European Commission

Exploring *Citizen Science Strategies and Initiatives in Europe*

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Executive summary

Citizen Science communities, projects and initiatives are increasingly enriching the European landscape - both at national and at international level. However, reasonably little is known about the existence of Citizen Science initiatives and strategies in support to policy making. This includes questions, such as, where do such initiatives take place, on which basis are they launched and carried out, what are the drivers and challenges they face, and who are the involved actors?

To address some of these questions, this report provides a synthetic summary of the findings stemming from three years of pan-European discussions and a survey on Citizen Science strategies and initiatives. The work was carried out by the members of the Working Group 3 "Improve society-science-policy interface" of the COST Action CA15212 on Citizen Science. The ultimate objective of this work was to understand the landscape of such initiatives, and whether these have developed as institutional, spontaneous, or commissioned by a given community. To this purpose four workshops have been organised and a survey was launched in 2019. This work helped to identify actors involved, methodologies and tools applied, their underlying dynamics, influencing factors and possible avenues to promote and further develop Citizen Science approaches in support to policy making - both, at country and at European level.

This was the first such attempt across Europe. Hence, the collaborative efforts of the representatives of COST Action 1512 and the Citizen Science team of the Joint Research Centre (JRC) of the European Commission, have presented a unique opportunity to achieve progress on the state-of-the-art through their combined knowledge of the European landscape, and their diversified expertise in the different countries.

Notably, the **findings** of this work can only represent a snapshot of the development of different practices in European countries. They stand as an example of the heterogeneity of Citizen Science understanding, definitions, terminology, approaches and methodology used across countries and disciplines.

In general, we found that the **presence** of institutional strategies at national level is limited to only a few countries. Initiators of projects are mainly scientific institutions, followed by Non-Governmental Organization (NGOs) and self-regulated communities. Main funders are public administrations at different levels.

In several countries, Citizen Science appears as a well-known **concept**, developed on a common understanding of the area. In other countries, the leading communities are getting organised to build upon and develop existing concepts and practices according to their respective understanding of Citizen Science.

Some countries appear to follow a top-down **approach**, whereby Citizen Science projects are originated and defined by the scientific communities, or government agencies. Other countries seem to follow more engaging bottom-up co-creating approaches, especially when common challenges and needs require to be jointly addressed by local actors and communities.

Besides suggesting that the **understanding** and the presence of Citizen Science activities and strategies in Europe are **highly contextualized**, the survey revealed also a number of **key characteristics**. Those help us to understand the ever-evolving ecosystem of Citizen Science in Europe. This ecosystem includes different actors and communities of practice. However, it is possible to extract main obstacles and challenges, the enabling conditions and the influencing factors driving or hindering the initiatives, and to determine their impact - on science, society, economy and, ultimately on policy making processes.

1 Introduction

At European level, the 2015 ***White Paper on Citizen Science***[1] rolled out a strategy for a substantial increase of the use of Citizen Science and practice in support to scientific advance as well as to policy-making. Since then, Citizen Science is getting increased attention both, in Member States of the European Union (EU) and in the EU policy agendas[2]. Policy makers increasingly recognize the potential of Citizen Science as an innovative approach to engage with the civil society and as a precious source of information in support to EU environment-related policies addressing the Sustainable Development Goals (SDGs)[3], and beyond.

Amongst others, the ***COST Action 15212 "Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe"***[4] (which successfully finished in September 2020) aimed to join resources across Europe to investigate the extent and increase the impact of scientific, educational, policy, and civic outcomes of Citizen Science. This effort involves stakeholders from all sectors (e.g., policy makers, social innovators, citizens, cultural organizations, researchers, charities and non-governmental organizations) in order to gauge the potential of Citizen Science as enabler of social innovation and socio-economic transition.

In particular, the COST Action's Working Group 3 "***Improve society-science-policy interface"***[5] focused on the outcomes of Citizen Science projects in support to policy makers at local, national, and European level. It dealt with policies affecting the environment, in the first place, and the society as a whole.

In order improve our understanding of the state of the art of Citizen Science in Europe, the Working Group initiated a pan-European debate and a survey aimed at identifying and map Citizen Science strategies, initiatives and policies in various COST countries (see also Annex A). The activities intended to allow Citizen Science stakeholders' communities to improve their knowledge and understanding of how the concept and practice of Citizen Science manifests itself. This included investigations of the perceptions of the different actors in different national contexts, as well as possibilities for the promotion and further development of these practices, at European and at country level.

This report provides a synthetic overview of the work carried out so far. It documents the methodology that we applied in preparing and initiating this joint endeavour (Section 2) and presents the results that we could obtain so far (Section 3). We also present the results of our discussions (Section 4) and lessons we learned through this activity (Section 5) and conclude with an outlook to future work (Section 6). More details are available from a series of related reports of the COST Action. References are included where appropriate in the text below.

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1 White paper on Citizen Science, https://ec.europa.eu/futurium/en/content/white-paper-citizen-science

2 See, for example, https://ec.europa.eu/info/horizon-europe/missions-horizon-europe_en and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:628:FIN

3 See, for example, the German Presidency high level event https://www.cs-sdg-conference.berlin/en/

4 Web page of the COST Action 15212, https://www.cs-eu.net/

5 Web page of the COST Action 15212, Working Group 3, https://www.cs-eu.net/wgs/wg3

2 Methodology

Between 2018 and 2019 four workshops have been organised to conceptualise, refine, assess and validate the work in terms of objectives, scope and methodology. This included the interpretation of the findings of a pan-European survey, extraction of related outcomes and the formulation of lessons learned during this exercise.

The idea of creating a pan-European comparison of the development and implementation of Citizen Science strategies and policies was initially formulated in the invitation to a COST workshop that was held on the 19th March at the ISCTE-Lisbon University Institute[6]. The meeting hosted also the presentation of case examples of national Citizen Science strategies by practitioners from Germany, Austria, Spain and Portugal.

In the same meeting, a working group was created in order to address Citizen Science definition. The aim was to provide (common and simple) working definitions with three application objectives:

(1) To understand different types of Citizen Science.

(2) To accommodate different needs, contexts, stakeholders and target groups (e.g. countries, regions, institutions, communities, etc.).

(3) To optimise alignment, mutual learning and impact across (1) and (2) without constraining creative and innovative approaches.

The group proposed a conceptual framework that should help to provide a common ground for the identification, mapping and categorisation of Citizen Science related initiatives. It should thereby also enable the analysis of the current landscape of Citizen Science strategies and initiatives. This **Analytical Framework** was then tested and improved together with members of the COST Action.

In a second workshop, alongside the European Citizen Science Conference 2018 in Geneva[7], participants took stock of the progress achieved so far, and defined the way ahead. This included the decision to set-up a pan-European survey that should help gathering additional knowledge from the network.

The **Online Survey** was prepared in the second half of 2018, and was launched in spring 2019. This was mainly developed by the Joint Research Centre (JRC) of the European Commission (EC), in collaboration with, the Natural History Museum Berlin (MfN), and the Policy Working Group of the COST Action, on the basis of the findings and conclusions stemming from the above workshops and meeting discussions.

A third workshop took place together with the COST Action's Management Committee meeting in Cēsis in June 2019[8]. Since this event fell into the period in which the survey was still active, it provided an opportunity to not only promote the activity, but also to discuss, both, the progress and intermediate findings.

A fourth and final workshop was then organised at the University of Natural Resources and Life Sciences (BOKU), in Vienna in November 2019[9]. This was to discuss the final results from the survey, discuss the overall results and approach, and to plan eventual next steps.

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6 Full workshop report available from the COST Action 15212 web page, https://www.cs-eu.net/events/internal/workshop-wg-3-pan-european-comparison-development-and-implementation-cs-strategies

7 Full workshop report available from the COST Action 15212 web page, https://cs-eu.net/news/workshop-report-wg-3-citizen-science-strategies-europe

8 Full workshop report available from the COST Action 15212 web page, https://cs-eu.net/news/cs-strategies-europe-event-report-cesis-latvia-june-4th-2019

9 Full workshop report available from the COST Action 15212 web page, https://cs-eu.net/news/workshop-report-wg3-recommendations-development-national-citizen-science-strategies

2.1 Analytical framework

The Analytical Framework to structure the work at hand was built by crossing two dimensions: (i) the citizen/public contribution to Citizen Science; and (ii) the acceptability of the Citizen Science by the science community[10]. These two dimensions were compared along two axes to produce the notional four segments (Figure 1 provides an overview, and a detailed illustration is presented in Annex B):

- The most powerful Citizen Science initiatives feature both, a strong engagement of civil society and high acceptance by the scientific community (top right-hand segment of the framework).
- Solid Citizen Science initiatives are greatly accepted in science, and often still include meaningful engagement of citizens (bottom right-hand segment). There remains a potential to increase significance if strategies can be found to make the initiative more relevant for citizens.
- Where the contribution is significant for the citizen, but there is little acceptance within the science community (top left-hand segment), there is potential for improvement if strategies can be found to increase the scientific relevance of the initiative.
- Initiatives that are neither appealing to the citizen nor relevant to science mark the fourth segment (bottom left-hand segment).

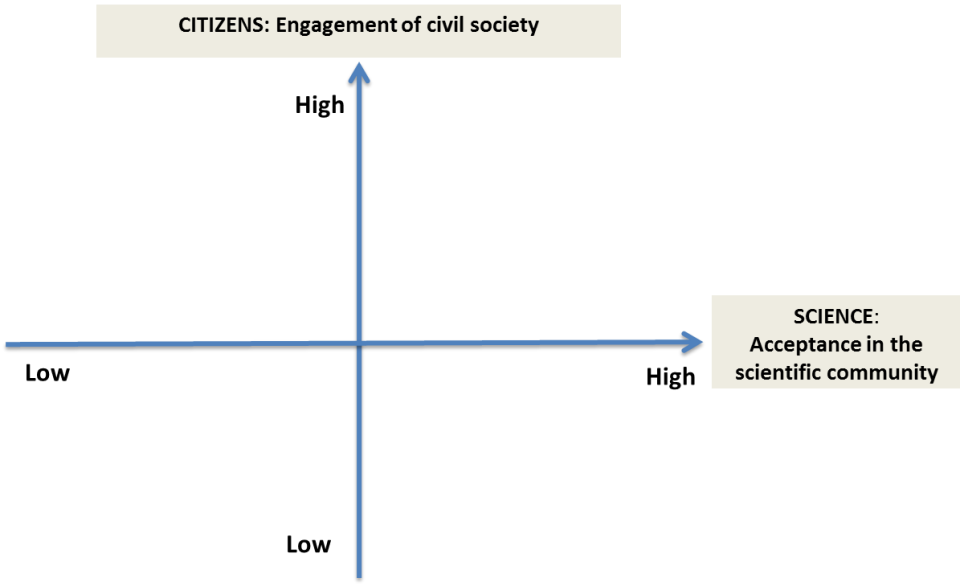

Figure 1. Sketch of the analytical framework

The Analytical Framework was designed during the COST Action workshops, and also inspired country specific debates - with specific inputs from the JRC's Citizen Science team[11], from relevant international bodies and from individual experts (members of the European Citizen Science Association (ECSA), Non-Governmental Organisations (NGOs), academia etc.).

Based on the findings from these discussions, the Analytical Framework was refined and sent out to a wider group of practitioners - in a combined attempt to gather country-specific information while also shaping the questions for the more detailed survey (see also below). In this round of consultations, inputs were received from Albania, Austria, Germany, Lithuania, Portugal, and Spain.

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[11] Web page of the JRC's Citizen Science team, https://ec.europa.eu/jrc/communities/en/community/citizensdata

2.2 Online survey design

The detailed online survey intended to provide an updated state of the art of Citizen Science strategies and/or initiatives in Europe. It should improve our understanding of the landscape, the actors involved and their underlying dynamics while, at the same time, exploring avenues to promote and further develop Citizen Science approaches in support to policy making, both, at country and at European level.

The survey relied on the following main principles agreed with the workshops participants:

- The Analytical Framework would serve as a tool to provide the underlying structure for the survey exercise and subsequent examinations. The Analytical Framework underpinning the survey, needed to be usable, meaningful and relevant to different country contexts. It should help Citizen Science practitioners identify and present an initial set of Citizen Science initiatives, strategies and practices at different levels (national/regional/local). The framework thus aimed to help information acquisition, subsequent analysis and, possibly, some comparison of relevant information, in a comprehensive and consistent fashion.
- To initiate this exercise, the survey had to rely on a minimum amount of information allowing a meaningful analysis that would lead to sound reflections, intermediate conclusions and recommendations for possible ways ahead. It should support the promotion, end eventually mainstreaming of Citizen Science approaches – again, both, at European and country level.
- For this survey to prove an effective and sensible exercise, its governance had to be based on the principle that the process of data acquisition had to be realistic and contextualised. To this purpose, the survey would have to make sure to (i) ask relevant questions, (ii) to the best positioned people inside the different European countries, who (iii) would possess the best available knowledge in view of providing sensible information.

In addition, we envisaged the following outcomes:

- The results from the present survey were meant to be summarised in the report at hand, which represents an important step towards an initial outlining of Citizen Science policies and practices throughout Europe. It should act as a springboard for further research, development, and promotion of Citizen Science practices and initiatives at national and EU level.
- Although only being capable to provide a partial snapshot, the information collected by the survey and the resulting report provides evidence-based knowledge for the development of EU and national policy papers and tools. The survey and report also document the challenges and benefits of the use of Citizen Science as a source of information in support to policy-making. This might serve as a starting point to further complement and maintain the information from this initial exercise, to observe and analyse this highly dynamic landscape – and to exchange experiences across Europe.
- As such, the report aims to contribute to the development of recommendations for the promotion and further development of Citizen Science approaches in support to policy-making processes at European level.

