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Policy recommendations based on CS Track results

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Executive summary	This deliverable presents policy recommendations based on the research conducted in the CS Track project. The construction of the policy recommendations involved a three-phase collaborative and qualitative decision-making process, which represents our research-based understanding of the current needs for policy recommendations in citizen science. There are seven chapters in this deliverable: introduction, theoretical background, empirical backgrounds, limitations, analysis and selection of priorities, policy recommendations and discussion. References made in the text can be found at the end of the deliverable.

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1. INTRODUCTION

Citizen science (CS) has evolved and developed in multiple ways during the last decades. One consequence of this evolution is the need and interest of regulation and policies, which would provide structure and means that would support the future development of CS.

One objective in the CS Track project is to produce policy recommendations that would provide an understanding of CS to support participating individuals and the society as a whole. Our perspective on the policy recommendations is empirically oriented and holds a scientifically critical and problematising approach with the aim of crystallising the roles of policy in CS. Thus, the results of the CS Track project will serve as the basis for the formulation of policy recommendations. The framework for policy recommendations and its limitations will also be discussed. The process of creating these policy recommendations involved all partners in an interactive decision-making process over several months.

This report is organised into seven chapters. Chapter one provides an introduction to the topic. Next, the basis for policy recommendations is explained by referring to theoretical and empirical studies (chapters two and three respectively) conducted in the CS Track project. Chapter four reviews limitations and addresses the framework and the challenges of policy recommendations. Chapter five unpacks how the analysis and selection of priorities for policy recommendations were processed. Chapter six contains the policy recommendations. Finally, the seventh and last chapter elucidates the presented policy recommendations.

2. THEORETICAL BACKGROUND

Citizen science (CS) is a term that is difficult to define, perhaps basically impossible to define meaningfully at all; its application is so broad that it is of little use for analytical considerations (Green Paper, 2013; dictionary.com; European University Association, 2021; European Commission, 2018; Wikipedia; Kullenberg & Kasperowski, 2016; Lewenstein, 2016). In addition, the term is highly charged politically and morally. Those who speak of CS are implying a form of civic participation in research and development that is not only desired but also required, even if it is not clear what this participation consists of, how it is structured and who benefits from it (Fan & Chen, 2019).

The research in CS Track is based on the explanation of CS the European Commission gives in the Horizon 2020 Science with and for Society Work Programme 2018-2020:

> *(…) citizen science should be understood broadly, covering a range of different levels of participation, from raising public knowledge of science, encouraging citizens to participate in the scientific process by observing, gathering, and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies. It could also involve publication of results and teaching science.* (European Commission, 2018, p. 41)

An extensive literature review in CS Track deliverables D1.1 and D1.2 confirmed that the term CS is used so widely that its uses need to be explored in order to be useful for analytical purposes. The spectrum of activities called CS ranges from individuals documenting their gardens, hikers and travellers documenting flora and fauna, collecting meteorological data, large international research projects folding proteins, documentation and identification activities for scientific collections, hobby astronomy, DIY biology, school projects collecting plastic litter, technical developments in FabLabs and Maker Spaces, to action research, classical science communication, and participation procedures in science policy.

And that is not all. CS activities vary greatly in respect to geographic factors, roles and tasks of contributors, objectives and scientific disciplines, just to name a few (see, e.g., Kenens et al., 2020, and Turreira-Garcia et al., 2018). Also, the key terms used to describe CS differ or have a different meaning in different contexts (Eitzel et al., 2017). What makes the matter even more complex is that there are different conceptualisations of CS, some of which contradict each other and some of which are amalgamated with each other. The two best-known conceptualisations of CS (Bonney et al., 2009 and earlier; Irwin, 1995) differ in that Irwin understands CS as an ideal according to which citizen concerns are taken into account in research, also through democratic participation in science policy, so that science and research contribute to the sustainable development of our societies. On the other hand, Bonney et al. understand CS as a set of research-related activities that involve citizens primarily for the purpose of collecting data that are difficult to obtain in other ways.

