

Exploring the role of e-waste management solutions and message framing in influencing consumer behaviours: the crowdfunding context

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Abstract

Electronics waste (e-waste) is the fastest growing category of hazardous solid waste in the world. While the generation of e-waste has recently attracted the attention of a number of researchers, currently, there is little awareness on its management, monitoring and control among the consumers of crowdfunding platforms. This is surprising because the supporters (backers) of crowdfunding are usually considered as disruptive innovators by other stakeholders. In this light, this research explores the role of e-waste management solutions and the formulation of “message framing” in influencing consumer behaviours in crowdfunding contexts. To do this, this study involves an in-depth investigation of fund-raising campaigns focused on e-waste, that were promoted between 2009 and 2020, through Kickstarter’s reward-based crowdfunding platform. The results show that environmentally sustainable projects focused on waste reduction and pollution prevention are generating increased funds and triggering the interest of a number of crowd investors who are willing to finance such laudable initiatives. At the same time, the findings suggest that the fundraisers elaborate framing messages on environmental protection and on the preservation of the natural eco-systems can increase the likelihood of the success of their crowdfunding projects.

This contribution contributes to both environmental management and to the crowdfunding literature. In conclusion, it offers practical implications for sustainable entrepreneurs who may resort to crowdfunding platforms to raise finance to decrease the accumulation of e-waste from the planet, as well as for other stakeholders including governments, policymakers, and public agencies.

Keywords: electronic waste; waste management; crowdfunding; waste prevention; waste reduction; message framing.

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1. Introduction

The management of waste is one of the most contentious topics in the sustainability literature (Camilleri, 2019). Undoubtedly, the production and consumption of electronic products are heavily responsible for the generation of waste in different context (Cole et al., 2019; Heacock et al., 2016; Kiddee et al., 2013; Sonogo et al., 2022). Electronics waste (from now on e-waste) is the fastest growing category of hazardous solid waste in the world (Apolloni et al., 2021; Awasthi et al., 2019; Sundar et al., 2023). Indeed, short product life cycles, poor repairability, growing segments of consumers of electronic products and quick replacements, mainly for consumer electronics, create enormous quantity of e-waste (Arain et al., 2020; Camilleri, 2020; Paiano et al., 2013; Rubin et al., 2014). In 2014, the amount of e-waste was 44.4 million tons, which increased to 53.6 million tons in 2019, and is projected to increase to 74.7 million tons in 2030 (Forti et al., 2020). As claimed by Opris (2020), the electronics industry is broken and designers, engineers, manufacturers, distributors, investors, consumers, and policymakers, all the stakeholders are called to fix this broken industry.

As regards consumers, their behaviours in terms of awareness and engagement in e-waste management have attracted attention in recent literature (e.g., Mugge et al., 2017; Najmi et al., 2019; Pérez-Belis et al., 2017). However, little is known about consumer behaviours in the context of crowdfunding (CF), a recent and growing form of digital infrastructure (Testa et al., 2022a; Troise et al., 2023; Nambisan, 2017). This is surprising because, in the dominant form of reward-based crowdfunding, campaign supporters, namely backers, mainly contribute to obtain future products or services, which makes them the first consumers of a specific product (Camilleri and Bresciani, 2022; Chan and Parhankangas, 2017; Cholakova and Clarysse, 2015; Roma et al., 2021; Stanko and Henard, 2017; Zhang and Chen, 2019). Campaign supporters show real interest in the product to the extent that they are willing to commit to buy early in advance even at risk of losing their investment in case of product development failure. Therefore, they can be considered very preliminary category of innovation adopters (Stanko and Henard, 2017), even prior to “innovators”, according to Rogers’ innovation-diffusion model (2003), i.e., consumers that, before than others, manifest attention towards innovative solutions (from now on pre-innovators). Investigating what happens in a CF context could thus be fruitful to forecast future trends in terms of e-waste management solutions. Understanding their behaviours and preferences can provide benefits because they do influence behaviours of next adopters (Rogers, 2003).

It is worth noting that consumer preferences not only depend on the type of consumers, but they are also influenced by message framing as explained in prospect theory (Kahneman and Tversky, 1979) and this also applies in the context of e-waste management related behaviours (see for example,

Baxter and Gram-Hanssen, 2016). Investigating what happens in a CF context could thus also be fruitful to understand effective framing to foster the attractiveness of e-waste management solutions. Hence, in this paper we aim at answering the following two questions related to e-waste management: What type of e-waste solutions do CF supporters prefer? What type of message framing is more effective to increase their preferences?

To answer these questions, we conducted an in-depth exploration of a dataset of the 47 crowdfunding campaigns related to e-waste that have been launched from 2009 to 2020, on the reward-based crowdfunding platform Kickstarter. Kickstarter is an internationally known crowdfunding platform with a large variety of projects. It does not have a particular green, sustainability-oriented profile, which was considered as an advantage since such a platform does not exclusively attract a sustainability-oriented crowd but a much broader public (Testa et al., 2019).

This study offers two main contributions. Firstly, we add to research on e-waste management, from the consumer perspective (Mugge et al., 2017; Najmi et al., 2019; Pérez-Belis et al., 2017). Our findings show that a specific category of consumers (the most innovative) seem to have a good level of awareness in terms of issues related to e-waste and show interest towards the preferable solutions, according to the EU waste strategy (European Parliament and the Council of the European Union 2008, Directive 2008/98/EC) (European Union, 2008). Our results also contribute at filling a gap regarding message framing effects on consumer behaviours as recently highlighted by a literature review (Florence et al., 2022, p. 641) where authors write: “(..) there are some under-researched contexts, such as waste management of electronic products.”. Secondly, we advance crowdfunding literature which has only recently begun to explore the role of this form of digital infrastructure in supporting sustainable/environmental initiatives and where research is still limited (Böckel et al., 2021; Caputo et al., 2022; Testa et al., 2019).