With this in mind, the online survey was structured along three main building blocks as follows: General information about Citizen Science in the specific country; Methodological and disciplinary approaches applied to Citizen Science; Relevance and impact of Citizen Science in different areas; these were then summarized in a final block including a number

of related considerations. The full list of questions can be found online[12], and it is also annexed to this report (Annex C).

2.2.1 General information about the research context

The introductory information requested by the survey, intended to summarise the underlying understanding, perception and values, main domain/area of application, and stage of development of Citizen Science in the different countries. Such contextualization was considered to be essential for a better understanding of the most recent picture. On the one hand, this information helped to identify and analyse the influencing factors, key variables, relevance and impact, cross cutting issues and trends. On the other hand, it provided a starting point for developing recommendations for possible improvements and desired scenarios - especially related to policymaking processes.

2.2.2 Methodological approach identified by the respondents

The second building block of the survey, intended to capture information about the following dimensions:

- The actual terms of existence of Citizen Science in support to policy making, including the state of the art in the different countries.
- The extent and level of implementation, including information on the key actors involved and their level of engagement.
- The areas addressed and geographical scope of implementation, and the main approaches including the applied practices and methodologies.
- The role played by technologies in supporting the implementation and spreading of practices and initiatives.
- The key influencing factors and available resources in the identified ecosystems.

2.2.3 Relevance and impact perceived by the respondents

This third building block addressed possible impacts of Citizen Science in the different countries, respectively in policy, scientific, and socio-economic terms. Despite being the shortest section of the survey, this was at the time the most difficult and the most important. It provided evidence on the benefits or barriers of Citizen Science approaches applied to different domains and for different purposes, for example, devoted to scientific, social, or political challenges/opportunities.

2.2.4 Additional considerations from the respondents

The survey closes with a few questions aimed to analyse and summarise the answers to the previous sections, thereby providing the possibility to take stock, identify key factors and pre-requisites, draw some preliminary conclusions, and formulate expectations about future evolutions.

[12] Survey available from the COST Action 15212 web page, https://cs-eu.net/sites/default/files/Survey_CitizenScienceStrategiesinEurope.pdf

3 Survey results

The Online Survey aimed to develop an educated picture of Citizen Science strategies in Europe, specifically on the following: to which degree national, regional and local entities support Citizen Science; what is the understanding of the added value of Citizen Science in the different regions of Europe; and what is its impact on science, society and policy making processes? An overview of the replies is provided in Annex C.

It has to be noted that these findings are a snapshot view of a highly dynamic and evolving landscape. They need to be set in the context of an initial survey exercise that, although addressed to all 36 COST countries, i.e. they encompass a subset of respondents, due to limited time and resource availability. As such, we have to read the findings within this survey with all consequent limitations, in terms of completeness of responses, resulting picture and derived conclusions. Besides, the contributors to the survey represent a vast variety of actors, from the Citizen Science scientific community, NGOs, museums, or administration. As such, the understanding of the questions, consequent replies, and the perceived landscape very much varies accordingly. Consequently, these findings cannot be considered as a fully representative image of Citizen Science in the covered countries (EU Member States or COST countries), nor fully definite in their conclusions.

Nevertheless, the current survey is the result of a long-lasting collective effort. The members of the COST Action 15212, the JRC and other independent experts and practitioners in the Citizen Science arena, followed a step-wise approach to develop a methodology for identifying and selecting the key issues, related questions, specific categories and indicators to be used in the survey. As such, the observations extrapolated from the current survey can be considered as indicative in respect to the full picture, allowing for some projections to be derived on a larger scale.

Consequently, this survey offers a valuable starting point (including a rich collection of influencing factors and practical suggestions) for exploring functional options how Citizen Science can more systematically create value for science, policy, economy, and the broader society. It lays the ground for future studies to ultimately guide the development of a pan-European strategy on Citizen Science that would harness its full potentialities.

3.1 The key elements addressed by the survey

The key elements addressed by the survey and its main findings focused on the following dimensions:

- Citizen Science presence/existing strategies and perceived level of development;
- Methodological approach and scope of intervention (collaborative vs participatory, initiators top-down vs bottom up, relevance vs geographical);
- Involved actors, their roles and scope of intervention (who, where, how and at what level);
- Tools and methodologies (platforms, guidelines, exchanges of BPs, events, etc.);
- Areas of applications (incumbent vs emerging);
- Impact (scientific, socio-economic, political ones);
- Common underlying issues;
- Drivers vs barriers;
- Influencing factors;
- Trends/plans for the future.

3.2 Overall picture

The survey was carried out through an online questionnaire hosted on the COST Website dedicated to the COST Action 15212.

The respondents addressed by the survey were in first line all MC Members of CA 15212. The survey received a total of 45 responses from all EU Member States, as well as Switzerland, Norway, Albania, Turkey, North Macedonia and Israel, for a total of 33 countries.

The respondents were private individuals or working in governmental programmes, public and private research institutions, academia, NGOs and trusts, international bodies (e.g. ECSA), and independent experts. Some of them belong also to established networks and communities of practice within this area. Most respondents acted in their capacity, either of project and/or policy managers, or responsible/leader of Citizen Science initiatives, and amateurs.

The graphical representations enclosed to this report (Annex C) summarise the findings related to the above, most significant, dimensions covered by the survey that were identified in the course of its preparation by the members of WG 3 of this COST Action, together with renown experts invited to the different workshops:

1. **Geographical coverage**: 45 replies were received from 33 European countries achieving a good geographical coverage, including eastern countries, and COST co-operating countries.

2. **Presence** of Citizen Science strategies and practices in Europe: Official/institutional/authoritative Citizen Science Strategies at national level were identified only in a few countries (5), followed by local level and regional level, whereas most of them could not identify formal Citizen Science strategies. (Figures 1, 2 and 3 in Annex C).

3. **Terminology**: It was observed that both, the terminology used to describe Citizen Science practices, and the level of engagement from citizens, seems to vary between all countries. Accordingly, also the perceived level of development declared by the respondents was not aligned to the same parameters (see examples used in Figure 3 in Annex C).

4. **Coverage of areas and disciplines**: In most countries the areas where Citizen Science practices appear to be present is environment and nature protection (with environmental pollution and biodiversity at the first place), but also land cover/use, astronomy, humanities, social science and cultural heritage. Half of them reported that Citizen Science practices seem to be used to contribute in some stage of the cycle for policy making processes. Emerging areas are medicine and health research, smart cities and traffic, economy, arts and historical sciences (see also Figure 4 in Annex C).

5. **Actors and their roles**: Initiators appear to be scientific institutions, NGOs/associations/foundations and self-regulated communities, whereas funders are mainly public administrations from national to regional to local level in decreasing order. The actual implementation seems to be done by NGOs, private companies and sectoral associations in the same decreasing order (see also Figures 5, 6 and 7 in Annex C).

6. **Tool and methodologies**: The most used supporting tools and methodologies to support Citizen Science practices appear to be: stakeholders' cooperation amongst practitioners mainly through Communities of Practice (CoPs), networks and platforms, followed by training courses and tutoring, guidelines and best practices and events. Policy documents and regulation or the availability of shared physical spaces were rarely mentioned (see also Figure 8 in Annex C).

7. **Impact on policy making processes**: In this context Citizen Science seems to affect first of all "resources" (Data) made available for policy making, followed by improving interactions amongst "actors", mostly on early stage "process", such as early warning/anticipation and definition, followed by design, implementation and, lastly, monitoring with compliance and evaluation (see also Figure 9 in Annex C).

8. **Scientific impact:** Impact was observed especially with reference to data gathering and science communication, followed by research design, software development and data evaluation, whereas it is surprising to see problem definition lagging behind. This might suggest that citizens are not sufficiently engaged by the scientific society at the very beginning of research (see also Figure 10 in Annex C).

9. **Impact on Society**: the first observations from the received responses suggest that Citizen Science is a tool for empowerment of citizens and the civil society in terms of (in order of importance): increase of scientific literacy, understanding of methodological research, improved collaboration, gathering evidence for documenting problems and identifying alternative strategies for problem solving (see also Figure 11 in Annex C).

10. **Economic impact**: At a glance, impact in the socio-economic sector seems to be perceived especially on the increase of social and technological innovation, followed by budget savings and consequent increase of budget availability to tackle additional issues of public concern (see also Figure 12 in Annex C).

11. **Influencing factors**: Whereas we see "Funding models for long-term sustainability" being the stronger influencing factor in the uptake and development of Citizen Science, the fact that this is almost directly proportional to the "Recognition of the benefits of Citizen Science", followed by the level of Citizen Science national strategies, suggests these indicators strongly depend on the level of political awareness about the benefits that Citizen Science can bring to the different segments of society. Mutual trust and educational systems seem to be important influencing factors, whereas "Technological and infrastructural factors" seem to be the least important ones, suggesting that it is rather Citizen Science that influences innovation in Information and Communication Technology, ICT (see impact on economy), while ICT act as an enabler of Citizen Science. Finally, EU support is considered to be an important supporting element in this context (see also Figure 13 in Annex C).

12. **Observed trends**: Respondents reported about some increase of awareness of Citizen Science benefits with consequent plans to increase Citizen Science local initiatives and activities, set up platforms and projects, and planned strategies following the path of the Open Science Initiatives triggered by the related EU strategy.

13. **Pre-conditions for Citizen Science successful development and sustainable engagement**: The identified favourable pre-conditions are: increased relevance and impact, strong motivation, mutual benefits, common challenges, political will, efficient organization of stakeholders, and agile collaborative models, long term funding, resources and alliances, mutual trust (scientist vs citizens vs policy), ICT as enabler, smart Data Governance including the need for robust quality assurance, impact assessment frameworks, and adequate feedback mechanisms (policy vis-a-vis scientists vis-a-vis citizens).

3.3 General trends

General trends were derived as follows:

- Most of the times the owners and initiators of Citizen Science activities appear to be the funders themselves.
- The main drivers of collaborative Citizen Science initiatives appear to be common motivation and the need to address impellent challenges.
- Citizen Science activities seem mostly driven by the scientific communities (even in AT, DE and ES), therefore still now Citizen Science is mostly based on a contributory level of engagement (with the exception of ES).
- National trends and planned activities seem more evident when there is an established and institutionalised strategy at national level.
- In terms of sectoral application (e.g. astronomy, cultural heritage, pollution, etc.), Citizen Science multidisciplinary nature becomes more apparent where there is a national strategy, whereas applications remain more sectoral where there is none (e.g. nature, environment, biodiversity).
- Citizen Science resources appear to be mainly used for up-front needs, such as, early warning and problem definition in both, policy and science, rather than for policy design.
- When no impact on the scientific community is recorded, it seems to be due to scientific culture (e.g. mistrust in stakeholder's interaction and quality of data issue).
- In terms of drivers and influencing factors, most countries seem to allocate higher importance to actors (willingness, interactions, culture, etc.). Others to funding availability, training material, rewards, data quality or technological/structural factors, this seems depend on the level of Citizen Science development in the country, namely on whether Citizen Science is still in early stage development or more advanced.
- Even in those countries where Citizen Science strategies and action appears most developed it seems mainly driven by scientists (see e.g. ES).
- Impact is recorded to be mainly on scientific work, some spin off (like in AT: a new company dedicated to develop Citizen Science mobile applications and web pages) and many of them appear unbalanced in terms of sector application, mainly addressing in the environmental domain.

3.4 Commonalities and cross-cutting issues

The different rounds of the survey revealed the following Commonalities and cross cutting issues throughout different initiatives, and at all operational levels:

- The need for research on suitable and modular impact assessment schemes.
- Recognition should be sought for the citizen scientists, either economic or curricular.
- Sustainability models should be promoted for successful Citizen Science initiatives to survive in time.
- Citizen Science should be embedded in the scientific culture and in educational programmes, both at early stages with children (to incentivise future citizen scientists) and in universities (to overcome scepticism and opposition).
- Support of Citizen Science scientific publications is needed to increase awareness and credibility.
- Infrastructure and cross cutting technical issues (interoperability and standardisation) are common to all contexts and need to be further investigated.

- Data Management also (data quality, its instrumental value –fit for purpose, its evaluation, etc.) are common to all contexts and operational levels and would need to be addressed in a coordinated and collaborative fashion.

3.5 Influencing factors

A number of strong influencing factors, including barriers and opportunities were identified throughout the investigated countries, namely:

- Political awareness and willingness are seen as the most needed requirements for strategy development.
- Sustainability funding models have resulted to be the turning points to strategies consolidation and mainstreaming.
- Trust and mutual recognition amongst actors are key to achieve the necessary level of cooperation leading to success.
- Culture, education and administrative organization of the territory are amongst the strongest contextualisation factors.
- Balanced relationship between independent and government-dependent mechanisms determine sound stakeholder roles and ecosystem dynamics.
- Infrastructure and cross cutting technical issues (interoperability and standardisation) are underlying features to strategies, models and practice development.
- Data Management (data quality, instrumental value, fit for purpose, evaluation models, etc.) and Framework Conditions (national and international regulation, administrative, financial and legal aspects) are amongst the strongest determinants in the adoption of Citizen Science practices and principles.

3.6 Summary

The above sections outline the findings of Citizen Science in terms of key features, commonalities, challenges, potentialities, general trends, and influencing factors. The findings from the detailed analysis of such dimensions allow also to draw some extrapolations and general conclusions that can be summarised below, in support to the shaping of the landscape of Citizen Science practices and initiatives in Europe.