There is no uniform, standardised concept for CS. CS is theoretically and methodologically underdetermined, so that the term can be attached to a wide variety of activities, even without much thought. This variety of understanding of CS and of its conceptualisations was confirmed by expert interviews conducted in CS Track. Conceptualisations of CS strongly depend on context and framing. Also, cultural contexts should not be underestimated: Someone who speaks of CS in the USA may mean something quite different from someone in Japan or Germany (see Strähle, Urban et al., 2022).

In view of this variety of activities that are called CS and the different conceptualisations of CS, it is not surprising that the European Commission defines CS so broadly. And it is not surprising at all that some representatives of CS demand a definition of the term and compliance with certain standards (Heigl et al., 2009) and other representatives criticise this (Auerbach et al., 2019; Haklay et al., 2021).

Narrowing down the term "CS" or developing a different conceptualisation of CS was no option for CS Track, because it would have contradicted the research questions, and just adding another definition or conceptualisation to the already existing abundance of definitions and explanations. It was decided to present an overview of the multiple, sometimes contradicting forms of CS instead which focuses on the different settings and situations, in which CS can take place.

For this purpose, a grid – the so-called Activities & Dimensions Grid of Citizen Science (Strähle, Urban et al., 2021; Strähle & Urban, 2022) - was created that lists CS activities grouped by areas that seem to be sufficiently different to justify a distinction and the activities' dimensions, such as the location of participation, the requirements for participating in a CS activity, demographic aspects of who is participating, funding schemes and others. To compile the Activities & Dimensions Grid of Citizen Science, frequently discussed categorisations, typologies, classifications and conceptualizations of CS were systematically examined. After having reviewed the Grid against additional categorisations and meta-analyses of categorisations, it was verified (Bonney et al., 2009a & 2009b; Cooper et al., 2019; Franzoni & Sauermann, 2014; Haklay, 2013 & 2018; Prainsack, 2014; Schäfer & Kieslinger, 2016; Schrögel & Kolleck, 2019; Serrano et al., 2014; Shirk et al., 2012; Strasser & Haklay, 2018; Wiggins & Crowston, 2011, 2012 & 2015). The questions guiding these analyses were: What activities are considered as CS? What categories, dimensions, types and characteristics of activities were taken into account? Which of them are useful for empirical research in CS Track and beyond? It is important to note that while activities were the focus, both activities and projects were used as units of analysis.

It has been the overall objective of CS track to understand and characterise CS activities so that experts, funders and policymakers can develop strategies to minimise potential caveats, pitfalls and barriers and to maximise potential benefits and enablers for all participants, citizen and professional, scientists, while meeting scientific standards of validity and reliability and respecting research, integrity and ethics. Developing such strategies requires to differentiate carefully between what is actually done, where, how, and by whom. The Grid provides a detailed overview of

CS activities and their conditions. This makes it possible to look at ethical issues, potential caveats, pitfalls, benefits, barriers and enablers, as well as questions of inclusion and exclusion, with all required differentiation.

3. EMPIRICAL BACKGROUND

Here, we provide a brief summary of the empirical studies in CS Track that were used to derive a basis for beginning the analysis and selection of priorities (explained in more detail in section 5). Overall, the empirical studies in CS Track Includes: a broad survey (N = 1076, mainly European), a thread content analysis of nine forum boards (12-17 posts) on Zooniverse, a Twitter analysis (19,543 tweets, filtered), a computation analysis via web crawling of three European CS platforms, a website content analysis of 25 COVID projects (seven of which used for case studies), a survey with project coordinators (N = 56, mainly European), and expert interviews with 12 CS researchers from different continents (further details can be found in other deliverables such as D2.2 and D2.3 and in relevant publications on https://cstrack.eu/). The following issues could be identified when reviewing the studies collectively: topics and research areas of projects, the role of digital technology, personal and socioeconomic backgrounds of participants, learning and knowledge building, and motivations of projects' coordinators and their participants.

First, projects identified in the two surveys as well as in the computational analysis seem to primarily relate to the natural sciences (e.g., biology, ecology), followed by the humanities (e.g., history, cultural studies) and social sciences (e.g., political science, sociology). Computational analysis in particular highlighted how many projects within three CS platforms (two Spanish and one European) were associated with the educational context and launched within the last 10 years. In addition, the global COVID-19 pandemic initiated interdisciplinary projects and the majority of the 25 projects focused on demographics, well-being and treatment for, e.g., a disease, and, in addition, discussed seven project coordinators' views on policy recommendations. Discussions within projects on sustainable development goals (SDGs) on Twitter focused mainly on climate change even though SDGs represent a minor part of overall tweets relating to CS.