The rest of this article is organized as follows. In Section 2, we introduce the theoretical background and advance our hypotheses. In Section 3, we describe data, variables, and methods used in this research. In Section 4, we present and discuss our empirical findings, while in Section 5, we conclude.

2. Theoretical background

To study consumer behaviours towards e-waste, we adopt two concepts: the waste hierarchy concept and the message framing concept.

2.1. The waste hierarchy concept

The waste hierarchy identifies a preferential order of waste treatment options: prevention/reduce, reuse, recycling, recovery for energy generation and disposal (European

Parliament and the Council of the European Union 2008, Directive 2008/98/EC) (European Union, 2008), from the most to the less preferable option.

The prevention principle refers to the minimization of the overall amount of materials, resources and waste generated in the economic system through the increase of efficiency in production and consumption, while reducing waste and the environmental impact (Camilleri, 2022; Ghisellini et al., 2016). The reuse principle claims that materials, products, and components that are not wasted, are used again for the same purpose that they were conceived. The reason is that reusing materials and products requires fewer resources and less energy than producing new ones (Castellani et al., 2015). The recycle principle refers to any recovery operation by which waste materials are reprocessed into products, materials, or components whether for the original or for other purposes.

Based on the waste hierarchy above introduced, we can identify two broad behaviours consumers may adopt to minimize the problems of e-waste, each characterized by different motivations and barriers: 1) the consumer buys electronics items with prolonged life and/or manages devices to prolong their duration of use (DOU), 2) the consumer recycles electronics items or buys recycled/used electronics items.

As regards the first behaviour (the consumer buys electronics items with prolonged life and/or manages devices to prolong their DOU), which is the preferable option according to the waste hierarchy, previous work has emphasized how the short life-span and rapid turnover of handsets is a compounding factor in dealing with e-waste (Sarath et al., 2015). Prolonging the lifetime of consumer electronics, particularly the DOU, is essential for reducing e-waste (Yamamoto and Murakami, 2022). Prolonging DOU of a device means, for example, repair and maintenance (Sonogo et al., 2022) and other attempts to postpone replacement, for example through preventive measures such as the use of a protection system like protective covers for smartphones (Ackermann et al., 2018). Modularity and eco-design are key elements to prepare the product architecture to be more easily disassembled and thus to reduce barriers to product repair (De Fazio et al., 2021; Sonogo et al., 2018) and to allow upgradability (Khan et al., 2018).

However, as noted by Bridgens et al. (2019), encouraging people to keep products for longer is notoriously difficult. Indeed, DOU is influenced not only by product-related characteristics (e.g., functional durability and appearance) but by individual and contextual characteristics (Cox et al., 2013), such as the lack of repair competencies (Rogers et al., 2021), individual novelty-seeking and lack of support (Ackermann et al., 2018; Jaeger-Erben et al., 2021) and of environmental awareness (Yamamoto and Murakami, 2022). The fact that product failure only accounts for half the reasons of obsolescence of a certain type of electronic devices indicates that product durability or reliability is only a part of the factors that determine the DOU (Pérez-Belis et al., 2017; Yamamoto and Murakami,

2022). For refrigerators and mobile phones, for example, Frick et al. (2021) showed that the attractiveness of newness had a negative influence on the DOU.

Mobile phones are a typical “up to date” product (in contrast with “functional” or “workhorse” products) as defined by Cox et al. (2013), meaning that most consumers want to change them often (no interest for prolonged life) and buy brand-new products (no interest in buying recycled or used products), attracted by new features (Magnier and Mugge, 2022). Mobile phones DOU, with replacement rates of approximately 18-24 months, is shorter than the designed service life (Penners et al., 2018).

As regards the second behaviour (the consumer recycles electronics items or buys used/recycled electronics items, from now on “recycle as an output” and “recycle as an input” respectively), previous work has examined barriers to and drivers for recycling in terms of facilities and services (for example Martin et al., 2006), in terms of knowledge (i.e. about environmental impact) and experience concerning recycling (for example Schultz, 2002) and in terms of other factors (Baxter and Gram-Hanssen, 2016; Penners et al., 2018) such as convenience (mainly related to the dimension of the electronics item), economic factors (for example direct incentives), moral norms (Yadav et al., 2022) and data security and privacy concerns (for example in case of mobile phones and personal computers).

A recent survey (WEEE Forum, 2022) shows that a huge amount of small electronic items is not collected and recycled but it is retained at home, creating a big sustainability problem (the so-called do-nothing option, which is especially significant, for example, for mobile phones (Baxter and Gram-Hanssen, 2016). Recent works emphasize the importance to immediate return used products to grant their optimal recovery value and to minimize the negative environmental impacts (Kamal et al., 2022). At the same time, it is important to understand whether a product is valuable for the consumer because his/her perceived value determines attitude towards the product, choice, willingness-to-pay, satisfaction and repurchase. For example, when products are the result of recycle, the main concern about perceived value by the end-user is that he/she might perceive the product as of lower value (Calvo Porral et al., 2020), both in terms of quality and safety.

