What motivates researchers to participate in citizen science projects?

A Q-methodological study to identify researchers latent perspectives

Master thesis submitted to Delft University of Technology
in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE
in *Engineering & Policy Analysis*
Faculty of Technology, Policy and Management
by

Javed Hassan Sabu

Student number: 4922573

Graduation committee

Chairperson	: Prof. Dr. Bert Enserink	Policy Analysis
First Supervisor	: Dr. Anneke Zuiderwijk	Information & Communication Technology
Second Supervisor	: Dr. Maarten Kroesen	Transport and Logistics

To be defended in public on October 27^{th}2020

An electronic version of this thesis is available at http://repository.tudelft.nl/.

TU Delft Delft University of Technology

EXECUTIVE SUMMARY

Rationale to perform this research

Citizen science projects has shown lot of potential in tackling challenges related to science and society, alongside, benefiting the actor's involved in it. Some of its examples are citizen science has promoted scientific literacy in the society through promoting knowledge of scientific research among the citizens by involving them in the scientific enquiry. In addition, citizen science has enabled researchers to overcome a variety of constraints on their research, mainly in generating and classifying many large volumes of novel datasets (Trumbull et al. 2000). Moreover, citizen science can address real on ground local challenges of societies by filling gaps in knowledge and challenging official accounts (Grindstaff, Hall, and Lo 2010), which can bring about policy change (Frickel et al. 2010).

These benefits and potentials have led to increased focus on citizen science projects by policymakers, international governmental and non-governmental organisations over past decades (Rauws 2015). Moreover, huge funding is being made in direction of using citizen science projects to enhance the engagement between science and society. For instance, in European Union alone, a budget of 462 million euros is allocated under *Horizon 2020*[1] to promote projects to build effective cooperation between science and society.

To achieve these goals and for success of these projects, crucial element is getting more researchers to participate in citizens science projects. Besides harmoniously sustaining the participation of existing researchers who are already engaged in citizen science. Göbel, Martin, and Ramirez-Andreotta (2016) claims, participation from researchers crucial for citizen science projects, because they are the key actors in citizen science, along with volunteers or citizens, with high-level of involvement in terms of participation. In case, failure in understanding the perspective of the researchers, will lead to decrease in participation and will further go on to impact the projects that are planed under citizen science. Impact on these projects will not only jeopardise the reputation of citizen science as research method, moreover, it will precede with loss of resources that are invested over these projects.

Furthermore, when we attempt to identify the perspective of researchers from the available literature on citizen science, we face two principal academic knowledge gaps: one, there is limited and insufficient research on the perspectives of researchers in field of citizen science (Yaela N Golumbic et al. 2017). And two, even the available literature on the perspectives of researchers, are published by the researchers themselves. These academic knowledge gaps lead to two significant problems: One, that there is no research to understand perspectives of the researchers. Two, no critical scrutiny of available literature in citizen science, which can compare the what is presented in literature with on

[1] https://op.europa.eu/s/olDf

ground perspectives of researchers. Therefore, we argue that there is a need for an independent look to identify the perspectives of researchers to participate in citizen science.

Objective of this research

Research objective: *'Explore the latent perspectives of researchers in citizen science, to understand what motivates them to participate in citizen science projects.'*

To answer this objective there is need to explore perspectives of both the group of researchers: (1) one who is experienced with citizen science and (2) those who have no experience with citizen science. In this research, we attempt to understand the perspectives by connecting them to the aspects of motivation and lack of motivation in the practices of citizen science, as we argue that participation in driven either by motivation or lack motivation. If researchers are motivated by certain aspects of citizen science, they will be driven to participate, and this will increase the participation and vice-versa.

Methodology used in this research

To bring out the latent perspectives we use *Q-methodology*, which is a mixed research method, and a well-established method to identify and explore the subjective perspective of a group of people about a topic or issue (Stephenson 1953). The Q-methods starts with concourse demarcation, which is the population of subjective statements about given topic. *Q-statements selection* is selection of statements from the population in such way that it covers the required heterogeneity about the topic of discussion. Next, it followed with *participant or respondent selection*, the selection of respondent is strategic in Q-method (Watts and Stenner 2012), in this case the respondents are selected, from both the group of researchers.

Further, these statements are presented to the selected respondents for *sorting*, where the respondents sort statements based on their feeling about the statement, for instance, in this research the respondents are the researchers, they are asked to sort the statements based on how they find each statement to be, either motivation or lack of motivation (demotivation) for them to participate in citizen science. Final part of this method is *Q-factor analysis*, where the gathered data from sorting is factorised on transposed data matrix in comparison to traditional factor analysis and these recognised factors are interpreted along with the open statements of the respondents. These open statements allow respondents to express their reason for why they sorted the statements in a specific way. Thus, the factors resulting from Q-method analysis represents clusters of subjectivity of the participants group about the topic (Brouwer 1999), because of these reasons we decided *Q-method* to be an appropriate method to unwrap latent perspectives of the researchers.

Results

Overall, seven distinct perspectives of the researchers related to participation in citizen science are identified. ***Perspective 1*** – participation is seen as enthusiasm towards citizen science and researchers of this group want to spread benefits of citizen science practises. Moreover, they want to establish themselves as leaders of the scientific process.

Perspective 2 – participation is seen as desire to promote science education and communicate science in better way that can change attitudes of citizens towards contested topics. ***Perspective 3*** – participation is to understand the citizen's problem in a better way and provide better solutions to them. ***Perspective 4*** – participation is inhibited because citizen science is not seen as method suitable for research. It cannot provide data to the research as citizens are not trained enough to collect data for research. ***Perspective 5*** – participation is inhibited because a lot of effort involved in citizen science. Especially in lot of planning and coordination is required in citizen science from the researcher's side. ***Perspective 6*** – participation is to establish an equal relationship between citizens and researchers. ***Perspective 7*** – participation is to empowering citizens, but exploitation of volunteers and ethical challenges are a major concern.

These seven perspectives are grouped into three major groups to provide gestalt meaning to perspectives researchers towards participation in citizen science. It is interesting to note these groups coincide exactly with the experience of the researchers in citizen science. ***Group 1***: represents the perspective of researchers who have intrinsic motivation to participate in citizen science and these researchers are experienced in citizens science. These perspectives are revealed by *perspective 1 & perspective 2*. These researchers are going to participate on their own. ***Group 2***: represents perspective of researchers who have no interested or inclination to participate in citizen science projects, as they consider it not suitable method answer their research question. These researchers have no experience in citizen science. These perspectives are revealed by *perspective 4 & perspective 5*. ***Group 3***: these researchers are inclined to participate in citizen science, but some inhibitors in citizen science practises are preventing them to participate in citizen science. Perspectives of this group is revealed by *perspective 3, perspective 6 & perspective 7*. This group is a intermediate group compared to *Group 1 and Group 2*, as they are less motivated to participated with respect to *Group1* and more motivated to participate then compared to *Group 2*. It is important to note their concerns needs to be addressed if we aim to increase their participation.

Policy recommendations

Policy recommendation are suggested to citizen science association, institutions framing ethical policy and to researchers. These are summarised as follow, For ***Citizen Science Associations*** four recommendation are made as these are identified as problem owner who wants to promote citizen science projects - (1) Promote citizen science through common benefits and science education. Every group agrees to common benefits of citizen science. To enhance participation these can serve as banner of promotion to citizen science associations . (2) Reduce the paperwork and other efforts involved in citizen science. Establish centres where researchers can outsource their paperwork formalities. (3) Increase scientific appreciation for citizen science. (4) Address data quality issues. For ***Institutions framing ethical policy***- dialogue with researchers and citizens for better ethical polices. ***Researchers***- be vocal about the extra burden that comes with long duration citizens science projects.

Scientific and societal contributions of this research

Three scientific contributions of research is discussed. One, this research provides critical scrutiny of the literature published on perspectives of researchers, by comparing with what is discussed in the literature with on ground thoughts of researchers. Two, this research identifies latent perspectives that have not been disused in the field of citizen science. Three, research identifies controversies in the perspectives of researchers.

In societal contribution, the policy suggestions made by this research, such as partnership with third party institutions to reduce the burden of researchers can help citizen science association to make better informed decisions in designing and promoting citizen science projects that can see enhanced participation form researchers. Which in turn, can prevent the wastage of resources invested on citizen science by non-government and governmental organisations.

Limitations of research

Research has three limitations due to choices made during the research. One, no concrete conclusions, could be made specific to any scientific discipline or level of engagement between high-level involvement actors, due to broad scope of the research. Two, focus on Bonney's (1996) definition of citizen science, that focuses on participation between high-level involvement actors. Led to exclusion on citizen science projects that fall under Irwin's (1995) definition of citizen science, that focus on opening science-policy practices to the citizens. Three, use of free sorting of statements to reduce the time for answering the survey, led to low variance in researchers responses, which shows researchers were not actively involved while sharing their insights.

Future Recommendation

To overcome these limitations, three recommendation are suggested that can be considered for future development in the research. One, targeting specific discipline of research such as ecology, environment, astronomy to make concrete conclusions. Two, have post research interviews with the researchers to overcome the low variance in the response and avoid the bias in interpretation of results. Moreover, two controversies in the perspectives of researchers are identified that can be scope for an entire new research in field of citizen science. One, compensation of citizens in citizen science projects. Two, different model to increase scientific literacy are identified between *perspective 6, perspective 7* and *perspective 1*.

ACKNOWLEDGEMENT

This document Master Thesis research, marks the end of my journey at MSc programme in Engineering & Policy Analysis at TU Delft. The entire master's programme was not easy for me and it challenged me at both an intellectual level and mental level. Looking back at these two years, I feel proud of myself for what I have accomplished. In this moment, I wish to extend my gratitude and acknowledge the support of everyone without whom this would have not been possible.

To begin with, I would like to express my sincere gratitude to my first supervisor, Anneke, for offering me this research topic and actively supporting me during this entire journey. Her constant support and belief in me, made me accomplish this daunting task. Then, I want to thank Maarten, my second supervisor for guiding me, in absence of Anneke. For making my life simple with research method and statistical things. I want to extend my sincere thanks to Bert, for accepting to be my chair. I could have not asked for a better graduation committee than this. It was the support and constructive feedback from my committee that significantly improved the quality of this report and kept me moving forward even after the setbacks and ongoing pandemic.

I am extremely thankful to my family members, without whom my journey of this master's program would have not been possible. I want to extend my sincere gratitude and thanks to everyone one of them. Especially to those whom I could not include here by name. A special thanks to my parents, Ahmed Hussain, and Sultana, for believing in me and motivating me to take up this journey. Living away from them for the first time, I realised the value of their love and care in my life. After my parents, I want to thank my spouse, Sadiya, who constantly pushed me to finish this program, during the times when I had no strength to go further.

I sincerely want to show extended gratitude to my sister, Amira, and my brother-in-law, Riyaz, for offering me space to live with them during the master's programme and supporting me morally and financially. Without their support I would have not made it till the end. I also want to thank my uncle, Yousuf, for his support too.