Next, the role of digital technology in CS was examined. Based on the broad survey, the majority of projects require participants to use their own smartphone and relevant applications as well as cameras. Projects typically establish databases online to which participants upload data, or online discussion forums in which participants can discuss with another as well as with, e.g., project initiators. For Zooniverse forums, some participants may even serve as moderators to act as mediator between other participants and the project initiator, suggesting a form of participation moderation and empowerment. In the case study of COVID-19 projects, mobile technology was a fundamental component for data on the spreading of viruses and observing wellbeing.

CS projects can draw a diverse audience, however, there are commonalities reported by participants and coordinators. Participants from the broad survey tend to be male, between the ages 51 and 70 with an upper secondary education background (e.g., masters) and married but living without children in a small city or large town. Interestingly, the survey of coordinators indicated that nearly half of the participants in their projects are female. According to interviews with coordinators, a diversity in age distribution was seen among participants and the amount of people participating ranged from less than 20 to over 1000. Interviewed expert researchers indicated that there is a need to establish standards regarding, e.g. ethics, to enhance outcomes at the participant and project levels as project coordinators can come from diverse backgrounds (except for COVID-related projects, which seem to include academics, commercial organisations, public bodies and non-governmental organisations) as understandings regarding the nature of CS are not uniform.

Regarding learning and knowledge building, from the broad survey, participants who interact with other people or use internet resources, as well as reflect on their own knowledge, reported the highest levels of perceived learning. Perceived learning varies between project research areas and subgroups (e.g., participant, project manager); however, social interaction (e.g. discussion, observing others) was regarded as important for learning among all subgroups. The research area of a project may be relevant to learning outcomes as participants in biology projects had reported lower overall perceived learning. Long-term participation seems to be associated with higher perceived learning outcomes compared to those who only participate in one project or activity, which may be connected with shifting motivations.

For Zooniverse, participants rather search for help or share opinions or ideas with others rather than participate in formal content discussion. When collaboration does occur between participants and moderators, it can lead to new knowledge and even citizen-led inquiries, in which participants take a role in leading CS activities. In similar fashion, regarding SDGs, participants on Twitter rather post and share their own content than retweeting existing content. Learning and interaction seems to be more limited in COVID projects as materials provided are limited and data collection may be the primary activity (which does not require much scientific skill) even though some participants demand more elaborate participation such as problem-solving.

Finally, motivation is related to learning and thus was further examined. Participants from the broad survey indicated having a thematic interest (e.g., supporting science, social issues like SDGs) in a project, participants in Zooniverse want to be part of a reputed network, and participants in COVID-19 projects look forward to the outcomes of projects. Thus, it seems that there are different motivation profiles in CS participants, e.g., a larger group mainly interested in science investigation and topics as well as personal enjoyment or a quite small, utility-oriented group. To engage participants to work in specific projects, project organisers may need to emphasise such motivational gratifications in their project descriptions. On Zooniverse, they advertise especially contributions to research and enjoyment, even though participants in general are also strongly motivated to share knowledge and engage in discourse.

4. LIMITATIONS

As the analysis and selection of priorities for policy recommendations (section 5) utilises the empirical studies within the CS Track, there are limitations. The main limitation lies in the difficulty to work with a research object, citizen science (CS), whose nature lacks a mutual agreement among researchers. The term is relatively young and used in different ways by those who participate, by scholars, proponents, policy makers and partners in a variety of activities and contexts. It may be sometimes unknown by those who organise and/or carry out CS that could fall under the term and, sometimes, it is deliberately rejected. Consequently, this limits the ability for quantitative surveys, qualitative research or online research on CS to find all participants and/or projects that meet any of the proposed definitions or forms of CS. In other words, determining what CS really is or should be is an ongoing debate within the community and subject of research.