Van Weelden et al. (2106) identify personal, contextual, and product-related factors impacting the acceptance of refurbished smartphones and Mugge et al. (2017) investigate possible solutions to increase such an acceptance among different groups of consumers. Hazen et al. (2017) suggest how to better communicate quality and standards for remanufactured products. Similarly, Cole et al., (2019) explores trends and barriers in applying the waste hierarchy for e-waste and claims that recovery through recycling is limited to easily salvageable materials and waste prevention and reuse are often neglected.

2.2. *The message framing concept*

As regards consumer engagement in e-waste management, some scholars emphasize the relevance of message framing, though with contrasting perspectives.

Arguably, a research stream focuses on the importance of an environmental framing and claims that sustainability and environmental protection are the ostensible reasons for being engaged in e-waste management initiatives. For example, several authors report that most European or North American consumers who recycle believe that they are reversing or at least mitigating environmental degradation by recycling their goods (Baxter and Gram-Hanssen, 2016; Borthakur and Govind, 2017). Other authors claim that making environmental benefits more salient may improve the perception of refurbished products, and increase their adoption, at least by groups of customers which are more sensible towards environmental issues (Harms and Linton, 2016; Van Weelden et al., 2016). Some authors suggest how to frame environmental messages (in terms of negative and positive framing) to give rise to higher rates of adoption of e-waste management related products (Baxter and Gram-Hanssen, 2016).

On the other hand, a research stream claims that, in line with consumers of other products such as fashion (Pal and Gander, 2018), consumers of electronics products are only marginally motivated by environmental factors (De Dominicis et al., 2017; de Vicente Bittar, 2018) and thus it is not relevant to frame the message in an environmental frame. In fact, it is recurrent that personal benefits – such as cost savings, convenience, and status – can play a crucial role in the decision-making process of consumers; this means that consumers frequently pay first attention to these benefits rather than to environmental ones, and consequently framing a message on personal benefits assumes a strategic relevance for the involved parties (i.e., message senders and receivers).

Due to the above-mentioned open discussion, despite the existence of several types of message framing (e.g., negative-positive, self-other and abstract-concrete, see Florence et al., 2022), sometimes used concurrently, the type of message framing examined in this paper is the self- versus other-focused frame. It is the most utilized in studies regarding sustainable consumer behaviour (ibidem). Indeed, sustainable consumer behaviour often involves a trade-off between personal (e.g., cost savings, convenience, status) vs societal or environmental benefits (e.g., lower emissions) (Green and Peloza, 2014; Testa et al., 2022b).

It is worth noting that framing is proved to be relevant not only in influencing consumer behaviour in traditional settings, but also in CF context and literature provides indications that the way crowdfunding projects are framed has a significant effect on their funding success (e.g., Defazio et al., 2021; Moradi and Dass, 2019; Nielsen and Binder, 2021; Penz et al., 2022; Rossolini et al., 2021; Troise et al. 2021). However, as already mentioned in introduction, the topic of message

framing in e-waste management issues is an under researched topic which deserves further research as findings in one context may not be applicable to others (Florence et al., 2022).

To conclude, it is worth noting that current literature on consumer decisions related to e-waste management mainly analyses individual products such as mobile phones (e.g., Baxter and Gram-Hanssen, 2016; Makov et al., 2019; Mugge et al., 2017; Penners et al., 2018; Shani et al., 2020; Van Weelden et al., 2016) and computers (e.g., Yamamoto and Murakami, 2022), neglecting other devices.

2.3. Hypotheses development

As explained above, literature shows that different factors (personal, contextual, and product-related) as well as message framing exert an impact on the acceptance of e-waste management related products. Hence, different elements could lead us to formulate our research hypotheses for the specific context of Kickstarter.

As regards the preferred solution, we should consider the following elements. First, Kickstarter attendants are primarily young adults. Indeed, the latest dedicated statistics (according to Similarweb, 2023) show that most supporters in Kickstarter are younger than 35 years, specifically 53.17% (of which: 21.63% between 18-24 years, and 31.54% between 25-34). As shown in literature (e.g., Hamzaoui-Essoussi and Linton, 2014; Nixon and Saphores, 2007; Tenner and Hörisch, 2021), young adults are likely to have a higher level of environmental consciousness and awareness of the consequences of e-waste mismanagement, compared to the whole population. Therefore, we can expect that they know that reducing waste is the most preferable option to deal with waste, though it often requires time and high technological skills, for example for properly caring (Ackermann et al., 2018) and repairing technological devices (Jaeger-Erben et al., 2021; Rogers et al., 2021).

Second, most Kickstarter attendants belong to a money conscious generation (they are millennials) and, as reported by a survey in 2016 (Gallup, 2016), they spend on average \$13 less per day than the comparable age group in 2008 and are more likely to participate in prudent spending and savings behaviours than other generations (Szendrey and Fiala, 2018). Therefore, we can expect that they are interested in solutions which allow them to save money and allocate their financial resources in a more responsible way.

Third, since Kickstarter attendants may be classified as pre-innovators as explained in introduction, we know (Stanko and Henard, 2017) that the valuable characteristics of early adopting consumers (Rogers, 2003) are likely intensified for them. Specifically, they have higher willingness to change their familiar practices compared to other types of later adopter categories and have strong technical knowledge, experience, and background (Sahin, 2006). Therefore, we can expect that they are willing to leave the comfort zone of the “buy, use and waste” consumption approach and adopt

the unfamiliar practices of maintaining and repairing their devices while having at the same time the knowledge needed to implement such kind of actions (Ackermann et al., 2018).

