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Comprehending e-waste limited collection and recycling issues in Europe: A comparison of causes

Charbel Jose Chiappetta Jabbour [a], Annarita Colasante [b], Idiano D'Adamo [c], Paolo Rosa [d], Claudio Sassanelli [e,f,*]

[a] Department Information Systems, Supply Chain and Decision Making, NEOMA Business School, Mont-Saint-Aignan Cedex, France
[b] Department of Law and Economics, Unitelma Sapienza—University of Rome, Piazza Sassari 4, 00161, Rome, Italy
[c] Department of Computer, Control and Management Engineering, Sapienza University of Rome, Via Ariosto 25, 00185, Rome, Italy
[d] Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Piazza L. da Vinci 32, 20133, Milan, Italy
[e] Department of Mechanics, Mathematics and Management, Politecnico di Bari, Via Orabona 4, 70125, Bari, Italy
[f] Tech Center for Good, École des Ponts Business School of École des Ponts ParisTech (ENPC), 6 Place Du Colonel Bourgoin, 75012, Paris, France

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ABSTRACT

In today's technological age, the issue of e-waste management is becoming increasingly critical. Although several studies have detected and proposed innovative technologies to both enable and increase e-waste recycling performance, end users often dispose of obsolete products inappropriately. The present work aimed at investigating the criteria that influence user behavior regarding e-waste recycling, starting from seven criteria (i.e., intention to recycle e-waste, awareness of the importance of e-waste recycling, environmental concern, attitudes towards e-waste recycling, subjective norms, perceived behavioural control, WTP for e-waste recycling) identified in the literature as most relevant. A questionnaire administered to students, interviews of academic experts, and several analytical techniques (i.e., descriptive statistics, the analytic hierarchy process, econometric regression) were used to identify the most relevant criteria for e-waste recycling. With willingness to pay (WTP) used as a reference criterion, the remaining six criteria were investigated as variables, with the aim of uncovering the relations among them and determining which had the most significant impact on WTP. The results revealed that individuals with strong pro-social attitudes were more aware of the need to recycle e-waste. Furthermore, those who disposed of waste correctly in specialized centers were more aware of the need to recycle. The study highlights the importance of raising awareness at a group level to promote e-waste disposal as a social norm.

1. Introduction

The distinction between assessing sustainability and the circular economy is not always perceived by businesses, which tend to perceive sustainability with a broader view including the social dimension (Roos Lindgreen et al., 2022). However, goals and indicators of the circular economy are not always clearly stated in sustainability reports (Opferkuch et al., 2022). The "3Rs" (recycle, refurbish/remanufacture and reuse/redistribute) enable the manufacturing industry to close the sustainability loop (Govindan, 2022); however, technologies to maximize material recovery need to be enhanced (Molla et al., 2023). In addition, it emerges that it is not always clear how much waste is available (Manoj Kumar and Chopra, 2023) and suitable criteria (Papamichael and Zorpas, 2022) are needed to support the decision-maker to identify the best end-of-life option (Papamichael et al., 2022). The dramatic increase in electronic waste (e-waste) is helping to make ecological sustainability a top priority for governments and business operators (Kannan et al., 2023).

E-waste management is an urgent issue requiring innovative technological solutions. The latest Eurostat report (Eurostat, 2019) estimated that, while approximately 12.5 million tons of electrical and electronic equipment (EEE) are put on the European market each year, only about 4.5 million tons are collected (Eurostat, 2019). The literature points out that e-waste management performance is very different among European countries (Colasante et al., 2022). Toxic chemical components in e-waste can have a negative impact on ecosystems and

* Corresponding author. Department of Mechanics, Mathematics and Management, Politecnico di Bari, Via Orabona 4, 70125, Bari, Italy.
E-mail addresses: c-j.chiappetta-jabbour@neoma-bs.fr (C.J.C. Jabbour), annarita.colasante@unitelmasapienza.it (A. Colasante), idiano.dadamo@uniroma1.it (I. D'Adamo), paolo1.rosa@polimi.it (P. Rosa), claudio.sassanelli@poliba.it (C. Sassanelli).

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human health, and their improper management does not enable the achievement of sustainable development goals (Cheshmeh et al., 2023). Despite recent research identifying and proposing innovative technologies to improve e-waste recycling performance (Alam et al., 2022), experts are still exploring why end users do not dispose of their electronic devices through official recycling channels. Other problems that characterize this industry are lower recycling efficiency and scale, lack of advanced technologies and corresponding regulations (Yu et al., 2023).

Previous studies have attempted to uncover the underlying motivations behind this issue. According to behavioral reasoning theory (BRT), individuals' reasons for recycling e-waste include self-image concerns, perceived negative effects, and salvage value; while reasons against recycling include inconvenience, lack of support systems, and emotional attachment (Yadav et al., 2022). However, the BRT approach has led to important policy findings, relating to the importance of: (i) providing information on recycling and collection centers, (ii) making the reduced privacy and security risks associated with recycling explicit, (iii) reducing transportation and management costs associated with e-waste recycling, and (iv) marketing the simplicity of the e-waste recycling process (Dhir et al., 2021a).

An analysis using the Fuzzy Decision Making Trail and Evaluation Laboratory (F-DEMATEL) and Fuzzy Interpretive Structural Modeling (F-ISM) approach revealed that a lack of customer awareness about returns is a significant barrier to effective e-waste management in developing economies (Jangre et al., 2022). This finding aligns with other studies (Kumar and Dixit, 2018a) highlighting the importance of policy, regulatory, and infrastructural barriers for effective e-waste management. However, some developed countries have demonstrated effective e-waste management practices, holding stakeholders accountable for their actions (Murthy and Ramakrishna, 2022). Furthermore, "market contenders" and " formation of cross-functional team" were found to be most important factors for successful implementation of circular economy to address e-waste in emerging economies (Bhattacharjee et al., 2023).

Recent research on e-waste management reveals a lack of consensus on the e-waste recycling behavior of end users. However, the literature highlights a main issue of a lack of general awareness about e-waste management and disposal (Thukral et al., 2022). To address this issue, there should be greater promotion of environmental awareness, public education on the benefits of e-waste recycling, and greater efforts to make e-waste recycling more cost-effective. Government intervention is also required, and environmental education may be effective in increasing consumers' willingness to pay (WTP) for proper recycling (Ananno et al., 2021). In fact, many articles have already underlined the importance of WTP as a main driver towards the adoption of circular behaviors among mass electronics customers (Cai et al., 2023; Corsini et al., 2020; Garg et al., 2023; Gilal et al., 2022; Mazlan et al., 2016; Moslehpour and Huyen, 2014; Yadav et al., 2022). As evidenced by Koshta et al. (2022), awareness of the consequences of incorrect e-waste recycling, e-waste recycling intention, and perceived behavioral control influence consumers' WTP for e-waste recycling. E-waste recycling intention is further influenced by environmental concern, subjective norms, and attitudes towards e-waste recycling, as well as value compatibility, environmental concerns, and the perceived benefits of performing appropriate e-waste recycling (Dhir et al., 2021b; Koshta et al., 2022). However, none of these factors has been compared or prioritized in its role of driving or discouraging correct e-waste management. To address this gap, the present research aimed at gathering perspectives from two stakeholder groups (i.e., students, and academic experts) in order to promote effective e-waste management in Europe. Based on these perspectives, the factors were ranked using specific logics (i.e., Likert scale, the analytic hierarchy process) and compared using descriptive econometrics, to identify important insights for scientists and policymakers.