I also want to acknowledge the participants, for being part of this research and sharing their valuable insights. I want to thank everyone for their time.

Finally, in this moment, I want to remember and dedicate this thesis to my first cousin, Mohsin, and my grandfather, Abdul-Sattar, whom I recently lost during this master programme.

Javed Hassan Sabu
(October 2020)

CONTENTS

Executive Summary i

Acknowledgements v

List of Figures viii

List of Tables ix

1 Introduction 1
- 1.1 Citizen science: a multi-actor system . . . 2
- 1.2 Academic knowledge gap . . . 4
- 1.3 Problem Identification . . . 5
- 1.4 Research objective and main research question . . . 5
- 1.5 Sub-questions and methods . . . 6
- 1.6 The relevance of this research . . . 7
- 1.7 Research outline . . . 8

2 Literature review & Theoretical framework 10
- 2.1 Literature review & search queries . . . 10
- 2.2 Positioning citizen science . . . 11
  - 2.2.1 Different types of citizen science projects . . . 13
  - 2.2.2 *'ladder model'* of engagement . . . 15
- 2.3 Aspects of potential motivation or lack of motivation in citizen science practise . . . 16
- 2.4 Summary . . . 18

3 Q-method 20
- 3.1 Suitability of Q-method . . . 20
- 3.2 Steps in Q-method . . . 21
- 3.3 Participants or Researchers selection . . . 22
- 3.4 Researchers' information . . . 23
  - 3.4.1 Demographic information of researchers . . . 23
  - 3.4.2 Researchers experienced in citizen science . . . 24
- 3.5 Q-statement selection & Sorting . . . 25
  - 3.5.1 Descriptive responses to Q-statements . . . 26
- 3.6 Q-factor analysis . . . 29
  - 3.6.1 Factor scores . . . 29
- 3.7 Ethical considerations of the research . . . 32
- 3.8 Summary . . . 33

4 Identifying Perspectives of researchers by factor interpretation **34**
4.1 How the factors are interpreted . . . 34
4.2 Detailed interpretation of Factors . . . 34
4.2.1 Interpretation of factor 1 . . . 35
4.2.2 Interpretation of factor 2 . . . 37
4.2.3 Interpretation of factor 3 . . . 40
4.2.4 Interpretation of factor 4 . . . 42
4.2.5 Interpretation of factor 5 . . . 44
4.2.6 Interpretation of factor 7 . . . 48
4.3 Distinct Perspectives of researchers on participation in citizen science . . . 50
4.4 Groups identified based on inclination to participate . . . 51
4.5 Application of results to enhance participation . . . 52
4.6 Summary . . . 53

5 Conclusion **54**
5.1 Conclusions regarding the research questions . . . 54
5.2 Policy recommendations . . . 57
5.3 Contributions of the research . . . 58
5.3.1 Scientific contribution . . . 58
5.3.2 Societal contribution. . . . 59
5.4 Limitations of the research . . . 59
5.5 Recommendations for future research . . . 59
5.6 Connection to the Engineering & Policy Analysis MSc programme . . . 60

References **61**

A Appendix A: Online survey **65**
A.1 Categorising question. . . . 65
A.2 Sorting questions & Open statements *(these questions are common for both group of researchers)* . . . 66
A.3 Demographic Questions *(these questions are common for both group of researchers)* . . . 67
A.4 End of survey . . . 67

B Appendix B: Descriptive statistics **68**

C Appendix C: Significant loading of participants **70**

List of Figures

1.1 Actors in a multi-actor system of citizen science 3
1.2 Outline & research flow diagram of the research 9

2.1 Summary of engagement (Schäfer and Kieslinger 2016) 13
2.2 Ladder of engagement (M. Haklay 2013) 15
2.3 Aspects of motivation lack of motivation from literature 17

3.1 Different steps in *Q-method* 21

4.1 Group of researchers identified based on perspectives 52

LIST OF TABLES

2.1 Search keywords for literature reviews 11
2.2 Summarising the citizen science projects 15

3.1 Demographic information of participants 24
3.2 Information of researchers experienced in citizen science 25
3.3 Descriptive statistics of responses from participants 28
3.4 Factors for motivation and lack of motivation statements 32

4.1 Standardised factor scores for motivation statements of *Factor 1* 35
4.2 Standardised factor scores for demotivation statements of *Factor 1* 35
4.3 Standardised factor scores for motivation statements of *Factor 2* 38
4.4 Standardised factor scores for demotivation statements - *Factor 2* 38
4.5 Standardised factor scores for motivation statements - *Factor 3* 40
4.6 Standardised factor scores for demotivation statements - *Factor 3* 41
4.7 Standardised factor scores for motivation statements - *Factor 4* 42
4.8 Standardised factor scores for demotivation statements - *Factor 4* 43
4.9 Standardised factor scores for motivation statements - *Factor 5* 44
4.10 Standardised factor scores for demotivation statements - *Factor 5* 45
4.11 Standardised factor scores for demotivation statements - *Factor 6* 46
4.12 Standardised factor scores for demotivation statements - *Factor 6* 47
4.13 Standardised factor scores for motivation statements of *Factor 7* 48
4.14 Standardised factor scores for demotivation statements of *Factor 7* 49

C.1 Significant loading of Factor - 1 70
C.2 Significant loading of Factor - 2 70
C.3 Significant loading of Factor - 3 70
C.4 Significant loading of Factor - 4 71
C.5 Significant loading of Factor - 5 71
C.6 Significant loading of Factor - 6 71
C.7 Significant loading of Factor - 7 71

1

INTRODUCTION

Looking around the world we live, scientific domain appears to be in a severe crisis, due to manipulation of scientific facts by politicians. Any settlement of disputes with science seems to be controversial. Which has led to lack of public trust in scientific procedure and evidences (Benessia et al. 2016). Statements like *"Currently, many published research findings are false or exaggerated, and an estimated 85% of research resources are wasted"* (Ioannidis 2015, p. 5), has led to a shift in the public opinion, from innocence or mistakes in science to assumption of corruption (Boden and Epstein 2006). Reckoning to the above crisis the society is seeing a transition, which needs new ways to do science and bring back the trust on scientific practises.

Citizen science is a potential research method that can offer solution to this crisis (Bonney, Cooper, et al. 2009; Wildschut 2017). In generic terms, citizen science is part of broad participatory research method that focuses on process of involving citizens (local people), in scientific research carried by professional experts (researchers), to answer scientific and societal investigations, with emphasis on promoting local knowledge and understanding (Cornwall and Jewkes 1995; Dickinson, Zuckerberg, and Bonter 2010). The projects that uses citizen science as research method are called *citizen science projects*.

Citizen science projects have benefited science, society and the actors involved in it (Shirk et al. 2012). For instance, citizen science allows researchers to collect valuable data from regional to national scales (Roy et al. 2012), in short timescale. Moreover, citizen science is applauded for making science equitable participation between the experts (researchers) and general public (citizens). Where citizen learn about scientific enquiry which increases scientific literacy in society and builds trust on scientific processes. One of famous projects of citizen science project from field of astronomy is *Galaxyzoo*[1], where 50 million galaxy images were classified with help of 150,000 citizens in its first year, this classification generated valuable data, which was used in 25 different research projects (M. J. Raddick et al. 2009).

[1] http://www.galaxyzoo.org/

These various promissory discourse has led to quick increase in citizen science projects over past decade (Rauws 2015) and made citizens science very significant concept among international decision making organisations, such as EU[2] and UN[3]. Moreover, these organisations see citizen science as a genuine field that can promote extensive public science engagement in the future (Chari, Blumenthal, and Matthews 2019). Besides, there is an aspiration to utilise citizen science's potential to tackle grand challenges[4] that world is facing, ranging from poverty to peace and justice. To achieve better sustainable future with in the end of 2030 (Fritz et al. 2019). These aspirations have led to huge investments and funding being made in direction of using citizen science projects. For example, in European Union alone, a budget of 462 million euros is allocated under *Horizon 2020*[5] to build effective cooperation between science and society.

Citizen science can appear as an idea that effectively unifies public engagement with the scientific objectives, alongside bringing out benefits to both citizens and researchers through answering their objectives (Silvertown 2009). This idea of citizen science can easily appear as a *win-win* situation for both researchers and citizens. On how citizens directly participate in aiding the researchers for their scientific research, in return citizens acquire knowledge about the processes of scientific enquiry. However, the participation in citizen science is not as easy as it appears, because of distinct objectives of citizens and researchers, across varying level of engagement between them. That addresses diverse goals of these citizen science projects across the discipline of science (Kullenberg and Kasperowski 2016; Shirk et al. 2012; Strasser et al. 2019).

This chapter further sets out to explain the problem and objective of the research through the following sections. Section 1.1, presents the multi-actor nature of citizen science, presenting different actors involved in citizen science. Section 1.2 and 1.3, elaborates on the problem identification and academic knowledge gap. Section 1.4 presents the research objective and main research question. After defining the main research question, section 1.5 explains the sub-questions, along with the methods used to answer these sub questions. Section 1.6 shows why this research is relevant now and provides rationale to conduct this research. Finally, the chapter ends by presenting the research flow diagram and an outline of this research in section 1.7.

1.1. CITIZEN SCIENCE: A MULTI-ACTOR SYSTEM

The term actor or stakeholder is used interchangeably with similar meaning. In the context of policy analysis, the term *'actor'* is defined as "a social entity, a person, or an organisation, able to act on or exert influence on a decision" (Enserink et al. 2010, p. 80). The above definition is used to define an actor in the context of citizen science. An actor is a person or corporation that contributes in completion of a citizen science project or has an assigned significance or benefits from the research activities and data produced in citizen science projects (Göbel, Martin, and Ramirez-Andreotta 2016). As different actors are involved in the field of citizens science, it is important to be aware of these

[2] European Union
[3] United Nation Organisation
[4] Grand Challenges are difficult but important problems, that are the greatest obstacles to attaining universal well being
[5] https://op.europa.eu/s/olDf

actors.

Five group of actors are identified in citizen science projects, who engage in the project in two ways: designing or organising the project and providing support to the project (in the form of time, funding, expertise, equipment etc.) (Göbel, Martin, and Ramirez-Andreotta 2016). These actors are explained in the following.

- ***Researchers or scientists***; these are actors who have expertise in their relevant field and are expert in using scientific methods for the research.
- ***Citizens or public or volunteers***; they do not have any expertise in the scientific method or research techniques, but they want to contribute towards the scientific endeavours.
- ***Policymakers***; these are generally government agencies and the departments; they are the users of the data and findings of citizens science projects for the decision making. Moreover, these can also be the funder for citizen science projects.
- ***citizen science associations (CSA)***; Organisation formed by researchers and communicators interested in citizen science, to encourages growth of citizen science and helping to develop good practice principles in citizen science. Also enabling citizen science practitioners from around the world to network with one another.
- ***Other***; these can be politicians, business or industries, who are funders and the users of the citizen's science data but are not involved at the policy level.

