Literature Review on motivation and incentives for voluntary participation in citizen science projects

Authors: Maria Delfine[1], Anna Müller[2], Rhys Manners[3]

1 Independent Consultant, deflinemaria@gmail.com

2 Bioversity International, a.muller@cgiar.org

3 IITA, r.manners@cgiar.org

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Abstract

Citizen science projects depend on the voluntary participation of individuals, whose motivations and engagement are shaped by a complex interplay of psychological, social and external factors. This literature review explores the diverse motivations driving initial and sustained participation in citizen science, drawing on theoretical frameworks such as Self-Determination Theory, Batson's framework of community involvement and Schwartz's Theory of Basic Values. Intrinsic motivations, including curiosity and the desire to learn, often dominate initial engagement, while sustained participation is influenced by a combination of collectivistic, egoistic, intrinsic and extrinsic factors. Incentives such as feedback, gamification and task relevance emerge as critical strategies for maintaining engagement. The review also highlights the demotivation factors and barriers, such as monotonous tasks and logistical challenges, that hinder participation.

Keywords: Volunteering, Motivations, Incentives, Barriers, Citizen science

Introduction

To gain a comprehensive understanding of the motivations driving people's voluntary participation in citizen science activities, it is essential to explore the broader context of voluntary engagement. Participation in any voluntary activity, including crowdsourcing, is shaped by a complex interplay of individual motivations and external influences (Hossain, 2012; West & Pateman, 2016). In this focused literature review, we will analyse existing research to uncover the diverse motivations that stimulate individuals to participate voluntarily in citizen science activities.

The review is structured as follows: First, we will delve into the general volunteering literature, where we will present several theoretical frameworks that help explain the underlying dynamics of voluntary engagement. This theoretical foundation will provide valuable insights into the psychological and social factors that drive individuals to participate in voluntary activities, setting the stage for a focused exploration and categorisation of motivations for voluntary participation. Next, we will examine the specific motivations that attract individuals to engage in citizen science projects. By synthesising findings from relevant studies, we aim to identify common motivations prevalent across different voluntary participation contexts. Following motivations, we will investigate the role of incentives in citizen science projects. We will explore several types of incentives that influence individuals' decisions to contribute to citizen science projects. Lastly, we will examine demotivation factors and barriers that may impede individuals' willingness to participate in these activities. Understanding these challenges is necessary for developing strategies to enhance engagement and sustain participation over time.

Theoretical Frameworks

Various theories are employed to understand the motivations driving people to volunteer. One prominent theory in this context is the Self Determination Theory (SDT) (Ryan & Deci, 2000). According to the SDT, motivations can be categorised as either intrinsic or extrinsic (Ryan & Deci, 2000). Intrinsic motivation arises from engaging in activities that are inherently interesting or enjoyable to the individual, whereas extrinsic motivation is driven by external factors such as rewards or external demands (Ryan & Deci, 2000).

Batson et al. (2002) proposed a framework comprising four motives for community involvement: egoism, altruism, collectivism and principles. *Egoism* focuses on increasing one's own welfare, *altruism* aims to increase the welfare of others, *collectivism* targets the welfare of a group or community and *principlism* seeks to uphold moral principles (Batson et al., 2002). Within this framework, Batson et al. (2002) emphasise that each of these motives possesses both strengths and weaknesses. They suggest that to effectively stimulate community involvement, the strengths of one motive can compensate for or mitigate the weaknesses of another. Building upon this framework, Beza et al. (2017) conducted a study in which they further

distinguished egoistic motivations based on the differentiation proposed by Ryan and Deci (2000). This study differentiates between egoistic motivations driven by intrinsic factors such as enjoyment and extrinsic factors such as networking (Beza et al., 2017).

Another well-grounded categorisation used in citizen science literature is by Clary et al. (1998), which outlines six motivational functions served by volunteerism (Chacón et al., 2017; Clary et al., 1998):

- *Values:* pertains to the expression of values associated with altruism and humanitarian concerns for others.
- *Understanding:* motivations focused on acquiring and/or improving knowledge, skills and experiences.
- *Social:* motivations related to what is important for other people.
- *Career:* motivation to enhance career-relevant skills and knowledge.
- *Protective:* motivations oriented toward protecting the ego or escaping from personal problems.
- *Enhancement*: motivations centred on self-improvement.