The paper is structured as follows: Section 2 presents the materials and methods used in the analysis, Section 3 presents the results, Section 4 discusses the findings and proposes new governmental measures, and Section 5 concludes the research.

2. Materials and methods

The main aim of the present research was to compare the perceptions of students and academic experts regarding e-waste. Data were collected by means of a questionnaire administered to undergraduate students and an interview conducted with academic experts. Different methodologies were employed to analyze the data, including descriptive statistics and econometric regression for the student answers and the analytic hierarchy process (AHP) for the expert opinions. The objective was to investigate the sustainability domain and identify the criteria with the greatest impact on end users' e-waste recycling behavior. In particular, the research invited students and academic experts to assess and prioritize seven criteria identified in the literature according to their relevance to e-waste recycling.

2.1. Questionnaire

Studies on students' perceptions of e-waste are a topic deemed important by the literature (Subhaprada and Kalyani, 2017). To collect student impressions, an online questionnaire was administered to a sample of 526 Italian students. The majority of students were enrolled at the Politecnico di Milano (northern Italy), the UnitelmaSapienza - University of Rome (central Italy), the Sapienza University of Rome (central Italy), and the Politecnico di Bari (southern Italy). The sample consisted of 62% male students, and the average age was 25.1 years. Of note, only 57% of respondents were solely students, while the remaining proportion were working students. Additionally, 57% were living with their families. Data were collected from April to July 2022. The validity of this sample is verified by the literature (Chiappetta Jabbour et al., 2023). The questionnaire aimed at collecting data on students' attitudes related to the purchase and disposal of three types of electronic products. It contained 26 items, divided into two main blocks, and a few socio-demographic questions. The first block assessed students' awareness and behavior with respect to e-waste recycling, while the second block elicited their WTP for electrical and electronic products and the characteristics they considered when making purchasing decisions.

The definition of factors significant to WTP was based on a recent contribution of Koshta et al. (2022), in which the well-known theory of planned behavior (Ajzen, 2011) was deployed to assess whether WTP for the recycling of e-waste products was influenced by socio-psychological factors. The authors proposed a set of questions, which could be grouped into the following sets.

1. Intention (i.e., willingness to spend time correctly recycling e-waste);
2. Awareness (i.e., an understanding of the consequences of the incorrect disposal of electronic products);
3. Environmental concern, or general pro-environmental attitudes;
4. Attitudes towards e-waste recycling (i.e., recycling attitudes and perceptions);
5. Subjective norms (i.e., the potential effect of social pressure on e-waste recycling);
6. Recycling intention; and
7. WTP for the correct disposal of e-waste.

The majority of questions were responded to by means of a five- or seven-point Likert scale associated with positive and negative feelings about the specific item.

2.2. Descriptive statistics and econometric analysis

As previously described, the questionnaire data were initially analyzed to generate descriptive statistics. The main aim of the

descriptive analysis was to determine which of the seven above-mentioned factors was rated as most important, and therefore had the greatest impact on WTP (Koshta et al., 2022). First of all, the questions related to individual attitude toward sustainable behavior were analyzed: in the related questions, it was asked subjects to rate how often they adopt a specific behavior by using a Likert scale (from *never* -1- to *always* -5-) - (Dhir et al., 2021a). The four-point Likert-type scale has also been used in the literature (Ananno et al., 2021). The Likert scale (scale from *not important at all* -1- to *extremely important* -5-) was also deployed to assess how much important respondents' rate all the aspects related to the 7 sets described above. Either the answers' average values or their distribution have been presented in order to provide a synthetic and clear picture of respondents' point of view.

Subsequently, an econometric analysis was performed to evaluate the principal variables that might influence WTP for e-waste recycling. This analysis aimed at understanding the impact of some selected variables on our variable of interest, meaning the WTP for e-waste recycling.

2.3. Interviews and AHP

The result of AHP is a priority level that is assigned to each criterion based on a pairwise comparison and a nine-point rating scale – Table S1 (Saaty, 2008). The weights of all factors are normalized for comparison, with the most crucial factors receiving the highest weight. In this way, AHP is a useful method for determining priorities in multi-criteria decision making. Its purpose is to identify decision weights and priorities by comparing each item of the problem with respect to any other item at the same level of the hierarchy. In the present study, to identify the correct weights, a panel of academic experts was consulted. These included the authors of published articles on the topic of e-waste in the circular economy, who were identified from the Scopus database (Basile et al., 2023; Colasante et al., 2022) and invited by email to participate. The email explained the objectives of the work and the methodology used, and specified that only the first 10 positive responses would have been considered. The reliability of the AHP results is not only quantified by the consistency ratio (Saaty, 2008) but also by the quality of the selected experts, and thus experience is a determining variable (Tsyganok et al., 2012). In this regard, the ten experts, 30% of whom are women, have an international profile with at least ten years of experience (Table S2). Once the list of participants was finalized, online interviews was organized to collect useful information for defining the AHP weights. A list of criteria connected to the seven sets of above-mentioned questions was identified, and experts were asked to rate these criteria by means of a desk analysis.

3. Results

The results presented below are based on a set of methods and analyses. Section 3.1 reports on the descriptive analysis of the questionnaire data. Section 3.2 reports the results of the AHP analysis. Finally, Section 3.3 reports on the econometric analysis of the relationships among the main criteria.

3.1. Descriptive statistics for the student data

The main result of the present analysis was the identification of the most influential criteria among the seven previously studied by Koshta et al. (2022) for the e-waste management behaviors and attitudes of Italian students. Of note, the participating students responded to direct questions without knowing their association with the seven criteria (i.e., intention, awareness, environmental concern, attitudes towards e-waste recycling, subjective norms, perceived behavioural control, WTP) considered in the analysis.

Initially, average values were computed to determine the general characteristics of the sample. This step provided a fundamental overview of the study sample and allowed for their attributes to be related to the criteria considered in the analysis, contributing to a more informed interpretation of the questionnaire data.

One compelling insight from students' answers was their frequent practice of sustainable and circular behaviors in daily life. The most commonly adopted behaviors were separate waste collection, followed by attention to reusable products, recoverable/reusable packaging and products with reduced or recyclable packaging. However students were less inclined to use public transportation, read product labels, and avoid purchasing products from environmentally-unfriendly businesses (Fig. 1). This suggests that further education may be needed to raise students' awareness of hidden or cryptic information on product labels and magazines regarding both products and their associated businesses. Furthermore, the survey revealed that students viewed public transportation unfavorably, preferring independent, trendy, and private means of transportation over reductions in greenhouse gas emissions and fossil fuel consumption. Finally, donating money to associations was the least common practice, suggesting that social responsibility, not motivated by personal interest or income, may be the most challenging aspect to activate.

Switching to the criteria analysis, once the values assigned to the different direct questions were obtained, equal weight was assigned to each related criterion, for the purpose of aggregation. For example, the awareness criterion obtained a value of 4.2, calculated as the average of the values obtained for the three questions related to how much they are aware about (i) the presence of valuable metals, (ii) the presence of dangerous materials, and (iii) the effect of incorrect disposal. The analysis identified two main criteria that significantly influenced students' behavior: awareness (4.2) and attitudes towards e-waste recycling (4.1). Specifically, regarding awareness, there was a discrepancy between students' knowledge that it is wrong to dispose of e-waste with regular waste (since it contains hazardous substances) and their understanding that e-waste contains valuable metals, such as copper, silver, and gold (Fig. 2).

