project.	Time	Time consumed in cooperating with other partners of the project, or time consumed in learning processes.
Money invested in the activity besides the purchase – Risk sharing.	Money	Besides the money spent for purchasing the product, a common practice sustains a cash fund to minimize the business risk.
Incentives such as discounted prices.	Money	This parameter could apply to general promotions offered and also to product sold at a low price compared to the market. e.g.: Food sold near to the expired date at a lower price.
Possibility of obtaining complete information about the purchased product.	Distress	In some case studies, the offered products may not be known at the time of purchase. For example, several case studies sell box of mixed vegetables where the buyer knows just partially the content of it.
Possibility to decide the exact quantity of the product.	Distress	This parameter describes the situation where the consumers could not decide the exact quantity of the product to purchase. This could happen for several reasons, e.g.: food near to expired date usually has a limited quantity, or food acquired in mixed box of different weights.
Limited variety of choices.	Distress	In several case studies, consumer may not have a large variety of products to choose from.
Purchase only on specific days.	Distress	Purchase is limited to specific, usually predefined, days.
Long waiting time to obtain the product.	Distress	Particular delivery services and time needed to prepare the product may result in a long waiting time by the consumers
The product may be close to deterioration.	Distress	Some case studies, for environmental reasons, sell food that may be close to deterioration or partially deteriorated.
The product comes from waste, by-products or unsold.	Distress	Selling, or encouraging the consumption, of food that otherwise would be waste

starting point to discuss about possible barriers consumers could experience in the CE, to promote these circular initiatives development, and suggest interventions to support their improvement and up-scaling.

The results of the evaluation process of the case studies through the selected effort parameters are reported in Table 3. Among all the case studies, the case study 20 - a German initiative of food sharing among community - and the case study 3 - an English company that redistributes surplus of food to consumers throughout mobile app - scored the highest index value (10 points). Followed, with a total score of 7, by Case study 17, a Dutch CSA with approximately 200 family members. At the base of the effort index ranking, we found two initiatives belonging to “Edibility of food” category, such as the Case study 12, an US start-up that offers a home stock management to avoid food waste, and case study 14, a new mobile application that helps consumers to better manage home food. These two cases scored just one point, appearing the less effort-requiring among the Circular economy initiatives in the food sector. None of the dimensions is present in all the case studies, indicating the variability in terms of the type of effort, among the different case studies.

Dwelling deeper in the results, and focusing on the top of the ranking, the CEI showed that initiatives ascribable to the category “Local and sustainable food” generally need higher level of effort (case studies 20 and 17). This finding is consistent with the engagement and the behaviour of consumers that participate to these initiatives. Consumers, called “members”, shape a community-based group and are actively involved sharing interests, values and common actions such as co-production, distribution of food products, or marketing-oriented actions [60]. Moreover, members invest money and share a certain level of risk with the organization [61].

In contrast, “Edibility of food” - with case studies 12 and 14 - seems to be the less effort-requiring category. This result is in line with the scope and the mode of operation of initiatives belonging to this class. Companies that want to operate in the light of “Edibility of food” principles have the scope to prevent and avoid food waste offering technological devices or Apps to manage home food stocks. Consumers who decide to use these Apps are advised on which foods or products are next to the expiration day or must be eaten before they go waste.

The effort required in this case is mainly materialized with the storing of leftover food inside the containers. In this manner foods are being tracked in the app on mobile phones and it is easy to remember to eat them (the light ring on the SmartTag moves from green to yellow to red as food sits in the fridge).

Practices undertaken in the domestic sphere with the objective to avoid the production of large amount of waste are comprised in literature as a “circular food consumption practices” [62]. More in detail, the practices of storing of food classifying them according to their expiry dates or using reusable packaging to store foods are considered fundamental elements in the shaping of circular food consumption, contributing to right material flows that is the main principle of circular economy [62].

Fig. 3 presents the mean scores achieved by Case studies belonging to the five categories, i.e.: “Edibility of food”, “Living with food”, “Appearance of food”, “Quantity of food”, and “Local and sustainable food”.

The highest average score is reached by “Local and sustainable food” initiatives followed by “Quantity of food”, “Appearance of

Table 3
CEI scores among case studies..

