

## Article

# Households' Food Waste Behavior at Local Scale: A Cluster Analysis after the COVID-19 Lockdown

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**Abstract:** The reduction of food waste, especially in households where more than half of its global quantity is generated, has become an increasing economic, social and environmental concern, and represents one of the 17 Sustainable Development Goals within the Agenda 2030 for Sustainable Development. In this context, the COVID-19 lockdown has significantly changed life, work and food consumption habits all over the world, highlighting food waste as a multi-sectorial issue. This paper explores current attitudes, perception and behavioral patterns related to food waste reduction at domestic consumption at the local scale (Apulia region, Italy), with the aim of identifying different types of “food wasters”. Through an online questionnaire and the application of a k-means clustering model, the authors focus on four emerging constructs in terms of food consumption and food waste habits after the COVID-19 lockdown at household level. Among three theoretical clusters, results have highlighted: (i) the paradox of the “green wasters”, which declared a high level of awareness of the food waste issue but also generates huge amounts of thrown away food; (ii) the “positive unawareness” of the “red wasters”, which have a slight notion of environment and sustainability but waste low quantities of food; (iii) the consistency of the “blue wasters”, which know of the food waste issue and convert theory into practice.

**Keywords:** food waste; food security; cluster analysis; consumer behavior; COVID-19 pandemic



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## 1. Introduction

Food waste is an economic, social and environmental issue and occurs along the whole food supply chain, from the agricultural to the production stage [1]. Although there is no harmonized definition and several definitions have been attributed to the term [2,3], in line with the current European (EU) legislative framework [4] food waste is mainly recognized as “any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans” that has become waste. Worldwide, it is estimated that each year more than 1.3 billion tons of food are thrown away [5], of which roughly 50% are generated at final consumption, both at food services (e.g., restaurants, school canteens) and households [6–8].

On average, each person wastes in a range from 180 kg/year [9] to over 290 kg/year [10], with several differences among EU countries and significant consequences on both the financial and the environmental side. According to the European Parliament [11], the highest levels of food waste have been registered in the Netherlands (541 kg/capita/year) and Belgium (345 kg/capita/year), while the lowest have been registered in Romania (76 kg/capita/year) and Slovenia (72 kg/capita/year), with an average of 179 kg/capita/year registered in Italy. In terms of financial and environmental losses, Italian food waste financial costs have been estimated at more than 140 billion euro [12,13] and its associated emissions at roughly 170 Mt of CO<sub>2</sub>eq [14]. The United Nations have counted food waste reduction among the Sustainable Development Goals (SDGs), imposing by 2030 a halving of final consumption [15,16].

At the country level, the Italian experience in food waste dates back to 1989 with the creation of Banco Alimentare, later implemented by the introduction of Law 460/1997 and Law 133/1999 to encourage donations [17]. The first project, so-called Buon Samaritano, was carried out in 2003 in Mogliano Veneto, Marcon e Treviso on the basis of Law 155/2003 [18]. In light of the latter law on the distribution of food products for social solidarity purposes, one of the first Italian analyses was conducted in 2012 by the Politechnic of Milan [19]. In 2013, after the introduction of Law 147/2013 [20] in the field of food donations, the National Program for Waste Prevention contained the first tips and suggestions to reduce food waste. Later, the National Plan for Food Waste Prevention (PINPAS, 2014–2017) proposed a taskforce to investigate and elaborate models to reduce food waste [21]. In the last decade, national and local authorities implemented actions towards food waste prevention and reduction [22,23]. In 2016, the Italian Government implemented a legislative provision concerning food and pharmaceutical product donation and distribution for solidarity and charity purposes known as Legge Gadda [24].

In the light of these premises, the COVID-19 outbreak has challenged all aspects of human modern society [25], highlighting food waste as a multisectoral issue. It has disrupted on an unprecedented scale all aspects of human living, changing the way people live, work, shop and eat [26]. Considering the COVID-19 pandemic as one of worst global health and economic emergencies after World War II [27], with more than 1.4 million deaths and over 62 million infected [28] on 30 November 2020, the main challenges in the agri-food sector are related to a novel way of understanding environmental, social and financial consequences of food waste, forcing people to rethink food production and consumption and encourage business and social profits [29].

In the field of food waste quanti-qualitative assessment, the EU Commission Delegated Decision 2019/1597 [30] proposed five measurement methodologies, namely (a) diaries, (b) direct measurements, (c) questionnaires, surveys and interviews, (d) mass balance approach and (e) waste composition analyses. Several authors applied questionnaires and interviews to analyze food waste behavioral tendencies in households [31–33], but only a few [34] investigated its trends in times of crisis (i.e., during the years of the Great Recession of 2008). Further, there are still a few examples [25,35,36] involved in research of food waste during the COVID-19 pandemic.