Concerning attitudes towards e-waste recycling (which plays a crucial role in influencing consumer behavior), students considered e-waste recycling a beneficial practice for the environment that could positively contribute to society. However, they understood it to have only minor importance to their own and their family's health, and they were not fully satisfied by the practice (Fig. 3).

Students also rated environmental concern strongly (3.9). However, while they seemed very concerned about their living environment, they placed less emphasis on their contribution to the environment. This may be due to their inability or lack of opportunity to contribute to this cause (Fig. 4).

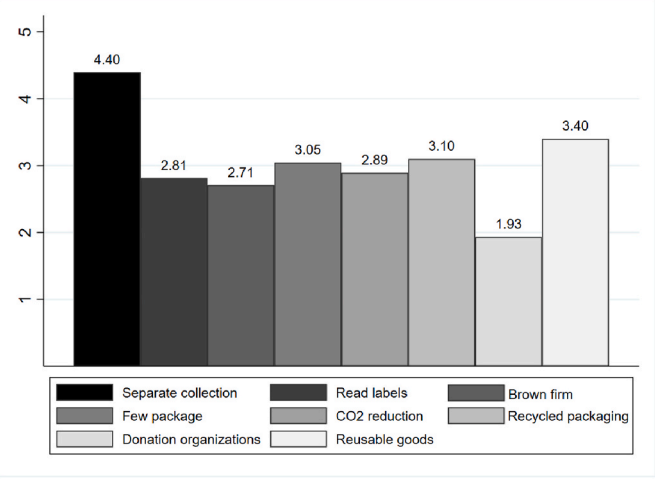

Fig. 1. Students' frequency of sustainable and circular behaviors and practices in daily life, expressed from 1 (*never*) to 5 (*always*).

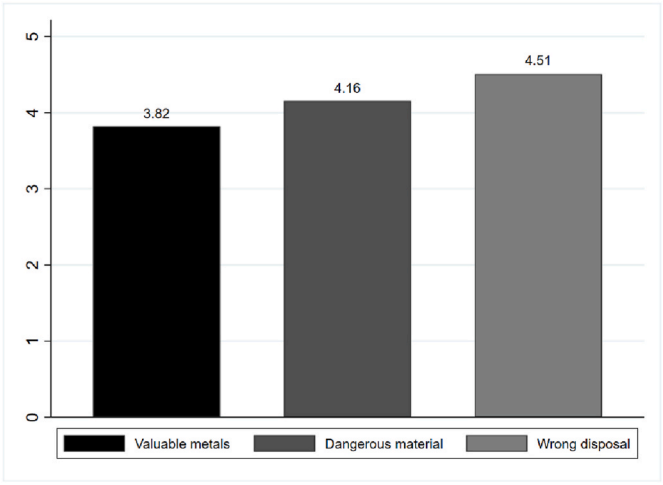

Fig. 2. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for awareness.

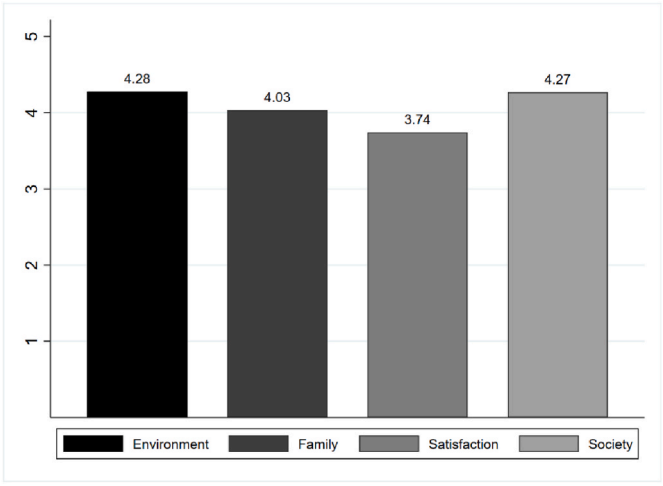

Fig. 3. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for e-waste recycling criteria.

Connected to this, while e-waste recycling intention was high (3.8), students expressed a desire for more information about e-waste recycling, and they were less willing to spend time bringing e-waste to recycling centers. This highlights the need for more widespread collection centers that are easier for consumers to reach and are supported by the provision of clear and comprehensive information (Fig. 5).

Subjective norms (3.2) received slightly less weight in the analysis, though students acknowledged their greater willingness to participate in e-waste recycling when their friends also did so. However, even for this set of answers there was a slight inconsistency. In fact, only intermediate weight was given to the fact that most students' friends believed that e-waste recycling was the right thing to do. Therefore, this does not seem to constitute an adequate trigger to push individual users towards e-waste recycling. Rather, communities may play a more important role in promoting this circular practice (Fig. 6).

Perceived behavioral control received sufficient weight in the analysis (3.0). Students described that e-waste recycling depends entirely on willingness, and they reported that they had the time and resources to properly recycle e-waste. In addition, students believed that they had full control over the recycling of obsolete electronic products, and that those who did not recycle e-waste only failed to do so because they did not want to (Fig. 7).

Finally, WTP for e-waste recycling occupied the last place in the ranking (2.7). An interesting finding emerged, with most students stating that they would be willing to pay for recycling fees if the government improved the e-waste management system. This demonstrates a strong WTP and strong desire to contribute to the recycling process. However, students gave less weight to the idea that customers, as the ultimate beneficiaries of products and services, should be the ones to pay for e-waste recycling. In fact, the students were not enthusiastic about paying for their e-waste recycling, either (Fig. 8).

3.2. Academic expert interviews: AHP and likert scale data

After the main results of the questionnaire (which used a Likert scale) were described, an AHP analysis was conducted to obtain the academic experts' perspectives on the seven criteria considered in the study (Tables S3–12). Unlike the student participants, who were only aware of the survey questions, the experts were informed about all seven criteria. Ten experts were asked to prioritize these seven criteria according to their relevance to the consumption behavior of end users (Table 1).

The first finding was that the most relevant criterion varied among the experts, with four assigning it to attitudes and three assigning it to WTP for e-waste recycling. The remainder split twice for perceived behavioral control and once for environmental concern. It is possible that the ratings differed depending on the experts' knowledge and opinions. However, the AHP method has the advantage of making statistically valid comparisons and aggregating judgments, even from different experts. The second finding was that subjective norms were consistently ranked as the least important criterion, with six experts assigning it the last position and four experts ranking awareness as least important.

To further analyze the criteria, the different judgments were aggregated through the assignation of equal weight to each expert. This allowed a ranking to be made, with consistency verified (since for all experts, the consistency ratio was less than 0.10). The ten experts identified WTP for e-waste recycling (0.205), attitudes towards e-waste recycling (0.200), and perceived behavioral control (0.177) the most important criteria explaining end users' consumption behavior. Environmental concern (0.158), e-waste recycling intention (0.101), and awareness (0.087) followed in decreasing order of importance. Subjective norms (0.072) were rated as the least important criterion.

The sum of the criteria obtained from the AHP analysis was equal to 1, while the sum of the values that resulted from the Likert scale was 24.9. To compare these results, the Likert scale values were normalized (e.g., the specific Likert scale value associated with awareness was 4.2, which was normalized to 0.169) to determine a criteria ranking (Table 2).