Fourth, since pre-innovators share with innovators the same high focus on functional performance (Rogers, 2003), we can expect that Kickstarter attendants, despite knowing the consequences of e-waste and being familiar with refurbishing/remanufacturing procedures, are more reluctant to buy used products as they are not convinced about their quality (see the “expert techie” customer group identified in the paper by Mugge et al., 2017).

Fifth, since innovators are status-motivated in adopting innovations (Rogers, 2003), we can expect that also pre-innovators perceive that prevention/reduction solutions may represent a positive signal towards third parties (e.g., they can signal their ability in repairing technological devices) while reuse/recycle solutions may represent a status concern (e.g., they can signal the acceptance of lower quality products due to economic constraints).

Concluding, we can assume that they are interested (and have appropriate knowledge) in adopting solutions to prevent/reduce waste through prolonging devices’ DOU as these solutions provide consumers with the opportunity to match environmental values with prudent spending and saving behaviours as well as to reduce quality and status concerns deriving from adopting recycled products. Looking at Kickstarter campaigns clustered as waste prevention/reduction solutions, we can find several initiatives focused on innovative systems of repair⁶ or prevention⁷ (e.g., smart kit of repairs and apps) as well as products/devices engineered to last longer⁸ and designed to be upgraded and even improved over time⁹. Based on the above considerations, we can formulate the following hypothesis:

H1: *Campaigns focusing on waste prevention/reduction display higher performance (in terms of both funding raised and number of funders) than their counterparts focusing on reuse/recycle solutions.*

As regards message framing, we should consider the following elements: Since Kickstarter attendants can be classified as pre-innovators as already explained and have the same intensified characteristics of innovators (Stanko and Henard, 2017), it is well known (Rogers, 2003) that these consumers are mainly attracted in their purchasing decisions by the technology itself, either for hedonic reasons or because driven by utilitarian needs, with a strong critical sense regarding the technology effectiveness and purpose (Barboza and Arruda Filho, 2019; Rogers, 2003), as well as its functional performance (Mugge et al., 2017). In this case, attributes related to environmental

6 For example, <https://www.kickstarter.com/projects/1236010782/watch-it-fix-watch-repair-kit-0>

7 For example, https://www.kickstarter.com/projects/privatec/privacy-and-damage-2-in-1-screen-protector-20-for-iphones?ref=discovery_category

8 For example, https://www.kickstarter.com/projects/doogee/doogee-s90-the-most-versatile-unbreakable-smartpho?ref=discovery_category

9 For example, <https://www.kickstarter.com/projects/transparent/transparent-speaker-1>

sustainability tend to be of no interest (Barboza and Arruda Filho, 2019) or at most they are claimed to be a nice addition when they do not conflict with the product's primary functionality (Olson, 2013).

It is worth noting that several scholars provided evidence that environmental factors have in general limited effects on consumers' intention of buying electronics products (De Dominicis et al., 2017; de Vicente Bittar, 2018) therefore, also in more general terms, it seems not relevant to frame the message in an environmental framing. Personal motivations such as cost saving, convenience and status can play a greater influence on consumer decision-making process (Green and Peloza, 2014).

These factors are particularly relevant for the main target audience of Kickstarter, namely the young adults, which pay great attention to economic aspects, as already explained.

Finally, as regards the specific context of CF, some studies highlight that environmental (or sustainability) orientation of CF projects does not influence the success of the campaigns and indeed may have negative effects on it (Hörisch, 2015; Lagazio and Querci, 2018; Vismara, 2019).

Also in this case, looking at Kickstarter campaigns, several of them clearly emphasize the self-oriented benefits for contributors. Typical examples of campaigns are slogans focused on "Save your money!" or "Better for your pocket, better for the planet", as it will be shown in the empirical section. Therefore, we can expect that emphasizing self-oriented benefits can increase the likelihood of success. Based on the above considerations, we can formulate the following hypothesis:

H2: *E-waste management-related campaigns emphasizing self-oriented benefits display higher performance (in terms of both funding raised and number of funders) than their counterparts emphasizing other-oriented benefits.*

3. Research Design

This study aims at exploring the role of e-waste management solutions and message framing in influencing consumer behaviour in a novel context, namely crowdfunding. In doing so, we seek to understand the impacts of waste prevention/reduction and self-oriented benefits on campaigns' performance compared to their counterparts (i.e., reuse/recycle solutions and other-oriented benefits). To estimate their quantitative effects on crowdfunding campaigns' performance and to test the two above formulated hypotheses, we conduct OLS (Ordinary Least Squares) regression analyses using two different dependent variables as explained in the variable subsection. We construct a sample of projects fulfilling the criteria of our research and specifically focused on e-waste management campaigns. Before that phase, we exploited and created several variables in line with previous as well as established studies and classifications.

3.1 Research setting and data collection

Our empirical analysis used data from Kickstarter, a well-known reward-based crowdfunding platform, used in many studies as empirical setting (Chan et al., 2020; Chan et al., 2021; Li and Wang, 2019; Mollick, 2014; Testa et al., 2020). This platform adopts the “all-or-nothing” model, and the provision of funding is motivated by rewards (Belleflamme et al., 2015; Chan et al., 2021), instead of equity shares or financial incentives (typically of other crowdfunding models like equity or debt crowdfunding).