The present paper, on the basis of a previous study on food waste among Italian households, which highlighted novel work-life balances, adequate time management and smart food delivery as good answers toward food waste reduction at households [37], explores the issue further at local scale. Through an online questionnaire and a k-means cluster analysis at the regional level, the authors investigate four constructs: a) consumer environmental concern (i.e., knowledge on food waste-related losses in terms of energy, natural resources and financial opportunities, as well as perception of climate change); (b) time management, distinguishing between shopping planning, diet planning, culinary activities management and time allotted for eating; (c) price/quantity consciousness; and (d) influence of the COVID-19 pandemic on food consumption and food waste behavior. The proposal is to identify and describe different types of “food wasters” and illustrate new paths for sustainable food consumption and food waste approach after the COVID-19 lockdown, in line with national and international goals (e.g., SDGs).

## 2. Food Waste Behavior at Households: Literature Background

The prevalent literature is full of articles highlighting the importance of food waste reduction along the whole food supply chain, from agricultural to final consumption. Several authors identified causes and opportunities of valorization along the upstream stages of the food supply chain [3,38,39], as well as causes of food wastage in the downstream ones [40–42]. However, although academia and authorities have clearly identified food waste as a crucial worldwide hotspot, its assessment in times of crisis, like that imposed by the COVID-19 pandemic, requires specific studies focused on the active role of household behavior in the field of food consumption and waste production.

Food waste behavior at households could be led back to planning, shopping, storing, preparing and consumption activities. Refs [43–45] demonstrated the introduction of shopping lists, meal-plans or checking inventories before shopping as good opportunities to reduce food waste in planning steps, while [46,47] highlighted the significance of consumers' behavior in-store (e.g., impulsiveness, compulsive buying) as key-points to be analyzed. In terms of food preparation, to avoid overcooking, [42] suggested the use of weighing scales to carefully measure raw ingredients, while [48] discussed the implementation of eco-cooking methods to reduce vegetable waste. In addition, the way food is stored plays a fundamental role in food waste reduction, making food shelf-life extension a possible solution toward sustainable behavior [49].

Habits and emotions still represent some of the major variables involved in food waste in households. Considering emotions as non-cognitive determinants of behaviors [50,51] and habits as relatively stable behavioral patterns [52], it is important to identify and intervene in repeated negative behaviors, underestimated errors, reiterated and unsustainable attitudes to waste through problem awareness and social norms [53]. Moreover, it is crucial to identify opportunities in novel and previously unpredictable contingencies, such as the COVID-19 pandemic. Therefore, to fill the lack in the literature, the authors investigate the active role of smart working, the change in food purchase habits, the improvement in food delivery and the opportunities offered by improved time management. Since entire countries remained under lockdown, millions of people had enough time to learn and/or improve food planning and storage operations, adopted a possible food program (diet), increased time allotted for eating and improved cooking skills, familiarizing themselves at the same time with domestic appliances never used due to exaggerated dynamic lifestyles [37]. Thus, the COVID-19 pandemic has brought new challenges, and opened new paths and opportunities for food waste reduction.

### 3. Methodology

#### 3.1. Questionnaire Methodology and Data Collection

Questionnaires are formal, structured ways to collect quantitative or qualitative data from participants and are successfully used in the field of food waste investigation, chiefly to obtain amounts, figures or additional information along the food supply chain, from producers to final consumers [6]. In the light of national and international studies, the authors have selected the following constructs: (a) environmental concern, intended as knowledge of food waste-related losses in terms of energy, natural resources and financial opportunities, as well as food waste-related production of greenhouse-gases emissions [43,54,55]; (b) time management, distinguishing between shopping planning, diet planning, culinary activities management and time allotted for eating [56]; (c) price/quantity consciousness [47]; and (d) influence of the COVID-19 pandemic on food consumption and food waste behavior, asking respondents to self-report an estimation of thrown-away food (from “not at all” to “very much”) and related eating habits during the pandemic.