The results indicated that the use of different methodologies on different samples of respondents led to significantly different outcomes. The only similarity observed was that both methodologies ranked attitudes towards e-waste recycling as the second most important criterion. This suggests that, from a theoretical perspective, e-waste recycling is a relevant issue that can cause various problems if not managed properly.

From the Likert scale perspective, awareness was deemed the most crucial criterion, while WTP for e-waste recycling was considered less important. This highlights the need to integrate end-of-life product knowledge into purchasing decisions. Despite a high level of awareness that e-waste should not be disposed of with ordinary garbage (ranked highest, at 4.5), individuals are not inclined to participate in its correct disposal (ranked lowest, at 2.4). The Likert analysis revealed that the difference between the first and last criteria was 0.061, which is justifiable, given that the first four criteria trended towards a value of 4 out of 5, while the next three trended towards that of 3 out of 5. Of note, the Likert scale only assessed single criteria, whereas the AHP considered pairs of criteria and involved a different panel of respondents.

From the AHP perspective, WTP for e-waste recycling was considered the most relevant criterion, while subjective norms were deemed

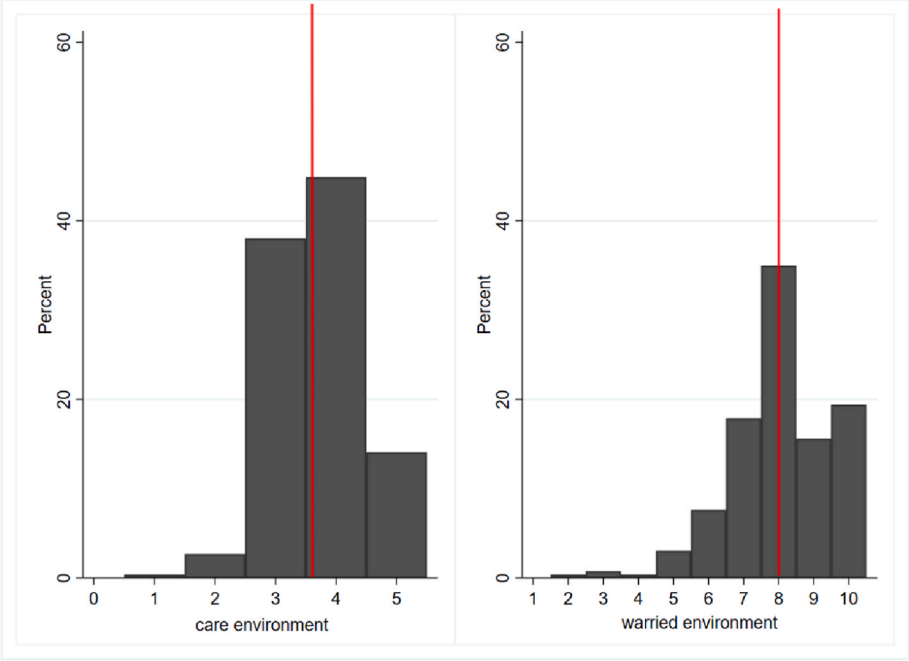

Fig. 4. Left: Average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for environmental concern. Right: Average values, expressed from 1 (*not at all important*) to 10 (*extremely important*), for environmental concern.

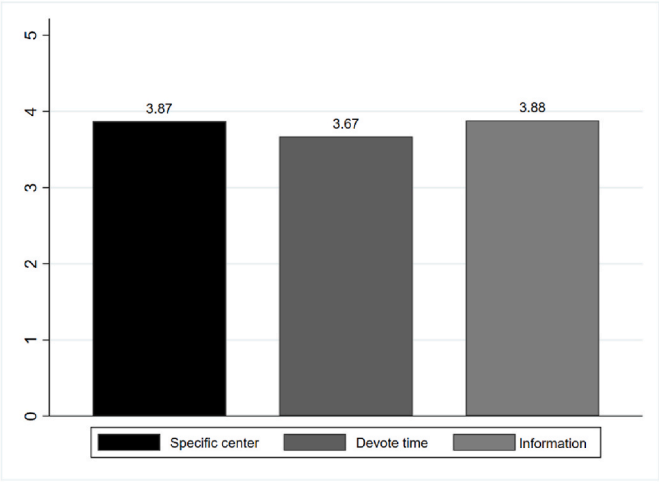

Fig. 5. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for e-waste recycling intention.

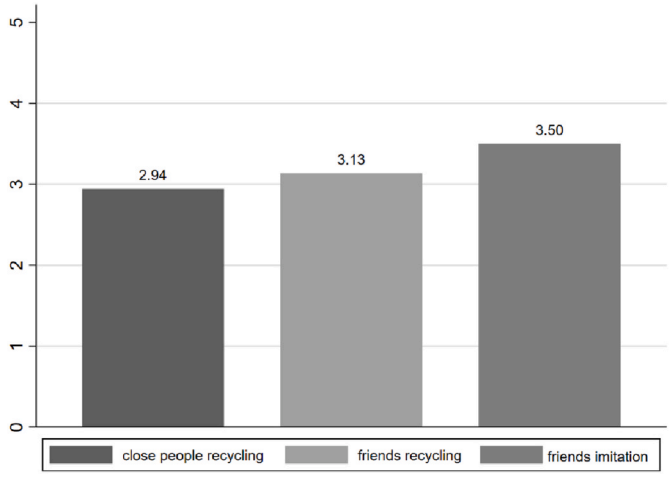

Fig. 6. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for subjective norms.

least important. Therefore, the experts believed that satisfying the economic component was vital for achieving the circular economy. The difference between the most and the least important criteria was more pronounced in the AHP analysis (0.133), relative to the Likert scale analysis. The AHP results were also more aligned with the work of Koshta et al. (2022). However, it is important to note that the analytical approach assessed the relevance of the criteria, rather than the relationships among the criteria, which is addressed in the following subsection.

3.3. Econometric analysis

As shown in Table 2, students and experts held differing opinions about the importance of the criteria. This section uses questionnaire data to estimate which variables had an effect on either WTP for e-waste recycling or awareness. The choice of these two variables as dependent variables was made on the basis of the AHP analysis of the expert opinions, which ranked WTP for e-waste recycling most important, and the Likert scale analysis of the student perceptions, which ranked awareness most important.

Table 3 presents the results of the ordinary least square (OLS) estimations considering WTP as a dependent variable. The aim of this analysis was to estimate the impact of all of the criteria (i.e., attitudes towards e-waste recycling, subjective norms, perceived behavioral control, e-waste recycling intention, awareness, environmental concern) on WTP for e-waste recycling. In addition, socio-demographic characteristics such as the number of people living in the family, area of residence, age, gender, and student/work status were controlled for in the analysis.

From this analysis, it emerged that only subjective norms and e-waste recycling intention significantly influenced WTP. The fact that the other variables lacked significant impact was likely due to the lack of

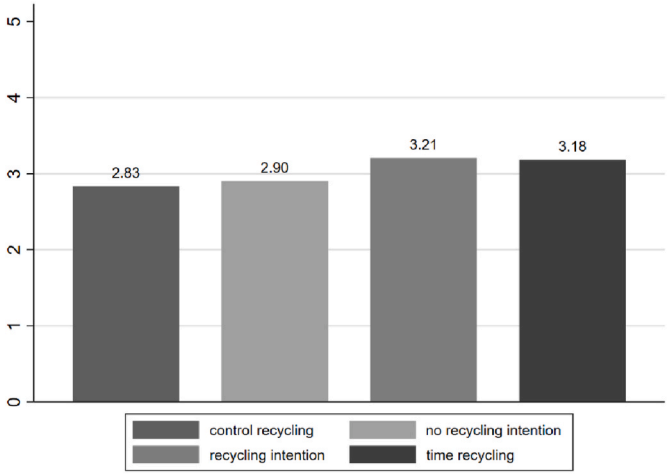

Fig. 7. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for perceived behavioral control.