To measure these motivations Clary et al. (1998) created the Volunteer Function Inventory (VFI), which consists of a questionnaire containing 30 questions divided into six motivations, with each category containing five items. Respondents rate these items using a 7-point Likert-type scale (where 1 is disagree and 7 is agree) (Clary et al., 1998).

According to a systematic review by Chacón et al. (2017) on this framework, the VFI "adequately assess the most common motives in most types of volunteers". However, they recommend complementing the closed-ended questions of the VFI with an open-ended question about the underlying reasons for the decision to volunteer, enriching the understanding of volunteer motivations beyond quantitative measures (Chacón et al., 2017).

From the previous theoretical frameworks, it is evident that a common thread among the motivations is what people value (Batson et al., 2002; Clary et al., 1998; Ryan & Deci, 2000). Schwartz (2012) developed the Theory of Basic Values, which identifies ten fundamental personal values that transcend cultural boundaries. At the core of this theory is the concept of a circular structure that represents the motivations underlying each value (Schwartz, 2012). These ten values, as outlined by Schwart (2012), are:

- *Self-direction*: Pursuing individual goals, creativity and exploration.
- *Stimulation*: Seeking excitement and challenge in life.
- *Hedonism*: Pursuing pleasure and gratification for oneself.
- *Achievement*: Striving for personal success, demonstrating competence and gaining social approval.
- *Power*: Seeking control over people and resources.
- *Security*: Pursuing harmony within oneself and society.

- *Conformity*: Restraining oneself from actions that violate social norms.
- *Tradition*: Respecting and upholding cultural or religious customs and traditions.
- *Benevolence*: Promoting the welfare of known individuals.
- *Universalism*: Protecting the welfare of all people and nature.

To assess these values Schwartz (2012) developed the Schwartz Value Survey (SVS) and the Portrait Values Questionnaire (PVQ). In the SVS, respondents rate the importance of each value item "as a guiding principle in MY life" on a 9-point scale from -1 (opposed to my values) to 7 (supreme importance) (Schwartz, 2012). The PVQ is directed to measure these values specifically in children (aged 11-14) and in individuals not educated in Western schools that emphasise context-free thinking (Schwartz, 2012). This questionnaire presents short verbal portraits of 40 different people, gender-matched with the respondent (Schwartz, 2012). Respondents then indicate the likeness of each person to themselves, ranging from “very much like me” to “not like me at all” (Schwartz, 2012).

Motivations for participation in citizen science projects

Motivations for voluntary citizen participation have been extensively studied across various domains, including environmental science (Beza et al., 2017; Bible & Clarke-De Reza, 2023; Domroese & Johnson, 2017; Etter et al., 2023; Hobbs & White, 2012; Larson et al., 2020; Palacin et al., 2020; Weeser et al., 2021), astronomy (Raddick et al., 2013), public health (Asingizwe et al., 2020; Dam et al., 2023; Land-Zandstra et al., 2016; Shehu et al., 2023) and geospatial science (Baruch et al., 2016), as well as more general citizen science projects (Amorim & Vieira, 2023; Jackson et al., 2015; Moghaddam et al., 2023; Ngo et al., 2023; Ponciano & Pereira, 2019; Tinati et al., 2015).

A prevalent approach among researchers has been the use of mixed methods, combining quantitative surveys with qualitative interviews or focus groups (Amorim & Vieira, 2023; Baruch et al., 2016; Beza et al., 2017; Bible & Clarke-De Reza, 2023; Dam et al., 2023; Domroese & Johnson, 2017; Eveleigh et al., 2014; Hobbs & White, 2012; Jackson et al., 2015; Ponciano & Pereira, 2019). Surveys have also played a significant role in identifying citizen motivations (Etter et al., 2023; Land-Zandstra et al., 2016; Larson et al., 2020; Moghaddam et al., 2023; Ngo et al., 2023; Raddick et al., 2013; Shehu et al., 2023; Weeser et al., 2021). In addition to surveys, interviews have been instrumental in uncovering the underlying motivations of participants. Asingizwe et al. (2020) and Palacin et al. (2020) conducted interviews to delve deeply into participant perspectives, offering rich qualitative insights into the diverse motivations driving citizen engagement. Tinati et al.(2015) also employed interviews, specifically targeting core design team members for the Zooniverse platform, to explore design considerations that influence participant motivations.