The questionnaire applied in the present study consisted of 29 single-option and multi-choice questions divided among four sections, each dedicated to investigating the following: (i) sociodemographic characteristics of the sample (ten items); (ii) shopping habits during the pandemic (four items); (iii) time management at households' activities during the pandemic (eight items); and (iv) food waste perception and behavior during the pandemic (seven items). Furthermore, to enlarge the chance of obtaining illustrative responses to the issue and record more accurate evaluations [57], several 7-point Likert scale queries were introduced. The questionnaire, addressed to social network users, was implemented online, from 14 November to 30 November 2020, in Google Forms. It circulated online across the main social networks (e.g., Facebook, Instagram, Twitter). Respondents were asked to participate in an investigation on domestic food waste habits after the COVID-19 lockdown, as well as to share the questionnaire according to the non-probabilistic snowball methodology [25,58]. As stated by previous studies [59–61], the snowball sampling method is widely applied in Internet research to reach as many respondents as possible. Moreover,

online research has guaranteed security under pandemic conditions [62]. Since the analysis refers exclusively to the Apulian population, respondents were asked to indicate their region of residence, not including those answers coming from other regions. Nevertheless, considering the restrictions due to physical distancing and the health emergency, the number of respondents ( $n = 323$ ) who correctly and completely answered all questions provided a respectable root for investigation at the local scale. Consent for data processing was requested from respondents in order to proceed with the questionnaire.

### 3.2. Data Analysis

In order to profile consumer perception and behavioral patterns after the COVID-19 lockdown at the local scale, and to examine specific aspects of the questionnaire (e.g., how has the attitude to consumption changed after the lockdown? how have household habits and time management changed?), the authors applied a k-means clustering analysis. This multivariate statistical technique, particularly used in economic studies with the aim of recognizing groups that appear naturally from observations [63], has also been successfully applied in the field of food waste investigations. For instance, [64] identified five different consumers profiles (epicures, traditional consumers, casual consumers, food detached consumers and kitchen evaders) in the United Kingdom, while [65] highlighted four groups among seven, that are conscious-fussy types, conscious-forgetful types and frugal consumer exaggerated cooks, in Italy. Recently, another analysis has been conducted in Romania, where results (careless, precautionous and ignorant consumers) highlight the need to increase awareness and educational campaigns at the governmental and civil society levels [58].

Cluster analysis is an exploratory method which consists of searching for the  $n$   $p$ -dimensional observations of groups of units similar to each other, not knowing a priori if such homogeneous groups actually exist in the data set. The functionality of the analysis is to demonstrate the presence of group structures, identified through a statistical methodology, for the purpose of interpretation, reducing the dimensions of  $R^n$  to arrive at  $g$  homogeneous groups ( $g < n$ ). Its aim is essentially to bring together units in homogeneous subsets [63]. The authors followed the subsequent steps: (i) choice and standardization of variables; (ii) choice of distance or similarity index; (iii) choice of group formation method; (iv) evaluation criteria of the obtained partitions and identification of the optimal number of groups. Data were processed using R 3.6.3 software.

### 3.3. Sample Characteristics

The sample was composed of 323 respondents from the Apulia region, Italy. In line with several studies [25,58], the majority of respondents were females (66%), while men represented a smaller percentage (34%). The ratio 2:1 is justified since women are conventionally the persons in charge of housekeeping, family and cooking activities [66]. In terms of age, the majority of respondents are aged between 18 and 55 years old, with the highest quota of respondents between 18–25 years old (34%), followed by 26–35 (24%) and 46–55 (21%). According to household composition, the majority of families were composed of 4 or more people (53%).

Regarding smart working, participants were asked to respond according to their working experience after the first Italian lockdown (Q9. Have you experienced smart working or smart studying as a result of the COVID-19 lockdown?). The highest number of respondents answered positively (73%). Of those, approximately 20% has completely smart worked (always), while more than 36% experienced half smart working on a monthly basis (more than 50% in the last month). Only 18% performed less than half of their work as smart work.

Table 1 summarizes the sociodemographic characteristics of the sample.

**Table 1.** Sociodemographic characteristics of the sample.

Sociodemographic Characteristics	Categories	Percentage (%)
Gender	Female	66
	Male	34
Age	18–25 years	34
	26–35 years	24
	36–45 years	13
	46–55 years	21
	56–65 years	6
	Over 65 years	2
Households composition	1	7
	2	18
	3	22
	4 or more	53
Residence area	Big city (over 100,000 inhabitants)	54
	Small city (10,000–100,000 inhabitants)	37
	Town (fewer than 10,000 inhabitants)	9
Education	Elementary school	1
	Middle school	2
	Diploma	40
	Bachelor's degree	45
	Master's degree, Ph.D.	12
Financial status	Hard	4
	Humble	31
	Good	57
	Excellent	8
Employment situation	Employed	53
	Unemployed	8
	Housemaker	4
	Retired	2
	Student	33
Smart working experience	Yes	73
	No	21

Source: Personal elaboration by the authors.