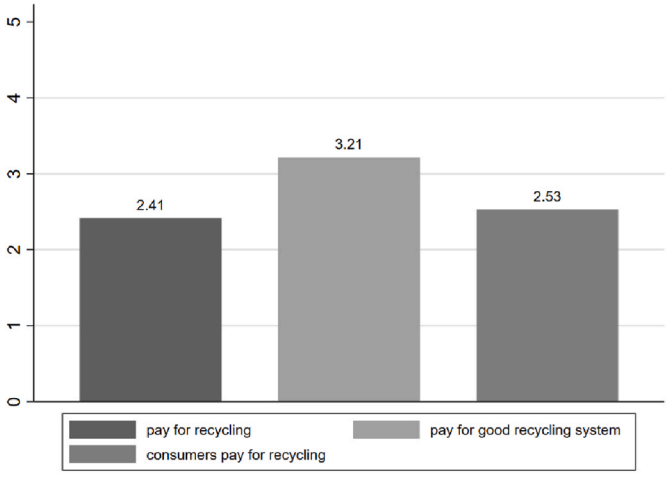

Fig. 8. Students' average values, expressed from 1 (*not at all important*) to 5 (*extremely important*), for WTP.

variation in the response data: respondents belonged to the same generation and led very similar lifestyles, and they shared similar perceptions and concerns regarding issues related to e-waste and the environment. Indeed, variables such as awareness, attitudes towards e-waste recycling, and environmental concern tend to be closely related to the information that individuals hold and the degree to which they care about environmental issues.

It can be concluded from the significant effect of e-waste recycling intention that respondents did not associate increased effort to recycle e-waste with higher WTP. Instead, the greater the commitment they declared to put into e-waste recycling, the higher their WTP for proper waste disposal. The significant effect of subjective norms suggests that if the proper recycling of e-waste were to be recognized as a social norm (similar to the separate collection of other types of waste), individuals would be willing to pay more for recycling.

In a similar exercise, the impact of the same variable on awareness was estimated (Table 4).

When awareness was considered as the dependent variable, subjective norms emerged as key. It is likely that subjects who recognized the importance of social norms received "education" from family members (or, more broadly, from their social network) on the importance of recycling e-waste, and therefore had greater awareness. The results reported in Tables 3 and 4 show that attitude significantly impacted awareness, but not WTP. More positive attitudes towards correct e-waste disposal were associated with greater awareness that e-waste was "precious." Of note, one of the items considered in the attitudes towards e-waste recycling criterion referred to the importance of correct e-waste disposal for society. Hence, subjects who showed greater awareness may have also had stronger pro-social attitudes. Furthermore, subjects' greater propensity to correctly dispose of e-waste in specialized centers (i.e., e-waste recycling intention) was associated with greater awareness.

Table 2
Comparison between the AHP and Likert scale rankings.

	AHP		Normalized Likert scale	
	Value	Ranking	Value	Ranking
Awareness	0.087	6	0.169	1
Environmental concern	0.158	4	0.157	3
Attitudes towards e-waste recycling	0.200	2	0.165	2
Subjective norms	0.072	7	0.129	5
Perceived behavioral control	0.177	3	0.120	6
E-waste recycling intention	0.101	5	0.153	4
WTP for e-waste recycling	0.205	1	0.108	7

Table 3
Results of the OLS regression considering WTP for e-waste recycling the dependent variable.

WTP	Coefficient	Std. Err.	*p*-value
Attitudes towards e-waste recycling	−0.121	0.081	0.136
Subjective norms	**0.164****	0.073	0.025
Perceived control	0.047	0.069	0.500
E-waste recycling intention	**0.392*****	0.079	0.000
Awareness	−0.089	0.080	0.266
Environmental concern	0.003	0.059	0.955
People living	0.055	0.058	0.339
Area of residence	−0.120	0.078	0.124
Age	0.001	0.013	0.955
Gender	−0.028	0.116	0.812
Student	0.025	0.064	0.700
_cons	1.447	0.517	0.006

* p-value<0.10; ** p-value<0.05; *** p-value<0.01.

Table 1
Experts' prioritization of end users' consumption behaviors.

Expert	1	2	3	4	5	6	7	8	9	10
C1	0.091	0.074	0.091	0.085	0.061	0.069	0.054	0.075	0.200	0.072
C2	0.168	0.133	0.194	0.149	0.126	0.104	0.142	0.123	0.314	0.127
C3	0.218	0.160	0.160	0.150	0.175	0.306	0.188	0.285	0.089	0.274
C4	0.073	0.111	0.074	0.105	0.099	0.053	0.061	0.056	0.023	0.069
C5	0.178	0.237	0.133	0.192	0.178	0.214	0.248	0.150	0.090	0.145
C6	0.110	0.091	0.111	0.101	0.112	0.077	0.107	0.088	0.082	0.131
C7	0.163	0.194	0.237	0.218	0.249	0.177	0.201	0.223	0.202	0.181

C1 = awareness; C2 = environmental concern; C3 = attitudes towards e-waste recycling; C4 = subjective norms; C5 = perceived behavioral control; C6 = e-waste recycling intention; C7 = WTP for e-waste recycling.

Table 4
Results of the OLS regression considering awareness as the dependent variable.

Awareness	Coef.	Std. Err.	P-value
WTP	−0.055	0.050	0.266
Attitudes towards e-waste recycling	**0.202****	0.062	0.001
Subjective norms	**0.132****	0.057	0.022
Perceived control	0.025	0.054	0.639
E-waste recycling intention	**0.165****	0.064	0.011
Environmental concern	0.000	0.047	1.000
People living	−0.092**	0.045	0.043
Area of residence	−0.011	0.062	0.859
Age	0.005	0.010	0.629
Gender	−0.268***	0.089	0.003
Job	−0.033	0.050	0.507
_cons	2.661	0.377	0

* p-value<0.10, ** p-value<0.05, *** p-value<0.01.

Based on these findings, it can be concluded that improving awareness of the importance of e-waste disposal at a group level (e.g., by passing on this information in university classrooms or schools) may increase both WTP for proper e-waste disposal and awareness of the consequences related to this waste. Working on a group level may also help to establish e-waste disposal as a social norm.

4. Discussion and policy implications

The circular economy has emerged as a prominent theme in the literature (Dwivedi et al., 2023; Lopes de Sousa Jabbour et al., 2019), using a multi-level approach (Dwivedi et al., 2022; Panchal et al., 2021), and relying on effective data management and the recovery of valuable materials (Sassanelli et al., 2021). E-waste sustainability is now a pressing issue that cannot be postponed (Kumar and Dixit, 2018b), and consumer participation in recycling programs has been identified as crucial (Shahrasbi et al., 2021). However, users do not typically dispose of their products properly (Corsini et al., 2020), and social analyses to assess public attitudes towards e-waste collection and disposal are important (Gilal et al., 2022; Thukral et al., 2022). Value compatibility, environmental concerns, and the perceived benefits of engaging in this behavior all influence people's intentions to recycle e-waste (Dhir et al., 2021b). As evidenced by Koshta et al. (2022), awareness of consequences, e-waste recycling intention, and perceived behavioral control influence WTP for e-waste recycling, and environmental concern, subjective norms, and attitudes towards e-waste recycling influence e-waste recycling intention.