The choice of the reward crowdfunding model allowed us to explore in depth projects focused on electronic waste and the role of contributors as consumers who aim to obtain rewards rather than acting as traditional investors (and therefore investing in exchange, for example, for shares of the company).

Apart from the nature of the crowdfunding model, Kickstarter represents ideal research setting for several reasons: first, it is the leading platform globally, as highlighted by the main reports (e.g., Technavio, Massolution reports); it represents a prominent crowdfunding model for product innovation and for exploring sustainable initiatives or issues (Testa et al., 2020).

We focused on campaigns launched on Kickstarter related to the management of electronics waste. Specifically, we used the Kickstarter category of Hardware – which includes manufacturing applications such as consumer electronics, 3-D printers, Internet-of-Things devices, drones, smart sensors, and robotics – and leveraging the following keywords: waste or valorisation or upcycle or upcycling or upcycled or by-product or reuse or recycled or surplus or remanufactured. For this step we have monitored and thoroughly reviewed all the campaigns in this specific category and the related information contained for each project.

We excluded the projects that were cancelled and obtained a final sample consisting of 47 campaigns; it included all the campaigns on these issues which have been launched on Kickstarter from 2009, that is the foundation year of the platform, till 2020. Of these projects, 27 failed to raise the funding goal, while 20 successfully achieved it. Both values of funding raised, and funding goals were converted using the euros (€) instead of USD (exchange rate as of August 29, 2020).

Variables description

In line with prior studies, our empirical analysis adopted two different dependent variables to measure the success of crowdfunding campaigns: the amount of funding raised and the number of contributors at the end of the campaign (Block et al., 2018; Chan et al., 2021; Clauss et al., 2020). The first represents a well-known measure of financial success, while the number of contributors is a typical measure of popularity success. Both these measures are widely recognized in literature and

considered fine-tuned measures as the aim of crowdfunding is to accumulate both many financial resources and supporters.

To investigate H1, we followed the waste management hierarchy classification by EU, namely the Waste Framework Directive 2008/98/EC, which measures the electronic waste solutions in terms of prevention/reduction or reuse/recycle. Specifically, we used a dummy variable, namely *Waste prevention/reduction*, equal to 1 if the project focuses on electronic waste prevention/reduction (while it is equal to zero in the case of waste re-use and recycling). The choice of this exploratory variable is related to its importance, being prevention/reduction the preferable option according to waste hierarchy (Sarath et al., 2015).

The second hypothesis, namely H2, was explored leveraging the theory of framing which measures the focus of the campaigns in terms of self or other oriented (socio/environmental) benefits. Specifically, we used a dummy variable as second exploratory variable, namely *Self-oriented benefits*, equal to 1 if the project focuses on self-oriented benefits (i.e., those of egoistic nature), while it is equal to zero in case of focus on social/environmental benefits.

Following prior research on reward-based crowdfunding, we included a set of control variables in our regression analyses (Chan et al., 2021; Li and Wang, 2019; Mollick, 2014). First, we controlled for *Funding goal*, that is the target capital (in natural logs) to be raised in the crowdfunding campaign, a typical measure of the project size. We included the number of projects that the creator has created before the launch of the project (*Project created*) to control for creator-specific characteristics. To control for project specific variables, we used the number of reward categories/levels offered (*Reward types*), the number of days for which a project accepts funding (*Duration*), the geographic location of the project (*Country*), and both the number of comments and updates posted during the crowdfunding campaigns (respectively, *Comments* and *Updates*). The list and the definitions of the variables discussed above are reported in Table 1.

Table 1. Descriptive Statistics and Variable Description

<i>Variable</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>	<i>Obs.</i>	<i>Variable description</i>
Funding Raised (€)	36,724.06	114,144.60	0	700,961.60	47	Total amount of funding raised at the end of the campaign
No. Backers	227.29	491.30	0	3,085	47	Number of backers pledging at the end of the campaign
Waste prevention/reduction	0.51	0.50	0	1	47	Dummy variable = 1 if the project focuses on waste prevention / reduction; 0 if the project focuses on re-use and recycling
Self-oriented benefits	0.51	0.50	0	1	47	Dummy variable = 1 if the project focuses on self-oriented benefits; 0 if the project focuses on social/environmental
Funding goal (€)	32,382.98	78,571.99	300.00	422,987.00	47	Funding goal to be raised in the campaign
Comments	147.68	475.62	0	2,756	47	The number of comments posted during the campaigns
Updates	8.76	13.94	0	76	47	The number of updates posted during the campaigns
Reward types	7.14	4.43	1	19	47	The number of reward categories (levels) offered
Duration	36.21	9.17	28	60	47	The number of days for which a project accepts funding
Projects created	0.89	1.37	0	5	47	The number of crowdfunding projects that the creator has created before the launch of the project
Country	0.53	0.50	0	1	47	Dummy variable = 1 if the project location is in the U.S.A.; 0 otherwise

4. Results and discussion

4.1 Descriptive statistics

Table 1 reports the descriptive statistics of our sample, and shows the mean, standard deviation, minimum and maximum values for each variable. The average amount of funding raised at the end of the campaigns is about 37,000 euros, while the average number of backers is 227.