#### 4. Results

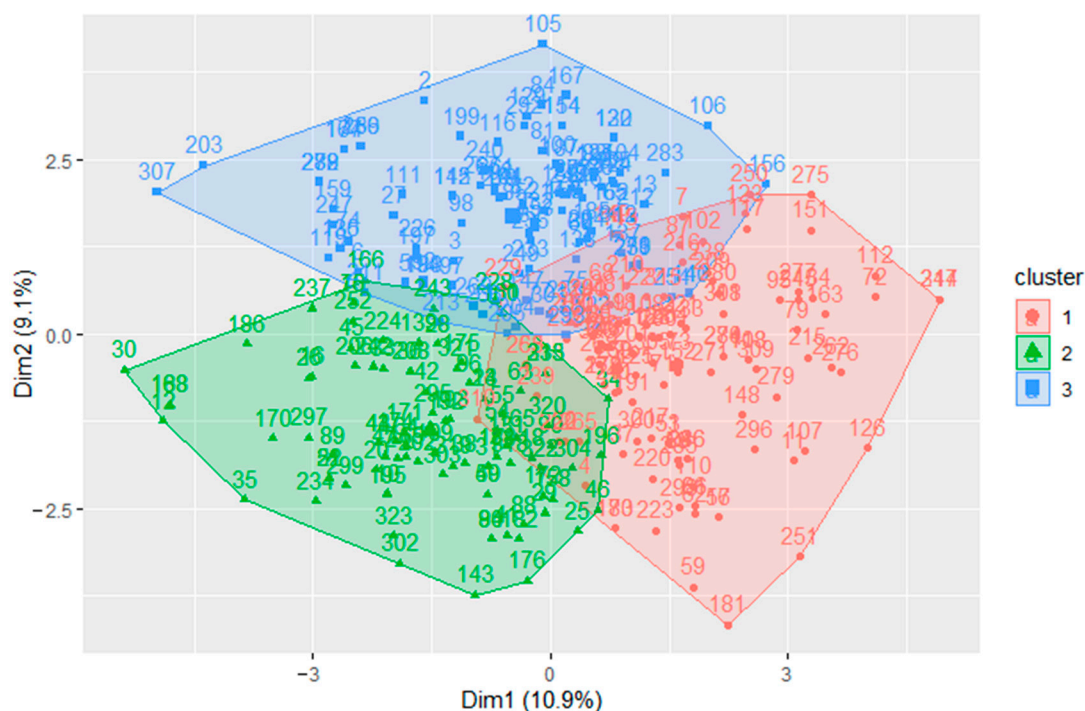
The authors identified three different clusters, named “red” ( $n = 121$ ), “green” ( $n = 92$ ) and “blue” ( $n = 110$ ) according to sociodemographic characteristics, smart working experience, food waste perception, environmental awareness and time management issues. First of all, clusters are consistent and tend to be composed of a similar number of components, meaning it is possible to identify equally distributed trends among the observations. Figure 1 illustrates the synthesized key components.

Table 2 illustrates the final results extracted from cluster analysis.

In terms of sociodemographic characteristics, the “red” cluster is more likely to be composed by men, aged approximately between 26–45, living in a family of 1, 2 or 3 members. They live in big cities (more than 100,000 inhabitants) and are more likely graduated, with a master's or a doctorate. Their financial status is quite good, they are tendentially employed and have experienced smart working more than 50% on a monthly basis. In terms of food consumption habits, “red” respondents tended not to take care of the ratio price/quantity care, go grocery shopping with high likelihood once a week and are used to ordering delivery food. Moreover, they have not registered a particular change in food consumption habits after COVID-19 lockdown. With regards to time management (Q14–Q17), “red” respondents declared that they did not have enough time for food shopping ( $-0.377$ ) as



well as for food planning ( $-0.4369$ ), cooking ( $-0.3763$ ) and eating ( $-0.3514$ ). In addition, they were more likely not to have particular knowledge of environmental issues in general, and of food waste in particular. In terms of food waste perception (Q25), “red” respondents have a low perception of the phenomenon—on a 7-points Likert scale, from 1 = not at all to 7 = very much, they tended to respond with values lower than 3 or 4—and are tendentially not aware that each year each person wastes approximately 170 kg per capita, as well as not being aware of food waste environmental consequences. Lastly, “red” respondents did not their food waste perception after the COVID-19 lockdown ( $-0.4816$ ). However, they declared that they waste, on average, slight amounts of food ( $-0.0439$ ).