Case study N.	Dimensions				Total CEI score
	Physical	Time	Money	Distress	
3	2	2	1	5	10
20	2	2	1	5	10
17	2	2	2	1	7
16	2	1	1	2	6
1	2	0	0	4	6
10	1	0	1	4	6
6	1	0	1	4	6
7	2	1	1	1	5
8	2	0	0	3	5
2	2	0	0	3	5
18	0	2	1	1	4
13	2	0	0	2	4
11	1	0	1	1	3
5	1	0	1	1	3
15	1	0	0	2	3
9	1	0	1	1	3
4	0	0	0	2	2
19	0	2	0	0	2
12	0	0	1	0	1
14	0	0	1	0	1

food”, “Living with food” and, at last, with the lower means score, by the category of “Edibility of food”. Going in detail in the composition of the Effort Index (Physical, Money, Time and Distress component) for each category of companies, results showed that in the “Local and sustainable food”, “Quantity of food” and “Appearance of food” each of the four components of effort are present with different levels of intensity. In the Local and Sustainable food category it is possible to underline a homogeneous distribution of each effort component with a slightly higher presence of “distress” and “time”. The component “money” is present in each category of case studies except for the category “Living with food”. The majority of start-ups working in the Circular economy principles are indeed based on a monetary risk sharing such as the presence of annual or periodical subscription at the beginning of the contract with the company. On the contrary the “money” component has a negative impact on the Effort index in the case of discounted prices for consumers that decide to buy circular products (e.g., products next to the expiration date). The “physical” components of effort are observed in each category except for Edibility of food; this result suggests that physical actions and energy are required by the majority of CE initiatives: taking the products chosen, or inspecting it, washing and/or separating food components are, usually, fulfilled by consumers involved in the CE case studies. The “distress” dimension is present in three out of five categories; we can suppose that there are several points of uncertainty that can bring consumers in a status of personal stress as: not having complete information about the variety and the type of products obtained; not having exhaustive information about the quantity of products; not having enough variance among options, nor the possibility to buy whenever they want; the presence of a risk related to the shipments of the products and the “close expiration date” of most products that Circular economy initiatives sell. The influence of “distress aspects” have been already highlighted in previous literature: the lower level of consumers awareness and uncertainty about several aspects in CE model could translate into consumers’ psychological and personal needs not satisfied, which could in turn lead to barriers in diffusion of the CE [63]. The “time” dimension of effort has emerged in three of the five groups of case studies (“Local and sustainable food”, “Quantity of food” and “Appearance of food”). Interestingly only in Local and Sustainable food cases “time” scored very high compared to the other initiatives. This outcome reaffirms, as stated by Pascucci and colleagues [60], that in “Local and sustainable food” cases consumers have the possibility to spend time in the organization and to be involved in lessons, workshops and practices such as co-production and firm labour. Finally, it is noteworthy that, coherently with the general result of the CE index score, for the group of case studies “edibility of food” the only component of effort emerged is the “money” one. The lowest score of this group depends on the central role of mobile App to manage household leftovers to avoid waste. There is no discounted price for products or periodical subscription for products such as vegetables and fruit as consumers just must follow the suggestion of their mobile app alerts.

Parameters apply to case studies with a different frequency. Fig. 4 shows each parameter and the number of times these apply to each category of case study. The most frequent applied parameter is *Necessary moving in order to take the product/use the service*, while

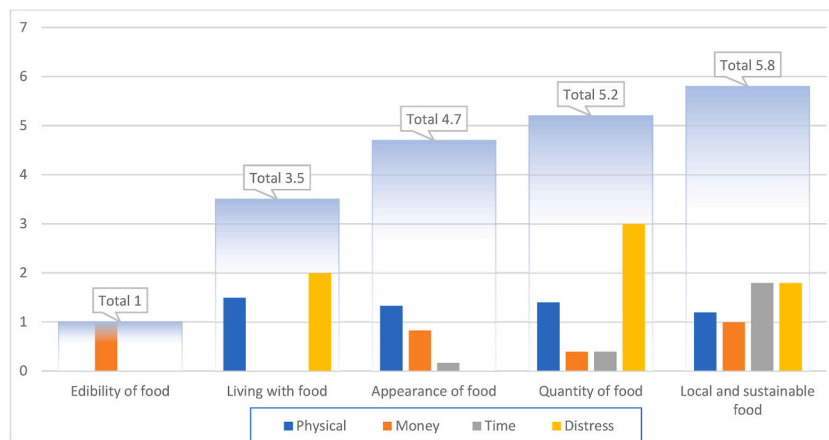


Fig. 3. CEI average scores per category.

the less frequent is *Necessary moving in order to return part of the product*. Notably, two of the four most frequent parameters are included in the *physical* category reinforcing the necessity to make physical effort to be involved in CE initiatives at the minimum. Just one out of these four parameters applies to at least one case study for each category. This is due to the limited amount of efforts required for the case studies belonging to the Edibility of food category.