- Typically, Citizen Science is often performed in self-organised and self-sustained Communities of Practice (CoPs), networks of common interest, and shared platforms.
- Evidence of impact of Citizen Science activities are found, to different extents, on all segments of the hosting ecosystem, namely at policy, scientific, economic and social level.
- The enabling pre-conditions for Citizen Science activities to grow, are mutual trust and interest in common challenges.
- The key influencing factors determining the development of Citizen Science initiatives are the presence of dedicated plans supported by funding models for long-term sustainability.
- The main obstacle hindering the use of Citizen Science approaches seems to be political will, due to lack of awareness of the benefit brought about by Citizen Science activities by policy makers.

Amongst the main conclusions, worth drawing higher attention from all stakeholders are the dimensions listed below.

- Where there is a clear understanding of the area and common challenges to be addressed, most of the times there is a sound strategy in place, both at national and local level, stakeholders of the given ecosystem react consequently, initiatives evolve and follow, and impacts become more visible at all operational levels.
- There is a need to create alliances amongst the different stakeholder communities (Governments, NGOs, Scientific communities/academies, private sector and CoPs) to exploit synergies and join up resources.
- There is a need to go beyond scientific purposes, and be more oriented to policy driven objectives, in response to societal common challenges.
- Beyond the currently dominating environmental domain, there are good potentialities to mainstream Citizen Science activities to a number of other areas (health, energy, urban management, transport, agriculture, etc.), where co-creation is key to effective policy making in support to societal impact.
- Influencing factors are instrumental to strategy development and their successful implementation, and need to be carefully addressed, as these seem to be common determinants in all countries and related operational levels within them.

As we can see, Citizen Science shows a concrete degree of successful application in a number of domains, with high potentialities for mainstreaming it to many other areas of societal, economic and political concern, with high potential impact.

However, the most notable obstacle to the uptake, development and mainstreaming of Citizen Science approaches in support to policy making processes, appears to be the lack of sufficient degree of awareness and understanding by policy makers of Citizen Science potentialities. Consequently, more efforts should be invested, at all levels, to identify and promote the benefits that Citizen Science can bring to relevant and effective policy making, thereby leading to increased motivation and concrete options for the development of relevant strategies and long-term sustainability plans.

4 Discussion

The findings from the survey served as the basis for discussion at two of the workshops. Preliminary results were discussed in the summer of 2019 and the final responses towards the end of the year.

4.1 Investigation of preliminary results

The preliminary results were discussed on the occasion of the COST Action 15212 Management Committee (MC) of the 4th of June 2019 in Cēsis, Latvia, and were summarised in the event report that can be found on the COST Website[13].

In depth discussions of the preliminary findings were held in group work sessions, around some critical elements of the survey that were identified before the meeting. This in order to interpret, validate, and formulate survey findings, improve its methodology, explore underlying commonalities and differences, as well as common patterns throughout the countries scrutinised.

Groups were set-up of 5-10 people, working in parallel and following a common structure. A group moderator presented detailed results from the survey according to the focus assigned to the group. Participants were encouraged to raise questions and raise possible open issues. Findings and results from the survey were jointly elaborated, followed by a group analysis of the main common issues (e.g. impact, drivers & barriers, influencing factors). Finally, recommendations addressing the specific topic of discussion were identified both, at national as well as at EU level.

During this exercise, the critical elements of the survey were identified as follows.

1. **Terminology** and **stage of development** (Survey questions 1-6: *What does Citizen Science mean? Which other terms are around? What practices are linked to it?)*
2. National **Citizen Science strategies** (Survey questions 7-13: *Are there "official" or governmental strategies, or others? What sectoral/for specific groups? Can you give examples, how and by whom are they written? By whom they are adopted? What are key measures? What are country differences? For what reason?)*
3. **Actor constellations** (Survey questions 14-16: *What type are these organisations, what is there mission, their power? Why do they support/oppose Citizen Science? Are there differences between the countries? How the organizational development can be supported?)*
4. **Tools and resources** (Survey question 17-20: *Which particular resources and tools are available to support Citizen Science in your country?)*
5. **Impact on policymaking processes**: (Survey question 21: *Which types of impacts of Citizen Science contributing to policy making processes are you aware of in your country?)*
6. **Socio-economic impacts** (*Survey question 21, 22, 25-33: Which types of socio-economic impacts of Citizen Science contributing to policy making processes are you aware of in your country? How is the link between science, society, economy, and policy? What are the main influencing factors? Are there factors common to all/other countries?)*
7. **Scientific impacts** (Survey question 23-24: Which types of scientific impacts of Citizen Science in your country are you aware of? What are the main influencing factors? Are there factors common to all/other countries?)

[13] https://cs-eu.net/news/cs-strategies-europe-event-report-cesis-latvia-june-4th-2019

4.2 Exploration of responses and reflections about the approach

During the last workshop held in Vienna on the 4th of November 2019, the final results stemming from the survey were contextualized in terms of objectives, scope (coverage of geographical and topic areas), methodology applied, actors involved, respondents, characteristics of responses, common issues and key outcomes.

The key outcomes were presented with the help of graphics providing a picture of the main features of the findings, including their interpretation and possible re-use.

Participants in the event were highly interested in the findings from the survey, and expressed a number of comments on how to further improve it in a way that could foster both, (1) the different definitions and the different realities of EU Member States (with their intrinsic characteristics), as well as (2) a more accurate picture of the state of the art of Citizen Science at pan-European level (in terms of benefits, commonalities, challenges, opportunities, horizontal issues, influencing factors and future trends).

The presentation of the outcome from this survey highlighted the many commonalities and similar findings stemming from related research and events – including a previous workshop co-organised by the JRC and COST on Citizen Science in Environmental Monitoring and Reporting of DG Environment in Ispra on 21-22 November 2018[14], as well as a similar research exercise resulting in a first overview and analysis of 13 initiatives carried out by the Citizen Science Network Austria (at the University of National Resources), and Life Sciences Vienna on National Citizen Science Networks and Initiatives.

4.2.1 Different understandings of the notion of Citizen Science itself

The discussion following the presentation of this survey focused especially on the definition of Citizen Science. In fact, participants in all workshops dedicated to the survey acknowledged that responses to the latter highly depend on both the definition and the interpretation of "Citizen Science" given or used by the respondents.

A number of examples of Citizen Science definitions encountered differences between the participating countries. Participants shared their impressions as follows:

CZ: The ECSA definition[15] as starting point, especially when it comes to EU-funding.

UK: Any participatory/engagement project, with a focus on the benefits for the participants.

ES: White Paper definition[16] as a basis complemented by specific definitions according to the focus area, e.g. social science, etc.

AT: Also mostly White Paper definition as starting point.

PL: Preference of descriptive definitions rather than normative, according to Arnstein's Ladder of Citizen Participation, and depending on the different focus activities, e.g. Open Education, Creative Commons, Open Access, and related Actors like Research Institutions and educational institutions, and NGOs working on them.

LT: The link of Citizen Science to actual activities and projects is often not clear.

TR: Citizen Science is defined as "Contributory Science".

BA: Work in progress on "Dedicated" definitions according to focus areas.

SL: Participatory approaches with focus on policy-making.

This discussion confirmed that the definition of Citizen Science should be instrumental. It must reflect the objectives of the actors, its use, and the extent of the engagement of

[14] http://publications.jrc.ec.europa.eu/repository/handle/JRC117665
[15] https://ecsa.citizen-science.net/2016/05/17/10-principles-of-citizen-science/
[16] https://ec.europa.eu/futurium/en/content/white-paper-citizen-science

citizens at different levels. This means that a definition of Citizen Science needs to encompass and promote an open and broad understanding of manifold research practices and participation. This comprehensiveness is essential to both, producing meaningful research on Citizen Science, as well as providing support to the development of Citizen Science on the national and European level. A solid start might be represented by the "White Paper" definition complemented by the Arnstein ladder of participation, together with the definition used in DITOs policy engagement work[17].

Going beyond the collection of definitions of Citizen Science, we could observe different perceptions of Citizen Science when referring to and applying Citizen Science approaches, according to existent cultural differences and diversified contexts of application. The derived highly-diversified approaches are based on and defined by the simultaneous use of different definitions applied to different contexts, in a multiple combination mode. The more the practice is contextualised, the many more combinations of definitions and approaches are applied to the initiative.

The examples identified by this survey also confirm the conclusions stemming from previous research carried out by different groups of stakeholders worldwide. In fact, also in similar research the understanding of Citizen Science is highly contextualised according to the objectives, and the use intended by the originating entities. Consequently, we can conclude that the understanding of Citizen Science and the approaches applied to the different disciplines within different scientific and socio-political contexts, vary from country to country, and from community to community, and this stands as a general rule.

We can expect that these multiple understandings and development processes of Citizen Sciences will mature over the coming decade, allowing a more in-depth analysis of how these different trajectories influence the practices of Citizen Science in support to policy making, and their impact on the different stakeholder communities and ecosystems.

4.2.2 Feedback about the survey structure

Participants in the survey expressed also some suggestions on the structure of the questionnaire underlying the Analytical Framework. This would need to be carefully considered for future research in particular in terms of:

- Length of the questionnaire;
- Clarity of terminology and concepts; and
- Response options (e.g. include the possibility to not answer, e.g. with an "I do not know" field).

Participants in the workshop then split into groups and elaborated specific comments, respectively on the survey outcomes.

During this workshop, the need for contextualizing the survey outcomes became clear. Participants concluded that the current findings from the survey while not being representative enough in terms of numbers. This can indeed serve to shape an initial picture of a state of the art which is comforted by similar results carried out in previous and on-going research exercises involving countries beyond Europe (e.g. Canada and Australia).

In fact, the results from this initial exercise allow for quite some projections to be derived on a larger scale that can be improved and compiled on the basis of future surveys building on the lessons learned.

[17] Göbel, C., Nold, C., Berditchevskaia, A. and Haklay, M., 2019. How Does Citizen Science "Do" Governance? Reflections from the DITOs Project. Citizen Science: Theory and Practice, 4(1), p.31. DOI: http://doi.org/10.5334/cstp.204

The full report is available at the following link on the COST Action 15212 Website[18].

[18] https://cs-eu.net/news/workshop-report-wg3-recommendations-development-national-citizen-science-strategies

5 Lessons learned

The ultimate aim of the present work was to kick off the process for providing the state of the art and updated information of Citizen Science for stakeholders to react timely and with relevance to the identified needs. To this effect, all participants provided valuable ideas on how to best formulate and articulate similar broader assessments in the future.

5.1 Critical factors

The present work - although within its limitations - largely confirms that the **critical factors** that strongly influence and determine the uptake and development of Citizen Science in support to policy making both, at European as well as at country level. These were found to be (in order of priority):

i) ***Awareness of the benefits*** of Citizen Science contributions to policy making.

ii) ***Clear understanding of possible contributions of Citizen Science*** both at European and national level.

iii) ***Political willingness and long term support*** through sustainable funding and planning.

With respect to the technical and scientific aspects, discussions held on findings and influencing factors reinstated that **further research and the development of guidelines on horizontal issues**, such as, interoperability, standardisation, quality, indicators and measurement frameworks are still needed.

It was also acknowledged that **socio-cultural differences and histories**, do have an impact on the interpretation, practice and development of Citizen Science throughout Europe - for instance the deep transformation in Eastern Europe.

The survey also acknowledged that the **role and potentialities of NGOs, and other similar organisations**, is fundamental as these are very often both the funder/initiators as well as the executors of Citizen Science initiatives. These play a crucial role acting as the interface between citizens, science, and political administration, and they would need more attention and resources for their potential to be fully exploited.

5.2 General suggestions

To this purpose, a number of **general suggestions** were put forward as follows:

1. **If a definition of Citizen Science is provided,** in order to establish a joint understanding of the topic. **Such a definition must be instrumental** to reflect the objectives, actors' roles and the extent of the engagement of citizens at different levels. This means that a definition of Citizen Science needs to encompass and promote an open and broad understanding of manifold research practices and participation. This comprehensiveness is essential to both – producing meaningful research on Citizen Science, as well for providing support to the development of Citizen Science at national and European level. The definition used in the project DITOs[19] provides a good example. The instrumental nature of the definition of Citizen Science is further confirmed by the conclusions presented in the recently published book providing a unique overview of the field of Citizen Science[20].

[19] Göbel, C., Nold, C., Berditchevskaia, A. and Haklay, M., 2019. How Does Citizen Science "Do" Governance? Reflections from the DITOs Project. Citizen Science: Theory and Practice, 4(1), p.31. DOI: http://doi.org/10.5334/cstp.204

[20] Vohland, K., Land, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K. (Eds.) (2021) The Science of Citizen Science. Springer, https://www.springer.com/de/book/9783030582777

2. **The initial survey might be repeated or kept open, but with some improvements.** Suggestions for improvements are listed below (in Section 5.3).
3. **Horizontal issues of common concern** need to be more thoroughly considered (e.g. data governance, interoperability, standardization, guidelines, best practices, quality and impact assessment models, and framework conditions). There is a need to explore the possibility to **develop guidelines for their regulation at EU level**. This would provide the necessary reference frameworks to harmonize and optimize resources engaged in the same direction, while allowing for the necessary adaptation to different contexts to ensure relevance of intervention at national and local level.
4. **Multi-stakeholder alliances and funding models for long-term sustainability**, in support to national strategies need to be further studied and developed, including the identification of good practices in this domain.
5. **The role of the EU and the level of intervention** is to be shaped in terms of providing a common reference point for the collection and development of Citizen Science practices, guidelines and policy initiatives, to increase awareness of the benefits, and to promote the use of Citizen Science for policymaking processes.
6. The possibility to **introduce Citizen Science innovative approaches as criteria for relevant funded programs and projects in EU research and development**, to pave the way to the mainstreaming of Citizen Science to those potential areas where Citizen Science can bring considerable impact.

