Weigh it and Share it! Crowdsourcing for Pro-Environmental Data Collection

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ABSTRACT

Crowdsourcing for addressing environmental challenges is a promising area in HCI research. This work investigates participation in a crowdsourcing initiative that combined a social-purpose activity with the interest of a company to crowdsource a labour-intensive task. The initiative was based on the deployment of a mobile application for pro-environmental data collection, namely collecting data about weight and type of product packaging. We report the results of a 9-month study conducted within a living lab that involved 96 customers of a large retail store. The analysis of usage logs and patterns of behaviour show different user categories: *constant*, *sprinter* and *casual* users. A survey was conducted to compare those categories as far as demographics, personality traits and usability metrics are concerned. Ten follow-up interviews further investigated motivations behind different usage patterns. The results provide insights on different types of contributors, reporting evidence on what motivated committed and less committed participants.

Author Keywords

Crowdsourcing; Motivation; Sustainability; Living lab

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION

Crowdsourcing for social goals is gaining attention for the opportunities it offers to face societal challenges, and many studies are depicting the peculiarities of these crowd-based initiatives in terms of participation and motivation [20]. Compared to general-purpose crowd work, the motivations that lead individuals to participate in social-purpose crowd work may be significantly different due to the nature of the work itself and the impact it can have on society. Moreover, as suggested by a number of studies [8,20,22], the engagement of the work community can be a challenge since workers' engagement is mediated by multiple individual characteristics, cultural values and motivational factors, as well as intrinsic and extrinsic needs. A major issue of crowdsourcing projects is indeed finding adequate rewards and incentives to motivate contributors, while ensuring the quality of data collected.

Figure 1. With the InGreen mobile application, users would weigh product packaging. They would (a) scan the product bar code, (b) weigh the empty packaging and (c) enter data on type and weight of packaging.

Understanding the motivation behind social-purpose crowd work is helpful to those who intend to engage in crowdsourcing initiatives, including activist groups, non-profit organizations, and the corporate world. Environmental commitment and sustainability values are recurrently adopted in business, communication and the marketing strategies of many companies and brands. For instance, corporate social responsibility is a business approach that contributes to the company's sense of responsibility towards the community and environment that has been found to enhance firm reputation and competitive advantage while improving the level of customer satisfaction [35]. Besides, customers are nowadays increasingly willing to assume responsibility for the environmental impact of their purchasing decisions [24]. This concern for the environment has led many retailers to run initiatives to protect the environment within which they

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operate, and to create stronger interactions with consumers at the same time. Crowdsourcing is one of the strategies used by many companies to directly engage their consumers and, eventually, benefit from their contributions and insights [12]. However, little is known about the actual motivations that drive customers to participate in such crowdsourcing initiatives. Even less is known on the reason for not taking part in such campaigns, or on the way individual attitudes mediate active participation and valuable contribution.

To fill this gap, this paper presents the results from a 9-month study based on a crowdsourcing initiative involving a community of customers of a retail company. The study addresses the following research questions:

RQ1: *How did participants contribute to the task? And which characteristics better describe more active participants?*

RQ2: *Which motivations lead to participation vs. non-participation?*

The research was conducted as part of a project in collaboration with a large retail chain and a telco as industrial partner. A crowd-based approach was implemented to collect data through a mobile application for a 9-month period from customers participating in a living lab. To investigate the contribution patterns, we analysed the system logs and conducted a questionnaire-based survey to assess motivations behind the participants' engagement, including reasons for not participating. The results were supplemented with some follow-up interviews.

This study extends previous works on demographics and motivations of individuals participating in a crowdsourcing project by focusing on pro-environmental data collection. The study focuses on the specific domain of crowdsourcing for sustainability targeting a community of consumers and contributes with insights on how to design and sustain pro-environmental initiatives exploring the motivations behind the participation of consumers as crowd-workers. We found that a small group of motivated participants accounted for most of the contributions in the crowdsourcing activity. Environmental values, personality traits and cultural context mediate crowd workers' commitment, while external rewards mainly affect short-term engagement. In the following sections, we review previous work on demographic characteristics and motivational factors from mainstream and social-purpose crowd working.

RELATED WORK

Crowdsourcing has been defined as an online, distributed problem-solving and production process that leverages the collective intelligence of online communities to serve specific organizational goals [40]. Since its inception, crowdsourcing has been used by companies to leverage their "crowd" of consumers in what is called mainstream crowd work. Companies might deploy crowdsourcing in various user-driven innovation activities: to share ideas, accelerate innovation, engage consumers in product and service co-creation, to accomplish activities which are time-consuming and labour-intensive, or to outsource tasks that cannot be easily computerized. The main idea behind crowdsourcing is opening the company's processes and business model to the "crowd" with the aim of gaining access to external resources such as ideas, skills or knowledge [39]. Brabham [7] has identified four main typologies of problem-focused crowdsourcing:

- *Knowledge Discovery & Management* – for information management activities where an organization mobilizes a crowd to find and collect information. Ideal for gathering information and creating collective resources.
- *Broadcast Search* – for problem solving tasks where an organization mobilizes a crowd to provide a solution to a problem that has an objective, provable answer. Ideal for scientific problem solving.
- *Peer-Vetted Creative Production* – for ideation problems where an organization mobilizes a crowd to come up with a solution to a problem which has an answer that is a matter of creativity or dependent on public support. Ideal for design, aesthetic, or policy problems.
- *Distributed Human Intelligence Tasking* – for large-scale data analysis where an organization has a set of information in hand and mobilizes a crowd to process or analyse the information. Ideal for processing large data sets that computers cannot easily or efficiently do.