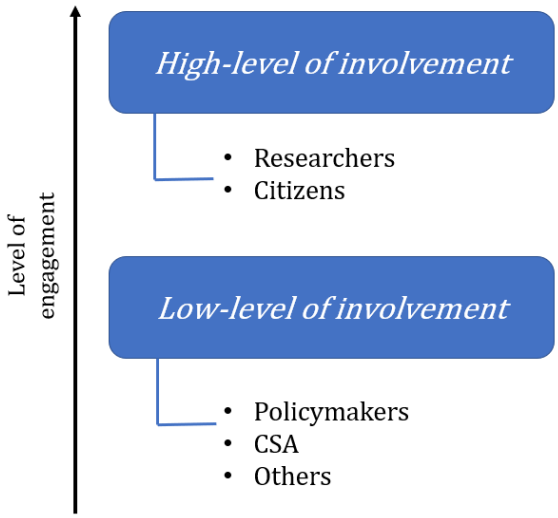

Figure 1.1: Actors in a multi-actor system of citizen science

Figure 1.1 classifies the above discussed five actors in two levels based on their level of involvement, one, *high level of involvement* actors and two, *low level of involvement* actors (Göbel, Martin, and Ramirez-Andreotta 2016). High level of involvement is where the actors are involved in the core of projects such as defining the project, leading the project, cooperating and coordinating, collecting the data. Under actors like *researchers and citizens* are included. On the other hand, the low level of involvement, are those policymakers and others such as politicians, industries and businesses, who are not involved in the way as the high-level involvement actors are, rather they are more inclined towards using the data and the results from the citizen science projects. They can also be fund providers or use citizen science for political benefits.

In this actor analysis we identify *citizen science associations (CSA)* as problem owner, who is interested in growth of citizen science projects with better practices. It is important to be noted that this classification does not signify the importance or the power distribution among of any actors, instead, it shows the level of work each actor is involved.

From the above discussion, it is apparent that citizen science projects are of multi-actor in nature. In multi-actor system it is essential to know actors *perspectives* of the actors - the way actors sees something around them. To understand their behaviour and action (Hermans and Cunningham 2018). After describing the system of citizen science, in the next section, we identify the problem with academic knowledge gap in academic literature.

1.2. ACADEMIC KNOWLEDGE GAP

When we set out to look at the literature to identify the perspectives of the researchers on citizen science, we encounter two major problems. First, there is scarce and limited literature in citizen science which discusses the perspectives of researchers (Yaela N Golumbic et al. 2017). As the studies analysing citizen science are more focused either towards the experience and motivations of citizens (Mankowski, S. J. Slater, and T. F. Slater 2011) or on the learning outcome of citizens in terms of traditional scientific knowledge (Crall et al. 2013; Cronje et al. 2011; Trumbull et al. 2000). Moreover, these studies have commonly focused on what learning after-effects citizen science can deliver and very few studies have been on concerns surrounding the participation in citizen science. One of the key concerns in particular is that, these studies have been fairly limited on perspectives of the researchers (Bonney, H. Ballard, et al. 2009). Especially the thoughts related to concerns and interests, that researchers could have encountered while working on citizen science projects have been seldom articulated.

Second, even the limited literature that is available on the perspectives of the researchers are published by the researchers themselves who are part of citizen science, which lacks critical scrutiny. In these studies researchers have prolifically published about their experiences of citizen science (Cooper et al. 2007; Gallo and Waitt 2011; Lee, Quinn, and Duke 2006), suggesting among events that worked well and that did not work well all through the projects. These studies give impression that participation from researchers is because of their enthusiasm to enhance scientific awareness in society and to drive citizen's positive attitudes towards science (Besley, Oh, and Nisbet 2013; Martın-Sempere, Garzón-Garcıa, and Rey-Rocha 2008). Despite there have been projects where the participation from the researchers have not been particularly great (Trumbull et al.

2000).

1.3. PROBLEM IDENTIFICATION

Above two knowledge gaps give rise to two significant problems. One, in a multi-actor system of citizen science, if the perspectives of the researchers towards citizen science are not identified. Especially the challenges the researchers face in participation are not addressed, can lead to a decrease in the participation from the researcher's community. The participation from researchers are essential for the success of citizen science projects, as they are one of the high-level of involvement actors. Therefore, it becomes essential to, know researchers' perspective, to achieve and sustain participation from the researchers. On the other hand, the lack of participation from researchers can lead to key issues of loss of opportunity and wastage of resources, in exploring the potentials of citizen science.

Two, lack of *critical scrutiny* of the literature published by researchers themselves on their perspectives towards citizen science will have more chance of *'publication bias'* (Cooper et al. 2007; Gallo and Waitt 2011; Lee, Quinn, and Duke 2006). The researchers will generally tend to publish those projects that are successful and little about the projects that were not successful. This precede to loss of valuable knowledge that can be useful to understand the reasons behind the failure of specific projects and avert these failures in future.

These above identified problems have led to need for an independent research that can look behind the scenes and uncover what researchers think about participation in citizen science. Moreover, to realise where researchers find genuine challenge in participation, that needs to address for their participation towards citizen science projects.

1.4. RESEARCH OBJECTIVE AND MAIN RESEARCH QUESTION

After problem identification, this section discusses the research objective and main research question which this research aims to answer. Also, explains how this research is going to identify the perspectives of the researchers.

Research objective: *'Explore the latent perspectives of researchers in citizen science, to understand what motivates them to participate in citizen science projects.'*

From the research objective, following main research question is formulated,

Main research question: *What latent perspectives of researchers in citizen science can be identified, that motivates them to participate in citizen science projects?*

The main research question is answered by connecting the perspectives with the aspects of *motivation and lack of motivation* in the practices of citizen science. It can be argued that, if a researcher finds any factor (aspect) of citizen science motivating, they will choose to participate, thus will increase their participation and vies-versa. Identifying and addressing these pivotal points of motivational or lack of motivation in the design of citizen science systems will facilitate improved collaboration from researchers (Rotman et al. 2012).

For identifying these motivation and lack of motivation, it is significant to examine the researchers form both the groups: 1) the group of researchers who are already involved in citizen science, are using citizen science for their research or actively been part of any citizen science initiatives for some time. 2) The group of researchers who have not used citizen science in their research or not been engaged in citizen science yet. These two groups of researchers can offer information illuminating their motivations and lack of motivations they perceive while they want to be part of a citizen science projects.

Before we go further in identifying the aspects of motivation and lack of motivation, we want to highlight a general notion about what motivation and lack of motivation is. *Motivation*, in general abstract, is kind of stimulus, that is, considered as positive force for behaving in a certain way (Dörnyei 2001), in this case the behaviour is to participate in citizen science. Other influences that have a negative effect on motivation is termed *lack of motivation*. These negative influences or lack of positive force are also termed as *demotivation*. We prefer to use the word *'lack of motivation'* instead of the word *'demotivation'*, however, in some places of the report term 'demotivation' is preferred instead of 'lack of motivation' to the ease reading, it is important to note both words signifies the same meaning.

1.5. SUB-QUESTIONS AND METHODS

To address the main research question three following sub-questions are framed. In this section these questions are stated and the methods used to answer these sub-questions are explained briefly.

Sub-question 1: *How citizen science is defined according to the literature?*

Citizen science is a vast and has diverse practices, because of its ranging adaptations and applications across the disciplines of science. To accommodate the vast and diverse practices, scholars and analyst of citizen science have used different ways to define these practices. This question aims to demarcate what all practises are considered as citizen science in this research. For answering this questions literature review of academic articles that discusses different types of engagements between researchers and citizens is used. Moreover, this question identifies different types of engagements practises between *high-level involvement actors*, in citizen science projects. Two reasons argued behind defining citizen science projects based on the engagement between *high-level involvement actors*. *One*, engagement between the high-level involvement actors is an essential enterprise in citizen science, considering its application across several disciplines of science, focused to achieve discrete goals (Strasser et al. 2019). Two, the research focuses on perspective of researchers to participate in citizen science, if the projects are defined based on the engagement of researchers, these can provide better insights to understand the motivations of the researchers.

Sub-question 2: *What factors (aspects) motivates researchers to participate in citizen science projects?*

Citizen science have produced a particularly concrete promissory discourse of bene-

fits to individuals, science and society. Three primary examples of these discourse are greater democratisation of science, better scientific literacy, and new scientific breakthroughs (Bhattacharjee 2005; Caruana et al. 2006; Strasser et al. 2019). This question intends to identify factors (aspects) like these which can be motivation or lack of motivation for the researchers to participate in citizen science projects. This question is foundation as it collects the group of aspects (factors) that will form *concourse* for *Q-methodology* (discussed in detail in chapter 3). To answers this question literature review of academic literature and non-academic literature is used, the reason to include non-academic literature is because concourse should capture as much as heterogeneity about the topic or context (Stephenson 1978), we think adding non-academic literature can give more insights to motivation and lack of motivation of researchers. It is important to note we prefer to use the term *aspects* over *factors* to avoid confusion with term factor that will be used in *Q-factor analysis* of methodology and results section of this research.

Sub-question 3: *What distinct perspectives are identified among researchers to participate in citizen science projects?*

In *sub-question 1 and sub-question 2*, defines what citizen science projects this research will focus and collects the aspects that can be motivation or lack of motivation for researchers in these citizen science projects. This question proposes to identify latent perspectives among researchers about their participation in citizen science, by connecting it to the motivation and lack of motivation as argued earlier. For which we use *Q-methodology*, because it is an established method for systematic examination of participant viewpoints, and it is useful to identify patterns on how different groups among the participants think about a given topic (Watts and Stenner 2012). Further these perspectives can provide clues to suggest policy recommendation to actors in citizen science and in particular to citizen science associations around the globe about how to promote more participation from the researchers in citizen science projects. Which is more relevant during the time when more policymakers such as government and non-government organisation are investing in citizen science initiatives. Relevance of this research is further elaborated in the next section.

1.6. THE RELEVANCE OF THIS RESEARCH

This research is of high relevance to science and society in the times when institutions ranging from small NGO's[6] to UN agencies have become interested in citizen science (Cornwall and Jewkes 1995). For instance, massive investment is made to sustain the benefits of science and civil society, within the EU alone with a budget of 462 million euros under Horizon 2020[7] (Moseley 2017; Rask et al. 2016). These investments have led to upsurge in citizen science projects over the past decade (Rauws 2015). Therefore, there is an obvious need for increased participation from researchers to keep the flourishing

[6] Non-governmental organisations

[7] Horizon 2020 is the largest EU Research and Innovation programme ever with nearly €80 billion of research funds made available over 7 years (2014 to 2020).

momentum of citizen science continuing.

In addition, researchers are one of the high-level involvement actors in citizen science and their participation is vital for achieving the goals of these projects. It is crucial to note, if the perspective of the researchers to participate in citizen science is not understood, then projects designed in citizen science can fail to attract new budding researchers and can also impact the participation of those who are already involved in citizen science projects, together these will lead to a decrease in participation from researchers in near future. The reduced participation from the researchers will cause a huge loss and waste of resources allocated to citizen science. This will jeopardise the reputation of citizen science as research method.