5.3 Complementary developments

The findings stemming from this survey, revealed also many commonalities and similar findings stemming from parallel research and related events, including a previous workshop co-organised by the JRC and COST on Citizen Science in Environmental Monitoring and Reporting (Ispra, Italy, 21-22nd of November 2018)[21].

Moreover, the findings resulting from the present survey were comforted also by a long list of resulting conclusions and commonalities stemming from similar exercises carried out also beyond Europe (including the USA, Canada and Australia)[22]. In fact, it was observed that the results stemming from an overview and analysis of 13 initiatives, carried out in parallel to this survey by the Institute of Zoology of the University of National Resources Networks and Life Sciences of Vienna, aiming to investigate Citizen Science initiatives on Platforms, are very similar and also based on a number of common underlying factors and principles. The observed similarities with these other research exercises, can be expressed in terms of: (i) areas addressed by Citizen Science; (ii) typology of organizations and actors involved; (iii) multiple approaches to governance; (iv) multiple goals and scopes; (v) type of activities; (vi) applied methodologies; (vii) funding schemes; (viii) challenges (funding, data management, awareness); (ix) achievements (awareness, collaboration; (x) establishment of initiatives); and (xi) desiderata (learn from each-other, development of collaboration schemes, identification of funding models, and set-up frameworks for long-term sustainability).

It was highlighted on several occasions that Citizen Science can make a **substantial contribution in complementing and in supporting environmental monitoring and reporting**. A concrete demonstration of this conclusion is represented by as Commission Staff Working Document "Best practices in Citizen Science for environmental monitoring" (SWD(2020) 149 final)[23] that was recently published and received high consensus and institutional recognition from the relevant communities of stakeholders.

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21 https://ec.europa.eu/jrc/en/publication/citizens-science-and-environmental-monitoring

22 Dörler D. and Heigl F. (2019). Citizen Science COST-Action CA15212: Report on National Citizen Science Networks and Initiatives. COST Action 15212, Working Group 3 - Improve society-science-policy interface.

23 https://ec.europa.eu/environment/legal/reporting/pdf/best_practices_citizen_science_environmental_monitoring.pdf

The extensive contributions that Citizen Science makes in framing and achieving sustainable development goals worldwide, was well demonstrated at the recent event organised under the EU Council German Precedency "Knowledge for Change: A decade of Citizen Science (2020-2030) in support of the SDGs"[24]. This event gathered a rich set of expertise from policy makers, institutional and citizen scientists, economists, NGOs, etc.

As a major achievement, a **Declaration on Citizen Science: *Our world – our goals: Citizen Science for the Sustainable Development Goals*** was put forward and undersigned by over 250 stakeholders. It includes a number of recommendations in support to its further development.

During the event, it become clear how a systematic review of the 244 SDG indicators revealed that Citizen Science can provide a valuable contribution in addressing specifically the UN Sustainable Development Goals (SDGs). Moreover, through the identification of past and ongoing Citizen Science initiatives, it has been demonstrated that Citizen Science is "already contributing" to the monitoring of 5 SDG indicators, and that Citizen Science "could contribute" to 76 other indicators which, together, equates to around 33% of all SDGs, covering 40% of those related to the environment.

Recently, the EU research framework set the basis for the requested policy support in research, innovation and development. Most prominently, this includes the **Horizon 2020 Missions**[25] (which are designed for citizen engagement per se, and provide a strong framework for Citizen Science supporting their implementation) and the **European Research Area** (ERA, including the commitment of the European Commission to "*organise with Member States and stakeholders Europe-wide participatory Citizen Science campaigns to raise awareness and networking, crowdsourcing platforms and pan-European hackathons, in particular in the context of Horizon Europe Missions. The Commission will develop with Member States best practices to open up science and innovation to citizens and youth*")[26].

[24] https://www.cs-sdg-conference.berlin/en/
[25] https://ec.europa.eu/info/horizon-europe/missions-horizon-europe_en
[26] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:628:FIN

6 Conclusions and future work

6.1 Conclusions

The present work began to develop an educated picture of Citizen Science strategies in Europe, specifically on the following questions. To which degree national, regional and local entities support Citizen Science? What is the understanding of the added value of Citizen Science in the different regions of Europe? What is its impact on science, society and policy making processes?

The findings stemming from this work provide a snapshot view of a highly dynamic and evolving landscape. This work provides a first cross-country analysis of a number of very different approaches in Citizen Science activities and research, i.e. different principles, tools, models, and collaborative alliances applied at different organizational and administrative levels, both internationally and nationally.

Participants in the survey and associated workshops were very interested in its findings, being these in scientific, methodological, or feature terms. The experts expressed a number of comments and recommendations on how to improve such research for the future. It emerged a clear need to distinguish the different definitions of Citizen Science reflecting the different realities of the European countries with their intrinsic characteristics - while providing a more accurate picture of the state of the art of Citizen Science at pan-European level in terms of benefits, commonalities and challenges.

On this basis, it was acknowledged that Citizen Science approaches need to be highly contextualized and adapted to the actual level of intervention to achieve impact. As such, given the variety of Citizen Science ecosystems and complexity of policy formulation, the analysis of Citizen Science approaches and the related impact assessment frameworks, need to be broken down into the different components of their specific ecosystems. This is in terms of level of interventions as follows: EU, national, regional and local; policy level-goals as compared to programme level-objectives; and measures vs. instruments, vs. tools.

In the light of the findings and opportunities brought about by this pan-European survey, the potentials of Citizen Science have to be clearly stated. It cannot be repeated often enough that Citizen Science not only contributes data, but also concrete experiences, and that Citizen Scientists can be involved to different degrees in priority setting. This might include their participation in the creation of methodologies, their validation, analysis, and interpretation of scientific observations and experiments. Such processes would ultimately help to catalyse societal participation in policy, triggering the virtuous circle around the dual dimension of Citizen Science in support to policy and policy in support to the development of Citizen Science initiatives across different dimensions and fully fledged strategies at local, national and international level.

Times are ripe, and the European institutions have a fundamental role to play in promoting the development of favourable conditions (political, administrative, legal and technical) in support to Citizen Science development. This for example by fostering added-value initiative and hosting infrastructures, developing relevant frameworks, and agreed guidelines around common issues (such as interoperability arrangements, standardisation, engagement methods and tools, quality assurance methodologies, and assessment frameworks).

Ultimately, this report aims at providing a pan-European oversight and, at the same time, it acknowledges country differences and commonalities. It identifies what can be referred to as good practice and/or influencing factor/pre-requisites at different levels, especially when it comes to policy formulation. As such, the extrapolations, the findings and the resulting conclusions derived from this pan-European survey (although with some limitations) are to be considered as an unprecedented ground for setting the picture. They pave the way to future improved versions of such research, in support to Citizen Science development and mainstreaming.

What this survey offers, is a valuable starting point setting the scene for action, with a rich collection of influencing factors and practical suggestions for exploring functional options of Citizen Science for science, policy, economy, and the broader society in more detail in future studies. Ultimately, this explorative work can prove to be a valuable tool for guiding the development of an educated pan-European strategy on Citizen Science that would harness its full potentialities.

Finally, this survey report provides the ground also for concrete recommendations to be derived on how to foster and promote the use of successful Citizen Science approaches and practices for policy-making processes, both at European and national levels. Now more than ever, under the current unprecedented circumstances affecting the whole world, joining forces and creating alliances, with citizens' full participation in addressing common challenges and the management of public good, has become an indispensable condition.

6.2 Future work

The presented work provided valuable research insights in this area, and a number of **items for future research** as summarised below:

- For the future improvements of this research, the issue of the definition of Citizen Science could be addressed either by including a selected definition up-front (e.g. the one provided by the ECSA), or by asking respondents to define Citizen Science as it is widely observed in their countries. With respect to the latter point, participants in the overall organization of the survey suggested that the latter exercise could be facilitated by referring to the infographic about citizens' levels of involvement developed during the previous workshops (see also Annex B). However, purpose and perspective of the respective definition should be made clear.
- As qualitative information is always very subjective, there is a need to gather and analyse more descriptive information that would present diversity/complementarity/commonalities with some citations etc.
- Reporting of "no presence" of Citizen Science is an issue. We assume that what is happening in reality in those countries is not perceived as part of public engagement in scientific research, and it is therefore sometimes called Invisible Citizen Science. This phenomenon should be addressed in further research.
- A stronger focus should be laid on target groups of the survey. In this respect, the resulting responses would need to be interpreted keeping in mind their roles, their specific interests, and ultimate objectives (science, policy, NGOs CoPs, etc.).
- The survey also revealed some open issues that need further consideration, eventually leading to the production of valuable scientific literature and future initiatives, such as, the development of desired tools, methodologies, training material, long-term sustainability models, and widely agreed guidelines on issues of common concern.

To share, maintain and advance the research presented in this report, we see a high value in providing three main **outputs** through a stepwise approach:

1. A set of Citizen Science ***Country Fact Sheets*** based on the presented work to be offered to stakeholders in European member states to maintain an updated picture of the state of the art in their respective country, including the features presented here.
2. A living ***Pan-European Inventory*** of Citizen Science strategies, initiatives, practices, and mapping of related stakeholders, at COST Country level.
3. A set of ***Recommendations*** for fostering the development and mainstreaming of Citizen Science and practices in support to policy making at EU level.

The further development, management and hosting of these resources, should be explored within the framework of relevant current initiatives, such as the European Citizen Science Association (ECSA).

Annex A: List of country abbreviations

Abbreviations of EU-27 Countries	Other countries not part of the EU-27
AT - Austria	AL - Albania
BE - Belgium	AD - Andorra
BG - Bulgaria	AM - Armenia
CY - Cyprus	BA - Bosnia
CZ - Czech Republic	BY - Belarus
DE - Germany	CH - Switzerland
DK - Denmark	FO - Faeroe Islands
EE - Estonia	GB - United Kingdom
ES - Spain	GE - Georgia
FI - Finland	GI - Gibraltar
FR - France	IS - Iceland
GR - Greece	MC - Monaco
HR - Croatia	MK - Macedonia
HU - Hungary	NO - Norway
IE - Ireland	RU - Russian Federation
IT - Italy	SM - San Marino
LT - Lithuania	TR - Turkey
LU - Luxembourg	UA - Ukraine
LV - Latvia	VA - Vatican City State
MT - Malta	
NL - Netherlands	
PO - Poland	
PT - Portugal	
RO - Romania	
SE - Sweden	
SI - Slovenia	
SK - Slovakia	

Annex B: Analytical framework for analysing Citizen Science initiatives and strategies

Dimensions of Citizen Science:

1) Contracted: run and conducted by scientists at citizens' request

2) Contributory: designed by scientists with citizens primarily contributing data

3) Collaborative: as 1 with citizens also helping to refine design, analyse data and/or disseminate findings

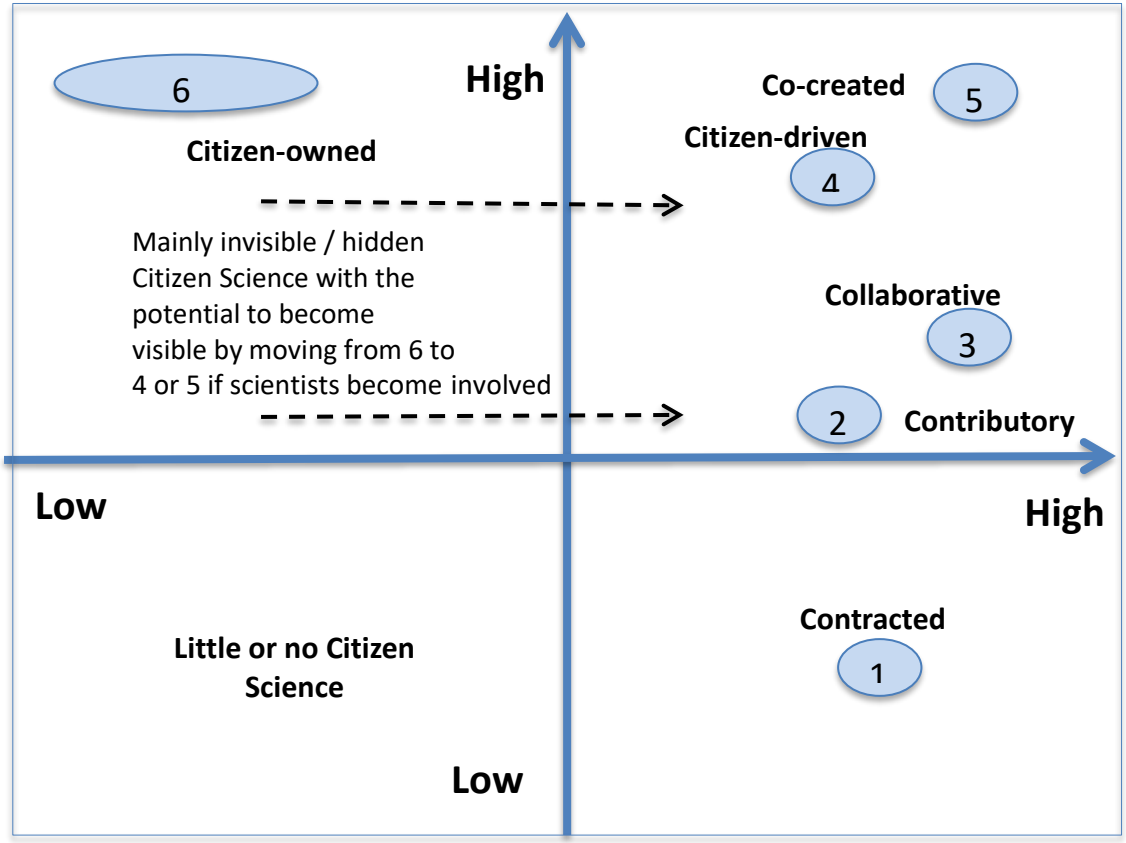
4) Co-created: designed by scientists together with citizens, with some involved in most or all parts of the research

5) Citizen-driven: designed, run and conducted by citizens with validation by scientists

6) Citizen-owned: designed, run and conducted by citizens with no involvement of scientists

CITIZENS: Engagement of civil society

Citizen dimension criteria: level of involvement, and contribution to skills, knowledge, identity, competences, behaviour, trust, etc.