This study describes the participation in a crowdsourcing initiative pertaining to the "Knowledge Discovery & Management" category where a company mobilizes the crowd to categorize and weigh product packaging using a mobile application. The initiative blended a social-purpose activity with the interest of a private company to crowdsource a labour-intensive task. Before presenting the task, we summarize related work on demographic and motivational strategies for mainstream and social-purpose crowd work.

Demographics and motivation of crowd workers

Mainstream crowd work might be defined as the performance of tasks online by distributed crowd-workers whose main motivation is financial compensation [19]. The most well-known platform for crowd work is Amazon Mechanical Turk (mTurk). Ross and colleagues [34] argue that the demographics of mTurk have been shifting from moderate-income American citizens to an increasing amount of international workers, especially young educated workers in India. Their study found that mTurk work was an important source of income for many of the workers yet both U.S. and Indian workers also shared secondary, non-economic motivations for performing crowdsourcing work, including entertainment and education. Another study [16] analysed the demographics of mTurk, focusing primarily on gender, income level, and educational background, and

concluded that crowd workers on mTurk largely mirror Internet users, with some biases - for instance, slightly younger, more females, slightly lower income, and smaller families. Regarding business initiatives that involved crowdsourcing, it has been found that the main drivers for participation are the opportunity to receive a monetary compensation (if participation is paid), the chance to develop one's own skills (e.g. creative skills) and, to a lower degree, the concern for one's community and the opportunity to develop friendships through the site [7].

Crowd working for social-purpose work

Recently, crowdsourcing has been used for supporting social-purpose collaborative activities [6,20,22]. Collaborative social-purpose crowdsourcing is, to some extent, close to mainstream crowd work since it involves groups of users in performing a number of micro-tasks. However, the overall activity is intended to pursue a social-purpose and to provide benefits to the community and the environment. Social-purpose crowdsourcing work has been experimented in different domains, such as in transcription [20], assistive services for people with disabilities [6,41], cultural heritage [29] and community activism [22].

Moreover, recent years have also seen a proliferation of projects on participatory sensing [9] as an emerging paradigm that focuses on the collection of information from a number of connected, always-on, always-carried devices, such as mobile phones. People are engaged as volunteers to collect data that would otherwise be difficult to obtain, and researchers are looking at the potential of ubiquitous technologies for setting-up real-world "social observatories" allowing the collection of very rich datasets [2]. Several participatory sensing projects deal with environmental monitoring and leverage on the ubiquitous use of mobile devices [26,36], highlighting the crucial role individuals can play in environmental monitoring. Motivated citizens can provide hyper-local measurements and therefore integrate regional data collected through fixed stations. However, one of the barriers of participatory sensing projects is recruiting enough people to commit their time and mobile phone for a meaningful purpose [15] and to maintain the community engaged and active.

Characteristics and motivations of social-purpose crowd workers

Unlike mainstream online paid crowd work, motivations to accomplish social-purpose crowd work may entail different motivations. Kobayashi and colleagues [20] introduced a framework to understand motivations to accomplish social-purpose crowd work and distinguish them from the motivations for mainstream online paid crowd work. Beside intrinsic and extrinsic motivations, the authors introduce personal and social motivations for social-purpose work since "motivation induced by the social relationship around the [crowd] worker may have a primary role in addition to the motivation based personal beliefs and enjoyment [p. 1816]". Other authors discussed the value of crowd work in relation to volunteerism and civic engagement [8,32] and showed how motivations for contributing span intrinsic and extrinsic factors that are both social (e.g. benefiting friends, supporting a cause) and personal (e.g. skill fit, hobbies, learning). Other studies focused on more specific classes of potential workers, such as older adults [8,20] and people with disabilities [41], in order to understand specific barriers they may encounter when accessing these new forms of work. These studies suggest that volunteer-based crowd work may be successful if it adopts a holistic view and create experiences that integrate personal and social factors. Considering a wider population, other studies [22,32] explored intrinsic and extrinsic motivations and strategies through the evaluation of a number of mobile applications to collect pro-environmental data. They investigate the impact of different strategies [32] and motivational factors [22] and report that some "pointsification" and "normification" mechanisms can increase performance and engagement. Massung and colleague [22] also looked into whether interest in environmental issues and existing tendencies towards pro-environmental behaviour correlate with higher engagement and found that they do not. The authors also pointed out that factors that encourage people to initially take part in a community activism project can differ from those that maintain interest.