A significant portion of the literature we analysed builds upon the theoretical framework introduced in the section *Theoretical Frameworks*, while others have developed their own distinct categorisations, as seen in the work of Hobbs and White (2012). Moreover, some studies have specifically differentiated between initial and sustained motivations, such as Asingizwe et al. (2020) , Baruch et al. (2016), Bible and Clarke-De Reza (2023) and Eveleigh et al. (2014) providing valuable insights into the dynamics of motivation over time in citizen participation.

Eveleigh et al. (2014), in particular, expanded this discussion by introducing the concept of "dabblers": participants who contribute only occasionally. The authors argue that dabblers play an important role in citizen science projects, comparable to "super-volunteers" who contribute frequently (Eveleigh et al., 2014). Dabblers, despite their sporadic involvement, are effective in identifying mistakes and maintaining enthusiasm by avoiding monotony in repetitive tasks. This study, however, focused on an online citizen science project, where such behaviour may be more feasible due to the anonymity and flexibility of virtual participation (Eveleigh et al., 2014). In face-to-face contexts, participants may be less inclined to engage sporadically and might instead withdraw entirely if unable to commit fully.

Initial motivations

Altruistic and collectivistic motivations, as defined by Batson et al. (2002), as well as values as conceptualised by Clary et al. (1998), emerged as recurrent themes across the studies we have reviewed. For instance, Shehu et al. (2023) investigated the motivations behind blood donation, highlighting how altruistic or social motives often drive the initial act of donation. In citizen science projects, contributing to scientific research and conservation efforts arose as prominent initial motivations. Raddick et al. (2013) surveyed Galaxy Zoo volunteers and identified contributing to original scientific research as a primary motivator among participants. This sentiment is echoed in public health studies by Asingizwe et al. (2020), Dam et al. (2023) and Land-Zandstra et al. (2016) where motivations include helping others, contributing to malaria control (Asingizwe et al., 2020; Dam et al., 2023) and advancing knowledge about flu (Land-Zandstra et al., 2016).

Environmental science studies by Larson et al. (2020), Domroese and Johnson (2017) and Hobbs and White (2012), underscored that the main motivations among participants are contributing to science and conservation efforts. Additionally, Beza et al. (2017) highlighted the importance of contributing to scientific endeavours within Indian farming communities. Weeser et al. (2021) also found that Kenyan respondents were motivated by the opportunity to contribute to water management and conservation efforts. Similarly, Ngo et al. (2023) emphasised that the desire to contribute to science is a key motivator for the general public with limited experience in citizen science.

Some of the reviewed studies have identified the presence of egoistic motivations, categorised based on Batson et al. (2002) framework. As outlined by Beza et al. (2017), these egoistic motivations can be further

distinguished into intrinsic and extrinsic categories. For example, Asingizwe et al. (2020) identified curiosity and the desire to learn new things as initial intrinsic egoistic motivations for contributing to malaria control efforts. Crowston & Fagnot (2018) similarly identified curiosity and the opportunity to learn as significant drivers of initial contributions to open online communities for user-generated content (UCG) such as Wikipedia. Dam et al. (2023) noted that gaining knowledge about harmful factors motivated local communities in Tanzania to participate in public health initiatives, further emphasising intrinsic egoistic motivations.

The study of Jackson et al. (2015), looking at the motivation to participate in the Zooniverse Planet Hunters projects, further echoed these findings. It revealed that participants were initially motivated by the opportunity to learn and gain expertise (Jackson et al., 2015). Amorim and Vieira (2023) focusing on older adults, emphasised dynamic tasks, curiosity and skill development as key intrinsic egoistic motivating factors for volunteer engagement. Ngo et al. (2023) also highlighted the importance of fun and knowledge gained through participation. Bible and Clarke-De Reza (2023) highlighted the importance of egoistic motivations for initial participation as well. In the study by Beza et al. (2017), contrary to Indian farmers, Ethiopian and Honduran farmers emphasised intrinsic egoistic motivations (such as interest in sharing information) as the most important.

Extrinsic egoistic motivations, such as monetary incentives, appear to play a less significant role. For instance, Amorim and Vieira (2023) found that factors like earning money, ease of tasks and speed of completion were among the least important motivators for volunteer engagement.