SCIENCE: Acceptance in the scientific community

Science dimension criteria: accepted/validated by the science community, including quality data and transparent, robust, open methods, tools and findings, capable of replication

Annex C: Survey Questionnaire

OUTLINE

Contextualization: Short Description of Country political-scientific-techno-socio-economic key specificities

In order to better understand the underlying principles and dynamics of Citizen Science (CS) approaches and strategies, especially those that intend to contribute to policy making processes, it would be useful contextualise the findings by spending a few introductory words outlining the main characteristics of each country ecosystem under scrutiny (e.g. scientific arena, actors roles, stakeholders networks and their dynamics, political trends, societal challenges, top-down versus bottom-up culture, etc.) and, possibly, explain what the interplays among these factors are, and how they possibly affect CS perception, implementation, impact and assessment of the undertaken initiatives.

The introductory information is especially useful when trying to identifying and analyse the influencing factors, key variables, relevance and impact, cross cutting issues and trends, as well as for providing educated recommendations for possible improvements and desired scenarios especially those contributing to policy making processes.

Respondents Qualifications and Affiliation

A. In which Functional Position do you stand on Citizen Science?

- Scientist
- Researcher
- Policy maker
- Entrepreneur
- Citizen Scientist
- Other

B. Which is your home Country?

- *(please use free text)*

C. Are you COST member (CA 15121 – www.cs.eu.net)?

- Yes as MS Member or Substitute
- Yes as a member of a the larger network
- No

General Information (for the first round of data gathering)

We begin this survey with a series of questions addressing general issues about the main settings and perception of Citizen Science practices and approaches in your country.

1. Is the **term** '**Citizen Science**' used in your country? (single choice)
    - Yes
    - No
2. Are **other terms used** to refer to Citizen Science (in the national language(s) and translated into English – if applicable)?
    - *(please use free text)*
3. Which **type of objectives and values** drive Citizen Science in your country? (multiple choice)
    - Societal (inclusiveness, education, active citizenship etc.)
    - Economic (innovation, growth, employment, etc.)

- Environmental (ecology, nature protection, sustainable use of resources, etc.)
- Improvement of Policy making processes and practices
- Underpinning vision (open science, better regulation, democracy, etc.)
- Other: *(please replace this with free text)*

4. In which **domains** is Citizen Science supported/applied in your country? (multiple choice)
    - Astronomy
    - Biodiversity
    - Cultural Heritage
    - Environmental pollution (air, water, noise, waste, smell etc.)
    - Human biology
    - Land cover/Land use
    - Nature protection
    - Participation in local policy making ad governance of public goods (-planning, organization, etc.)
    - Other: *(please replace this with free text)*
5. How would you describe the **stage of development** of Citizen Science in your country?
    - *(please replace this with free text)*
6. How would you evaluate the **stage of development** of Citizen Science in your country with respect to your knowledge of other existing experiences and your expectations?
    - *(please score from 0 to 10)*

Approaches and Practices

This second part intends to capture information about the actual state of the art of Citizen Science approaches and practices in your Country.

7. How do **governmental authorities consider** Citizen Science in your country? (multiple choice)
    - As support to scientific disciplines
    - As a contribution to education
    - As a contribution to improve policy making processes
    - As a means for science communication
    - As a means to increase of trust in science
    - As a means to increase of trust in public administration
    - As cheap labour
    - Not at all

- Other: *(please replace this with free text)*

8. Do official/institutional/authoritative **Citizen Science Strategies** exist in your country? (single choice)
    - Yes, at national level
    - Yes, at regional level
    - Yes, at local level
    - Not at all

9. If yes, could you list existing references to their **official basis and related institutional documentation** (existing law, regulations, guidelines, etc. -including links if possible)?
    - *(please replace this with free text)*

10. Are these regulating/supporting Citizen Science in your country at different level? (multiple choice)
    - Yes, at national level
    - Yes, at regional level
    - Yes, at local level
    - Not at all

11. Where do current Citizen Science activities in your country **originate from**? (multiple choice)
    - Government bodies
    - NGOs, Sectoral Associations and Foundations
    - Private sector
    - Self-regulated communities
    - Other: *(please replace this with free text)*

12. Do any **non-governmental Citizen Science entities** support Citizen Science in your country? (multiple choice)
    - Yes, at national level
    - Yes, at regional level
    - Yes, at local level
    - Not at all
13. If yes, which **kind of entities** are these?
    - NGOs
    - Sectoral associations
    - Private companies

- Other: (*please replace this with free text*)

14. Could you list existing **references** to the previous answer (incl. links if possible)?
    - *(please replace this with free text)*

15. If applicable, how are the governmental and non-governmental entities **connected/collaborating** in your country? (e.g. through formal/informal agreements and or alliances, delegation, coordination, etc.)
    - *(please replace this with free text)*

16. Are there any **communities' shared/common working documents/practices** supporting Citizen Science in your country? (multiple choice)
    - Yes, at national level
    - Yes, at regional level
    - Yes, at local level
    - Not at all

17. If yes, could you list existing **references** (incl. links if possible)?
    - *(please replace this with free text)*

18. Which **particular resources and tools** are available to support Citizen Science in your country? (multiple choice)
    - Policy documents and regulations
    - Stakeholder Communities, Communities of Practice, Networks
    - Guidelines and Best practices
    - Training material
    - Training courses and Tutoring
    - Regular gathering events
    - Shared (physical spaces)
    - Online platforms
    - Other: *(please replace this with free text)*

19. Could you list examples of any of the above (incl. links if possible)?
    - *(please replace this with free text)*

20. How do you see the **role of technologies** in support of Citizen Science in your country? (multiple choice)
    - As an enabler
    - As a catalyst
    - As underlying infrastructure (mobile, *IoTs*, etc.)
    - Marginal

- Other: *(please replace this with free text)*

21. How would you consider the current **level of actors' involvement** in citizen in science practices in your country? (multiple choice) (see also Annex 1)
    - Contracted
    - Contributory
    - Collaborative
    - Co-created
    - Community-driven
    - Other: *(please replace this with free text)*

22. How would you characterise the **extent of implementation** of Citizen Science approaches in your country? (multiple choice)
    - Based on Geographical scope
        - ✓ National level
        - ✓ Regional level
        - ✓ City level
        - ✓ Neighbourhood level
    - Based on Relevance of challenge
        - ✓ Community priority
        - ✓ sectoral relevance,
        - ✓ Other? (please specify with free text)

Relevance and Impact

This pillar addresses possible impacts of Citizen Science in policy, scientific, socio-economic terms in your country.

23. Which **types of impacts** of Citizen Science contributing to **policy making processes** are you aware of in your country? (multiple choice)
    - Early warning/anticipation
    - Problem definition
    - Policy shaping/design
    - Policy implementation
    - Policy monitoring
    - Policy evaluation
    - Compliance assurance
    - Other: *(please replace this with free text)*
    - None

24. Can you give any **example of policy impacts** stemming from Citizen Science approaches in your country?

- *(please replace this with free text)*

25. Which **types of scientific impacts** of Citizen Science in your country are you aware of? (multiple choice)
    - Scientific advancement
    - Problem definition
    - Research design
    - Outputs evaluation
    - Other: *(please replace this with free text)*
    - None

26. Can you give any **example** of scientific impacts of Citizen Science in your country?
    - *(please replace this with free text)*

27. Which **types of social impacts** of Citizen Science in your country are you aware of? (multiple choice)
    - Scientific literacy
    - Active citizenship/increased citizens-level engagement
    - Stakeholders structure and interactions
    - Citizens/communities wellbeing
    - Other: *(please replace this with free text)*
    - None

28. Can you give any **example** of social impacts of Citizen Science in your country?
    - *(please replace this with free text)*

29. Which **types of economic impacts** of Citizen Science in your country are you aware of?
    - Budget savings in a given sector/area
    - Budget availability to tackle challenges of common concern
    - Economic incentives
    - Other? *(please replace this with free text)*

30. Can you give any **example** of economic impacts of Citizen Science in your country?
    - *(please replace this with free text)*

Preliminary Considerations

This survey closes with a few questions considering the previous answers, thereby providing the possibility to take stock, identify key factors and pre-requisites, draw some preliminary conclusions and share expectations about future evolutions.

31. What would do you consider as potential **drivers** or **pre-requisites** for promoting Citizen Science in your country? (multiple choice)
    - Policy support
    - Regulatory frameworks
    - Long-term planning
    - Funding and sustainability plans
    - Collaborative approaches
    - Capacity Building
    - Education
    - Technology
    - Other: *(please replace this with free text)*

32. What would do you consider as potential **barriers** for promoting Citizen Science in your country? (multiple choice)
    - Political unwillingness/immaturity
    - Distrust culture
    - Scepticism and opposition
    - Legal issues
    - Over regulation
    - Funding and resources
    - Education
    - Technology
    - Other: *(please replace this with free text)*

33. Which **influencing factors** do you consider to be most important for future developments of Citizen Science in your country? (multiple choice)
    - Political willingness/strategies;
    - Trust in government-science-citizens collaboration
    - Balanced relations between independent and government-dependent mechanisms
    - Stakeholders' interactions
    - Culture and citizenship awareness
    - Sustainability funding models
    - Underlying Infrastructure (Networks, platforms, etc.)
    - Suitable Technologies (mobile Apps, IoT, etc.)
    - Different level of Data Quality (fit for purpose versus scientific excellence)
    - Other: *(please replace this with free text)*

34. Would you like to share any **cross-cutting issue** identified in the course of this survey (pre-conditions, challenges, opportunities, practices, etc.) that you consider as being important elements for the promotion of Citizen Science in your country?
    - *(please replace this with free text)*

35. Are you aware of any **plans or emerging trends** (political-socio-economic-scientific developments) that might impact the evolution of Citizen Science strategies and initiatives? If yes, which ones?
    - *(please replace this with free text)*

36. Would you like to **share anything else** with us that you deem important for providing a realistic picture of Citizen Science state of the art in your Country?
    - *(please replace this with free text)*

THANK YOU for completing this survey!!!

Annex D: Overview of survey results

Throughout this Annex, we briefly present the replies to the survey questions using a set of diagrams.

Figure 2 presents the responses to the question **"Do official/institutional/authoritative Citizen Science Strategies exist in your country?"** (multiple choices were possible).

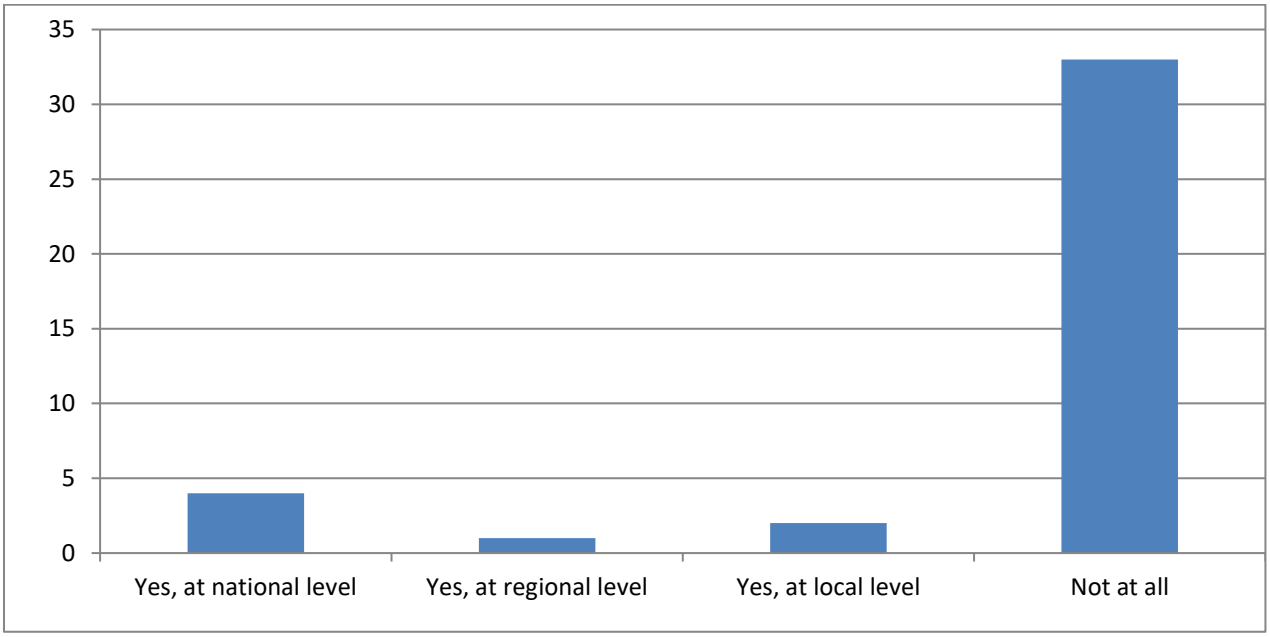


Figure 2. Existing Citizen Science strategies

Proportions presented by Figure 2 combined **with Figure 3** (level of implementation) indicate that funders may be different from the actual executors, since part of strategies funded at national level are executed mostly at regional level by regional stakeholders.