As for individual belief and attitudes, personality is a factor that might mediate participation in crowd-working – especially when the activity deals with environmental values and behaviour. However, very few studies have investigated personality factors in crowdsourcing, mainly investigating the relationship between personality and quality of the work done [17,18]. It has been found that among personality traits, openness to new experience and conscientiousness are positively correlated with accuracy in a labelling crowd-based task [18] while extraversion and neuroticism show a negative relation [17]. On the other hand, studies have investigated the relationship between personality traits and the likelihood to show pro-environment behaviour and opinions. These studies found that people who score high in conscientiousness and agreeableness display more environmentally-friendly behaviour [23]. Moreover, people who are open to experience report a greater concern for the environment [23]. Personality traits may also influence the acceptance of technology by individuals: agreeable users were found to be more persistent in investigating frustrating websites that are user-unfriendly and difficult to navigate [21], and extraverted people are willing to share information with others, and this might positively influence new services and applications use [11]. Individuals with a high level of agreeableness (who are assumed to be kind, considerate, likable, helpful, and cooperative) and of emotional stability (who tend to be calm and free from persistent negative feelings) have a higher propensity to perceive smart phone technology as more useful, while people with a higher level of openness to experience (who characterize people who are

imaginative, broad-minded, independent, and willing to try new things) perceive smart phone technology as more easy to use [30]. Openness to experience has been found to have an impact on intention to use beyond perception of usefulness or ease-of-use [11]. Conscientious people (who are self-disciplined and intrinsically motivated to achieve the goals they believe in) might be less likely to use crowdsourcing applications especially if they regard it as distracting or unproductive. Among these traits, openness to experience and agreeableness seem potential characteristics of innovators' and early adopters' personalities, especially when products and services are devoted to the pro-environment cause.

Our study analyses demographics, personality traits and personal motivations of individuals participating in a crowdsourcing project by focusing on pro-environmental data collection, as detailed in the next section.

THE INGREEN PROJECT AND MOBILE APPLICATION

In Europe, packaging waste represents about 17% of the municipal solid waste by weight and 3% of the total waste stream. Furthermore, packaging waste represents a high proportion of the wastage of some specific materials — approximately 70% for glass, 60% for plastics and 40% for paper and cardboard [13]. Starting from these premises, the InGreen project aimed at exploring novel solutions to promote more sustainable choices for what concerns packaging waste. The initiative was supported by two industrial stakeholders, a telco and a large retail chain. A small software company was also involved for the development and maintenance of the technological infrastructure.

The main motivation for launching the project for the retail company was customer engagement. Yet, the retail chain representatives also expressed their need to trace product packaging for internal purposes: the company managers were interested in exploring to what extent crowdsourcing would be an effective way to do that. As for the telco, their main motivation was to investigate the possibility of leveraging the use of personal data for improving customer experience. Both these aspects were clarified at the beginning of the project and determined the design process.

The design work was conducted by the research team in collaboration with representatives from the industrial stakeholders. We started by leveraging the principles elicited in the literature and considering the constraints posed by the stakeholders. In particular, the following design rationales were discussed and considered in the design process:

- *Design rationale #1:* although the activity will be performed mostly at home (since it requires the use of a scale to weigh the packaging of the products), we aimed at designing a mobile phone app since the crowd task will mainly occur when dealing with food products. A mobile application would be (i) more handy when people dispose of food packaging (mostly in the kitchen or in the storage room) and (ii) it would easily allow to recognize products through bar code scanning;
- *Design rationale #2*: we deemed important to provide information about the impact of different types of packaging on the environment as well as a feedback about the participation in the crowd activity.

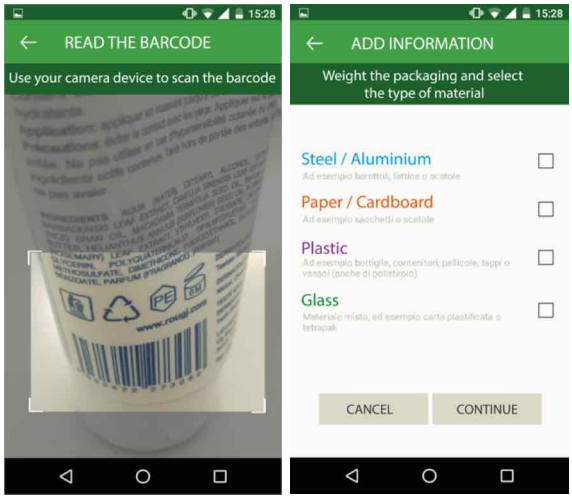

Figure 2. Two snapshots of the InGreen application: the app asks users to (a) scan product labels and (b) fill packaging information in (type of packaging and weight). (Translated from Italian).

In order to encourage participation, InGreen integrated both extrinsic and intrinsic mechanisms for encouraging participation:

- an *extrinsic* reward: participants earned loyalty points for each packaging weighing, and the more active of them received badges, coupons and extra points;
- an *intrinsic* reward: customer participation was valued by explaining the environmental impact that the initiative had and by framing individual contribution in a meaningful context. Moreover, the application provided feedback on the data submitted with the aim of making each personal contribution tangible.

The app was designed using an Agile process by quick development sprints and few usability tests with small groups of representative users.

The actual prototype developed is a mobile application for Android (Figure 2). The application includes a simple workflow to scan a product and add information about the weight of the different parts of its packaging (see Figure 1).