**Figure 1.** Cluster plot. Source: Personal elaboration by the authors.

“Green” respondents are equally distributed between female and male (0.0054), aged between 18–35, and are in a household composed of four members or more. They are more likely to live in small cities (between 10,000 and 100,000 inhabitants) or towns (less than 10,000 inhabitants). In terms of education, they probably got a diploma, have a financial status between humble and hard, and are more likely students (0.9696). “Green” respondents have experienced smart working or smart studying more than 50% in a month (0.3884). They are more likely to take care of the ratio price/quantity and go grocery shopping two or three times a week, with good chances to buy delivery food. In terms of change in food consumption habits after the COVID-19 lockdown (Q13), “green” respondents registered a slight but positive change (0.0200). People belonging to such cluster are more likely to have enough time allotted for food shopping (0.4439), food planning (0.6034), cooking (0.5578) and eating (0.3225). According to their knowledge, “green” respondents are quite interested in environmental issues in general, as well as food waste issues in particular. They have a strong perception of food waste (on a Likert scale from 1 to 7, they tend to respond 4 or 5), and are aware that each year each person wastes 170 kg of food. Moreover, “green” respondents are conscious of food waste environmental consequences, are more likely to know food waste reduction apps and have declared a slight change in food waste perception after the COVID-19 lockdown (0.1816). However, “green” respondents are still wasting, on average, a huge amount of food (0.4598).

Table 2. Final cluster centers.

	Item	Cluster		
		Red	Green	Blue
Q1	Gender	0.2718	0.0054	−0.3036
Q2	Age	−0.0193	−0.8662	0.7458
Q3	Households' composition	−0.1955	0.4631	−0.1722
Q4	Residence area	−0.4898	0.5941	0.0419
Q5	Education	0.2958	−0.4257	0.0305
Q6	Financial status	0.1749	−0.2090	−0.017
Q7	Employment situation	−0.0448	0.9696	−0.7616
Q8	Smart working experience	0.1533	0.4541	−0.5485
Q9	Time spent in smart working	0.2579	0.3884	−0.6086
Q10	Ratio price/quantity care	−0.4352	0.2937	0.2331
Q11	Purchase frequency	−0.1585	0.0282	0.1507
Q12	Delivery food	0.0151	0.0056	−0.0064
Q13	Change in food consumption habits after COVID-19	−0.1474	0.0200	0.1454
Q14	Time allotted to food shopping	−0.3777	0.4439	0.0442
Q15	Time allotted to food planning	−0.4369	0.6034	−0.0241
Q16	Time allotted to cooking	−0.3763	0.5578	−0.0526
Q17	Time allotted to eating	−0.3514	0.3225	0.1168
Q18	Adoption of voluntary food diet	−0.3559	0.1239	0.2877
Q19	Adoption of mandatory food diet (health reasons)	−0.1303	0.1178	0.0448
Q20	Sport activities	−0.0072	0.2233	−0.1788
Q21	Voluntary organic collection	−0.5934	0.3708	0.3426
Q22	Mandatory organic collection	−0.7231	0.5173	0.3627
Q23	Knowledge of environmental issues in general	−0.2052	−0.0448	0.2632
Q24	Knowledge of food waste issue in general	−0.1120	0.0136	0.1118
Q25	Perception of food waste issue	−0.4448	−0.0166	0.5032
Q26	Awareness of 170 kg of food waste/capita/year	−0.4215	0.0611	0.4125
Q27	Awareness of food waste environmental consequences	−0.2884	0.0369	0.2864
Q28	Knowledge of food waste reduction apps	0.1648	0.1016	−0.2664
Q29	Change in food waste perception after COVID-19	−0.4816	0.1816	0.3778
Q30	Food waste generation (on average)	−0.0439	0.4598	−0.3362

Source: Personal elaboration by the authors.