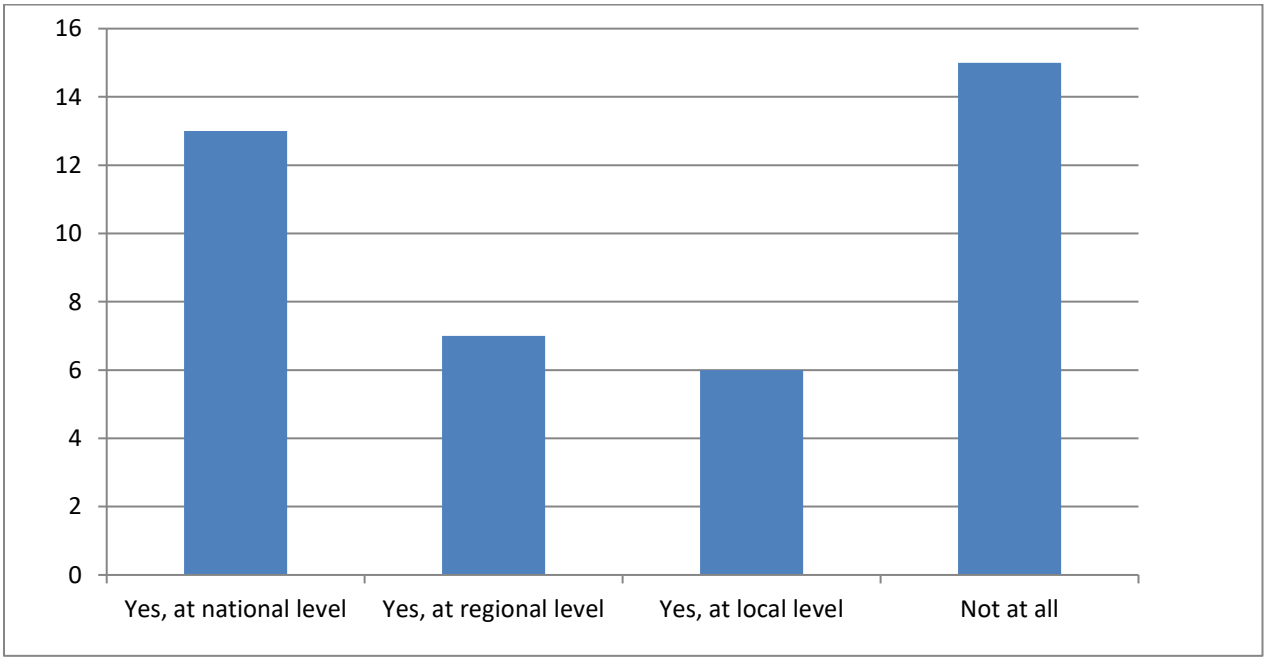


Figure 3. Institutional level of Citizen Science practices implementation

Figure 4 presents the responses to the question ***"How would you describe the stage of development of Citizen Science in your country?"***

As one can see from the graph, most of the respondents did not answer this question. This could be explained by the fact that respondents did not have a reference against which they could assess the requested level of development. This issue was addressed by developing the Analytical Framework (Annex B), to be added to future investigations.

In fact, from the remaining answers, we can see how the description of perception of the level of development differs according to the respondents e.g. 5 = mature; 4 = developing; 2 = intermediate; 1 = very early stage.

The discrepancies of perception are possibly due to the subjective and/or cultural differences, especially with respect to expectations from the different respondents about Citizen Science desired evolution.

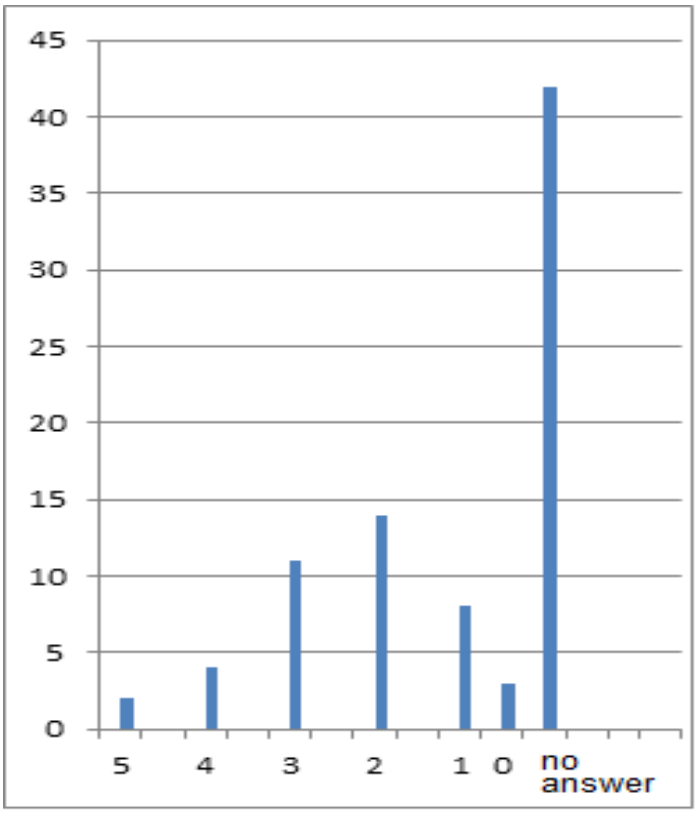


Figure 4. Perceived average level of Citizen Science development

Figure 5 presents the responses to the question ***"In which domains is Citizen Science supported/applied in your country?"*** (multiple choices were possible).

This picture indicates those domains of applications, beyond those related to environment, where Citizen Science approaches are by nature deemed to reach the highest relevance and impact, namely, cultural heritage, agriculture, social science, participation in local policy-making and astronomy.

The survey revealed also that new areas of applications are emerging in areas related to health and urban management. Apart from classical areas, we can identify several emerging application areas, such as medicine, economy, arts; health research, historical sciences; and traffic counting.

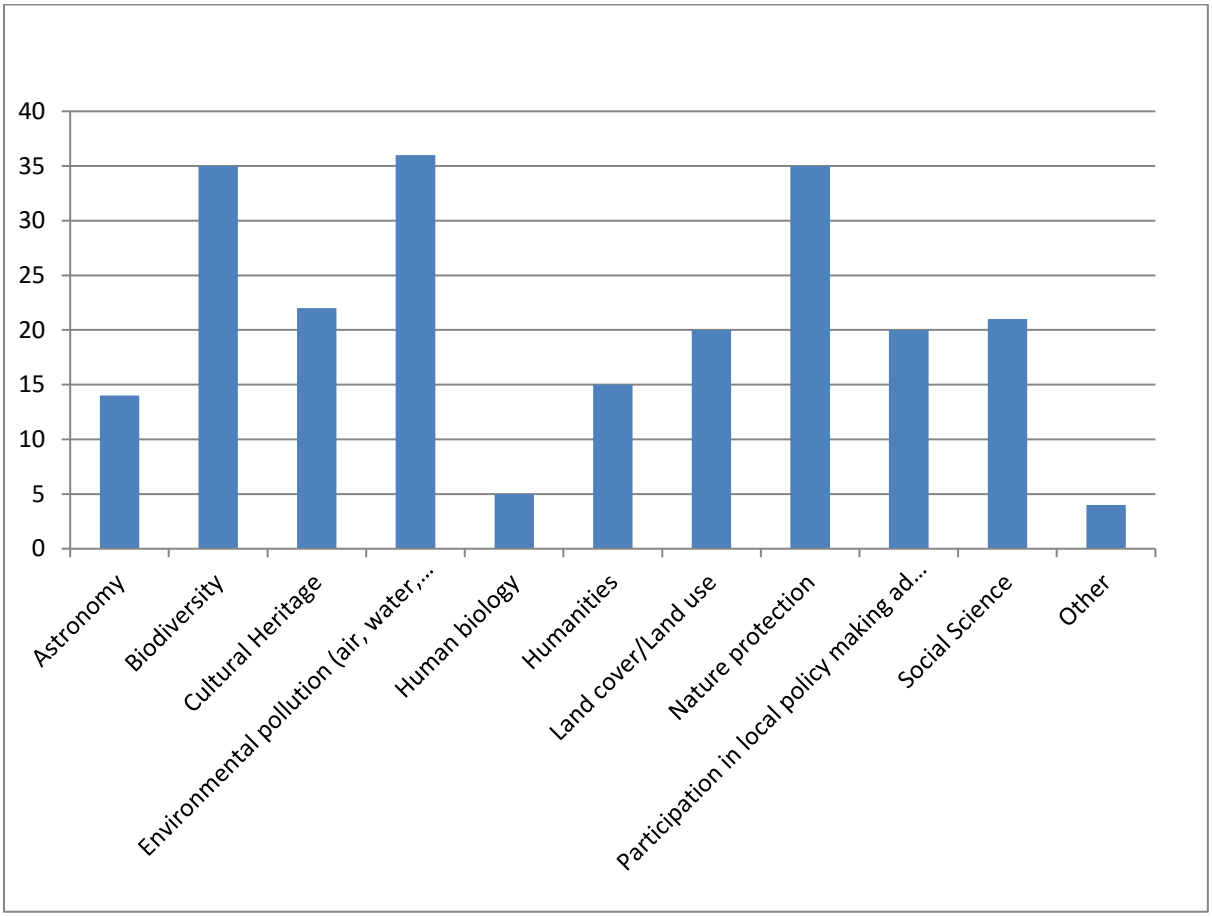


Figure 5. Areas of thematic coverage

The following **figures (7, 8 and 9)** all relate to the question "***Where do current Citizen Science activities in your country originate from?"*** (multiple choices were possible).

These graphs show that there are different initiators of Citizen Science activities. It appears that the scientific communities, NGOs and local communities are the most active in the area of Citizen Science, and they seem to suggest that these actors both trigger and implement Citizen Science activities at national as well as regional level.

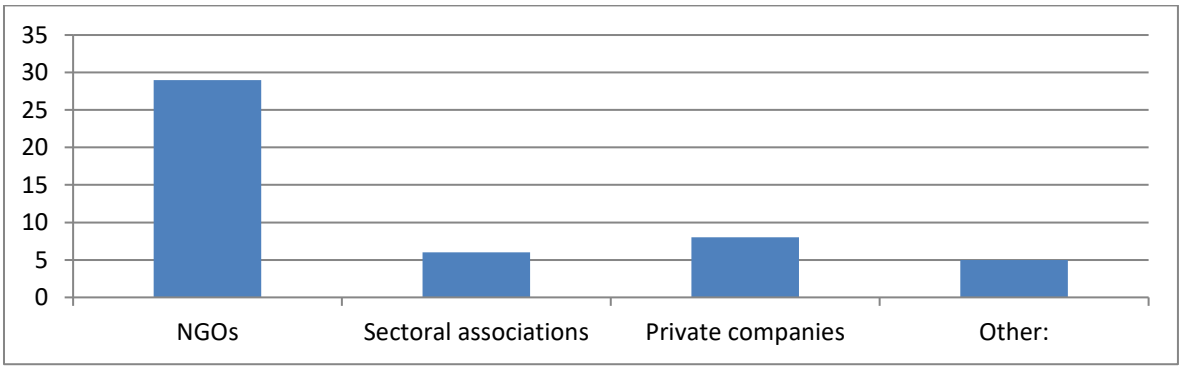


Figure 6. Distribution of actors by sector

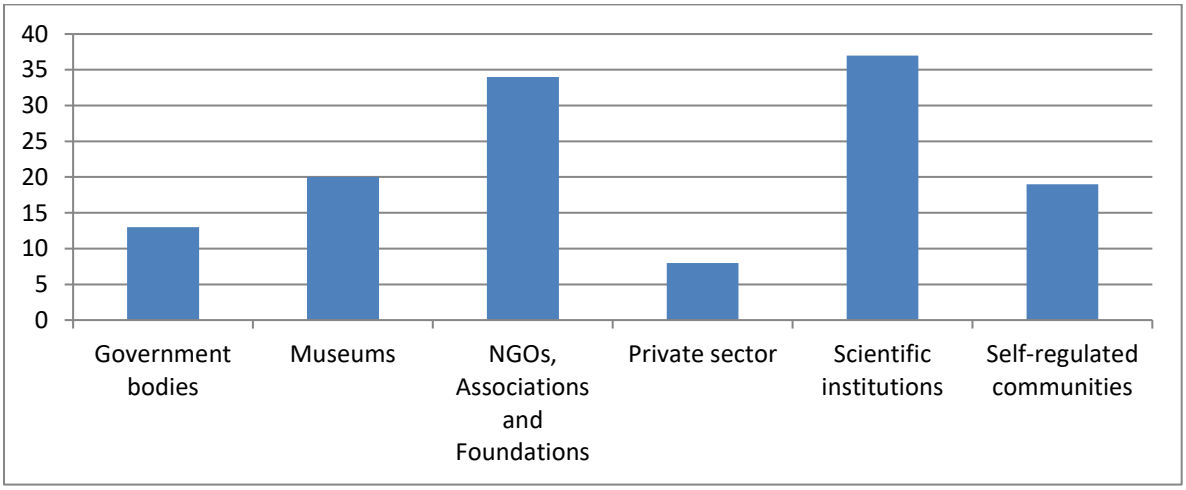


Figure 7. Distribution of actors by sector (details)

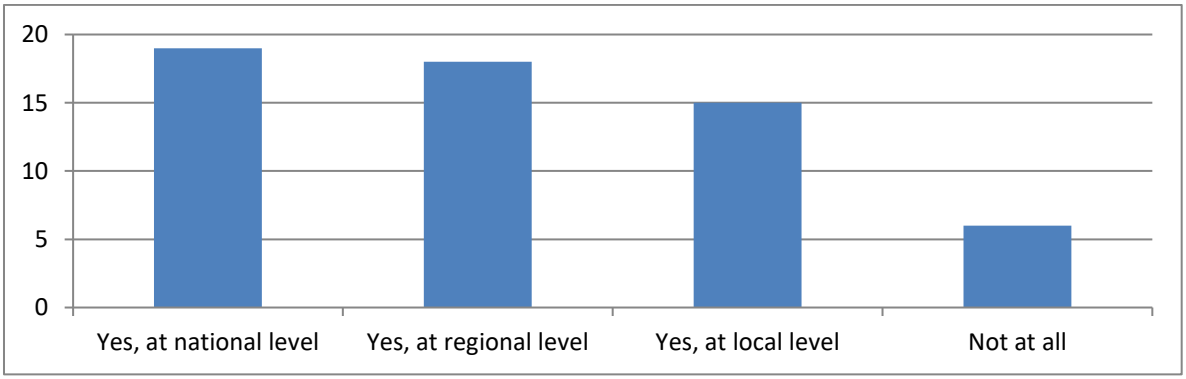


Figure 8. Distribution of actors by administrative level

Figure 9 represents replies to the question ***"Are there any communities' shared/common working documents/practices supporting Citizen Science in your country?"*** (multiple choices were possible).