THE EVALUATION STUDY

InGreen was evaluated by analysing the results from a 9-month deployment of the system in a real context. The study was conducted as part of a living lab initiative in which research centres and private companies collaborate to

foster technology innovation in the retail domain. In a living lab, users are not involved as observed subjects but as active participants in an open and continuous dialogue to design technological solutions [28]. This study was performed in the LivLab, a living lab involving a permanent community of 96 clients of a large retail consumers' cooperative located in Italy. Participants of the living lab are recruited by promoting the initiative in the local stores and receive benefits (points to be used in a loyal program) in exchange for their active contribution to the research tasks.

Participants

At the time of the study, the living lab was composed of a community of 96 members. Of them, 57 (59%) female and 39 (41%) males with an age ranging from 23 to 63 years (M= 44.6, SD=7.9). Most of participants (86.5%) were part or full time employees; their education levels varied, ranging from middle school certificate (11%), to high school diplomas (65%), university degrees (17%) and post-graduate degrees (6%).

Procedure

The InGreen evaluation started in March 2016, when an email was sent to all the living lab members (96 people) to promote the initiative. Participants were informed that the purpose of the InGreen campaign was to support the retail company in collecting data about product packaging and to trace the environmental impact of their products. In the email, participants were invited to download the application and were provided detailed instructions on how to collect and share data about product packaging through the mobile application.

After 6 months, a questionnaire (see the *post-evaluation survey* below) was distributed by email to all the members who had received the initial invitation. The app usage logs were collected for other 3 months. At the end of the 9-month period, 8 users and 2 non-users were invited to participate in a semi-structured phone interview. Some information (such as demographic and pro-environmental attitudes) were already available from previous surveys conducted within the living lab.

Material and data collected

Demographic data for all participants (age, occupation, level of education, income, etc.) had been gathered at the time of living lab membership registration.

Survey on pro-environmental attitudes. For 75% of the participants (n= 72) we had information, from a previous survey, about pro-environmental values and attitudes toward organic and fair-trade products. The survey investigated the motivational factors that drive consumers

Pro-environmental values and attitudes explored in the survey				
Dimension	*Factor*	*Definition*	*Items*	*Adapted from*
Intention to purchase	Intention (Organic / Fair-trade)	Individual likelihood of buying organic / fair-trade products	Willingness to purchase organic / fair-trade products next time, Preference in purchasing organic / fair-trade products instead of traditional food, Commitment in purchasing organic / fair-trade products	[3]
Attitude	Intention (Organic / Fair-trade)	Personal predisposition to buy organic / fair-trade products	Taste, Environmental impact, Safety, Health, Quality, Fashion, Responsible purchasing, Support of developing countries	[1]
Subjective norms	Intention (Organic / Fair-trade)	Social pressure towards buying organic / fair-trade products	Friends, Colleagues, Family	[3], [4]
Perceived behavioural control (PBC)	I Intention (Organic / Fair-trade)	Perception of the ability to buy organic / fair-trade products	Financial capability, Information regarding where to buy, Ability to handle difficulties related to buying decision, Availability in the area of residence	[4]
Environmental concerns	Beliefs	Degree to which environmental concerns affect consumer behaviour	Environmental protection, Ethical obligation to protect the environment for individuals, Ethical obligation to protect the environment for the entire society	[40]
Health concerns	Beliefs	Degree to which health concerns affect consumer behaviour	Physical activity, Physical and psychological wellbeing, Healthy diet	[39]
Ethical concerns	Beliefs	Degree to which ethical values affect consumer behaviour	Equity and social justice for individuals, Equity and social justice for the entire society, Contribution toward equity and social justice	[5]
Product labels	-	Information displayed on product's labels	Trust, Truth, Reliability, Completeness, Usefulness	[27]

Table 1. Survey on pro-environmental values and attitudes

Dimensions explored in the post-evaluation survey	
Dimension	*Description*
1. Personality traits	Personality trait constructs were assessed with the 10-item Personality Scale (BFI-10) [27], Italian version [12].
2. Understanding of the initiative	Set of questions to understand whether users understood the motivation behind the initiative
3. Application usage	A question to understand whether participants used or did not use the InGreen app • Respondents who answered that they installed and used the mobile application →#4 • Respondents who answered that they did not use the mobile application → #10
Dimensions explored with participants who DID use the application	
4. Social context	Set of questions to understand whether the activity was performed individually or with other people (family members, roommates, etc.)
5. Mobile application usability	System Usability Scale (SUS) for assessing the application usability
6. Perceived difficulty	5-points Likert scale to understand whether the task was perceived as challenging or an easy one
7. Perceived usefulness	5-points Likert scale to understand to what extent participants perceived the initiative as being useful for the retail company, or for the environment
8. Gratification (Intrinsic)	5-points Likert scale to understand users' perception about their involvement in the initiative (social contribution, personal gratification, community participation)
9. Gratification (Extrinsic)	5-points Likert scale to understand users' perception about the extrinsic reward received (loyal points)
Dimensions explored with participants who DID NOT use the application	
10. Motivations behind non-use	Set of questions to understand motivations of customers that did not download the application (lack of understanding, service perceived as not relevant, task perceived as too demanding, lack of a scale for weighing packaging)

Table 2. Post-evaluation survey administered to users and non-users

to purchase organic or fair-trade products and food. The theoretical framework underlying the survey is the "theory of planned behaviour - TPB" [3] that states that individual's behavioural intentions are shaped by attitudes, subjective norms and perceived behavioural control. TPB has been applied in various fields, including consumer behaviour, food choice, and motives for organic food consumption [1,4]. The survey explored also consumer health, environmental and ethical beliefs [5,39,40] and investigated respondent opinions on the information reported on product labels [27]. Table 1 includes a description of the dimensions investigated in this questionnaire.