The present results demonstrate that social analyses, depending on the methodology and the reference sample used, may result in different perspectives. However, a comprehensive dataset and a comparison of the results obtained using a variety of techniques can facilitate the identification of a common perspective. Specifically, unlike AHP analysis, the Likert scale assesses each criterion individually, without requiring the respondent to compare that parameter with others. Moreover, while the opinion of academics may reflect more interdisciplinary and comprehensive knowledge, it may nevertheless conflict with the needs of younger people (Garg et al., 2023). Similarly, a business may produce a product it believes to be perfect, but the market will ultimately evaluate its characteristics. The present study started from an understanding that electrical and electronic equipment are set to play an increasingly important role in the digitization of both the production system and human lives. However, significant environmental challenges accompany this trend, including climate change and the scarcity of some raw materials, which prevent some production processes from being completed (Pinheiro et al., 2022; Sassanelli et al., 2020). This is further compounded by changing geopolitical risks. The literature emphasizes the critical role played by policies in ensuring proper waste management to promote the circular economy (D'Adamo et al., 2022; Sundar et al., 2023). Additionally, sustainable education and youth confidence can be classified as key pillars of future civil society (Biancardi et al., 2023), because education is preparatory to sustainable development (Ramos et al., 2020). Previous research has shown that survey respondents are dissatisfied with current political management (Cai et al., 2023).

The findings from the younger cluster (i.e., students) suggest that there is a discrepancy between good intentions and actual behavior when it comes to e-waste recycling. While respondents in this group showed a strong awareness of the consequences of improper e-waste disposal and a positive attitude towards recycling, they lacked confidence in their ability to properly dispose of their electronic products and were unwilling to bear the costs associated with recycling. This highlights the need for targeted and specific information campaigns aimed at educating the public on the importance of e-waste recycling and the proper methods for disposal. Adding to this, academics emphasized the importance of WTP for e-waste recycling as a necessary prerequisite for the successful circular economy. These findings show that environmental concerns, alone, are not enough to drive economic behavior towards circular models. Therefore, policymakers should consider how to share disposal costs among stakeholders and determine whether business should be penalized for failing to initiate take-back, recycling, and recovery pathways.

Incentives for consumers to participate in e-waste recycling programs should also be carefully considered. Monetary incentives, such as bonuses for buying a new product, are one possibility, but other non-monetary incentives, such as the opportunity to contribute to the environment or the ability to dispose of an old product responsibly, may be just as effective. Overall, a comprehensive approach that combines targeted information campaigns, financial incentives, and appropriate regulatory measures may be necessary to promote e-waste recycling and move towards a more sustainable, circular economy.

The present research contributed several insights to knowledge and practice, as well as multiple managerial and policy implications. Theoretical implications included the development of a new research approach combining three methods (i.e., Likert scale, AHP, econometric analysis) to assess the criteria that affect end users' willingness to correctly dispose of electronic devices. This approach considered and evaluated criteria not only individually (using the Likert scale), but also in combination (using AHP). Additionally, an econometric assessment was used to explore the relations among the criteria, providing not only a ranking of the criteria but also a correlation map, generating key insights for researchers in this domain.

The prioritization and relations defined in this study may contribute to practice by providing businesses with useful information and guidelines to encourage end users to dispose of their electronic devices through official collection channels. The results also have managerial and policy implications, impacting managers' daily activities in managing the flows of end-of-life electronic devices and supporting them in understanding the main dynamics behind this flow. Businesses cannot address environmental issues individually, but there is a need for a holistic view that combines ecological challenges with shortages in raw materials and digitization (Fatimah et al., 2023). Some suitable approaches are: i) awareness campaigns for e-waste education; ii) staff training for safe disposal of e-waste; and iii) production of environmentally friendly EEEs (Sharma et al., 2021).

Finally, policy makers may also benefit from the results of this research, which could help them to redefine assets, policies, and regulations to facilitate the electronic devices disposal process. Dhir et al. (2021a) highlighted several policy findings: (i) making information on recycling and collection centers available, (ii) making the reduction of privacy and security risks associated with recycling explicit, (iii) reducing transportation and management costs associated with e-waste recycling, and (iv) marketing the simplicity of the e-waste recycling process.

Governments cannot expect consumers to adopt new circular approaches without the correct information. This transition should be supported and emphasized through a set of measures (e.g., subsidies, services) that allow individuals to perceive the recycling of e-wastes

(and any other waste source) as the easiest behavior to apply. Attitude and knowledge are the most decisive elements in consumer purchase decision making, but there is a lack of analysis on attitudes in the post-purchase phase (Vidal-Ayuso et al., 2023). The literature shows that businesses can adopt different incentive policies for types of EEEs, but it is essential to encourage consumers to actively participate in formal recycling (Wang et al., 2023). In this direction, involvement should be formulated starting with the younger generation itself who are unwilling to recognize higher WTP for different circular versions of products (i.e., recycled, reconditioned, and second-hand (Chiappetta Jabbour et al., 2023)). In this way, stakeholder engagement will play a key role in supporting the sustainability of e-waste management.

5. Conclusions

The present study evaluated seven main criteria (i.e., intention to recycle e-waste, awareness of the importance of e-waste recycling, environmental concern, attitudes towards e-waste recycling, subjective norms, e-waste recycling intention, WTP for e-waste recycling) to investigate why end users are reluctant to dispose of their electronic devices through official channels for proper recycling. The primary objective was to compare the perceptions of two stakeholder groups and contribute new insights to the literature in this field.

The study applied a combination of research methodologies (i.e. Likert scale, AHP, econometric analysis) to gather and analyze data from two groups of users (i.e., students, academic experts). This approach was innovative and effective, even compared with that available in the literature. Indeed, from a research methodology perspective, the innovative feature of this study consists in the fact that the approach was used to define the relevance of the criteria, and not the relationships among the criteria (which was later assessed through the econometric analysis).

From a results perspective, several main contributions, both theoretical and practical, were obtained. First, the Likert scale analysis revealed that awareness was the most relevant criteria, while WTP for e-waste recycling was the least important. Second, the AHP method showed that WTP for e-waste recycling was the most relevant criterion, while subjective norms were the least important. The only commonality between the two perspectives was that both assigned the second place to attitudes towards e-waste recycling. This suggests that, from a theoretical perspective, e-waste recycling is relevant and may cause various problems if not well managed. Finally, the econometric analysis, also considering some socio-demographic characteristics of the sample, explored the relationships among variables. From this, it emerged that only subjective norms and intention to recycle e-waste significantly influenced WTP.

Despite the valuable contributions of this research, the study also presented some limitations, while also opening new avenues for further research. From a methodological perspective, the main limitation pertained to the study sample (i.e., students, academic experts) and it might be interesting to consider whether the results change if respondents are paid for their answers. Further research should seek to replicate the investigation, extending it to other categories of users (e.g., decision makers, industry experts), to identify the different perspectives of multiple stakeholders towards e-waste recycling. Finally, the policy proposals presented in the previous sections (i.e., information campaigns, monetary incentives, economic penalties, stakeholder engagement) should be evaluated through more focused analyses.