1.7. RESEARCH OUTLINE

This section outlines the flow of this report going further and figure 1.2 provides a diagrammatic representation of the outline. Chapter 2 discusses literature review and theoretical framework of the research, which also answers the *sub-question-1 and sub-question-2*. The answering of the question 1 and question 2 by chapter 2 is symbolised by arrows coming towards it. The aspects (factors) of motivation and lack of motivation that are identified form the sub-question-2 and are used to design the *Q-statements*, which will be used in *Q-methodology* for collecting data from participants (researchers). This use of statements from sub-question 2 to design *online surveys* is shown by arrows going from aspects of motivation lack of motivation to online survey in chapter 3. Chapter 3 explains Q-methodology used in this research, that elaborates why Q-method is best suited for research and how this method answers the research. Chapter 4 presents the results and answers the *question 3* with qualitative and quantitative interpretations of the factors identified from Q-method. Chapter 5 is the final chapter where the conclusions of the research is presented along with policy recommendations to citizen science association, further discusses limitations of this research and future recommendations to overcome these limitations.

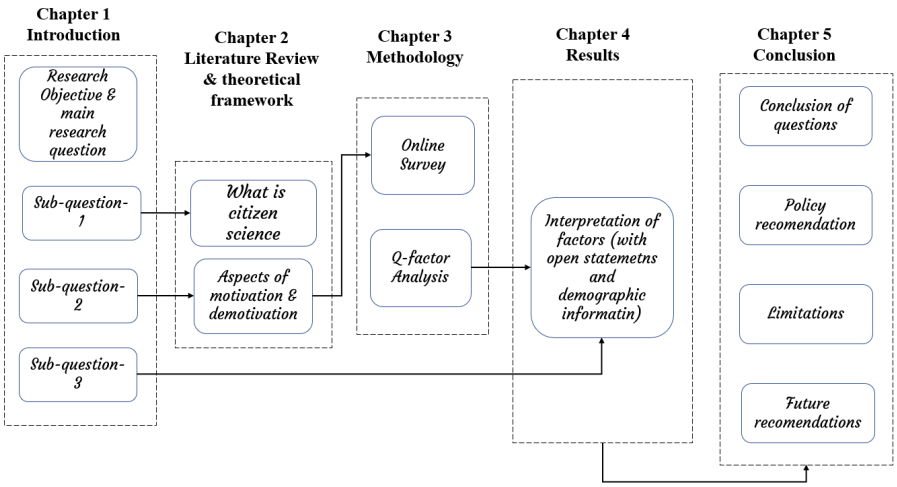

Figure 1.2: Outline & research flow diagram of the research

2

LITERATURE REVIEW & THEORETICAL FRAMEWORK

This chapter answers the sub-question-1 and sub-question-2 of the research through literature review, along with explaining how the relevant literature was identified. The answer to sub-question-1 demarcates what all practises are considered as citizen science according to this research. That Identifies different citizen science projects based on the engagements between high-level involvement actors and comprehends different possible roles researchers can perform in these citizen science projects. Based on the above-identified different citizen science projects. The sub-question-2 collects the aspects that can be motivation or lack of motivation for the researchers to participate in citizen science.

- *Question 1— How citizen science is defined according to the literature?*
- *Question 2— What factors (aspects) motivates researchers to participate in citizen science projects?*

2.1. LITERATURE REVIEW & SEARCH QUERIES

To identify the relevant literature a search strategy was adopted. Primarily four research databases — Scopus[1], Web of Science[2] , jstor[3] and google scholar[4], were used to search relevant publications. Table 2.1, illustrates the search keywords that were formulated with similar words, identified from the questions that we intend to answer. Then these set of queries are combined per the requirement of the question to get the required literature.

[1] www.scopus.com
[2] www.webofknowledge.com
[3] https://www.jstor.org/
[4] https://scholar.google.com/

Queries	Keywords	Combination of similar words
Q1	Citizen science	("Citizen Science" or "participatory science")
Q2	Classification	("typology" or "categorisation" or "typology")
Q3	Engagement	("engagement" or "collaboration" or "cooperation")
Q4	Researchers	("researcher" or "scientist" or "analyst" or "investigator")
Q5	Perspectives	("perspective" or "positions" or "viewpoint" or "view" or "vision")
Q6	Motivations	("motivation" or "motive" or "incentive" or "reason" or "desire")
Q7	Lack of motivation	("challenges" or "issues" or "problems")

Table 2.1: Search keywords for literature reviews

QUIRES BASED ON THE QUESTIONS

1. What are the researchers' perspectives on citizen science?
("researcher" or "scientist" or "analyst" or "investigator") AND ("perspective" or "positions" or "viewpoint" or "view" or "vision") AND ("Citizen Science" or "community science" or "participatory science")

2. Types of citizen science projects?
("engagement" or "collaboration" or "cooperation") AND ("typology" or "categorisation" or "classification") AND ("Citizen Science" or "community science" or "participatory science")

3. What are motivations and lack of motivations for researchers to participate in citizen science?

("motivation" or "motive" or "incentive" or "reason" or "desire") AND ("researcher" or "scientist" or "analyst" or "investigator") AND ("Citizen Science" or "community science" or "participatory science")

CRITERIA TO INCLUDE LITERATURE

To include the literature for the research the literature had to fulfil at least one of the criteria from the three as listed: (1) the article is about engagement between the researchers and citizens (high-level involvement actors), (2) The article discusses the perspectives (viewpoints) of researchers such as motivation and lack of motivation of the researchers and (3) The article address the challenges and future possibilities in citizen science. Then these identified citizen science articles were reviewed.

2.2. POSITIONING CITIZEN SCIENCE

This section answers sub-question 1 of the research, *"How citizen science is defined according to the literature?"*. After positioning citizen science based on engagement between high-level involvement actor from the literature. The section is divided in two sub-sections, 2.2.1 discusses respective citizen science project in detail and explains different roles played by researchers and citizens in specific projects. 2.2.2 discusses *'ladder model'* of engagement (M. Haklay 2013), that is used for designing *online surveys* (see Appendix:A).

According to literature, the term citizen science was first used in the 1990s, independently by both Irwin (1995) and Bonney (1996). The definitions by these two contribute to the array of meanings, understandings and hopes for goals that researchers associate with citizen science. Rick Bonney (1996), definition focus on citizens engagement in scientific projects carried out by researchers or experts from the field. In turn to promote communication of science to citizen in better way. While Irwin's (1995), definition fosters concepts of scientific citizenship by emphasising on the need to open science-policy practices to the citizens and presents citizen science as political concept (Riesch and Potter 2014). This report focuses on engagement aspect of citizen science, so the definition of Bonney (1996) is preferred going forward in the research.

The reason for this is that, engagement between the citizens and researchers is a focal activity for citizen science projects (Bonney, H. Ballard, et al. 2009). Moreover, defining citizen science in this way becomes crucial when we want to identify different roles of researchers play in these projects. Then, translate these roles to identify their aspects of motivation and lack of motivation in practices of these projects.

Numerous different classifications are proposed by analysts and experts of citizen science to make sense of diverse practices in engagement (Strasser et al. 2019). Each of these classification emerged based on the context of focus. Three context of focus are identified, these are: (1) the level of citizen engagement in the projects (M. Haklay 2013), (2) degree of citizen involvement in the project and ownership of the activities (Shirk et al. 2012). (3) The goal and environment project occurs (Wiggins and Crowston 2011).

In this report *matrix model* of classification by Schäfer and Kieslinger (2016) is presented in figure 2.1, which summarises these above-mentioned contexts of classifications in to one dynamic representation. This matrix model segregates citizen science projects based on two primary traits: (1) the *locus of knowledge creation* — which is represented along y-axis, moving alongside the axis is range of projects where researchers are the main knowledge creators to the projects where citizens are main knowledge creators. (2) The *focus of project activities* — which is represented along x-axis, moving along the axis, the projects where research is carried with a primary objective to answer scientific questions to projects focusing to support socio-ecological interventions in systems (Schäfer and Kieslinger 2016).

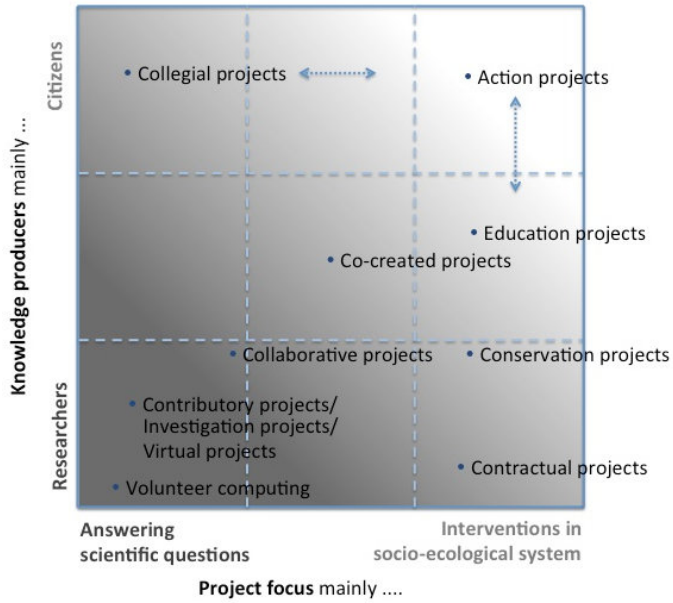

Figure 2.1: Summary of engagement (Schäfer and Kieslinger 2016)

2.2.1. DIFFERENT TYPES OF CITIZEN SCIENCE PROJECTS

This section explains different projects in citizen science projects identified in figure 2.1 based on engagement between scientists and citizens (*high-level involvement actors*). Overall, seven different types of citizen science projects are identified and are explained in detail below. Further these projects are summarised in the table 2.2.