Post-evaluation questionnaire. A questionnaire (Table 2), administered after the InGreen evaluation, was specifically designed to (i) investigate the user experience with the InGreen app for the participants that actually used it; (ii) explore motivations and barriers experienced by participants and their experience with the crowdsourcing initiative and (iii) understand "non-use" reasons [37]. Regarding the user experience, we investigated the perceived frequency of usage, the system usability, the barriers and challenges encountered (in using the system, weighing the packaging, entering data), the shared use of application (whether it was used alone, with friend or relatives), the perceived usefulness related to sustainability challenges, and the intrinsic/extrinsic gratification (measured through statement to be evaluated through a 5-points Likert scale).

Another set of questions was administered only to participants who did not install the app, or who reported that they tried out the application for a short time. The questions investigated limitations to the use of the InGreen app such as technical challenges, the difficulty in understanding the task, the lack of interest in sustainability issues, the unavailability of required tools (i.e. a scale), the perception of the task as being too complex and the perception that it would require too much effort.

In order to explore the impact of customer personality on app use/non-use, we measured participant personality with the BFI-10 [14,33], a 10-item personality questionnaire to assess the Big Five personality traits (extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience).

Application usage. Participant usage of the mobile application was tracked by collecting system logs that provide data on number and frequency of weighings, pattern of usage over time and participant engagement levels over the study period.

Semi-structured interviews. Ten follow-up semi-structured interviews were performed to better explore motivations for using or not using the InGreen app. Interviewees were

Class	*n*	*Fem.*	*Male*	*Mean*	*SD*	*Max*	*Total*	*Active days*
Constant	13	92%	8%	2.98	5.2	25.92	125.3	19.5
Sprinter	15	47%	53%	0.68	2.6	14.65	28.76	4.8
Casual	18	69%	31%	0.17	0.75	4.31	7.13	2.7

Table 3. User classification based on system logs

Class	*n*	*Female*	*Male*	*Age*	*Occupation*
Constant	8	100%	-	39.8 (9.9)	87.5%
Sprinter	14	46%	54%	44.6 (9.4)	85%
Casual	17	56%	44%	43.1 (8.8)	78%
Non-users	16	63%	38%	47.4 (7.0)	87.5%

Table 4. Respondents to the post-evaluation questionnaire

selected based on application usage patterns resulting from the log and on survey analysis in order to investigate motivations for different types of users and non-users. Interviews were performed via telephone and lasted from 30 to 40 minutes. Dimensions explored were (i) motivations for using or not using the mobile application (the questions were adapted to the type of users interviewed: non-user, casual user, sprinters, constant user, see below); (ii) the relevance of intrinsic and extrinsic motivations; (iii) the challenges experienced with the task proposed (technical, social or personal issues); and (iv) the perceived impact of proposer of the task on the decision whether to participate or not in this initiative.

RESULTS

Among all members, 68 (71%) downloaded the application. The post-evaluation survey (sent both to users and non-users) was completed by 39 users and 16 non-users.

Usage behaviour. The mobile application was downloaded by 68 members of the living lab, and 46 of them (68%) successfully installed and used the application at least once. The community weighted almost 2232 packages for a total of 1722 different products (Figure 3, left). Overall, about 93.7 kg (2065.7 lb) of packaging material was weighed and classified. To measure the task quality, we calculated the standard deviation of each product weighing, considering those items that were weighed more than once. Package weights varied from 1 g to 1 kg / 0.03 oz to 2.2 lb (M= 51 g / 1.8 oz; SD= 92 g / 3.2 oz) and the average standard deviation was quite small (SD= 15 g / 0.5 oz). This suggests a good similarity among multiple weighings, and indicates the good quality of the crowdsourcing task.

User classification. In order to understand participation patterns, we tried to group users based on app usage. The K-means clustering algorithm was used with the following measures of usage extracted from the system logs: mean, SD and max number of weighings per week; total number of weighings over the entire period; and number of active days in which at least one weighing was submitted. The K-means algorithm divides users into K clusters where each user is assigned to the nearest cluster (center). We first performed a classification with two (K=2) classes. The resulting categorizations (Explained variance = 80.7%) effectively divided very active users (n=13) to less active contributors (n=33). In order to better refine the clustering, we run the algorithm on the latter group. The second classification (Explained variance = 72.5%) two clusters of 15 and 18 members respectively. Overall, the clusterings defined three groups of users (Table 3):

- *Constant active users* (13 users), who steadily performed a certain number of tasks each week after they installed the application;
- *Sprinters* (15 users), who made most of their contributions in their first weeks, concentrating their activity only in few days and putting less effort later on;
- *Casual users* (18 users), who performed a limited number of tasks distributed intermittently over the entire period.