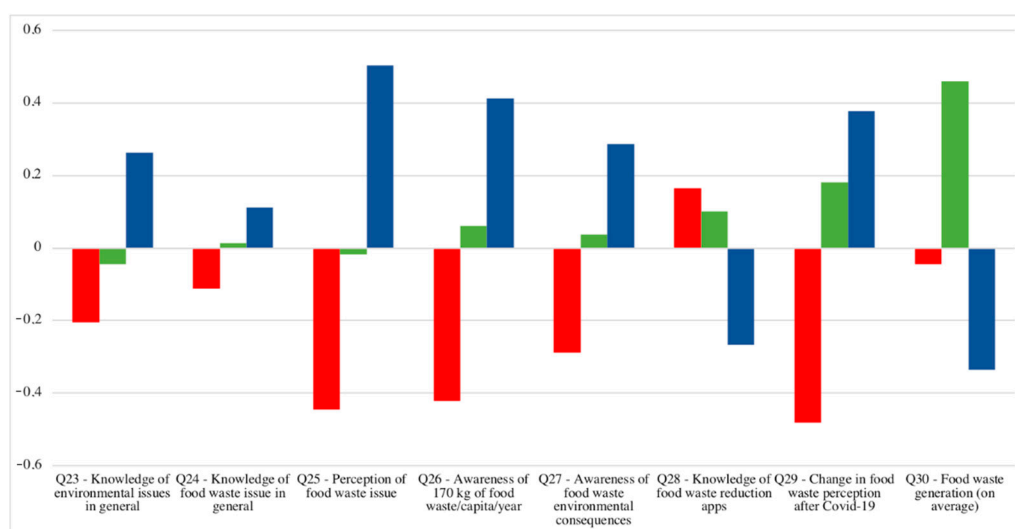
The “blue” cluster is more likely to be composed of females, aged between 36 and 65 years old, with an average household composition of three members. Tendentially, they live in in big (more than 100,000 inhabitants) or small cities (between 10,000 and 100,000 inhabitants), got a diploma or maybe a bachelors' degree, and have a good financial status. In terms of their employment situation, “blue” respondents are more likely to be homemakers that have not experienced smart working on a monthly basis. Such people take care of the ratio price/quantity, tend to go grocery two-three times a week or more and are not used to buying delivery food. “Blue” respondents have declared a significant change in food consumption habits after the COVID-19 lockdown (0.1454). In terms of time management, they have a slight amount of time to do food shopping (0.0442), as well as food planning (−0.0241), cooking (−0.0241) and eating (−0.0526). According to their knowledge, “blue” respondents are likely to be aware of environmental issues in general, and of food waste issues in particular. They have a strong perception of the food waste issue (0.5032) and its related environmental consequences and seem to be perfectly aware that each year each person wastes approximately 170 kg of food. However, “blue” respondents are more likely not to know food waste reduction apps. Such people have stated that they have significantly changed food waste perception after the COVID-19 lockdown (0.3778) and have declared, on average, that they waste a quite irrelevant amount of food (−0.3362).

## 5. Discussion

This analysis has been conducted at the local level, with reference to the Apulia region (Italy). According to Lăcătușu et al. [67], Southern Italy is used to adopting the

Mediterranean diet, intended not only as a food choice, but also as a certain “way of living” based on three pillars: moderation, conviviality and culinary activities. This is to say that, generally, people from Southern Italy pay attention to the way of selecting, cooking and eating food, adopting a healthy lifestyle and preserving traditions [68]. Southern food culture is mainly based on cooking and sharing food among household members, devoting enough time and space for culinary activities and stressing food planification, programming and preparation.

In the light of these premises, it is possible to highlight some points which have emerged from the cluster analysis results: (i) the paradox of the “green” cluster, which declares a high perception of the food waste issue but also generates huge amounts of thrown away food; (ii) the “positive unawareness” of the “red” cluster, which has a slight notion of environment and sustainability but wastes low quantities of food; (iii) the consistency of the “blue” cluster, which knows the food waste issue and converts theory into practice. Figure 2 illustrates the main items discussed.



**Figure 2.** Clustering according to food waste perception, knowledge and generation. Source: Personal elaboration by the authors.

One of the major results regards the paradox of the “green” cluster. People included within the group—students experiencing smart studying during the lockdown—declared a significant awareness of the food waste issue, are quite interested in environmental issues, are conscious of food waste environmental consequences but, at the same time, represent the most wasteful subjects. According to their self-reported knowledge on environmental issues, the theoretical food waste perception of the “green” cluster would suggest that school/university education for sustainable development, educational campaigns through social networks/media and family teaching have positive effects on the new generations. However, considering that young people have a certain “irresponsibility” toward grocery shopping and food preparation—students have no responsibility toward domestic activities—the self-reported awareness does not translate into a real decrease of food waste. Therefore, young generations are very informed, but are unable to enact conscious and sustainable behaviors. To bridge the gap between food waste perception and food waste minimization, it is necessary to intervene on educational campaigns and make them even more incisive, avoiding outdated slogans and including within their programs more pragmatic contents. Indeed, it is necessary to explain in detail how much food waste “costs” in financial, material and nutritional terms, bringing out the hidden side of food waste, which does not mean only food in the bin, but material resources, energy, water and money thrown away every day. Another paradox is related to their time-management, since the “green” cluster has declared that they have enough time to take care of domestic



activities, food programming and eating. According to [25], it would be expected that people forced to stay at home (24 h a day) would improve food purchase programming, storage operation, eating choices and cooking skills, thus reducing food waste. However, the high availability of time did not contribute to food waste reduction among young generations, confirming their tendency to waste more food than older generations despite their interest on the issue [65]. To sum up, the “green” cluster represents a group for which it is essential to intervene, considering that young people seem to have a high reactivity toward environmental issues and could represent the “healthy carriers” of inspiration, hope and culture toward sustainable development.