This graph indicates that the most commonly used working practices and methodologies in support to the implementation of Citizen Science practices, are those dedicated to collaboration and aggregation of efforts (Communities of Practice (CoPs), platforms and networks, regular events, training and tutoring), rather than the use of policy documents and regulations. This suggests that, lacking the availability of official policy documents and regulations to refer to, there is a need from the stakeholders to join forces, gather, share and access common tools and information, as a reference framework in support to their work.

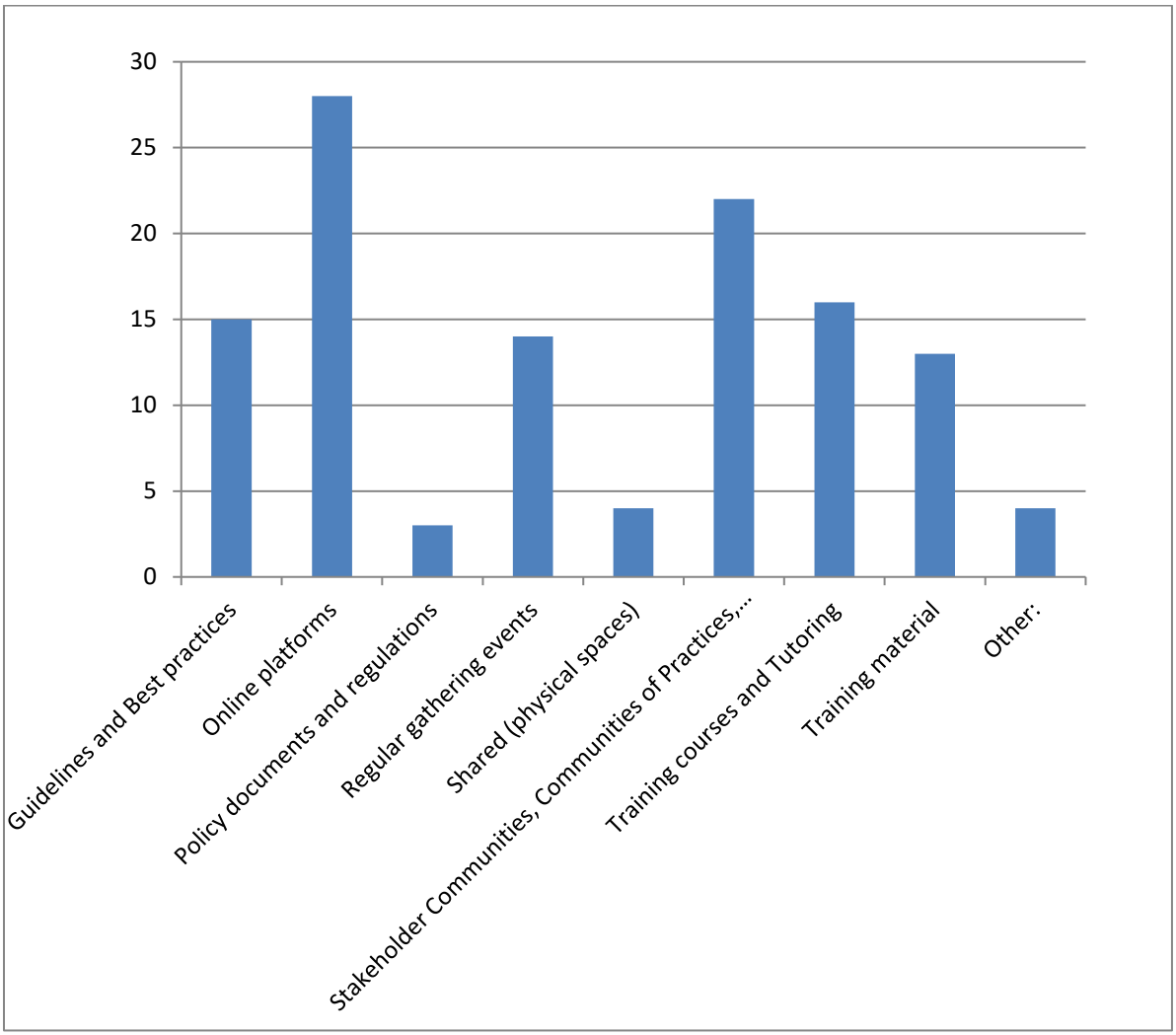


Figure 9. Overview of tools and resources

Figure 10 addresses the question ***"Which types of impacts of Citizen Science contributing to policy making processes are you aware of in your country?"*** (multiple choices were possible).

The graph indicates that impact is still higher especially on data and information provision, improved stakeholders interactions and collaboration. This is followed by influence on the underlying processes (early warning and problem definition), before showing some impact on *policy design and implementation and monitoring processes*.

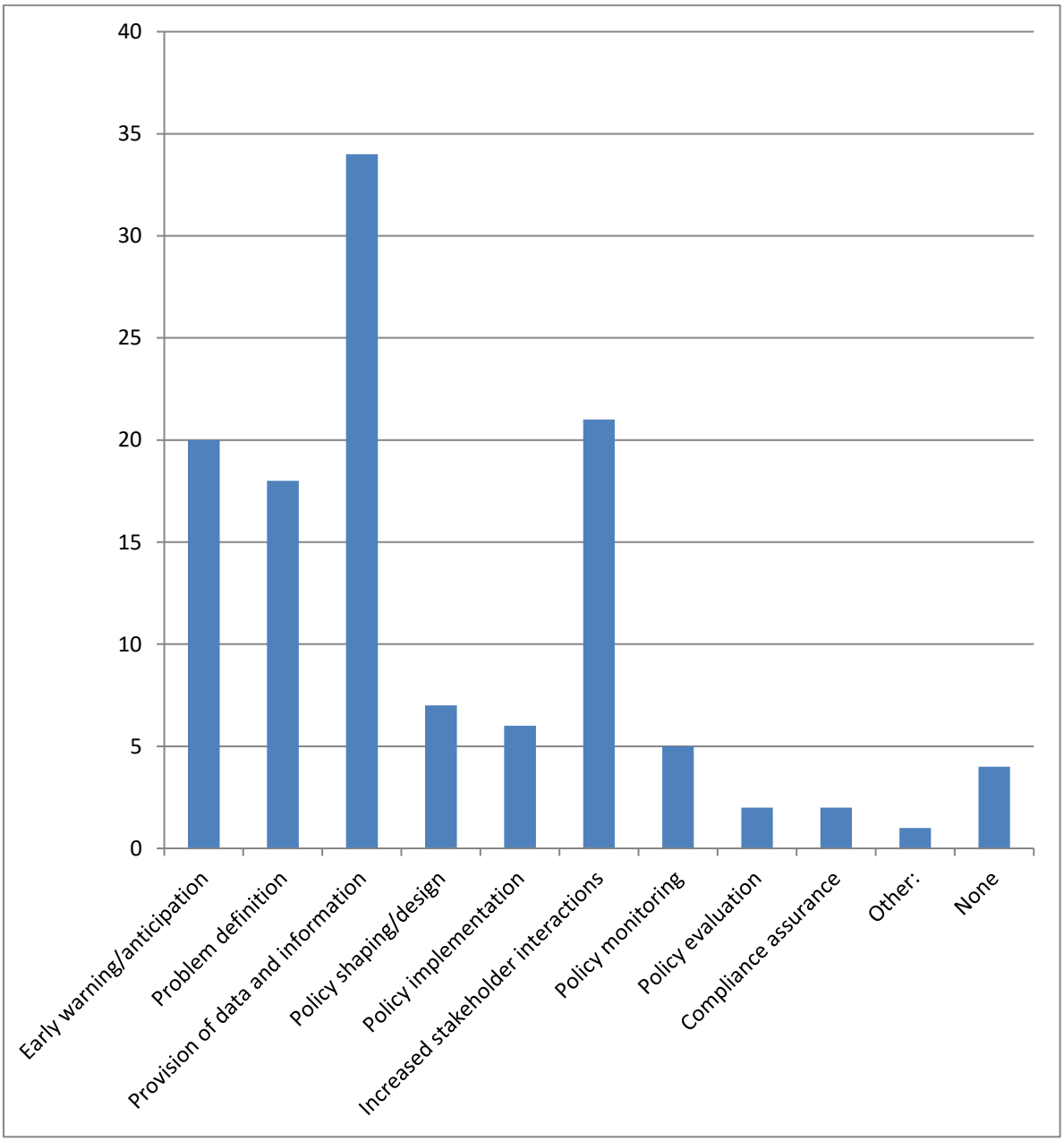


Figure 10. Policy impacts

Figure 11 addresses the question ***"Which types of scientific impacts of Citizen Science in your country are you aware of?"*** (multiple choices were possible).

Also in terms of scientific impacts these seem to be found especially on data gathering and science communication, followed by some attempts to implement collaborative research design and problem definition, whereas the good news lays in the fact that technology does not play such a fundamental role as it might be problem scoping, research design and assessment of data.

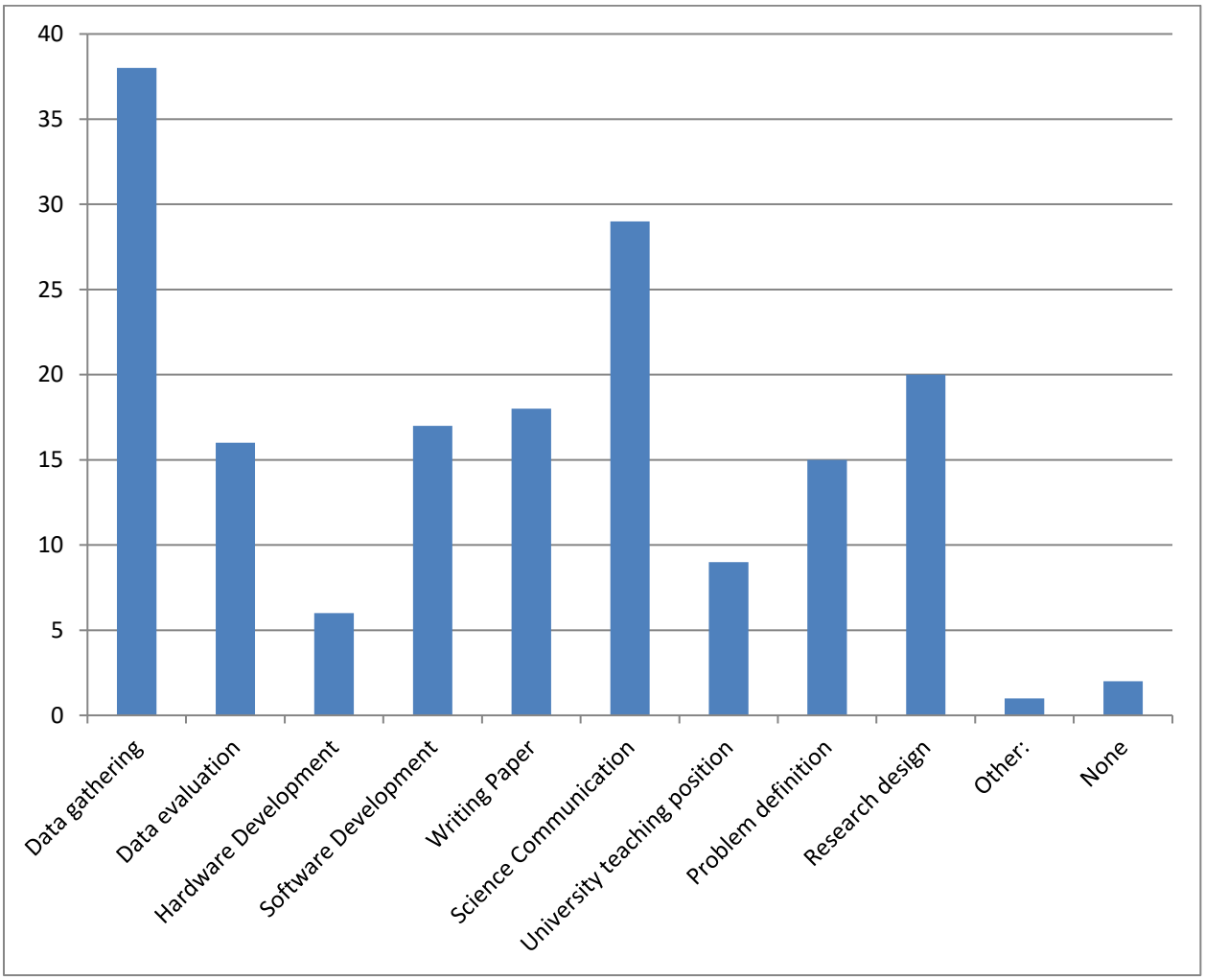


Figure 11. Scientific impacts

Figure 12 addresses the question ***"Which types of impact of Citizen Science on society in your country are you aware of?"*** (multiple choices were possible). These data indicate that more and more Citizen Science approaches are used to address issues requiring a higher degree of *engagement and participation* from different stakeholders, leading to *collaborative practices and alternative solutions* to address *common challenges and needs*.