(1) Contributory projects: Researchers are knowledge creators and designers of these projects. Citizens are asked by the researchers to contribute mainly by collecting data samples or uploading the data, which is further processed by the researchers. Location of these projects in the matrix is in the lower left corner. This category projects are closest to *"traditional"* forms of research. *Galaxyzoo* is one of the well-known projects that fall under this category, where 150.000 citizens helped researchers in classification of over 50 million galaxy images.
(2) Contractual projects: These projects are in the lower right corner, which implies the researchers are the main knowledge creators. The research is focused on the answering question related to specific societal concerns of public. In these projects, researchers are *"contracted"* by the citizens to conduct research and analysis. European Science Shops[5] are usual implementers of these projects as they take on research based on the requests and appeals coming from civic society.
(3) Collaborative projects: These projects have a greater collaboration between citizens and researchers, compared to above discussed projects. Researchers are the knowledge creators and project designers. Citizens volunteering in these projects analyse the data

[5] http://www.livingknowledge.org/livingknowledge/

and also, assists the researchers in developing the research.
(4) Co-Created projects: These projects have a greater collaboration between citizens and researchers. Where citizens assist researchers with designing and developing research. Alongside, analysing data and interpreting results. This shows engagement of citizens is active in entire research process, because of which these projects are in the centre of matrix. *Royals Dock Noise Mapping*[6] case research is an example for this type of projects. In this project resident of London located near the Royal Docks collaborated with researchers of UCL[7] to gather noise estimates and present as evidence of disturbing levels of noise because of the operation at London City Airport.
(5) Collegial projects: In these projects' citizens are the primary knowledge creators, where they autonomously conduct the research, which advances knowledge in scientific fields. In contrast to above discussed projects, here the roles of researchers are limited to validation of the newly created knowledge. These projects are in top left corner of matrix. Extension of *Galaxyzoo* can be example of these projects, where along with simple task of classification of galaxy images. Some citizens were also provided with research data, building on which resulted in scientific publications (J. Raddick et al. 2007).
(6) Education projects: Researchers in these projects do jobs of educationist and science communicators. In these projects, the clear aim is on *learning goals* of citizens about specific scientific method or topic. These projects are in left top corner of matrix. *Fossil Finders*[8] , can be presented as example for these kinds of projects, where students are involved in defining and classifying fossil rock samples. Another example of education project is from Austria, where the Federal Ministry of Science, started a new programme under the heading of *"Young Citizen Science"*[9].
(7) Action-projects: In these projects' citizens are the main knowledge creators, wherein the role and aim of researchers is to chiefly assist citizens. These projects are in top right corner of matrix. Sometimes these initiatives are called *'Extreme citizen science'*, as these projects are closest to society initiatives (Marlanne 2005). Moreover, these projects have true potential for societal change as it is imbibed with in the community, where citizens express their concerns that need an action. BP oil spill of 2010 in North America can is an example for these projects, where citizens documents environmental damages caused by this accident and researchers assisted citizens in collaborative way for development of portable measurement instruments for citizens.

[6] http://mappingforchange.org.uk/projects/royal-docks-noise-mapping/
[7] UniversityCollegeLondon
[8] http://fossilfinder.coe.uga.edu/
[9] http://www.youngscience.at/fileadmin/youngscience/Fotos/Young_Citizen_Science/Young_Citizen_Science_Research_with_the_help_of_young_people.pdf

Projects	Locus of knowledge creation		Focus of project activities	
	Researcher	Citizen	Traditional	Society
Contributory project	X		X	
Contractual projects	X			X
Collegial projects		X	X	
Education projects		X		X
Action projects		X		X
Collaborative projects	X	X	X	X
Co-Created projects	X	X	X	X

Table 2.2: Summarising the citizen science projects

2.2.2. *'ladder model'* OF ENGAGEMENT

Although the matrix model discussed above, is dynamic and covers a wide range of citizen science projects, it is not simple and easy to infer varying levels of engagement in citizens science. For this reason, we introduce the *'ladder model'* presented by M. Haklay (2013), which uses ladder representation to encapsulate the different level of citizens engagement in the citizens science projects. M. Haklay, argues, a ladder is a representation to show degree of engagement, not to be interpreted as a hierarchy in engagement. Due to the simplicity and ease of interpretation, we use the Haklay's *'ladder model'* for designing the online survey to identify what level of citizens engagements the researchers had with in their citizen science projects (see Appendix: A)

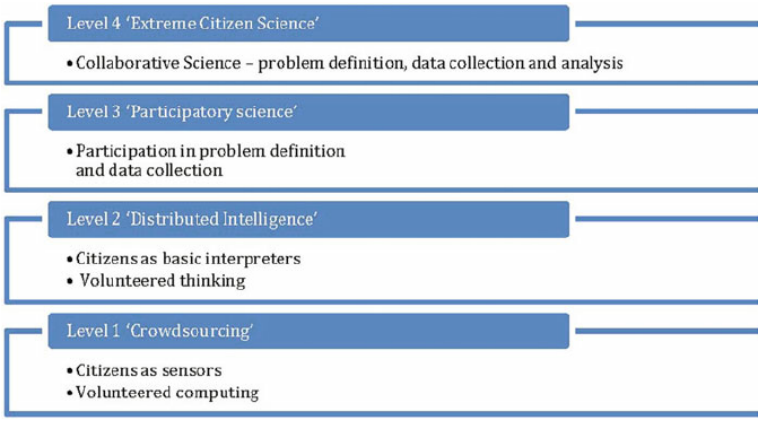

Figure 2.2: Ladder of engagement (M. Haklay 2013)

Figure 2.2 shows *'ladder model'* that has four levels of engagement the levels of engagements are explained as following.

- level 1 — *"crowdsourcing"* where the citizens engagement is limited to the temporary resources of participants such as computational power of the laptops. The engagement of citizens at cognitive level of is minimal. In other words, citizens act as sensors for the projects, citizens are asked to keep sensors along, while

performing specific tasks and bring these sensors back to the experiment coordinators.Projects like SETI@home project (2002) is example, that is working at this level, where the participants share their computing resources to the researchers to run complex models and algorithms.

- Level 2 — *'distributed intelligence'*, here the cognitive skills of the citizens are used. Projects like *GalaxyZoo* (2007) is example of citizen science project functioning at this level. In this level, the citizens get fundamental training on collecting data and carry out a basic interpretation task.
- Level 3 — *"participatory science"*, in this level of engagement, citizens take part in defining problem and collecting data. Data collection method is devised based on consultation with citizens and experts. This level is common in the environmental justice cases. This type of engagement is also possible when the volunteers develop expert skills through their engagement, and they suggest new research question to researchers.
- Level 4 — *"extreme citizen science"* in this level citizens do most of the work and scientific problems to work on are decided by the citizens based on their concerns. Example of this engagement is seen in some civil society projects, that are concerned with policy changes.

2.3. ASPECTS OF POTENTIAL MOTIVATION OR LACK OF MOTIVATION IN CITIZEN SCIENCE PRACTISE

This section, answers the *sub-question-2* of this research: *"What factors (aspects) motivates researchers to participate in citizen science projects?"*. We argue that participation is influenced through aspects of motivation and lack of motivation. Therefore we want to identify the aspects in the practices of citizens science projects that can be either motivation or lack of motivation for researchers to participate in citizen science. These aspects of motivation and lack of motivation that are discussed in the report are identified from the literature of citizen science based on the criteria of selection discussed in section 2.1.

These aspects are broadly classified under the five themes as presented in figure 2.3. Each theme is explained with the relevant literature in below, however, it is important to note these themes can overlap with each other sometimes. The main aim of these aspects of motivation and lack of motivation is to capture as much as heterogeneity possible. These aspects will serve as *concourse* for the *Q-methodology* that is discussed in chapter 3 in detail. Moreover, identifying and addressing these pivotal points of motivational or lack of motivation in the design of citizen science systems will facilitate improved collaboration from researchers (Rotman et al. 2012).

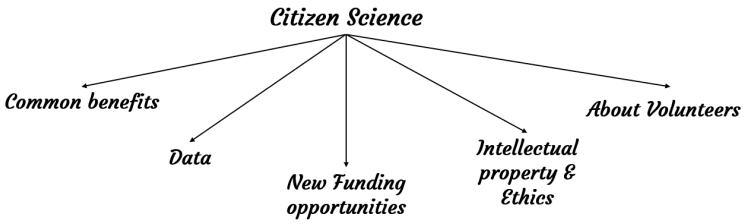

Figure 2.3: Aspects of motivation lack of motivation from literature

Common benefits: Citizen science is an emerging field with much potential that has benefited society and science in different ways. Frequently discussed benefits of citizen science in the literature are presented in this paragraph. These benefits can be motivational aspect for researchers to use citizen science. Several papers highlight citizen science has improved the understanding of scientific concepts and practices among the citizens, through promotion of knowledge in the society, which consecutively has increased scientific literacy among citizens (Bonney, Cooper, et al. 2009; Trumbull et al. 2000). Some papers further claim that citizen science empowers citizens (common public) in a multiple ways, such as enhancing their leadership skills and developing social capital (Bhattacharjee 2005; Caruana et al. 2006).

Moreover, through citizen science researchers had overcome a variety of constraints concerning to research, mainly in generating and classifying many large volumes of novel datasets. Citizen Science is a great way to make research more accessible to a broader audience and increase its reach (Hochachka et al. 2007; Lukyanenko, Wiggins, and Rosser 2019). Further, citizen science is applauded by multiple studies for making science more participatory, which makes science engagement between experts and citizens (laypeople) equitable (Soleri et al. 2016). Additionally, citizen science is seen as a symbol of democratisation of science, because it empowers people without professional credentials to contribute towards scientific knowledge creation (Cavalier and E. B. Kennedy 2016). In addition, many papers also indicate citizen science has potential to bring about policy change (Frickel et al. 2010), with help of social movements that questions official accounts and fulfils gaps in knowledge (Grindstaff, Hall, and Lo 2010).

Data: The main advantages of citizen science is the diverse and vast quantity data collected through the involvement of citizens. The data collection through citizen science becomes crucial particularly when the scope research requires assembling a lot of information over wide geographic zones (Dickinson, Zuckerberg, and Bonter 2010). Citizen science has empowered researchers to overcome a range of constraints mainly in producing and classifying several large volumes of novel datasets. Citizen science is an extraordinary method to make research more available to an extensive crowd and wider its reach. Citizen science has immense potential to meet monitoring needs expense effectively, as government-based natural resources monitoring is extremely hard to fund, in the context of political and practical challenges (Hochachka et al. 2007; Lukyanenko, Wiggins, and Rosser 2019).

However, there are significant concerns among the researchers towards data collected through citizen science, because of the errors and the biases that come with data collection. The chief reason for this is the data collection is conducted by diverse bunch of individuals (Kullenberg and Kasperowski 2016; Theobald et al. 2015). Many researchers also indicate citizen science data is posing difficulties for their use, as sometimes data has incomplete metadata. Researchers have also voiced on lack the quality scientific output in citizen science data. Which is resulting in low publication rate for citizen science projects and this may turn out to be chief discouragement for many researchers to use citizen science (Tulloch et al. 2013).

New funding opportunities: Expanded interest about open engagement between science and citizens (common people) around the world has brought improved funding opportunities for researchers in citizen science (Yaela Naomi Golumbic 2015). Enormous investment is being made to support the benefits of science and civil society, within the EU alone with a budget of 462 million euros under Horizon 2020. Based on these developments, it is anticipated, more funding opportunities will be there for researchers who want to use citizen science in their research. which makes it easy for getting initial funding and can be motivation for researchers to use citizen science in their research (Moseley 2017).

Ethical Intellectual property issues: Collaborations between researchers and citizens can pose numerous advantages for both science and society, but this also increases the ethical issues and concerns related to the (citizens) participants (Riesch and Potter 2014). Moreover, data collected by local people can cause concern such as data possession and intellectual property (e.g. patenting) disputes. The local communities (citizens) who collect data can emphasise ownership and control on the data and information gathered, especially how the information is used and shared (Resnik and C. E. Kennedy 2010; Riesch and Potter 2014).

About volunteers: In this time of diminished public support for research, such "free labour" by involving citizens in projects can be increasingly vital for the success of projects, as they can reduce the load on the researchers of collection and classifications of large data sets(Resnik and C. E. Kennedy 2010).