Another limitation lies in the disclosure of information by CS projects. This applies to information on websites and in many reports. There may be good reasons not to disclose some information such as to protect sensible biotopes, the privacy of participants, or to keep participants uninfluenced by expectations of certain results. When participation is anonymous, there is not much, or any at all, information available regarding their profiles. CS Track did not investigate one phenomenon called "CS" - it had to examine a broad range of phenomena called or resembled "CS", many of which are relatively unrelated to each other. Hence, CS Track alone cannot comprehensively examine each different form of CS separately in order to shed light on possible caveats, benefits, enablers, barriers and (dis-)incentives. The scientific literature on CS mainly consists of a plethora of case studies. Systematic studies and reviews exist but are still relatively meagre compared to case studies.

Finally, the empirical research limitations are twofold, within research and across other explanatory levels. First, the limitations within empirical research relate to the level of explanatory power, that is how widely and deeply can empirical research explain a particular phenomenon, in this case, CS. Second, there are limitations on the ontological-epistemological jump made from research results to broader policy recommendations. Research results were attained by investigating a specific research question using a particular research methodology; however, policy recommendations, by nature, have a variety of paradigmatic stances.

5. ANALYSIS AND SELECTION OF PRIORITIES

The analysis and selection of priorities for policy recommendations, as per contractual requirements, was informed from project outcomes - as reported in a variety of project documentation (evidence), and the understandings that were developed from partners' interactions with the general theme of CS (observations) in the project's (CS Track) life cycle. The scope of the activity was to develop an evidence-driven, coherent, and realistic policy proposal for CS stakeholders and target groups focusing on pertinent dimensions of the context for CS activity. The analytical approach applied is separated into three distinct but highly interrelated phases, where in phase one the concern was on identifying the analytical tools to derive a set of policy axes, the second, to conduct an in-depth review of the CS Track case studies undertaken in the frame of WP2 (under the scope of identifying specific field-related shortcomings/barriers), and the third, to structure the recommendations (full structure explained later).

The project's working group engaged in forming the bases for articulating policy recommendations by understanding policy proposals as "written advice that is prepared for a group or persons that has the authority to make an influence on policy decisions". In the case of CS Track, policy proposals constitute advice on action to be taken that maintain and promote a healthy ecosystem for CS, e.g., good practices in CS engagement in the process of scientific understanding and making. The reflective activity put in place in the initial stage of considerations was driven by the CARDI (Center for Aging Research and Development in Ireland) approach to structure policy recommendations (a ten-step reflective approach), the first step calling for the definition/decision of the objective for drafting recommendations. Other steps considered include decisions on target groups, setting out the issues clearly, providing options, recognising the current economic climate and emphasising the importance of clearly defined action-taking.

Under this guidance, the policy recommendation task force set by the CS Track partnership decided that the scope of the activity (for articulating policy recommendations) was to ensure contribution towards and promote a healthy CS ecosystem. In this frame, the principal focus was on facilitating an explicit process for making recommendations for CS and, in general, CS stakeholders. The decisions taken imply that, from an evaluative perspective, the scope of the CS Track policy recommendations is of incremental nature (low information grasp and small or slow degree of change requirement), for the purpose of enhancing continuous improvement of the field (as opposed to pursuing complete change).

Stufflbeam's CIPP (Context, Input, Process, Product) generic evaluation model was selected as the framework to guide the task of defining the principal axes for policy considerations. The partnership's interaction with the model's components facilitated discussion beyond the identification of policy axes, as issues embedded in the process of identifying means for improvements on/for CS, and challenges that had to be faced in defining the policy axes were also addressed. Amongst the issues identified were: complexity (because of a lack of a sound/universal conceptual framework on CS), diversity in how CS activities operate in diverse settings, and project endeavours, multiplicity of target groups, and diverse interests of stakeholder groups as well as undocumented procedures applied in CS activities. The challenges identified in defining policy axes concern the one to fit all principles, and a clear definition of objectives and sub-objectives to be addressed.