Table 3 shows statistics for each feature between the three groups. Furthermore, the *constant* users differ from the other groups by being formed mostly by women (χ^2= 6.9, p<.05). Figure 3 (right) displays the contribution from each user group: *constant* and *sprinter* users contributed for almost 95% of the total logs – i.e. 2118 weighings over a total of 2232 entries.

Pro-environmental attitudes and values

Pro-environmental values were available for 27 participants among app users and 45 participants among non-users for a total of 72 participants. Statistical analyses were performed

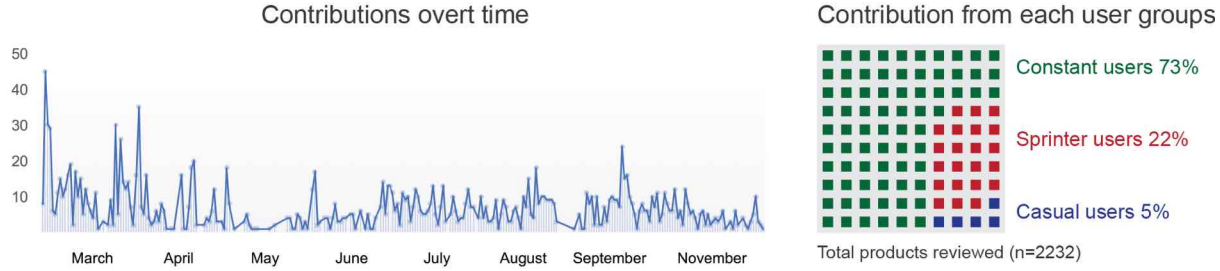

Figure 3. Left, packages weighted with the mobile app during the study. Right, contribution to the crowd work from each user group. Each square represents 1% of the total 2232 weighings.

using non-parametric tests (i.e. Mann-Whitney test). Item scores were averaged to provide a single value for the Organic Intention factor (Cronbach's Alpha = .828) and the Fair-Trade Intention factor (Alpha = .811).
Generally, respondents gave medium to low scores on the factors regarding their opinions toward organic (M= 3.65, SD=0.83) and fair-trade (M= 3.63, SD=0.82) products (measured on a 7-point Likert scale). For both factors, values were significantly lower when compared to the middle-scale point (value 4; t(71)= 3.5, p<.01 and t(71)= 3.7, p<.01 respectively for organic and fair-trade products). No differences were observed between gender.

Table 5 shows the comparison between the scores of active users (*constant* users and *sprinters*) and of non-active users (*casual* users and *non-users*). Active users assigned higher scores in both organic and fair-trade factors (U= 318.5, p<.05; U= 309, p<.01 respectively). Users who actively contributed in the task seem to have more positive attitudes toward organic and fair-trade products, they exhibit an increased willingness to pay higher prices for these products and reported to be more informed about the characteristics of these products. When considering single factors only, active users have a more positive attitude toward both organic and fair-trade products (U= 296, p<.05; U= 306.5, p<.05, respectively). Active users also perceive stronger subjective norms toward fair-trade products (U= 294, p<.05) compared to non-users.

Personal beliefs were investigated by using three different scales comparing food habits with health, environment and social equity respectively. These scores were averaged in the Beliefs scale (Alpha = .915). Generally, all respondents agree on the benefits of eating healthy food and living an active life; they also perceive the environmental and social equity implications of their food habits as important. No significant differences were observed between user groups, even though the trend indicates that active users have slightly stronger beliefs compared to non-users (statistical significance was not reached, see Table 5).

The community showed a positive opinion about label information (nutritional information, organic or fair-trade certification, etc.): participants generally trusted the information provided, and considered it as complete and exhaustive (Table 5). However, the quality and completeness of the information displayed scored significantly higher among active users when compared to non-active users (U= 287.5, p<.05). More active users were probably better informed on the type of information contained in the label and on what this information means for their health

Dimension	*Active users*		*Non-active users*		*Sig.*
	Med.	*Mean (SD)*	*Med.*	*Mean (SD)*	
Intention toward organic products	4.1	3.98 (4.1)	3.6	3.5 (0.88)	< .05
Intention toward fair-trade products	4.1	3.9 (0.70)	3.6	3.5 (0.83)	< .05
Belief	4.3	4.4 (0.66)	4.2	4.1 (0.8)	ns.
Information on the label	5.8	5.7 (1.1)	5	4.8 (1.5)	< .05

Table 5. Pro-environmental attitudes and values. Active users = Constant and Sprinters; Non-active users = Casual and Non-users

Results from the post-evaluation survey

Among the respondents of the post-evaluation survey (39 users and 16 non-users), 62% were female and 38% were male. Age ranged between 23 and 63 years old, with an average of 44.3 years (SD= 8.5). The data analysis was performed considering the three user categories based on log usage – 8 Constant, 14 Sprinter, 17 Casual users – and included 16 Non-users. As displayed in Table 4, a trend (not statistically significant, though) shows that more active users were also younger, while education level and job status were balanced among user categories. Notably, all *constant* users (who also took the survey) were women, while gender distributions for the other groups were mostly balanced.