2.4. SUMMARY

This chapter sets a theoretical framework for this research by answering *sub-question 1 and sub-question 2*, alongside explaining how the relevant literature is identified. Answer to sub-question 1: *"How citizen science is defined according to the literature?"*. Demarcates what different types of projects are considered as citizen science in this research, Based on the of engagement between *high-level involvement* actors, seven types of citizen science projects are identified. These are (1) Contributory projects, (2) Contractual projects, (3) Collegial projects, (4) Action-projects, (5) Education projects, (6) Collaborative projects and (7) Collaborative projects. Additionally, the *'ladder model'* of engagement is presented, which is used in designing the online survey, for its simple represen-

tation of engagement between high-level involvement actors.

From these identified citizen science projects, the aspects that can be motivation and lack of motivation for researchers are identified, which answers the sub-question 2: *"What factors (aspects) motivates researchers to participate in citizen science projects.?"*. These aspects of motivation and lack of motivation are grouped in *five themes*, (1) common benefits, (2) data, (3) about volunteers, (4) new funding opportunities, and (5) intellectual property ethics. These forms basis for *Q-methodology*, discussed in detail in the chapter 3.

3

Q-METHOD

This chapter discusses the method used to answers *sub-question 3* of the research: *"What distinct perspectives are identified among researchers to participate in citizen science projects?"*. The chapter has seven sections, the outline is explained as follows. The section 3.1 discusses suitability of *Q-method* for this research and briefly explains different parts of Q-method. Section 3.3 explains approach on how the researchers who participate in this research are selected. Section 3.4 presents the researchers information, which is divided into two sub sections, 3.4.1 discusses overall demographic information and 3.4.2 discusses information about researchers who are experience in citizen science. The section 3.5 explains *Q-statement statements* selection, with descriptive responses of statements during *sorting*. Section 3.6 explains *Q-factor analysis* and presents the output of the analysis in table 3.4. The section 3.7 gives details about the ethical consideration that was accounted in the research to ensure rights and privacy of the participants. Finally, Section 3.8 summarises the chapter.

3.1. SUITABILITY OF Q-METHOD

This section discusses why *Q-method* is suited for the research. Q-method is an established method for systematic examination of participant perspective, that is useful to characterise how different groups of people think about an issue or a topic (Watson and Floridi 2018). It was developed William Stephenson 1953, since then Q-method has been applied in range of disciplines from political science (Brown 1980) to environmental science (Barry and Proops 1999). Moreover, two specific reasons are presented for using *Q-method* in this research, first, it is a popular method to identify latent perspectives, that can understand in-depth opinions and points of consensus with in the group about given topic (Zabala, Sandbrook, and Mukherjee 2018). Two, this method provides *gestalt*[1] picture on the perspectives, that shows how these perspectives are related to the participants, which can be used to compose nuanced perspective of participants about

[1] structure or experience, when considered as a whole

a topic (Ligtvoet et al. 2016; Goodchild 2007). Due to these reasons *Q-method* is argued as suited method for the research.

3.2. STEPS IN Q-METHOD

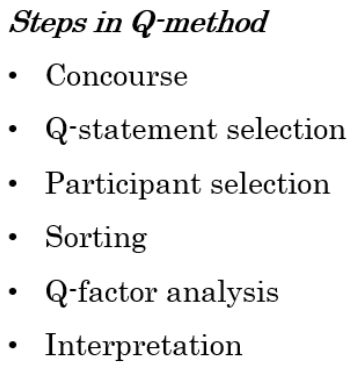

Figure 3.1: Different steps in *Q-method*

This section discusses different steps involved in *Q-method*, that is presented in the figure 3.1 . Q-method starts with *"concourse"*, which refers to identification of population of subjective statements about given topic (Stephenson 1978). These statements are formulated based on *aspects* identified from *sub-Question 2* (see section 2.3). These statements are framed in such way that they capture adequate variation about the topic. For instance, to suit research these statements are focused on *potential motivation and lack of motivation for researchers to participate in citizen science.* These set of selected statements from concourse are called *Q-set or Q-statements.*

Then, the target group of researchers are selected by deciding whose perspective we want to know about the topic, this step is called *participant selection.* In this research participants are researcher, we prefer use word researchers to avoid confusion. Next step is asking researchers to rank-order the statements based on their individual perspective, according to their preference, judgement, or feeling about how strong they feel about specific statement in forced distribution using in *Q-grid.*

By having participants to rank or sort a series of statements, researchers reveals their subjective perspective towards the statements and their subjective profiles (Brouwer 1999). This step is called *sorting.* In this research we use free sorting of statements on Likert's[2] scale, instead of forced sorting on Q-grid, to keep time taken to answer the research minimal. The implications of this choice will be discussed in limitations sections in chapter 5.

After ranking of the individual statements, in next step, these rankings are subjected

[2]Likert scale is a psychometric scale commonly involved in research that employs questionnaires measuring either positive or negative response to a statement.

to *Q-factor analysis*. In comparison to factor analysis, Q-factors analysis uses *transposed* data matrix, which switches the researchers from cases to the variables of analysis. Stephenson (1953) argued, if each individual had exclusive likes and dislikes, the participants profiles would not correlate. However, if there existed significant clusters of correlations in the participant's profile, these clusters could be factorised and described as shared perspective and individuals could be measured in relevance to them. According to Brouwer (1999), an important advantage of Q-factor analysis is that, it analyses the questions related to identical domain or topics in their mutual coherence for the participant, rather separate items of information.

Then next step is *interpretation*, which is the final step of Q-method where results of a Q-factor analysis are interpreted along with the open statements of the participants and their demographic information, who load significantly on respective factors. The purpose of *open statements* is to further enrich the participants responses by allowing them to express their reasons behind their sorting on why they sorted the statements in the certain way. The interpretation of Q-method provides *gestalt*[3] picture on the perspectives, that shows how these perspectives are related to the participants (Good 2000). Therefore, the interpretations resulting from Q-methodological research describes perspective of population by representing their clusters of subjectivity (Brown 1993; Risdon et al. 2003).

3.3. PARTICIPANTS OR RESEARCHERS SELECTION

This section explains how the researchers were selected and approached to take part in the research. The target were researchers from two groups: 1) who have prior experience with citizen science and 2) who do not have prior experience with citizen science. From both academic and non-academic fields. In academia researchers with minimum of PhD, were considered because they would have spent considerate amount of time with a research compared to Masters or Bachelors degree. The reason to keep target researchers broad was to mitigate the issue of low response rates to the surveys and capture wider perspectives across the field of citizens science .

A strategy was devised to invite researchers to participate in the research, the plan was to reach as many as researchers as possible. To reach the target researchers, *invitation link* for survey was posted on social media websites such as twitter, Facebook and LinkedIn. Besides, emails to different citizen science associations such as *European citizen science association, Australian citizen association, Asian citizen science association*[4], were sent requesting them to share the survey link to their respective researchers group. Moreover, other citizen science groups and affiliated educational institutions were also approached. Example of these citizen science groups are, citizenscience.org[5], citizenscience.gov[6], scistarter.org[7] and educational groups are *Museum fuer naturkunde berlin*[8].

[3] structure or experience, when considered as a whole
[4] info@citizenscience.asia
[5] https://www.citizenscience.org/
[6] https://www.citizenscience.gov/#
[7] https://scistarter.org/
[8] https://www.museumfuernaturkunde.berlin/

Further, to ensure the required number of researchers are reached for the research, researchers were also invited through personal emails, as these have more response rates then compared to group emails; however, it was not easy to get personal email of researchers. Therefore, we reached the researchers from the universities that had explicitly published list of researchers involved in citizen science. Based on this, two universities: University College London (UCL) and Cornell University were selected. These universities had explicit list of researchers involved in citizen science under name of *ExCiteS Research Group*[9] and *The Cornell Lab of Ornithology*[10], most of personal email were sent to these two universities. Apart from these other researchers were also reached, in total approximately 80+ personal emails were sent to researchers, whom we identified to be involved in citizen science.

For researchers, group who are not involved in citizen science, we aimed to target researchers form the Delft University of Technology, the place where the author is doing masters programme and the researchers group in India, where author comes from. The above approach was used because, it had more chance of getting response rather targeting random university or people who we personally do not know. Anyhow, above approach did not limit researchers only from those region, as an *invitation link*, request to participate in research was posted in social media platforms, through which researchers all around the world can participate in the research.

3.4. RESEARCHERS' INFORMATION

This section explains the detailed information on of the researchers who participated in the research. Information of the researchers will be used in interpretation step of *Q-method*, to provide *gestalt* picture about the perspective of researchers. of Before the survey link was shared few trails were conducted to *validate* the questions and time taken to complete the survey. During these trails it was identified that it takes 10 to 12 minutes to answer the survey. The link to participate in research and answer the survey was made from 24th July 2020 and it was open till 31st August 2020, through social media platform and emails as discussed in above section.

Total 92 participants answered the survey out of which 61 participates completed the survey, which shows the completion rate of the survey was 62%. Out of these 61 responses, 56 responses were selected for the research based on the two stated criteria. (1) The responses should be valid, if the variance in the responses of the participant is zero (see Appendix B) the responses were removed. (2) If the responses are from out of target group, for example master's students, undergraduates and citizens or volunteers were also removed. These exclusion criteria ensured only completed and properly answered surveys from the researchers were considered.

3.4.1. DEMOGRAPHIC INFORMATION OF RESEARCHERS

Table 3.1, shows demographic information about the participants on: *(1) age, (2) gender, (3) country of residence, (4) experience with involving citizen their research.* These information are used in interpretation step of Q-method. It is observed that participation

[9] https://www.geog.ucl.ac.uk/research/research-centres/excites
[10] https://www.birds.cornell.edu/home/staff-directory/#all

from researchers with experience of involving citizen in research was more, compare to those with no experience. The responses were from different regions of the world, it is to be noted participants from Netherlands and India share 50% of the responses, other parts combine share other 50%. In the category of age, responses were blend of all age group of participants, with majority of participants were from age category of *31-40* which is 41%.

Classification	Category	Percentage
Age of the participants	20 or younger	0%
	21-30	21%
	31-40	41%
	41-50	25%
	51-60	7%
	61-70	4%
	71 or older	2%
Gender of participants	Male	52%
	Female	43%
	Prefer not to say	5%
Experience with involving citizen in research	Yes	62%
	No	38%
Country of residence	United Kingdom	13%
	United States of America	14%
	India	21%
	Netherlands	29%
	Germany	5%
	Italy	4%
	Austria	2%
	Colombia	2%
	France	2%
	Nigeria	2%
	Pakistan	2%
	Spain	2%

Table 3.1: Demographic information of participants

3.4.2. RESEARCHERS EXPERIENCED IN CITIZEN SCIENCE

Table 3.2, provides further insights about the researchers who have experience with involving citizens in their research on areas: *(1) which topic areas did the project cover?, (2) what role they played in the project?, (3) what was the level of citizens participation in the project (based on* 'ladder of participation'*, see section:* **??***)? (4) what is the current academic position and (5) overall experience with citizen science.* These information are used in interpretation step of Q-method.