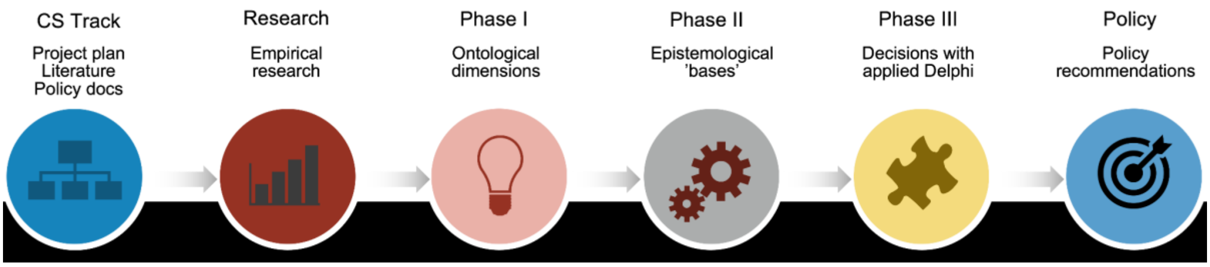


Figure 1. A funnelling process in the research-based analysis and selection of priorities for policy recommendations

In summary, the analysis and selection of priorities for policy recommendations were articulated as a theory-based complex problem-solving process with three distinctive phases (see Figure 1). The theoretical background was primarily based on evaluation theory (see Stufflebeam & Coryn, 2014).

The first phase concentrated on elaborating the conceptual and ontological basis of possible dimensions for policy recommendations based on the empirical and theoretical work conducted in the CS Track project. Then, a survey was formed and conducted. Based on its results, a larger set of dimensions and descriptors within those dimensions were identified for further investigation.

The second phase was based on the knowledge gathered earlier from partners. An inquiry on the most essential policy recommendations issues was gathered, which were analysed and further elaborated. The results included five ontological and epistemological relevant issues in CS (explained further under policy recommendations), which were found to be essential in representing the research in CS Track.

The theory-related issues address theoretical and scientific perspectives behind CS. Creation-related issues address the creation and regulation of knowledge and understanding. Operation-related issues address CS projects' operative issues, management, recruitment, and the leading of projects. Finally, value-related issues address the value created for an individual, the project and scientists.

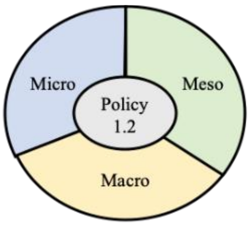
During this second phase, we conducted a collaborative workshop where we looked into each of the five issues from the perspective of three different levels: micro, meso, and macro. Micro refers to the level of practitioners in CS, meso refers to the level of operations in CS, and macro refers to the level of society in CS. The micro level addresses the basic questions of who does what, when, where, how and, if possible, why. Thus, it mainly includes not only the project stakeholders implementing projects (e.g. academics), but also the participants who support the project by engaging in CS activities. The meso level addresses the functional framework or system regarding the operation of projects. In other words, it mainly includes the training provided to participants as well as the organisations that serve as a vehicle for project implementation (e.g. museums, clubs, science centres, other local organisations), and platforms that systematise the knowledge and skill sets within CS or CS projects (e.g. SciStarter). The macro level addresses the overarching goals or purposes within CS. It primarily includes policymakers and policy influencers in CS (e.g. European Commission) as well as the organisations supporting and funding research in innovative digital practices in CS.

These exercises led to the third and final phase. A large set of possible policy recommendations within the five issue areas along with their rationales generated a set of policy recommendations. The recommendations were included in a short questionnaire, whose format was created with an applied 'Delphi'-method in mind. Based on the responses, we were able to consolidate a final set of policy recommendations, which are presented in the following section (6).

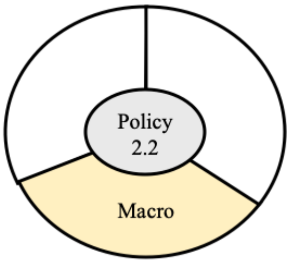
6. POLICY RECOMMENDATIONS

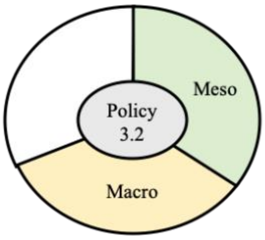
One challenge in policymaking for citizen science (CS) is the organic nature of CS. As described in section 2, the term CS can allude to specific stakeholders even though CS is not clearly or agreeably defined, which means that other stakeholders face the risk of exclusion. Policies drafted in CS should, therefore, carefully consider the broad nature of CS to determine which stakeholders are most likely involved, i.e. relevant. In this section, we propose 10 policies separated by issue (theory, creation, operation, technology, and value), which are viewed through three levels: micro, meso, and macro.