Social context. A large number of users reported that they weighed the products on their own, just 18% said they completed this task with another person.

Usability. The average SUS score is 76.9 (SD= 17.2) and it is significantly higher (one sample t-test: t(38)= 3.2, p<.01) than the reference value of 68 (i.e. average SUS score for mobile application, as reported in [38]). Subsequent analyses were conducted merging *constant* and *sprinter* users in the category "*active users*". Ratings from active users were compared against those reported by casual users, with the goal of exploring the reason for a regular contribution through the application. Both scores from active and casual users indicated the generally high usability of the mobile application and no differences were observed between the groups (Table 6).

Usefulness and gratification. Respondents perceived the application as useful (M= 3.9, SD= 1.2), understanding the value of contributing through the InGreen app. They perceived the application as useful both for the retail company (M= 3.8, SD= 1.3), and for themselves as consumers, since they could make a positive contribution to the environment (M= 3.9, SD= 1.2). Generally, all users were motivated in using the application both intrinsically

Dimension	*Active users (Constant + Sprinter)*	*Casual users*
Usability	78.7 (13.9)	74.9 (20.7)
Usefulness (Company)	4.1 (1.1)	3.6 (1.3)
Usefulness (Environment)	4.1 (1.1)	3.7 (1.4)
Gratification (Intrinsic)	3.9 (0.9)	3.6 (1.3)
Gratification (Extrinsic)	4.1 (0.9)	3.8 (1.5)

Table 6. Results from the post-evaluation questionnaire. Mean values (SD).

(*M*= 3.8, *SD*= 1.0) and extrinsically (*M*= 3.9, *SD*= 1.2). Again, no differences were observed between groups (average scores between groups are presented in Table 6).

Personality. Considering user categories, active users show higher scores on the "openness to experience" trait compared to casual users (U= 245, $p<.05$), while no differences could be observed for the other traits. It is worth noting that the average score for openness measured in our population is slightly lower than the normative mean (from [14]): *Z* scores = -0.9 for active users and -1.2 for casual users. Our participants indicated scores that were more than one standard deviation below the average national data.

Motivations for not participating. Among the 16 respondents who did not install the app, 4 reported that they did not have time for this activity (stating that they "think the effort was too big" and they "gave priority to other things"); 8 respondents reported little interest in this type of crowd work in general (they "were not interested in the service offered by the app" and they "did not understand why the company needed that kind of information"). Finally, 4 respondents had difficulties in installing the applications and were unable to complete the installation process. These concerns were further examined in the interviews.

Semi-structured interviews

To deepen our understanding on the motivations behind usage/participation and non-usage/non-participation, we conducted 10 semi-structured phone interviews. Participants were sampled from the 4 categories, randomly selected: two constant users, three sprinters, three casual users and two non-users. We report below some findings that highlight the complexity of the motivations behind the choice to actively contribute to the crowdsourcing initiative.

"Constant" users: pro environmental interest and fun. The two participants that scored very high in participation level and constant engagement (constant active users), reported a solid interest in environmental issues, curiosity about new technologies. They both reported that financial rewards (points) were not relevant for motivating participation. One of them reported that "*I liked the idea of positively contributing toward the goal of sustainability... people shouldn't consider only points... it's more important to feel part of something, […] and to know that what you do is really useful* (P6)". Besides, fun and enjoyment seemed to play a key role in sustaining engagement over time. The other interviewee explained: "*I liked the playfulness of the initiative... I would like to make it even more fun, in this way also my children could participate* (P9)".

"Sprinter" users: financial rewards and routine. From participants that contributed in the first weeks and decreased their participation over time (sprinters), we found that at least initially the extrinsic reward was the main motivator for participation. For them, gaining discount points is considered an adequate reward for participating while the interest toward environmental issues is a crucial factor but not enough to guarantee participation to such a demanding initiative. Participants also mentioned the difficulty of making product packaging weighing part of their daily routine: "*you need to develop a new habit (routine) to consider packages and not to throw them away without even noticing them* (P2)." Even for these participants, providing more information on the broader context around the initiative would have made the task more meaningful and hence more relevant for them.

"Casual" and non-users: lack of context, support and communication. Environmental values were also strong motivators for casual users. They reported that they were highly interested in initiatives in support of sustainability and appreciated the "green" approach to reducing waste. Participants however reported a number of challenges that resulted in limited and sporadic contributions. Criticalities range from technical ones (lack of familiarity with mobile applications) to motivations related to their lifestyle (lack of time). For these participants, the main issues were related to a scarce understanding of the task to be performed: "*it has been difficult to understand how to enter the weight, also scanning the products was not easy… my hands trembled* (P3)". Other issues reported were the lack of understanding of the motivations behind the task proposed, scarce transparency (how would the data collected be used) and in general poor communication of the final goals of the initiative. Furthermore, lack of a social dimension was reported as an issue: "*I would have appreciated [the possibility] to discuss these issues with others, about recycling and so on…* (P10)." Overall, uninvolved users missed the broader context for the initiative: "*an initiative like this should be integrated into other activities that address environmental issues* (P7)".