These responses in table 3.2, already capture insights in citizens science, that are highlighted below. It can be noticed that major focus of area of citizen science is from the *environmental sciences* that is 34%. It is seen that majority of researcher participants

take up the roles of *project initiator, project designers and project coordinator*. Most of the participants are *PhD candidates* and *post-doc* researchers, these two combined take up more than 50% of the researchers' participants. In the level of engagement of citizens, based on *"ladder-model"*, all four level are share equally with majority being level 3- "participatory science" with 29%. Finally, in experience of the participants, 1 years to 3 years in citizen science is 38%, then followed by more than 9 years which is 21%, which reveals there is active participation from new researchers in citizen science.

Classification	Category	Percentage
Topic of research	Space Science	9%
	Applied & Engineering Science	14%
	Environmental science	34%
	Social science & Humanities	19%
	Information science & public administration	15%
	Clinical science & Neuroscience	9%
level of participation of citizens	Level 1:"Crowdsourcing"	27%
	Level 2:"Distributed intelligence"	19%
	Level 3:"Participatory science"	29%
	Level 4:"Extreme citizen science"	25%
Role in the project?	Project initiator	26%
	Project coordinator	22%
	Project designer	21%
	Project manager	13%
	Facilitator	12%
	Data analyst	6%
Academic position	PhD candidate	35%
	Post-doctoral researcher	21%
	Assistant Professor	15%
	Associate Professor	13%
	Full Professor	4%
	Other, namely	13%
Academic position	Less than 1 year	2%
	1 year to less than 3 years	38%
	3 years to less than 5 years	17%
	5 years to less than 7 years	17%
	7 years to less than 9 years	5%
	9 years or more	21%

Table 3.2: Information of researchers experienced in citizen science

3.5. Q-STATEMENT SELECTION & SORTING

This section discusses *Q-statements* that are designed from the *concourse* that were collected by answering *sub-question-2*: *"What factors (aspects) motivates researchers to participate in citizen science projects?"*. The concourse is grouped into five themes: (1) *com-*

mon benefits, (2) *data*, (3) *about volunteers*, (4) *new funding opportunities*, and (5) *intellectual property ethics*.

Initial plan was to use *Q-grid* for sorting using forced distribution, which required *33 Q-statements*, were 15 are statements focus on motivation (marked as M) of researchers to involve citizens in research and 18 statements on lack of motivation (marked as D). These statements are presented in table 3.3. However, sorting statements on Q-grid took approximately 28 minutes, to reduce time taken to answer the survey, sorting over*free distribution* on *likert's scale* was preferred. Sorting over a free distribution reduce the survey time considerably by 48%, compared to sorting on Q-grid.

These statements were validated with the help of thesis supervisors who had knowledge and aware about research and two friends who had no knowledge about the research. To check if the questions are offering them to express their subjective motivations, while they were sorting the statements. Even though these themes meaning, and statements may somewhat look arbitrary and overlapping, this was to guarantee heterogeneity and capture as much as insights as possible (Brown 1980).

3.5.1. DESCRIPTIVE RESPONSES TO Q-STATEMENTS

Table 3.3, provides the descriptive information on the *sorting* of statements from all the researchers. The attitude was measured on 7-point Likert scale from strongly disagree to strongly agree, the numbers signify attitudes as listed: *1-Strongly Disagree, 2-Disagree, 3-Slightly Disagree, 4-Neutral, 5-Slightly Agree, 6-Agree, 7-Strongly Agree*.

Insights after analysing of table 3.3 is presented as follows. There was no statement that was either strongly agreed or strongly disagreed as the range of mode is from 2 to 6. Looking at the statements that were sorted as agree (with mode 6), were all motivation statements. This is due to majority of experienced researchers in the population that answered the research and they all agree to common benefits of citizen science (see section2.3) . This shows that most of the researches were motivated to participate in citizen science or involve researchers in their research. These motivation statements were related to collection of widespread data with no additional funding (M1), citizens can bring new idea to research (M9) and promote scientific literacy among the public (M11). Citizen science increases scientific literacy and trust among the public about scientific research (M12 M13).

The statements with disagree (with mode 2) were all from lack of motivation (demotivation) statements, these statements are citizens in my research because this adds no value to my research, citizen science reduces my research quality, and long duration reduces the funding from investors as they lose the excitement about the project as time progresses (D4 D5). These statements are of from themes of duration of about volunteers. Out of 33 statements 12 statements were sorted neutral (with mode 4). In these two statements (M2 M7) are from motivation and remaining 10 (D2, D7, D8, D9, D10, D11, D15, D16, D17, D18) are from lack of motivation (demotivation) statements (see: table 3.3). .

No	Statements	Mode	Variance
M[11]1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	6.0	3.3
M2	I am or would be motivated to involve citizens in my research because the data collected by citizens is of high quality.	4.0	2.5
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	6.0	1.8
M4	I am or would be motivated to involve citizens in my research because I can reach out to a broader audience worldwide.	6.0	1.0
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	6.0	1.4
M6	I am or would be motivated to involve citizens in my research because this type of research may lead to new funding opportunities.	5.0	1.8
M7	I am or would be motivated to involve citizens in my research because that allows me to keep my research question flexible, as I can collect almost any type of required data.	4.0	2.4
M8	I am or would be motivated to involve citizens in my research because this allows me to address both scientific and societal concerns in my research.	6.0	1.0
M9	I am or would be motivated to involve citizens in my research because they can bring new ideas into the research.	6.0	1.3
M10	I am or would be motivated to involve citizens in my research because this increases the validity of my research compared to other research methods.	5.0	2.4
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	6.0	1.3
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	6.0	1.6
M13	I am or would be motivated to involve citizens in my research because this allows me to collaborate with local people in addressing real societal problems.	6.0	1.1
M14	I am or would be motivated to involved citizens in my research because this helps me to promote intra-group coordination.	5.0	1.6
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	5.0	2.1

D[12]1	I am or would be demotivated in involving citizens in my research because I lose control over my data, as data is collected by many volunteers.	3.0	2.4
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	4.0	2.9
D3	I am or would be demotivated in involving citizens in my research because this leads to reduced scientific output.	3.0	2.2
D4	I am or would be demotivated in involving citizens in my research because this adds no value to my research; instead, it reduces my research quality.	2.0	1.4
D5	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	2.0	2.1
D6	I am or would be demotivated in involving citizens in my research as unpaid volunteers, I feel like I am making use of them as free labourers.	3.0	2.8
D7	I am or would be demotivated in involving citizens in my research because this has a lot of ethical concerns.	4.0	2.7
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	4.0	2.6
D9	I am or would be demotivated in involving citizens in my research because this can lead to exploitation of volunteers.	4.0	3.2
D10	I am or would be demotivated to involve citizens in my research because this has long-running projects.	4.0	2.6
D11	I am or would be demotivated to involve citizens in my research because of long-running projects, I need to continually look for new volunteers to keep my project going.	4.0	2.0
D12	I am or would be demotivated to involve citizens in my research because it is time-consuming	5.0	2.8
D13	I am or would be demotivated to involve citizens in my research because this leads to data that is hardly reusable for other researchers.	3.0	2.6
D14	I am or would be demotivated to involve citizens in my research because this has poor standardisation for reporting and presenting data.	3.0	2.1
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	4.0	2.2
D16	I am or would be demotivated to involve citizens in my research because the motivation of the citizen's declines as time progresses.	4.0	2.3
D17	I am or would be demotivated to involve citizens in my research because this is confusing due to no standard terminologies.	4.0	1.9
D18	I am or would be demotivated to involve citizens in my research because my motivation reduces as time progresses.	4.0	2.0

Table 3.3: Descriptive statistics of responses from participants

3.6. Q-FACTOR ANALYSIS

Q-factor analysis is a statistical method aims to identify shared patterns of perspectives among the group of individuals, in terms of *factors*. Q-factors analysis uses the *transposed data* matrix where correlation of people is used instead of variables, which results in overall configurations produced by the participants to be inter-correlated, and grouped in factor (Watts and Stenner 2012). Different methods like centroid method, simple summation method, principal component analysis (PCA), are used to extract factors from Q-factors analysis, it is implied that in all these methods, generate equally satisfying results (Watts and Stenner 2012). This research uses principal component analysis (PCA) and varimax rotation to extract factors, as it is recommended to use extraction and rotation method comes along with specific method (Akhtar-Danesh, Mirza, et al. 2017).

The relevant factors are identified based on the *Humprey's rule* for significant factor loadings; a factor should have at least three researchers significantly loadings on the factor, in the rotated component matrix for the factor to be sufficiently interpreted (Montanelli and Humphreys 1976). If a researcher is said to significantly loading on a factor, then that factor represents the perspective the researcher and the perspective is identified more strongly with the factor. While interpretation of the factor, we will consider the perspectives of the researcher, with respect to the factor. Humprey's rule for significant factor loadings, is based on iteration method, initially, a random number is set for extracting factors; for example, initially the factors number was set to eight, then rotated component matrix was visualised. If significant loadings of participants for each extracted factor is less than three, then the above procedure is repeated by reducing set factor number by one. On repeating the above discussed step, we identified seven relevant factors, that satisfied *Humprey's rule*. After identifying the number of factors, the standardised scores for each factor linked to statements are identified with *regression method*, which shows the weighted average of the sorting done by the researchers. This reveals what each group of participants who load significantly on the same factor thinks or feels about each statement, and it is presented in table 3.4.

3.6.1. FACTOR SCORES

The table 3.4 reveals average weighted sorting scores of *Q-statements* which characterises factor and is presented in columns namely from *F1 to F7*. If the statement is motivation is represented by *M*, for lack of motivation (demotivation) is represented by *D* respectively. In column F1, we can see that, item M1 has a standardised score of -0.65 and M2 is with standardised score of +0.60 so on. Reading the table by row wise reveals the standardises scores of a statement across all the factors. For example, in column F2, we can see that item M1 has standardised score of +0.10 for Factor 2(F2) and +0.11 Factor 3(F3), at by Factor 4(F4) and Factor 5(F5) it is +1.44, and +2.46 and -3.37 for Factor 6(F6) and Factor 7(F7) respectively. The detailed interpretation of table 3.4, will be done in the chapter 4.