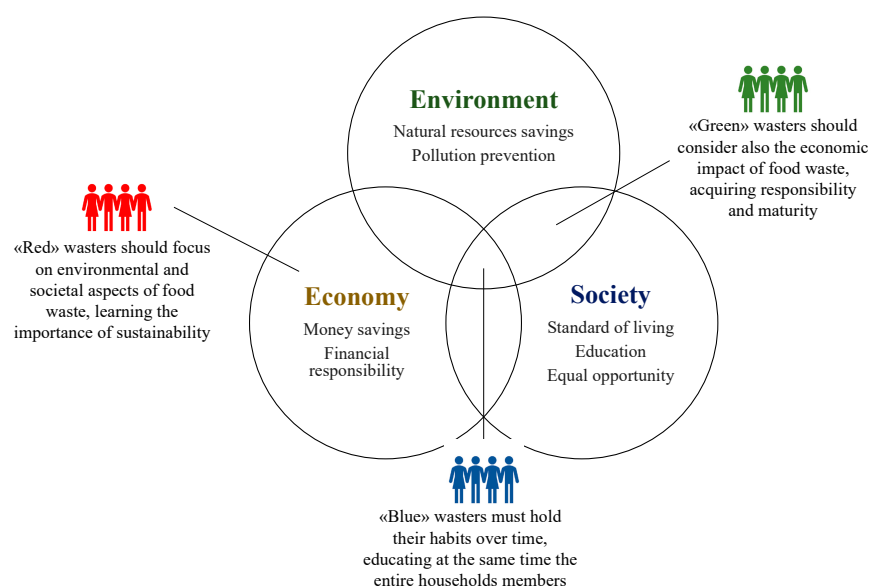
The second key-point is represented by the “positive unawareness” of the “red” cluster, mainly composed by adult workers, financially responsible for household activities. First, the group is represented by people who declared a low awareness of environmental issues and food waste perception. Secondly, they did not have enough time for any of the activities related to food (programming, planning, eating) and did not show particular interest in concrete domestic management. However, “red wasters” are considered as those who generate limited amounts of food waste. Their discrepancy could be attributable to a certain “positive unawareness”, probably due to the fact that they consider food waste a significant waste of money. Indeed, one of the strongest motivators to reduce food waste appears to be money savings [69,70] and price consciousness [71]. Considering that the “red” cluster is made up of people who work and dedicate most of their time to professional activities—even during the lockdown, in smart working—it is likely that they know and attribute to food an economic rather than a social or an environmental value. The reported low levels of food waste, as well as the slight perception of their related environmental consequences, could therefore be attributed to mere economic considerations. Which seem, however, excellent motivations to reduce food waste.

The last point of reflection regards the consistency of the “blue” cluster, which knows the food waste issue and converts theory into practice. The cluster, mainly composed by adult women, is made up of people highly aware of the sacrifice embedded within domestic food management and culinary activities. On this basis, a coherence has emerged among food waste perception and food waste generation. Indeed, “blue wasters” were the ones that generated the least food waste. The significant perception of food waste and the low amounts of thrown away food, two sides of the same coin, have been recorded simultaneously with the advent of the pandemic, thus it is not possible, in this exploratory step of the analysis, to attribute to the pandemic itself the consequence of food waste generation. However, considering that “blue wasters” have declared that they have a significantly changed food waste perception after the COVID-19 lockdown, it is still possible to take into consideration this option. Obviously, we hope that such change will last over time and will not remain just a “temporary consequence” of the shock resulting after the lockdown.

Figure 3 summarizes the main features of “green”, “red” and “blue wasters” according to the environmental, economic and social pillars of sustainability.

Several studies have tried to identify homogeneous clusters and profile wasters’ categories in designing intervention to stimulate behavioral changes [65] and promote awareness and education campaigns [58]. With reference to previous cluster analyses, the “blue wasters” seem to have something in common with English “traditional consumers” identified by [64]: family-orientated, pressed for time but not stressed, price-conscious, slightly interested in innovation (e.g., apps, delivery food), but highly concerned about discarded food and low production of food waste. Moreover, “red wasters” are quite similar to [64] “food detached consumers”, not particularly engaged in social aspects of mealtimes, not involved in meal preparation, moderately concerned about food waste but low producers of discarded meals. Interpreting “red wasters” according to an Italian study [72], they could be defined as “consumers unaware but not wasteful”, which is to say consumers that never consider domestic food waste but do not throw away still edible food. Finally, as regards “green wasters”, they have some characteristics of the Romanian “Precautious” and “Igno-

rant” consumers [58], which is literally a paradox: either waste-fighters or waste-producers, both concerned with food waste but not interested in what a portion of food means in terms of money, time and resources. In other words, still immature, unconscious and irresponsible. With regard to previous studies conducted in Southern Italy through cluster analysis [73], Southern Italian regions began to produce lower amounts of food waste compared to the Northern ones. Post-pandemic, as illustrated by the present results, this trend seems to have even intensified. Therefore, it could be useful to stress Mediterranean traditions, rediscovering food culture and the culinary habits of the Southern regions.