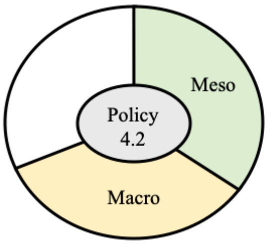
In light of the nature of CS, while the term 'level' is used, a hierarchical relationship between the levels does not explicitly exist. To illustrate the relationships between the three levels while simultaneously emphasising their unified connection with policy, we utilise a target diagram. In the target diagram, a proposed policy or goal is located in the centre, which is surrounded by micro, meso, and macro. Micro, meso, and macro each have their own colour to indicate whether they are relevant to the proposed policy. The presence of colour indicates relevance to the proposed policy whereas an absence of colour indicates a lack of relevance to the proposed policy. It is, therefore, possible for one policy to be applicable to more than one level.

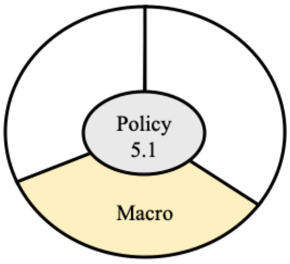
1. Theory-related issues and their proposed policies		
	Policy:	Clarity should be achieved for participants on project planned activities pertaining to CS.
	Description:	As the practices of CS have expanded, more emphasis is needed on how projects are described, how activities within projects are organised, and what the contents of the activities are planned for the participants.
	Example:	Creating specifications that allow participants to be aware of whether the tasks, in which they are engaging, are CS so that projects can improve their practices and institutions will be able to see how the operations should be organised.
	Policy:	Create models of CS in education, whether lower or higher education, that generate added value to research and/or the school curriculum.
	Description:	CS is conducted in various learning environments (e.g. schools, museums, local/global communities, online, at home) which involve different learning characteristics, methodologies, stakeholders, resources and materials in addition to the possibility of certification.

	Example:	SciStarter is an online platform that brings together CS projects from various networks and its participants. It provides modules that are relevant for projects in their respective fields and its participants. Badges are awarded for completion of modules that can be used to indicate and promote the relevance and importance of certain skills applicable not only to CS but to certain projects. SciStarter also provides tools for educators who are interested in incorporating CS in their classroom.

2. Creation-related issues and their proposed policies		
	Policy:	Ensure that project platforms and tools, at the project and participant levels, support learning and the process of co-creation in research, knowledge building and skills development.
	Description:	CS projects generate new learning and scientific results provided that there are tools to supplement and facilitate the interaction and thus activities between projects and participants.
	Example:	SciStarter (see example under 1.2)
	Policy:	Proactively seek ways to incorporate CS as a part of the research process in relevant research projects
	Description:	CS can be a powerful methodological approach used in certain science projects when it has been properly incorporated into the planning of the research (e.g. objectives, methodology) and that the necessary funding is secured.
	Example:	When a university research project enlists the help of citizen scientists in data collection, they have established the opportunity for co-writing parts of the paper (e.g. results) as well as giving credit to citizen scientists for the participation.

3. Operation-related issues and their proposed policies		
	Policy:	Ensure clarity in project descriptions and incorporate managerial instruments in systems and practices as well as moderators (e.g. self-guided tutorials, automated chatbots, experienced tutors or volunteers) that can facilitate and streamline the understanding, interaction, and collaboration between participants and projects.
	Description:	Project sustainability is connected with the participation of all relevant participants. Projects need to be equipped with the appropriate managerial practices and individuals who can serve as a bridge between the project and its participants.
	Example:	A CS project is running its third version of a project and has its own online bulletin board (forum) in which both the project stakeholders and participants can discuss, e.g., the different activities of the project. As the forum includes both old and new participants, more experienced participants are selected to serve as moderators between the project and the rest of the community therein, thereby answering practical questions and providing guidance that may be otherwise absent or not available from the project's main information page.
	Policy:	Projects and organisers of CS should provide opportunities for participants to enhance their science literacy skills and researching competencies.
	Description:	CS aims to enlist the participation from a relevant yet diverse demographic in scientific projects; however, not all participants necessarily have a uniform or adequate background understanding regarding certain scientific processes that may be necessary for sustained participation in a project, and some may participate solely to enhance their scientific understanding.
	Example:	SciStarter (see example under 1.2)