DISCUSSION

The following sections address the key findings in relation to our research questions.

RQ1: *How did participants contribute to the task? And what features better describe more active participants?*

Extending findings from previous works [20] that used a qualitative approach for categorizing types of contributors or fixed thresholds [17], we adopted a quantitative approach and identified three different user categories based on user behaviour patterns: constant, sprinter and causal users. The first two categories can be defined as active users while casual users are closer to non-active users (together with those participants who did not even downloaded the app) since their activity was spared and contributed to only 5% of the data collected. Indeed, the contribution provided by the constant users reflects the Pareto principles since 28% of participants (13 constant users) contributed for 73% of the data collected (that is 1629 of the 2232 total weighings).

Constant users were mainly women (12 women and 1 man) and this cannot be explained by the different participant gender composition. We propose that it might be related to two factors. First, women participation rate in crowd work:

studies have shown that women involved in crowd-work tend to stay committed for a longer term than their male counterparts [10]). Second, the cultural context in which the campaign was conducted: in Italy, women generally contribute more in household chores and food preparation compared to men [25]. We did not observe any significant differences in other demographic information (age and occupation) between the three groups or among active and non-active users. These results differ from what reported in other studies on pro-social crowdsourcing, which found that older [20] and unemployed [22] users tend to be more active contributors. This might be due to the limited size and diversity of our sample. However, the interviews show that time shortage was one of the major factors leading to disengagement. Therefore, it might be the case that time availability, and not demographics, is a crucial factor for participation – demographics may be a predictor for time availability in some cases while not in others. This aspect needs to be further investigated in future studies.

Regarding the impact of (perceived) usability and gratification on active participation, we did not observe any differences between groups as for usability, gratification and perceived usefulness of the initiative. This suggests that those dimensions were not strongly associated with the actual level of contribution. Indeed, this might agree with the findings by Phang and colleagues [31], by which usability is more important for knowledge seeking task than for knowledge contributing tasks (as was the task of InGreen).Yet, we observed a trend showing that most active contributors gave higher ratings in perceived usefulness and gratification. Considering personality traits of most active users, we found that "openness to experience" is the trait that better differentiates active from non-active users. This finding is in line with previous studies that linked this trait to environment-friendly behaviour [23] and to better performance in crowdsourcing tasks [17,18]. Agreeableness and extraversion were not influential as it might be expected from previous studies [17,18]. This might be due to the limited size of our sample or, rather, from the complex interrelation between personality, technology use and participation to pro-social initiatives. Further studies are needed to better investigate this aspect; however, our results confirm that openness to experience is a trait that mediates crowdsourcing participation. Specifically, we observed that participants who scored low in this trait contributed to a lesser degree in the initiative. Individuals that reported scores closer to or higher than the average reference (i.e. the national average) tend to be more committed contributors.

RQ2: *Which motivations lead to participation vs. non-participation?*

Findings from the survey and the interviews highlighted the complexity of the motivations behind the choice to participate in the first place, and behind the decision to continue to contribute. Participants who were actively involved in the initiative had stronger purchase intention toward pro-environmental products – in terms of organic and fair-trade goods. Moreover, active users show more positive opinions on the information displayed on product labels. The main difference between constant users and less active ones lies in the type of individual motivations, as revealed by the interviews. The engagement of constant active users is supported by the feeling that their contribution had a positive impact on the environment: environmental values, that are related to personal intrinsic values, have proven to be a stronger driver to participation compared to external incentives (i.e. the financial reward). Differently, sprinters reported on the importance of the external rewards as the main motivation for taking part in the campaign. This is in line with the findings of Mass [22], indicating that external rewards might be useful for initially engaging users in the initiative, but intrinsic motivation is the main driver for a constant and active user engagement.

CONCLUSION

In this paper, adopting both a quantitative and a qualitative approach, we have investigated the motivations behind participation and non-participation in a crowdsourcing initiative targeting a community of consumers. We found that a small group of (intrinsically) motivated participants had mostly contributed to the crowdsourcing activity. Our analysis showed that usability, gratification and demographic characteristics such as age and occupation did not differ between committed and less committed contributors. Higher environmental values, personality traits (openness to experience) and cultural context were identified as the main factors that characterized active users who constantly contributed in the task. Casual users who intermittently contributed were initially motivated by external drivers but were unable to incorporate the crowdsourcing task into their routines. We believe that improving communication and campaign transparency in the long run might be a strategy to turn casual participants in more motivated committed contributors. However, if the crowdsourcing activity involves a task that can be completed in a short time, sprinter users can provide their contribution in the very first phase, and thus external incentives may be enough. Concluding, this study points to specific aspects of the design of mobile crowdsourcing activities that can be improved to better support the engagement of different groups of consumers in social-purpose crowd work. These aspects include considering user differences in personal values and personality traits, planning communication strategies that support the user community, and taking different motivational drivers into account.

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