Overall, the findings suggest that intrinsic egoistic motivations, particularly curiosity, learning and skill development, are central to driving initial volunteer engagement. In contrast, extrinsic factors, such as financial incentives, tend to have limited influence.

Sustained motivations

Understanding the factors that sustain volunteer participation in citizen science initiatives is crucial for long-term engagement (West & Pateman, 2016). Research indicates that sustained participation is influenced by a mix of collectivistic and egoistic motivations, as well as intrinsic and extrinsic factors.

Bible and Clarke-De Reza (2023) conducted a study highlighting sustained motivations among participants, which included more collectivistic examples such as the desire to make a meaningful difference, establish new social connections and contribute to scientific research. Baruch et al. (2016) further specified that volunteers' continued participation is associated not only with collectivistic motivations but also with egoistic ones, highlighting the multifaceted nature of sustained engagement.

Etter et al. (2023), identified key sustained motivations among participants in environment-focused citizen science projects, including the desire to contribute to science, share knowledge, experience the outdoors and have fun. Crowston & Fagnot (2018) similarly emphasised the importance of enjoyment, showing that the perceived need to contribute, combined with the element of fun, plays a significant role in sustaining participation. Asingizwe et al., (2020) identified opportunities for learning, helping researchers, contributing to malaria control and receiving recognition as critical factors in motivating sustained involvement. Jackson et al. (2015) highlighted sharing knowledge and experiences with other volunteers as a driver for sustained engagement, enabling participants to support one another and collectively advance project goals.

Palacin et al. (2020)' study on digital citizen science initiatives emphasised the role of sustained participation linked with extrinsic motivations. They suggested that when individuals direct to the project their own extrinsic motivators, they not only perform tasks willingly but also sustain their engagement enthusiastically over time (Palacin et al., 2020). This means that when people feel personally connected to their tasks, they are more likely to stay committed and enthusiastic in their participation. In terms of egoistic extrinsic motivation, Ngo et al. (2023) emphasised that offering direct compensation to cover participants' expenses may help sustain their involvement and commitment over time.

Long-term projects may require adaptive strategies to maintain sustained participation, as motivations can evolve over time. Asingizwe et al., (2020) observed changes in participants' motivations throughout their one-year project, indicating the importance of periodically exploring the motivations of participants in long-term projects to effectively adapt strategies to maintain sustained participation.

Age Differences in Motivations

Motivations for volunteerism and citizen science participation are influenced by age (Asingizwe et al., 2020; Baruch et al., 2016; Etter et al., 2023; Raddick et al., 2013). Baruch et al. (2016) and Raddick et al. (2013) observed a higher level of engagement among older adults in online volunteering platforms. Asingizwe et al., (2020) noted that older respondents were more motivated by health concerns related to malaria compared to younger participants, who showed greater interest in curiosity and learning new things.

Etter et al. (2023) further identified age-related differences in motivations, noting that younger respondents often emphasise altruism and contributions to science, whereas older respondents prioritise enjoyment and physical activity in volunteer activities. Moreover, Etter et al. (2023) highlighted that "super-users", individuals who participate systematically and extensively, tend to be older, suggesting a sustained commitment to volunteerism among older age groups.

Demotivation Factors and Barriers for participation in citizen science projects

Understanding the factors that demotivate volunteers and present barriers in citizen science projects is necessary for enhancing participant engagement and ensuring project success.

Amorim and Vieira (2023) identified as Brazilian adults' demotivation factors in completing microtasks could be categorised as non-challenging tasks (e.g., monotonous tasks) and worthless tasks (e.g., time-consuming tasks). Time-consuming tasks emerged as a significant barrier in several studies we reviewed, including Asingizwe et al. (2020) and Domroese and Johnson (2017).

Participants of the Great Pollinator Project cited a lack of training, general difficulties in following the protocol and residing outside the study area as notable barriers (Domroese & Johnson, 2017). Asingizwe et al. (2020) noted that Rwandan participants in malaria control efforts faced barriers due to insufficient information about the recruitment process. Moreover, volunteers encountered other challenges such as the perceived low efficacy of traps, difficulties in collecting observations under pressure and issues related to changing torch batteries during nighttime (Asingizwe et al., 2020). Weeser et al. (2021) identified barriers for participants monitoring water levels in Kenya, including difficult access to the areas and lack of cellphone credit.