4. Technology-related issues and their proposed policies		
	Policy:	Remove barriers that are related to the affordability and availability of technology that are used in projects and their activities.
	Description:	Technology, particularly digital technology (e.g. smartphones, websites) are fundamental tools that are used and thus taken for granted in CS projects; however, it presupposes that they are readily acquired and thus available for all participants despite the variability of cost and availability of infrastructure across countries and regions.
	Example:	Non-governmental organisations and crowdsourcing schemes run by, e.g., museums provide additional support to the procurement of technology used in the project and by its participants.
	Policy:	Officials (CS project organisers, universities, scientists) should provide appropriate practice templates to communicate and enable consent regarding the use of participation data and profiles.
	Description:	Projects in CS enlist the help of diverse volunteers who have a different understanding regarding the scientific process and how their participation may be handled (e.g., recorded). Communication by project organisers and within projects need to be consistent in explaining procedures and outcomes.
	Example:	Platforms such as SciStarter or Zooniverse that serve as a hub for CS project organisers and participants provide project organisers the appropriate language and tools to communicate the use of participation data and profiles when listing a project.

<table>
<tr><th colspan="3">5. Value-related issues and their proposed policies</th></tr>
<tr><td rowspan="3">
</td><td>Policy:</td><td>Establish a transparent system of measurement of pre-defined indicators for the various stakeholder levels based on systematic evaluation so as to enable assessment of advantages as well as costs and funding details of CS projects.</td></tr>
<tr><td>Description:</td><td>There is a need to create, gather, maintain and facilitate the access to reliable economic information on CS projects for estimating the costs of planning and implementing projects. Not all CS projects are funded equally, and funding can be a significant challenge for projects in addition to acquiring the necessary participants.</td></tr>
<tr><td>Example:</td><td>CS platforms that host information and direct access to projects such as Zooniverse and SciStarter discuss with projects to list budgeting information alongside the general information of the project when possible.</td></tr>
<tr><td rowspan="3">
</td><td>Policy:</td><td>Projects should include a system whereby feedback from participants is encouraged, supported, and valued for current and future project development.</td></tr>
<tr><td>Description:</td><td>CS projects typically enlist volunteers to engage in a variety of activities. Volunteers are diverse, but their reasons for participation and experiences are also diverse. Feedback may enable projects to better understand whether their activities are relevant to those of participants.</td></tr>
<tr><td>Example:</td><td>Projects have participants fill out pre- and post-surveys regarding their motivations, interests, and (expected) experiences in a project.</td></tr>
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7. DISCUSSION

Policy recommendations and citizen science (CS) have had close relations during the past years. A range of different kinds of policy recommendations on CS has been presented recently, focusing on mainstreaming CS (Notermans et al., 2022), how to develop CS across EU (Radicchi et al., 2021) or within a specific country, e.g. Germany (Bonn et al., 2022). These policy recommendations are founded from an empirical research perspective and on the CS Track project's overall objective to observe and analyse. This report and policies proposed are based on the current knowledge of the field of CS and from the empirical research and knowledge generated within the CS Track project.

Our policy recommendations aim to raise awareness of the nature of CS, scientific understanding of CS, and improve CS practices relating to five different issues, examined at three levels. We focused on pertinent issues relating to the theory, creation, operation, technology, and value in CS within the micro, meso, and macro levels. Reading these policy recommendations should be done with the attitude of a keen researcher, that is, to have curiosity and a critical view on what is presented as well as have interest in experimentation. It should also be done using a problematisation perspective, i.e., consider how a certain policy recommendation would serve a certain project, community or organisation.

The goal of CS policy recommendations is to equip each stakeholder with the necessary tools for reflecting and understanding the nature and operations of CS projects from varying perspectives. One outcome for developing CS via policy may be the recognition of the evolving skill set of citizen scientists. In this line of development, the accreditation of CS would become a relevant and necessary practice. The connections between CS and accreditation have been explored in parallel with this document, revealing their intimate and relevant connections with one another. Finally, the policy recommendations could facilitate the creation of CS scenarios to help the CS community to better understand and to improve the field of CS at both the individual and societal levels.

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