The average funding goal is around 32,400 euros and the reward categories are on average 7 for each project; comments and updates are on average around 476 and 14 respectively. Just over half of the projects (precisely 53%) are launched in USA and their creators have created about 1 previous project (precisely 0.89%) before the launch of the project. The subdivision of the projects according to the classification of the waste hierarchy is quite fair, in fact 51% of the projects are focused on waste prevention/reduction and the 49% on re-use and recycling. Similarly, the focus of the projects is subdivided evenly (51% of them have a focus on self-oriented benefits, while the 49% on social and environment). Some examples are provided in Appendix 1.

4.2 Regression results

To test our hypotheses, we performed the analyses with reference to two types of outcome variables considered. In *Model 1*, we explored the effects of *Waste prevention/reduction* on the success of crowdfunding campaigns, and specifically in *Model 1a* we used the funding raised as a dependent variable, while in *Model 1b* the dependent variable is the number of backers. Similarly,

Model 2 investigated the impacts of *Self-oriented benefits* on the success of crowdfunding campaigns; also in this case, we adopted a specific model for the two dependent variables (respectively *Model 2a* for the funding raised as dependent variable, and *Model 2b* for the number of backers as dependent variable).

Following prior studies in the reward crowdfunding sphere, and given the distribution of values, we log-transformed both dependent variables (see among others Chan et al., 2021; Clauss et al., 2020); hence, we performed OLS regressions using the natural logs (ln) of the dependent variables¹⁰. The results of regression analyses are shown in Table 2.

¹⁰ In line with previous studies, data is log transformed as $\ln(\text{variable} + 1)$ because some projects failed – i.e., they fail to raise any funding and involve any backers – and solve the issues related to values equal to zero.

Table 2. Regression results

	Model 1a		Model 1b		Model 2a		Model 2b	
	Dependent v. ln(Raised)		Dependent v. ln(Backers)		Dependent v. ln(Raised)		Dependent v. ln(Backers)	
Waste prevention/reduction	1.742	**	0.981	*				
	(0.842)		(0.533)					
Self-oriented benefits					2.599	***	1.833	***
					(0.804)		(0.553)	
Funding Goal (€)	-0.023		-0.077		0.209		0.081	
	(0.261)		(0.173)		(0.279)		(0.161)	
Comments	0.001	*	0.001	**	0.001	**	0.001	**
	(0.001)		(0.001)		(0.001)		(0.001)	
Updates	0.021		0.043		0.024		0.044	
	(0.052)		(0.037)		(0.046)		(0.030)	
Rewards types	0.369	***	0.138	*	0.297	***	0.086	
	(0.108)		(0.082)		(0.090)		(0.058)	
Duration	0.025		-0.007		0.039		0.002	
	(0.047)		(0.027)		(0.049)		(0.028)	
Previous projects created	0.574		0.311		0.369		0.147	
	(0.414)		(0.281)		(0.352)		(0.222)	
Country	-0.347		-0.482		-0.253		-0.455	
	(0.955)		(0.542)		(0.931)		(0.525)	
Constant	1.983		2.412		-0.472		0.669	
	(3.189)		(1.874)		(3.750)		(2.093)	
No. Observation	47		47		47		47	
R ²	0.581		0.584		0.615		0.651	

Significance level at 1 % (***), 5 % (**), and 10 % (*)

Note: Robust standard errors in parentheses.

VIF, variance inflation factor.

Using $\ln(\text{raised})$ and $\ln(\text{backers})$ as dependent variables, respectively, the evidence supports both our hypotheses H1 and H2. First, we find that the variable *Waste prevention/reduction* has a positive and significant impact on the success of crowdfunding campaigns measured in terms of funding raised (Model 1a) and number of backers (Model 1b); specifically, model 1a shows that our explanatory variable has a coefficient equal to 1.742 and significant at 5%. This result confirms our hypothesis, and it highlights that projects focused on waste prevention/reduction are associated with a greater amount of capital raised.

These projects have a greater probability of success, in terms of capital raised, and attract more financial resources than projects focused on re-use, recycling, or others. We find support also for a positive impact on the number of backers involved at the end of the crowdfunding campaigns. In accordance with our hypothesis, in fact, Model 1b, shows statistically significant evidence that *Waste prevention/reduction* positively influences the number of backers involved; specifically, the explanatory variable has a coefficient equal to 0.981, significant at 10%. The projects focused on waste prevention/reduction are positively related to the success of the campaigns in terms of backers involved and attract a larger number of supporters than projects focused on re-use, recycling, or others.

At the same time, our results show that the variable *Self-oriented benefits* has a significant and positive impact on the success of crowdfunding campaigns. Precisely, Model 2a highlights that it positively influences the amount of funding raised and has a coefficient equal to 2.599 (significant at 1%); model 2b, shows that this variable has a positive impact on the number of backers involved at the end of the campaign (coefficient 1.833, significant at 1%).

Both our hypotheses tested, and the related models' results, show that project focus in terms of electronic waste hierarchy is crucial in influencing the trajectories of crowdfunding campaigns and the decision-making process of backers/consumers. Both the amount of funding raised, and the number of backers involved are positively correlated to projects targeting *waste prevention/reduction*, in line with our theoretical argumentations. Solutions focused on innovative systems of repair or prevention, as well as devices designed and engineered to last longer and to be upgraded and even improved over time show a higher probability of being financed by CF contributors, in line with the waste hierarchy and the preferable option according to this classification. It is worth noting that waste prevention solutions seem to be appreciated not only for workhorse but also for up-to-date products (see among others, these campaigns related to smartphones¹¹), maybe testifying a mentality change in the last decade among young adults described as wishing rapid replacements for this kind of devices (e.g., Ongondo and Williams, 2011).