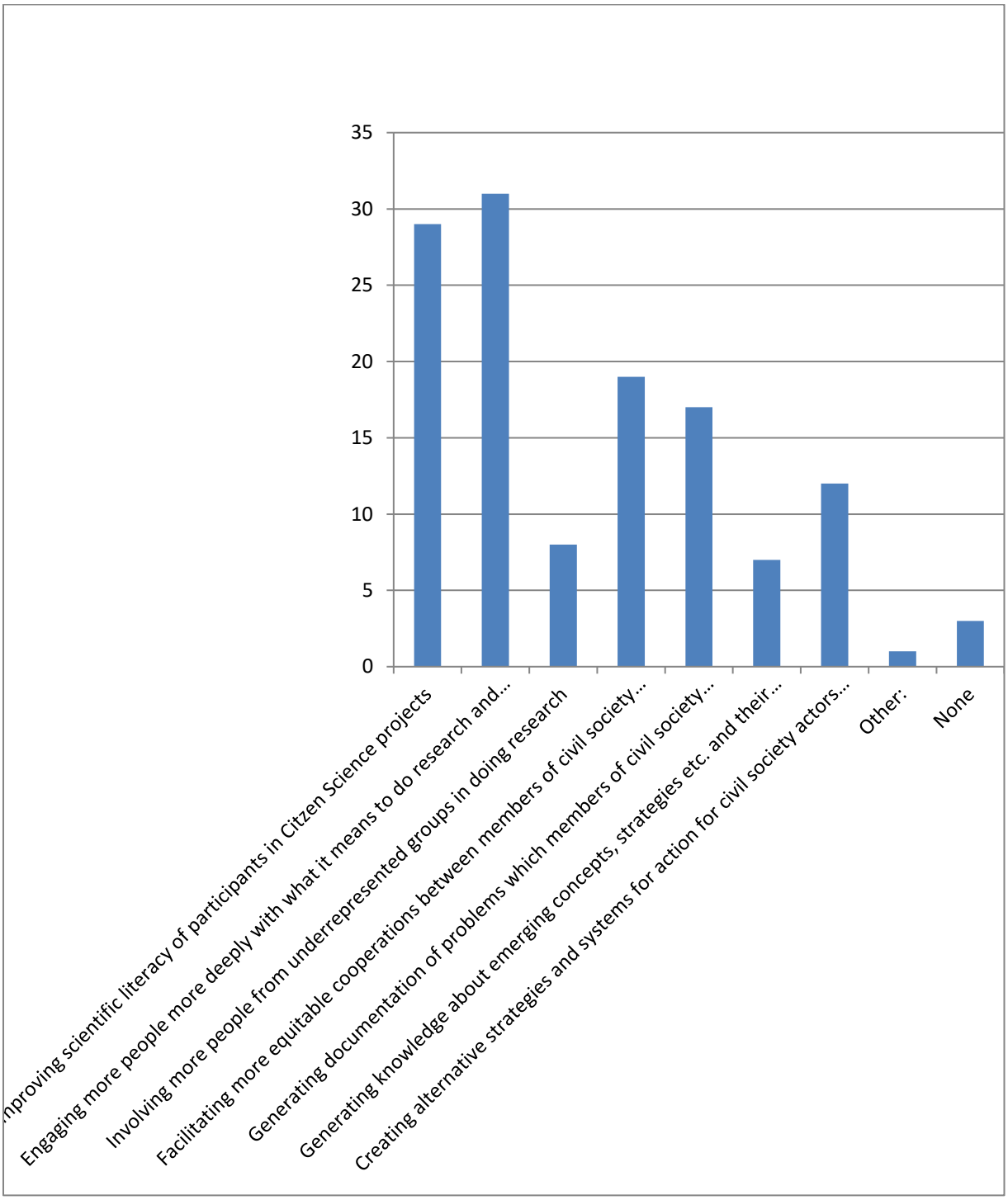


Figure 12. Societal impacts

Figure 13 addresses the question ***"Which types of economic impacts of Citizen Science in your country are you aware of?"*** (multiple choices were possible).

It is difficult to disentangle the social from the economic impacts and what comes first, as both dimensions are closely interdependent, and mutually influencing in a directly proportionally fashion.

These data seem to suggest that Citizen Science approaches are still laying in the first phase of the reciprocal circle, affecting in the first place especially social innovation practices and technology innovation outcomes, before arriving to budget savings and planning. This might be because awareness of the benefits that Citizen Science practices have on different socio-economic aspects and policy areas need to be strongly put forward to the political and financial constituencies, in order to get more budget availability and trigger the virtuous circle that would lead to self-sustainability.

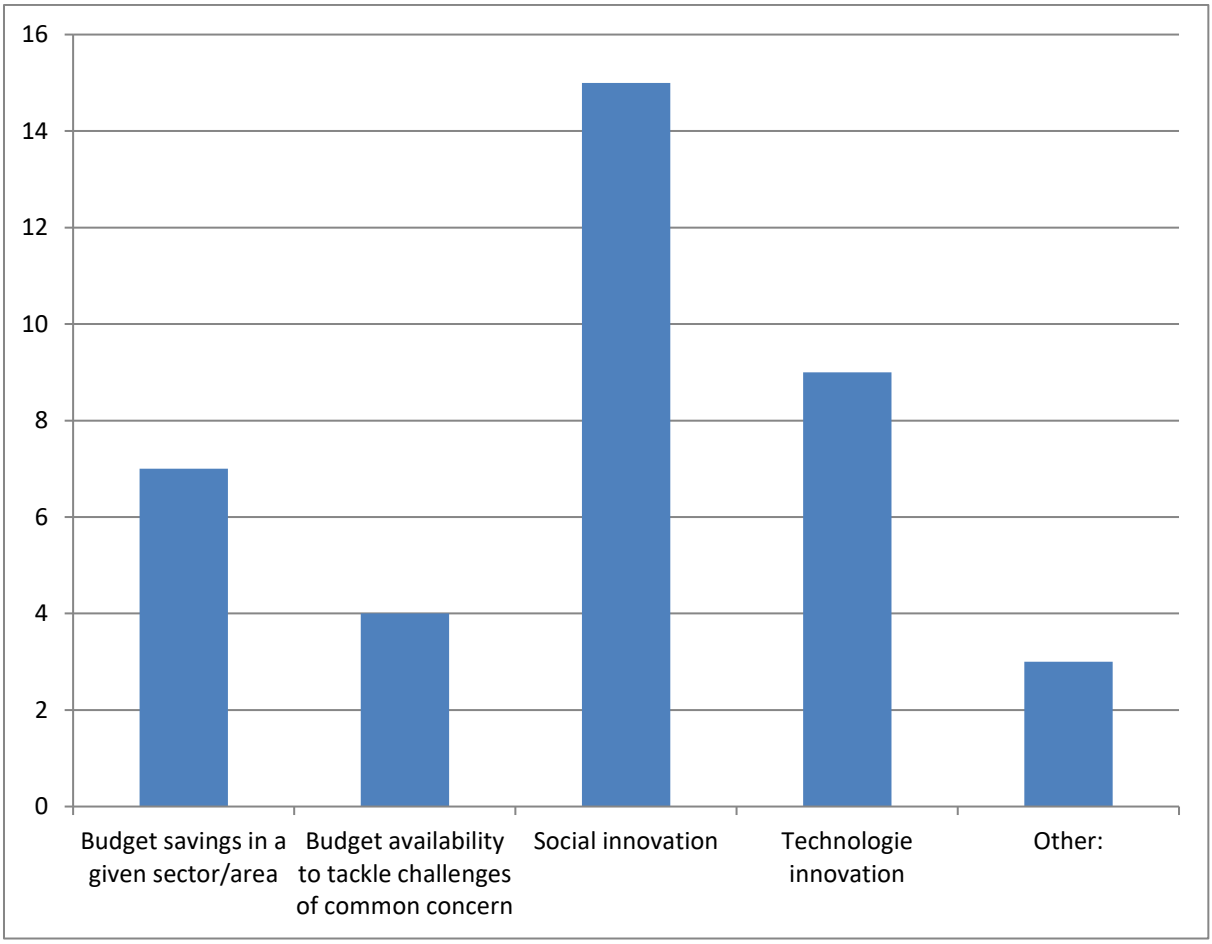


Figure 13. Economic impacts

Figure 14 addresses the question "***Which influencing factors do you consider to be most important for future developments of Citizen Science in your country?"*** (up to three choices were possible). These data seem to stand in support to the previous interpretation, about the interdependence between the socio and the economic impact.

In fact, the graphs indicate that the availability of ***funding schemes in support to self-sustainable models*** is directly dependent from the *degree of the acknowledgement of the benefits brought about by Citizen Science practices* in different policy areas, and at different levels of the socio-economic ecosystems (local, national and international). In this context, the role of educational systems and mutual trust seem to be fundamental as well as the presence of national strategies and European support.

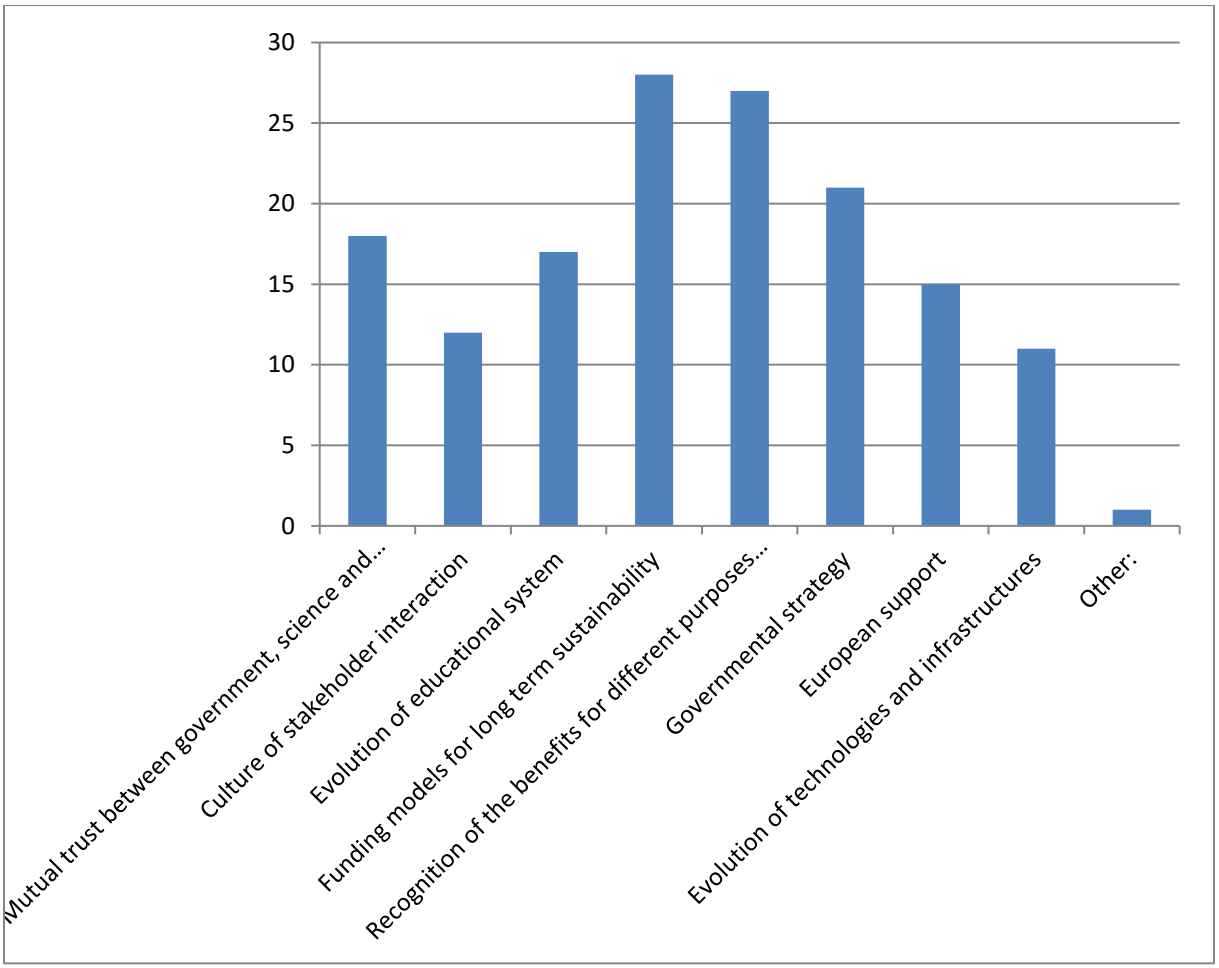


Figure 14. Influencing factors

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