CRediT authorship contribution statement

Charbel Jose Chiappetta Jabbour: Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Investigation, Supervision, Validation, Writing – review & editing, All authors contributed equally to the prepared manuscript. **Annarita Colasante:** Conceptualization, Methodology, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Validation, Writing – review & editing. **Idiano D'Adamo:** Conceptualization, Methodology, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Validation, Writing – review & editing. **Paolo Rosa:** Conceptualization, Methodology, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Validation, Writing – review & editing. **Claudio Sassanelli:** Conceptualization, Methodology, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Validation, Writing – review & editing.

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.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2023.139257.

References

Ajzen, I., 2011. The theory of planned behaviour: reactions and reflections. Psychol. Health 26, 1113–1127. https://doi.org/10.1080/08870446.2011.613995.
Alam, T., Golmohammadzadeh, R., Faraji, F., Shahabuddin, M., 2022. E-waste recycling technologies - an overview, challenges and future perspectives. In: Paradigm Shift in E-Waste Management. CRC Press - Taylor & Francis Group, p. 34.
Ananno, A.A., Masud, M.H., Dabnichki, P., Mahjabeen, M., Chowdhury, S.A., 2021. Survey and analysis of consumers' behaviour for electronic waste management in Bangladesh. J. Environ. Manag. 282 https://doi.org/10.1016/j.jenvman.2021.111943.
Basile, D., D'Adamo, I., Goretti, V., Rosa, P., 2023. Digitalizing circular economy through blockchains: the blockchain circular economy index. J. Ind. Prod. Eng. 40, 233–245. https://doi.org/10.1080/21681015.2023.2173317.
Bhattacharjee, P., Howlader, I., Rahman, M.A., Taqi, H.M.M., Hasan, M.T., Ali, S.M., Alghababsheh, M., 2023. Critical success factors for circular economy in the waste electrical and electronic equipment sector in an emerging economy: implications for stakeholders. J. Clean. Prod. 401, 136767 https://doi.org/10.1016/j.jclepro.2023.136767.
Biancardi, A., Colasante, A., D'Adamo, I., 2023. Sustainable education and youth confidence as pillars of future civil society. Sci. Rep. 13, 955. https://doi.org/10.1038/s41598-023-28143-9.
Cai, K., Wang, L., Ke, J., He, X., Song, Q., Hu, J., Yang, G., Li, J., 2023. Differences and determinants for polluted area, urban and rural residents' willingness to hand over and pay for waste mobile phone recycling: evidence from China. Waste Manag. 157, 290–300. https://doi.org/10.1016/j.wasman.2022.12.032.
Cheshmeh, Z.A., Bigverdi, Z., Eqbalpour, M., Kowsari, E., Ramakrishna, S., Gheibi, M., 2023. A comprehensive review of used electrical and electronic equipment management with a focus on the circular economy-based policy-making. J. Clean. Prod. 389, 136132 https://doi.org/10.1016/j.jclepro.2023.136132.
Chiappetta Jabbour, C.J., Colasante, A., D'Adamo, I., Rosa, P., Sassanelli, C., 2023. Customer attitudes towards circular economy in the e-waste context: a survey assessing sustainable consumption dynamics. IEEE Eng. Manag. Rev. (in press).
Colasante, A., D'Adamo, I., Morone, P., Rosa, P., 2022. Assessing the circularity performance in a European cross-country comparison. Environ. Impact Assess. Rev. 93, 106730 https://doi.org/10.1016/j.eiar.2021.106730.
Corsini, F., Gusmerotti, N.M., Frey, M., 2020. Consumer's circular behaviors in relation to the purchase, extension of life, and end of life management of electrical and electronic products: a review. Sustain. Times 12, 1–16. https://doi.org/10.3390/su122410443.
D'Adamo, I., Mazzanti, M., Morone, P., Rosa, P., 2022. Assessing the relation between waste management policies and circular economy goals. Waste Manag. 154, 27–35. https://doi.org/10.1016/j.wasman.2022.09.031.
Dhir, A., Koshta, N., Goyal, R.K., Sakashita, M., Almotairi, M., 2021a. Behavioral reasoning theory (BRT) perspectives on E-waste recycling and management. J. Clean. Prod. 280, 124269 https://doi.org/10.1016/j.jclepro.2020.124269.
Dhir, A., Malodia, S., Awan, U., Sakashita, M., Kaur, P., 2021b. Extended valence theory perspective on consumers' e-waste recycling intentions in Japan. J. Clean. Prod. 312, 127443 https://doi.org/10.1016/j.jclepro.2021.127443.
Dwivedi, A., Moktadir, M.A., Chiappetta Jabbour, C.J., de Carvalho, D.E., 2022. Integrating the circular economy and industry 4.0 for sustainable development:

implications for responsible footwear production in a big data-driven world. Technol. Forecast. Soc. Change 175, 121335. https://doi.org/10.1016/j.techfore.2021.121335.
Dwivedi, A., Sassanelli, C., Agrawal, D., Moktadir, M.A., D'Adamo, I., 2023. Drivers to mitigate climate change in context of manufacturing industry: an emerging economy study. Bus. Strateg. Environ. n/a. https://doi.org/10.1002/bse.3376.
Eurostat, 2019. Overview - Waste [WWW Document]..
Fatimah, Y.A., Kannan, D., Govindan, K., Hasibuan, Z.A., 2023. Circular economy e-business model portfolio development for e-business applications: impacts on ESG and sustainability performance. J. Clean. Prod. 415, 137528 https://doi.org/10.1016/j.jclepro.2023.137528.
Garg, S., Ahmad, A., Madsen, D.Ø., Sohail, S.S., 2023. Sustainable behavior with respect to managing E-wastes: factors influencing E-waste management among young consumers. Int. J. Environ. Res. Publ. Health 20, 81. https://doi.org/10.3390/ijerph20010801.
Gilal, F.G., Shah, S.M.M., Adeel, S., Gilal, R.G., Gilal, N.G., 2022. Consumer e-waste disposal behaviour: a systematic review and research agenda. Int. J. Consum. Stud. 46, 1785–1803. https://doi.org/10.1111/ijcs.12767.
Govindan, K., 2022. Tunneling the barriers of blockchain technology in remanufacturing for achieving sustainable development goals: a circular manufacturing perspective. Bus. Strat. Environ. 31, 3769–3785. https://doi.org/10.1002/bse.3031.
Jangre, J., Prasad, K., Patel, D., 2022. Analysis of barriers in e-waste management in developing economy: an integrated multiple-criteria decision-making approach. Environ. Sci. Pollut. Res. 29, 72294–72308. https://doi.org/10.1007/s11356-022-21363-y.
Kannan, D., Solanki, R., Darbari, J.D., Govindan, K., P.C, J., 2023. A novel bi-objective optimization model for an eco-efficient reverse logistics network design configuration. J. Clean. Prod. 394, 136357 https://doi.org/10.1016/j.jclepro.2023.136357.
Koshta, N., Patra, S., Singh, S.P., 2022. Sharing economic responsibility: assessing end user's willingness to support E-waste reverse logistics for circular economy. J. Clean. Prod. 332, 130057 https://doi.org/10.1016/j.jclepro.2021.130057.
Kumar, A., Dixit, G., 2018a. Evaluating critical barriers to implementation of WEEE management using DEMATEL approach. Resour. Conserv. Recycl. 131, 101–121. https://doi.org/10.1016/j.resconrec.2017.12.024.
Kumar, A., Dixit, G., 2018b. An analysis of barriers affecting the implementation of e-waste management practices in India: a novel ISM-DEMATEL approach. Sustain. Prod. Consum. 14, 36–52. https://doi.org/10.1016/j.spc.2018.01.002.
Lopes de Sousa Jabbour, A.B., Rojas Luiz, J.V., Rojas Luiz, O., Chiappetta Jabbour, C.J., Ndubisi, N.O., Caldeira de Oliveira, J.H., Junior, F.H., 2019. Circular economy business models and operations management. J. Clean. Prod. 235, 1525–1539. https://doi.org/10.1016/j.jclepro.2019.06.349.
Manoj Kumar, N., Chopra, S.S., 2023. Insights into material recovery, revenue, and global warming potential of India's end-of-life photovoltaic installations reveals the urgent need for blockchain-based solar passports. Sustain. Energy Technol. Assessments 58, 103326. https://doi.org/10.1016/j.seta.2023.103326.
Mazlan, S., Ariffin, S., Zarith Delaila, A.A., Yusof, J.M., 2016. Factors affecting purchase intention of Iphone among business students in UiTM Puncak Alam, Selangor. Int. Acad. Res. J. Bus. Technol. 2, 57–62.
Molla, A.H., Moghtaderi, S.H., Harun, Z., Jedi, A., Manoj Kumar, N., 2023. Insights into end-of-life vehicle recycling and its quality assessment systems in Malaysia reveals the need for a new stakeholder-centric approach for vehicle waste management. Prod. Manuf. Res. 11, 2236676 https://doi.org/10.1080/21693277.2023.2236676.
Moslehpour, M., Huyen, N.T. Le, 2014. The influence of perceived brand quality and perceived brand prestige on purchase likelihood of iPhone and HTC mobile phone in Taiwan. Res. Bus. Manag. 1, 62–77. https://doi.org/10.5296/rbm.v1i1.4882.
Murthy, V., Ramakrishna, S., 2022. A review on global E-waste management: urban mining towards a sustainable future and circular economy. Sustainability 14, 647. https://doi.org/10.3390/su14020647.
Opferkuch, K., Caeiro, S., Salomone, R., Ramos, T.B., 2022. Circular economy disclosure in corporate sustainability reports: the case of European companies in sustainability rankings. Sustain. Prod. Consum. 32, 436–456. https://doi.org/10.1016/j.spc.2022.05.003.
Panchal, R., Singh, A., Diwan, H., 2021. Does circular economy performance lead to sustainable development? – a systematic literature review. J. Environ. Manag. 293, 112811 https://doi.org/10.1016/j.jenvman.2021.112811.
Papamichael, I., Voukkali, I., Jeguirim, M., Argirusis, N., Jellali, S., Sourkouni, G., Argirusis, C., Zorpas, A.A., 2022. End-of-Life management and recycling on PV solar energy production. Energies 15, 6430. https://doi.org/10.3390/en15176430.
Papamichael, I., Zorpas, A.A., 2022. End-of-waste criteria in the framework of end-of-life PV panels concerning circular economy strategy. Waste Manag. Res. 40, 1677–1679. https://doi.org/10.1177/0734242X221132886.
Pinheiro, M.A.P., Jugend, D., Lopes de Sousa Jabbour, A.B., Chiappetta Jabbour, C.J., Latan, H., 2022. Circular economy-based new products and company performance: the role of stakeholders and Industry 4.0 technologies. Bus. Strat. Environ. 31, 483–499. https://doi.org/10.1002/bse.2905.
Ramos, T.B., Caeiro, S., Disterheft, A., Mascarenhas, A., Deutz, P., Spangenberg, J.H., Montaño, M., Olayide, O., Sohal, A., 2020. Rethinking sustainability: questioning old perspectives and developing new ones. J. Clean. Prod. 258, 120769 https://doi.org/10.1016/j.jclepro.2020.120769.
Roos Lindgreen, E., Opferkuch, K., Walker, A.M., Salomone, R., Reyes, T., Raggi, A., Simboli, A., Vermeulen, W.J.V., Caeiro, S., 2022. Exploring assessment practices of companies actively engaged with circular economy. Bus. Strat. Environ. 31, 1414–1438. https://doi.org/10.1002/bse.2962.
Saaty, T.L., 2008. Decision making with the analytic hierarchy process. Int. J. Serv. Sci. 1, 83–98. https://doi.org/10.1504/IJSSCI.2008.017590.
Sassanelli, C., Rosa, P., Terzi, S., 2021. Supporting disassembly processes through simulation tools: a systematic literature review with a focus on printed circuit boards. J. Manuf. Syst. 60, 429–448. https://doi.org/10.1016/j.jmsy.2021.07.009.
Sassanelli, C., Rossi, M., Terzi, S., 2020. Evaluating the smart maturity of manufacturing companies along the product development process to set a PLM project roadmap. Int. J. Prod. Lifecycle Manag. 12, 185–209. https://doi.org/10.1504/IJPLM.2020.109789.
Shahrasbi, A., Shokouhyar, S., Zeidyahyaee, N., 2021. Consumers' behavior towards electronic wastes from a sustainable development point of view: an exploration of differences between developed and developing countries. Sustain. Prod. Consum. 28, 1736–1756. https://doi.org/10.1016/j.spc.2021.09.016.
Sharma, M., Joshi, S., Govindan, K., 2021. Issues and solutions of electronic waste urban mining for circular economy transition: an Indian context. J. Environ. Manag. 290, 112373 https://doi.org/10.1016/j.jenvman.2021.112373.
Subhaprada, C.S., Kalyani, P., 2017. Study on awareness of e-waste management among medical students. Int. J. Community Med. Public Heal. 4, 506–510. https://doi.org/10.18203/2394-6040.ijcmph20170281.
Sundar, D., Mathiyazhagan, K., Agarwal, V., Janardhanan, M., Appolloni, A., 2023. From linear to a circular economy in the e-waste management sector: experience from the transition barriers in the United Kingdom. Bus. Strat. Environ. https://doi.org/10.1002/bse.3365.
Thukral, S., Shree, D., Singhal, S., 2022. Consumer Behaviour towards Storage, Disposal and Recycling of E-Waste: Systematic Review and Future Research Prospects. Benchmarking in press. https://doi.org/10.1108/BIJ-12-2021-0774.
Tsyganok, V.V., Kadenko, S.V., Andriichuk, O.V., 2012. Significance of expert competence consideration in group decision making using AHP. Int. J. Prod. Res. 50, 4785–4792. https://doi.org/10.1080/00207543.2012.657967.
Vidal-Ayuso, F., Akhmedova, A., Jaca, C., 2023. The circular economy and consumer behaviour: literature review and research directions. J. Clean. Prod. 418, 137824 https://doi.org/10.1016/j.jclepro.2023.137824.
Wang, F., Liu, Q., Yin, X., 2023. Exploring influencing factors of consumers' wasted household appliances disposal behavior considering product heterogeneity in China. J. Clean. Prod. 418, 138065 https://doi.org/10.1016/j.jclepro.2023.138065.
Yadav, R., Kumar Panda, D., Kumar, S., 2022. Understanding the individuals' motivators and barriers of e-waste recycling: a mixed-method approach. J. Environ. Manag. 324, 116303 https://doi.org/10.1016/j.jenvman.2022.116303.
Yu, Z., Gao, C., Yang, C., Zhang, L., 2023. Insight into quantities, flows, and recycling technology of E-waste in China for resource sustainable society. J. Clean. Prod. 393, 136222 https://doi.org/10.1016/j.jclepro.2023.136222.