Unfortunately, as regards the *recycling* option, it seems to be confirmed what claimed by Cole et al. (2019): “resource recovery is in practice limited to easily salvageable materials, whilst recovery of critical raw materials is often neglected”. Indeed, if we look at the campaigns aimed at selling products obtained by recycled components, we notice that recycled products do not recover

¹¹ <https://www.kickstarter.com/projects/doogee/doogee-s90-the-most-versatile-unbreakable-smartpho>;
<https://www.kickstarter.com/projects/teracube/teracube-the-sustainable-smartphone-with-a-4-year-warranty>;
<https://www.kickstarter.com/projects/berashield/berashield-2-total-protection-system-for-smartphone>;
<https://www.kickstarter.com/projects/949264272/liquidnano>; <https://www.kickstarter.com/projects/privatec/privacy-and-damage-2-in-1-screen-protector-20-for-iphones>

all the most dangerous and valuable materials contained inside electronic items (see for example: https://www.kickstarter.com/projects/lukas-g/recycled-screen-softlight-kit?ref=discovery_category_newest aiming at recycling only broken PC screens for producing a soft light for photography and indoor lightning).

At the same time the frame of a project is particularly relevant in influencing the success of the campaigns. The results highlight that the variable *Self-oriented benefits* is of primary importance for consumers interested in savings and convenience. This confirms that the role of self-oriented framing, and hence egoistic one, is crucial, while environmental aspects are marginal and less relevant in influencing the consumers' decision-making process.

4.3 Robustness checks

To ensure and verify the robustness of our results, we considered several aspects in our analysis and used different tests. First, we used robust standard errors in both of our models, as well as we used a set of control variables. We checked for multi-collinearity, i.e., the correlation amongst independent variables, and the variance inflation factors (VIFs). Table 3 shows both the correlation matrix and the VIF values for each variable. No multicollinearity problem was noted, in fact, the correlation matrix shows values lower the conventional threshold (0.7) and also the VIF values do not exceed the thresholds: the maximum VIF is 2.56 (as reported in table 3, below the conventional threshold of 10), and the average VIF is 1.82 (below the conventional threshold of 6).

To further check the robustness of our findings, in our models we used additional control variables related to both the creator and the campaign/project (e.g., video and website), and we also performed analysis adopting OLS standard errors. The results were like the previous ones and above all the explanatory variables were statistically significant and had similar impacts on the two dependent variables. As a final check, we also performed the analysis using other dependent variables related to the success of crowdfunding campaigns (e.g., the percentage of funding collected) and the explanatory variables were statistically significant.

Table 3. Correlation Matrix and VIF Scores

	1	2	3	4	5	6	7	8	9	VIF
1 Waste prevention/reduction	1									1.99
2 Self-oriented benefits	-0.65	1								2.50
3 Funding goal (€)	0.09	0.09	1							1.37
4 Comments	0.28	-0.29	0.13	1						1.31
5 Updates	0.26	-0.40	-0.01	0.23	1					2.56
6 Reward types	0.22	-0.37	0.31	0.41	0.47	1				1.94
7 Duration	-0.03	0.15	0.06	-0.16	0.06	-0.14	1			1.12
8 Projects created	0.27	-0.42	0.08	0.22	0.68	0.28	0.05	1		2.36
9 Country	0.10	-0.02	-0.16	0.07	-0.02	-0.07	-0.14	-0.23	1	1.20

Note: VIF, variance inflation factor.

5. Conclusion

5.1 Theoretical Contributions

Through this explorative study we provided several contributions in the field of e-waste management from a consumer perspective (Mugge et al, 2017; Pérez-Belis et al., 2017; Najmi et al., 2019). First, it adds evidence related to the behaviour of consumers in a CF context. Such a context was till now neglected despite its relevance. Indeed, by investigating consumer preferences in this context is possible to understand the behaviours of those that are among the early adopters of innovative solutions and that play a role in shaping the behaviour of next adopters (Rogers, 2003). Second, our findings show preferred e-waste management solutions of this specific group of consumers. CF contributors prefer waste prevention solutions, in line with the established waste hierarchy which shows waste prevention preferable to reuse and recycle. This is good news as other research (see e.g., Cole et al., 2019) reports waste prevention as often neglected. Third, our study considers a broader category of electronic devices than those usually considered in literature on consumer decisions related to e-waste management (see section 2.1), as they range from 3D printers to watches, from computers to air conditioners, from smartphones to batteries. Fourth, our paper contributes at filling the gap regarding message framing effects on consumer behaviours in the context of waste management of electronic products, till now neglected (Florence et al., 2022), with a few exceptions (e.g., Baxter and Gram-Hanssen, 2016). However, while Baxter and Gram-Hansen (2016) investigate the effects of negative and positive framed messages, our research investigates the effects of self and other-oriented message framing and shows that a self-oriented framing increases the success probability of e-waste related CF campaigns.

In addition, our study contributes to CF literature, at the intersection with sustainability issues (Testa et al., 2019; Böckel et al., 2021) where research is still limited. We contribute by providing new insights in a novel context, namely e-waste projects, and by highlighting the effects of two

categories of factors, namely e-waste management solutions and message framing, on campaign supporters' behaviours.

5.2 Implications for practice

We are cautious about drawing prescriptive conclusions based on an exploratory study. Nonetheless it would appear that the findings reported above have implications for both campaign creators and platforms.