Eveleigh et al (2014), looked at the reason for dropping out, which resulted in: the feeling that what participants are submitting is not useful anymore; monotonous tasks that bring boredom; and as in previously cited studies, time.

Incentives for participation in citizen science projects

A fundamental aspect of sustaining volunteer engagement in citizen science projects involves understanding and effectively leveraging incentives (Hossain, 2012). Incentives play a fundamental role in motivating participants and can be categorised into intrinsic and extrinsic types, with extrinsic incentives further segmented into financial, social and organisational categories (Hossain, 2012)

Palacin et al. (2020), drawing on Schwartz's value theory, raised important concerns about the reliance on rewarding systems and self-enhancement values, which may result in short-term engagement. Instead, they supported fostering values rooted in universalism and benevolence, such as offering opportunities to learn new things, ensuring fairness and providing a sense of accomplishment through feedback, to promote sustained participation over time (Palacin et al., 2020).

Beza et al. (2017) discovered through surveys among farmers that while financial rewards were rated as important, agronomic advice, capacity building and seed innovation were identified as the most needed for maintaining engagement in agricultural citizen science initiatives. Similarly, Asingizwe et al. (2020) highlighted the importance of non-monetary recognition for sustaining volunteer involvement. Preferences for visits, workshops, ticket reimbursements and feedback were identified as effective methods for fostering a sense of belonging and commitment among participants (Asingizwe et al., 2020). Dam et al. (2023) revealed that monetary incentives alone were not sufficient to motivate sustained participation of Tanzanian participants in uploading mosquito sounds, while the provision of feedback and tangible benefits like mosquito bed nets emerged as more influential factors (Dam et al., 2023). A study by Amorim and Vieira (2023) among older adults also challenged the conventional reliance on monetary incentives, revealing preferences for engaging in tasks with real-life connections over financial rewards.

Providing feedback has emerged as a central theme across multiple studies. Tinati et al. (2015), focusing on the Zooniverse project, emphasised that periodic feedback motivates continued participation while adding context to tasks increases engagement. Similarly, Crowston & Fagnot (2018), highlighted that both negative and positive feedback can incentivise sustained contribution. Wenz et al.(2022), investigated the hypothesis that personalised feedback would enhance participation in mobile app studies. Conversely, their findings revealed that personalised feedback neither increased nor decreased participation, possibly because those invited to the study were already highly committed participants (Wenz et al., 2022).

Gamification has also been proposed as an effective strategy to incentivize participation. Tinati et al. (2017) proposed gamification as a compelling strategy to incentivise participation in citizen science. Their study suggested that incorporating gamification features such as points, leaderboards and rankings can attract participants seeking entertainment and challenge, fostering sustained engagement (Tinati et al., 2017).

Lastly, Moghaddam et al. (2023) underscored the importance of aligning incentives with participant motives for optimal outcomes. Their research showed that allowing participants to select their preferred incentives led to higher-quality contributions compared to standardised incentive systems (Moghaddam et al., 2023).

In summary, feedback emerges as a recurring theme in much of the analysed literature, along with strategies such as gamification and tailored incentive systems, all of which contribute to sustained engagement when aligned with participant needs.

Conclusions

This literature review demonstrates that motivations for participating in citizen science are diverse and context-dependent, driven by both intrinsic and extrinsic factors. Initial participation often stems from intrinsic motivations, such as curiosity, altruism, and the opportunity to learn new skills, while sustained

engagement is supported by a blend of collectivistic goals, such as contributing to a meaningful cause, and egoistic incentives, including recognition and enjoyment.

Key strategies for sustaining participation include providing regular and meaningful feedback, aligning tasks with participants' values and preferences, and leveraging gamification to make tasks engaging. However, reliance on monetary incentives has shown limited success in promoting long-term engagement, with participants often valuing real-life relevance and non-monetary recognition over financial rewards.

Barriers such as task monotony, logistical difficulties, and insufficient training pose significant challenges to participation. Addressing these issues requires adaptive strategies that evolve alongside participant motivations, particularly in long-term projects.

By identifying and understanding the factors that motivate and demotivate volunteers, this review offers practical recommendations for citizen science project managers. These include fostering intrinsic motivations, aligning incentives with participant needs, and mitigating barriers to create more engaging and inclusive citizen science opportunities.

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