**Figure 3.** “Red, green and blue wasters” with relation to sustainability pillars. Source: Personal elaboration by the authors.

In light of these considerations, it is undeniable that the identification of a prototype of consumer or “waster”, in the wide and heterogeneous context of the European Union, is very complex. Comparison between studies/countries with different cultures and traditions, diverse buying, consumption and culinary habits, are clearly possible, but somehow challenging. The keywords to stress are still awareness, sensitivity and education.

#### *Limitations and Future Directions of the Research*

Considering that the cluster analysis is an exploratory method whose aim is to recognize groups that appear naturally among observations, it presents some intrinsic limitations. The first and most significant consists in data availability in studies conducted through an online questionnaire. The risk of self-selection of participants, poor data quality due to approximation or undervaluation and consumer behavior reactivity should be considered. Moreover, the cluster analysis is merely a statistical technique, thus it assumes no underlying knowledge of the phenomenon or how consumers actually behave. Outputs are important, but their interpretation certainly represents the most complex part. However, it results in a consistent methodology to obtain information, as well as a valuable technique to target consumers and identify patterns and behaviors.

On the basis of these preliminary results, a more detailed analysis is required to interpret relationships between variables and obtain more precise information. Since people have begun to “familiarize” with the pandemic, and considering that vaccines are disseminated and diffused worldwide [74], it will be necessary to verify whether trends, at the end of the pandemic, will remain similar or will change, in the light of individuals aversion, avoidance and abandonment of provisional consumption behaviors [75,76]. First, it is crucial to confirm whether the change in food waste perception among “blue wasters” is

temporary or definitive. Secondly, it is essential to stress the role of “green wasters” according to more sustainable and inspiring educational programs; it is crucial to generate the *urgency* or the *desire* to act at a personal level through more specific information, calling for commitment and trying to instill concrete needs in the target audience [47]. Suggestions for future studies could apply the causal research, also known as explanatory research, in order to verify the extent and nature of cause-and-effect relationships between variables [77].

## 6. Conclusions

The present paper has investigated current attitudes, perceptions and behavioral patterns related to food waste reduction in households in the Apulia region through an online questionnaire and a clustering model, identifying three clusters: “red”, “green” and “blue”. The “red wasters” seem to not be particularly sensitive to changes imposed by the pandemic. They have not substantially modified their food consumption habits and their food waste perception; nevertheless they declare that they waste a slight amount of food. The “green wasters”, even if they confirmed a significant change in food consumption habits and food waste perception, on average, have still self-reported a huge amount of food waste. Lastly, the “blue wasters” have affirmed that the COVID-19 lockdown has significantly changed food consumption habits and food waste perception, registering the lowest amount of food waste among groups.

The interpretation of this data is certainly complex, but interesting conclusions could be proposed. The “green” cluster, on a theoretical basis, seems to be composed of responsible and virtuous wasters. “Green wasters” have changed food waste perception after the COVID-19 lockdown, probably enjoying novel time management or, in general, experiencing the chance to improve their awareness in terms of food purchase, food preparation and food storage activities. However, there is no connection between perception and sustainable behavior. On the other hand, and regardless to the pandemic consequences, “red wasters” can be defined as “unaware wasters”. Considering that they seem to be “in” an involuntary system whose final result is low food waste, they would be unlikely to change their way of relating to food. Such consumers must be educated according to the sustainability pillars (economic, social and environmental), highlighting the main aspects of wastage-related losses in terms of money, water, energy and greenhouse gases emissions. The “green” cluster shows significant opportunities to switch toward more responsible practices, but major efforts should be addressed toward “green” consumers, since they are able to, but actually do not, act. It is crucial to reduce the gap between theory and practice. As “green wasters” are mainly composed of young people, thus, they represent the future generation on whose shoulders stays the burden of sustainable development and climate change reduction; their positive approach toward food waste reduction is essential. Until perception does not find concreteness in behavior, it will be difficult to progress in the field of food waste minimization.

In conclusion, the analysis confirms the crucial role of education within each generation and between generations. Educational programs should be targeted and become more incisive, making evident what hides beyond thrown-away food in terms of resources (e.g., financial costs, natural resources, water) and highlighting wastage-related consequences (e.g., food security, malnutrition, hunger). In a world ravaged by the COVID-19 pandemic, young people are “healthy carriers” of inspiration, hope and culture, and their role of communication and dissemination, inside and outside their families, must absolutely be amplified.

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