Debatably, project creators should be aware about the preference towards a self-oriented message framing of potential contributors if they are to engage in mutually beneficial relationships with those potential contributors. Framing e-waste management campaign messages to emphasize personal benefits could help to increase success chances. Entrepreneurs should also consider that consumer behaviours are maybe changing and testify a willingness to consume in a more sustainable manner by adopting e-waste prevention solutions. Developing such solutions could become an entrepreneurial opportunity, in terms of both manufacturing and services. As regards the former, it does not come as a surprise that Fairphone – a company which has popularized repairable and upgradeable smartphones – relied on a (very successful) crowdfunding campaign to scale up and expand its business. As regards the latter, marketplaces which connect consumers to services could help consumers to make better decisions about their electronic devices' repairing.

Yet, on the other hand, CF platforms should encourage campaigns related to e-waste management being the number of this kind of campaigns surprisingly low, compared to the seriousness of the problem.

Another potential and interesting implications of this research is related to the development and design of specific programs to support e-waste management projects by different actors. In fact, we could consider the perspective of governments, policymakers, agencies, authorities, incubators/accelerators, etc, and that they could implement ad hoc programs to promote the use of new systems like CF - as well as informing and sensitizing citizens, investors, and consumers, etc. - in supporting projects and startups in this field.

Finally, this research highlights an increase in the level of environmental consciousness and awareness of the importance of managing e-waste among consumers in CF who are paying primary attention to prevent/reduce waste through prolonging devices' DOU; this could support and increase the dissemination of a meaningful message for the community, namely to increasingly focus on e-waste prevention solutions, as advocated by the waste hierarchy, which at the same time represents a valuable way to save money without reducing quality (or "social" status) and correspond positively to environmental values. In this vein, CF contributors, and the related communities of users, represent

a valuable category of consumers capable of potentially representing the trajectories of the behaviours of present and near-future aware consumers.

Awareness of the above e-waste prevention practices can be increased within the community by creating more information about the benefits and opportunities deriving from such practices. As suggested by other studies (Rejeb and Appolloni, 2022; Sundar et al., 2023), this type of diffusion – supported by new technologies – can be particularly useful in helping to change the public's point of view and address some types of barriers (such as public perception of e-waste reuse).

5.3 Limitations and future developments

We would also like to acknowledge three main limitations of this study and suggest related future developments. Firstly, now we do not distinguish between “recycling as an input” and “recycling as an output” as the campaigns in the former category are too few, as anticipated in the empirical section. It will be done on a larger sample, for example by considering also campaigns launched on other platforms. We anticipate that we expect a preference for the second category as the first could have an impact on perceived quality and status stigma (i.e., the common belief that a consumer buys used products because he/she cannot afford new ones).

Secondly, as restated above, reuse and recycle aversion is often due to reduced quality perceptions. The problem related to quality perception is also true when we buy, for example, a used car. People need to trust the seller or the intermediary. For this reason, we could investigate the role of crowdfunding platforms in attenuating problems related to quality perception. More generally, we did not consider other factors than projects previously launched which can contribute to increase the “perceived” quality of project creators (like for example, endorsement by third parties). In future studies we could control these factors under the framework of signalling theory (e.g., Vismara, 2018).

Thirdly, the chosen empirical context allowed us to study a specific type of consumers i.e., CF platform attendants. As we said, they represent a type of consumer which is a minority in consumer market (Rogers, 2003). Though they can influence the behaviours of later innovation adopters and thus anticipate future trends, it is important to remember that preferences and effective message framing differ across segments and thus our findings should not be generalized.

Finally, the number of projects considered is small, although it is representative of the entire Kickstarter population of e-waste management projects. In a subsequent study it will be possible to expand the sample size by also considering other important global CF platforms and due to the fact that the number of these specific e-waste projects is growing.

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Appendix 1. Examples of self-oriented benefits (message framing)

<i>Campaign excerpts</i>	<i>Campaign links</i>
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<p><i>“Use Charggee not for just protecting your devices but for also saving money” and “Change how you charge. Protect devices, prolong battery lifespan, save money & save our planet”.</i></p>	<p>https://www.kickstarter.com/projects/1740700612/charggee-a-new-way-to-charge-protect-your-mobile-d</p>
<p><i>“Watch It Fix is a high-quality Watch Repair Kit. That will teach and help the consumer save money on expensive repairs” and “Save money and time! Using our superior tool kit, customers get to save money and time on repairs”.</i></p>	<p>https://www.kickstarter.com/projects/1236010782/watch-it-fix-watch-repair-kit-0</p>
<p><i>“Teracube is the only phone you'll ever need for the next 4 years and beyond. Better for your pocket, better for the planet.”</i></p>	<p>https://www.kickstarter.com/projects/teracube/teracube-the-sustainable-smartphone-with-a-4-year-warranty</p>
<p><i>“Vector Cupholder: The best computer accessory is . . . the one that can save you \$1,000 or more.”</i></p>	<p>https://www.kickstarter.com/projects/1030552097/vector-cupholder-protect-your-laptop-and-your-lap</p>
<p><i>“Need the latest electronics on your 3D printer? Want to build them yourself to save some \$\$\$? We do, and it's always more fun to share.”</i></p>	<p>https://www.kickstarter.com/projects/365519109/3d-printing-electronics-for-makerbot-reprap-cubely</p>
<p><i>“Basically, it's good for you, your wallet...”</i></p>	<p>https://www.kickstarter.com/projects/669090894/trademade-an-exciting-trade-and-barter-app-with-a</p>