6. Conclusion

Circular Economy has the objective to transform the actual economic system in the light of sustainability principles. The negative response of consumers to the new pattern of circular offering could represent a strong barrier; consumer's approval is indeed crucial for the success of small and medium companies that have launched circular projects [64]. Certainly, the key to success of CE initiatives implies radical changes and depends on consumers' availability to modify their routine behaviour in different stages [19,29], which entails, most of the time, an active engagement and a certain level of consumers' effort [19]. Nevertheless, in some cases consumers completely refuse the need of effort [56] prompting the failure of initiatives or companies. Given the need to better understand the importance of consumers' effort in the real cases of CE initiatives, the scope of the present research is to offer a measure of consumer's effort in actual examples of Circular economy initiatives operating in the agro-food system. The study of consumers' effort in groups of companies operating in the market is relevant as the level of effort required to consumers could be completely refused, ratifying the failure of initiatives or firms. Stemming from the analysis of 20 circular initiatives' operation mode, the attempt was to build a novel Effort Index composed by 14 parameters (3 Physical, 2 Money, 2 Time and 7 Distress), with scores defining the level of consumers' required effort. Moreover, applying the identified parameters to the group of selected case studies, results have indicated which are the types of Circular initiatives that imply a higher level of effort. Findings revealed that the category of "Local and sustainable food" which was composed by examples of Community Supported Agriculture and the venture of sharing of unwanted and in excess food conducted by volunteers, had the highest level of effort due to the strong involvement of consumers who decide to participate. On the contrary initiatives that allow consumers to avoid food waste in the household by the use of a mobile App ("Edibility of food" category) have scored the lowest levels of effort required. The classification of cases studies in terms of total level of effort provides the first important portray on which are the initiatives that are more demanding for final consumers. Nevertheless, we acknowledge that this research is a first attempt to provide effort dimensions; and the parameters are obtained throughout an inductive process without consumers' participation into the research steps. However, consumers' positive or negative evaluation of product could be highly contingent on the judgement of required level of effort (Kivetz and Simonson, 2002; Franke et al., 2009; Franke et al., 2010; Troye and Supphellen 2012; Inzlicht et al., 2018). Therefore, drawing from the present study, future research should obtain consumers' insights to understand in detail individual opinions, evaluations and willingness to accept the required effort of circular initiatives. This information will provide practical suggestions for entrepreneurs that want to embark on circular projects, and at the same time could offer important feedbacks for policy makers interested in incentivizing and improving existing or new start-ups in the circular arena.

A further limitation of the current study is related to the parameters that explain the level of effort. We have extrapolated and listed 14 parameters and categorized them in the four types of effort previously validated in academic literature (Physical, Money, Time and Distress). However, it is important to underline that other categories of effort could be detected, and consequently other explanatory parameters should be taken into account. Finally, we have analysed only twenty firms operating in developed countries and in the agro-food sector. Future research should analyse a wider number of case studies and aim to broaden the geographical area and product domain.

	Local and sustainable food	Appearance of food	Edibility of food	Quantity of food	Living with food	Total
Physical						
<i>A transfer is necessary moving in order to take the product / use the service</i>	3	4	0	4	1	12
<i>A transfer is necessary moving in order to return part of the product</i>	1	0	0	0	0	1
<i>Product cleaning, washing or inspection required</i>	2	4	0	3	2	11
Time						
<i>Time dedicated to the project, besides purchasing</i>	4	0	0	1	0	5
<i>Moments of sharing, lessons involved in the project</i>	5	1	0	1	0	7
Money						
<i>Money invested in the activity besides the purchase – Risk sharing</i>	1	2	0	0	0	3
<i>Incentives such as discounts or promotions and discounted prices</i>	4	3	1	2	1	11
Distress						
<i>Possibility of obtaining complete information about the purchased product</i>	1	3	0	2	0	6
<i>Possibility to decide the exact quantity of the product</i>	2	3	0	2	0	7
<i>Limited variety of choices</i>	3	0	0	2	0	5
<i>Purchase only on specific days</i>	1	3	0	0	0	4
<i>Long waiting time to obtain the product</i>	0	0	0	1	1	2
<i>The product may be close to deterioration</i>	1	0	0	4	2	7
<i>The product comes from waste, by-products or unsold</i>	1	5	0	4	1	11

Fig. 4. Parameters frequency for CE category.

Author contribution statement

Conceived and designed the experiments
 Performed the experiments
 Analysed and interpreted the data
 Contributed reagents, materials, analysis tools or data
 Wrote the paper.

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Data availability statement

No data was used for the research described in the article.

Declaration of interest's statement

The authors declare no competing interests.

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