M/D	Statements	F1	F2	F3	F4	F5	F6	F7
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	-0.7	0.1	0.1	1.4	0.7	2.5	-3.4
M2	I am or would be motivated to involve citizens in my research because the data collected by citizens is of high quality.	0.6	-0.2	0.5	1.4	-2.7	-0.4	-0.9
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	1.1	0.4	0.4	-0.1	-0.9	1.8	-1.0
M4	I am or would be motivated to involve citizens in my research because I can reach out to a broader audience worldwide.	0.4	0.8	1.0	-0.1	-0.1	1.9	1.0
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	0.9	2.2	0.1	0.6	-0.2	-1.2	-0.2
M6	I am or would be motivated to involve citizens in my research because this type of research may lead to new funding opportunities.	0.0	0.8	0.2	0.6	0.1	-0.3	-0.7
M7	I am or would be motivated to involve citizens in my research because that allows me to keep my research question flexible, as I can collect almost any type of required data.	1.1	-0.6	0.1	-0.3	-0.7	-1.6	-2.1
M8	I am or would be motivated to involve citizens in my research because this allows me to address both scientific and societal concerns in my research.	0.8	0.5	0.6	0.0	0.2	1.3	0.5
M9	I am or would be motivated to involve citizens in my research because they can bring new ideas into the research.	1.1	0.1	0.7	-0.3	0.7	0.6	0.2
M10	I am or would be motivated to involve citizens in my research because this increases the validity of my research compared to other research methods.	1.3	-1.4	1.2	-0.1	-0.7	-0.6	-0.5
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	1.2	1.3	-0.2	-0.1	0.9	-0.5	1.1
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	1.6	1.4	-1.0	0.2	0.3	-1.0	0.4

M13	I am or would be motivated to involve citizens in my research because this allows me to collaborate with local people in addressing real societal problems.	1.2	0.9	0.4	0.0	0.6	0.2	1.4
M14	I am or would be motivated to involved citizens in my research because this helps me to promote intra-group coordination.	1.0	-0.3	0.7	-0.9	0.5	0.0	0.4
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	1.2	-2.3	1.1	0.1	1.3	0.1	0.1
D1	I am or would be demotivated in involving citizens in my research because I lose control over my data, as data is collected by many volunteers.	-0.3	0.4	-0.7	-1.3	2.1	-2.0	-2.1
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	-0.9	0.9	0.3	-2.1	1.4	0.8	-0.6
D3	I am or would be demotivated in involving citizens in my research because this leads to reduced scientific output.	-1.1	-0.2	0.4	-2.0	-0.8	0.9	0.2
D4	I am or would be demotivated in involving citizens in my research because this adds no value to my research; instead, it reduces my research quality.	-0.9	-0.2	0.2	-1.7	-2.1	-0.4	0.0
D5	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	-0.9	1.0	-0.9	-1.7	-1.6	-0.4	-0.2
D6	I am or would be demotivated in involving citizens in my research as unpaid volunteers, I feel like I am making use of them as free labourers.	1.0	-0.9	-2.5	-0.3	-1.4	0.2	0.3
D7	I am or would be demotivated in involving citizens in my research because this has a lot of ethical concerns.	0.6	-1.8	-1.9	0.3	1.0	0.3	0.4
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	-1.2	1.0	-1.6	0.9	0.5	0.1	-0.1
D9	I am or would be demotivated in involving citizens in my research because this can lead to exploitation of volunteers.	0.2	-0.7	-2.8	0.9	-0.1	0.7	0.7
D10	I am or would be demotivated to involve citizens in my research because this has long-running projects.	-1.4	-0.1	0.4	1.6	0.3	-0.5	0.2
D11	I am or would be demotivated to involve citizens in my research because of long-running projects, I need to continually look for new volunteers to keep my project going.	-1.0	0.3	0.0	1.6	0.3	-0.6	0.2

D12	I am or would be demotivated to involve citizens in my research because it is time-consuming	-1.4	1.2	0.4	0.9	-0.2	0.5	1.1
D13	I am or would be demotivated to involve citizens in my research because this leads to data that is hardly reusable for other researchers.	-1.2	-1.0	0.2	-0.5	0.8	-0.8	0.2
D14	I am or would be demotivated to involve citizens in my research because this has poor standardisation for reporting and presenting data.	-1.1	-0.6	-0.5	-0.7	0.1	0.4	0.6
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	-0.7	-0.8	0.8	0.5	0.3	-1.2	0.8
D16	I am or would be demotivated to involve citizens in my research because the motivation of the citizen's declines as time progresses.	-0.6	0.3	1.3	0.9	-0.1	-1.4	0.6
D17	I am or would be demotivated to involve citizens in my research because this is confusing due to no standard terminologies.	-0.6	-0.9	0.3	-0.5	0.4	0.6	0.9
D18	I am or would be demotivated to involve citizens in my research because my motivation reduces as time progresses.	-1.2	-1.2	0.8	0.8	-0.6	-0.1	0.4

Table 3.4: Factors for motivation and lack of motivation statements

3.7. ETHICAL CONSIDERATIONS OF THE RESEARCH

To ensure the issues related to risk and privacy of the researchers participating in the research are mitigated and reduced to acceptable size. Study was conducted after it was approved from Human Research Ethics committee of Delft University (HREC). Dignity of researchers participating in the research was ensured by identifying the correct researchers for the study and to ensure the time of the researcher is valued the survey was designed such that it takes no more than 10 minutes of time to complete. Plus, brief emails were sent to researchers to request for answering the survey. The informed consent was displayed before the start of survey, where it was clearly stated researchers have all freedom to choose if they want to be part of this research or not. In between answering they survey, if the feel like not continuing further, they can leave the study, without explaining the reasons. Moreover, in the study no physical and psychological harms to the researchers participating was identified. To ensure there is no deception to researchers participating, the motivation and purpose of study is presented clearly with explaining why and who is conducting the study and where the data collected will be used. Finally,

the research explains clearly where the data will be stored and with whom the data is shared.

3.8. SUMMARY

This chapter justifies why *Q-method* is the best suited method for the research and further elaborates on how this method identifies perspectives of group about a given topic. Further the chapter explains different steps in Q-method and how research is conducted in detail. In total 57 researchers shared their views on participating in citizen science, in which 62% where of those who already had experience with citizen science and 38% were researchers who did not use citizen science. This shows major participation was there from scientist group who have experience with citizen science. The researchers were taken from different regions around the globe, majority form Netherlands and India.

The researchers were provided with 33 Q-statements to sort based on their judgement, or feeling about how strong they feel about specific statement, over likert 's scale. Besides, researchers had open statements to explain why they sorted statements in certain way, to capture their subjective profiles. Then *Q-factor analysis*, of these sorts were performed. The detailed standardised factor scores for each statement with respect to factors is presented in Table 3.4. Total seven factors are identified, that satisfies Humprey's rule of significant factor loadings. Finally, the chapter ends with discussion on the ethical consideration, that were taken to ensure the safety and privacy of participants. After discussing the research method, in next chapter the results are interpreted based on information that is gathered through Q-method, to identify the perspectives of researchers.

4

IDENTIFYING PERSPECTIVES OF RESEARCHERS BY FACTOR INTERPRETATION

This chapter answers sub-question of the research: *"What distinct perspectives are identified among researchers to participate in citizen science projects? "*. The chapter is divided in six sections. Section 4.1 explains how the factors are interpreted. Section 4.2 discusses detailed interpretation of factors. Section 4.3, locates these identified factors in the context of participation in citizens science projects, to identify distinct perspectives. Section 4.4, groups these perspectives in their motivation to participate in citizen science projects. Section 4.5, applies these identified perspectives to enhance participation. Finally, Section 4.6 summarises the chapter.

4.1. HOW THE FACTORS ARE INTERPRETED

Factors are interpreted based on combination of information available from *Q-method* (see chapter 3). These information are: (1) researchers loading significantly on each factor (see Appendix C), (2) Standardised scores from sorting of motivation and demotivation (lack of motivation) statements (see table 3.4), (3) open statements and demographic information of researchers who load significantly on the factor.

4.2. DETAILED INTERPRETATION OF FACTORS

This section discusses the factor interpretation in detail. Each factor is explained first based on demographic information of researchers, then the standardised scores of motivation and demotivation statements, that describes factor most appropriately are presented in the form of table. Finally these two are combined with open statements by the researchers who load significantly on the respective factors, to provide detailed interpretations of the group. Further the interpretations are linked back to the *five themes* that

were identified in chapter 2 (see section 2.3) in detail.

4.2.1. INTERPRETATION OF FACTOR 1

Demographic Information; 22 researchers load significantly on this factor, out of these 22 researchers 18 have experience with citizen science and experience levels range from less than 12 months to more than nine years. As most of the researchers are experienced in citizen science, we consider *factor 1*, to voice perspectives of researchers experienced in citizen science. These researchers have involved citizens across all the levels of engagement discussed in the *'ladder model'* (see section 2.2.2).

Motivation statements:

Motivation statements with standardised scores		
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	1.6
M10	I am or would be motivated to involve citizens in my research because this increases the validity of my research compared to other research methods.	1.3
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	1.2
M13	I am or would be motivated to involve citizens in my research because this allows me to collaborate with local people in addressing real societal problems.	1.2
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	0.9
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	-0.7

Table 4.1: Standardised factor scores for motivation statements of *Factor 1*

Demotivation: Statements:

demotivation statements with standardised scores		
D3	I am or would be demotivated in involving citizens in my research because this leads to reduced scientific output.	-1.1
D10	I am or would be demotivated to involve citizens in my research because this has long-running projects.	-1.4
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	-1.2

Table 4.2: Standardised factor scores for demotivation statements of *Factor 1*

LINKING TO THEMES IDENTIFIED IN LITERATURE

Common benefits: Researchers of this group agree to all the motivation statements that indicate to common benefits citizen science promises to bring. These group of researchers

motivated to promote *promotion scientific literacy, increase trust and validity of the research and build trust in the society about science.* . Researchers says, "communicating science and acceptance of research results is easiest when the public is involved in formulating the issues, collecting data and implementing strategies". These group of researchers believe citizen science is way towards *open science* and breaking the barres between science and the ordinary public, which they express in their open statements: "I follow an open science ethos and citizen science opens up science even more than just open data or methods as it truly breaks down the final barriers in science by getting everyone involved." and "My own research is value based and it is focusing on societal concern and deep democratisation of science."

Moreover, these researchers are also interested in citizen science because of its collaborative nature and it helps in tackling concerns of citizens, researchers says "Key motivator for me as my work focuses on citizen social science and involving citizens in trying to tackle social issues" Along with collaborative nature, researchers also emphasise on *extreme citizen science* projects. One of the researcher who is affiliated with ExCiteS Research Group from UCL university says, *"Extreme citizen science appears to be the only option for engaging with the communities in very remote, technologically difficult scenarios. One of the great outcomes is that, because led locally as much as possible, there is no separation between the scientific and societal concerns."* Besides, Researchers sees citizen science enables them to conduct research that was never done before, by allowing them address wide range of questions. Researcher say *"citizen science enables me to conduct research that might not have been possible because I think that citizen science allows for the framing of research in new and interesting ways that might not have been thought of/approached in that way if citizens were not involved"* And another researchers says *"We believe that involving citizens in our research would allow us to address a wide range of research questions and bring new ideas"*.

Data: In one had these researchers agree that citizen science provides them opportunity to collect widespread data, one of the researchers says, *"My main motivation for using citizen science data is that it allows me to gather data that I would not otherwise have access to, geographically and sample size, but I see many additional benefits to connecting with people and training interested citizen researchers in different parts of the world"*. On other hand, they also acknowledge the data is not of high quality, *"In my opinion, some citizen science data is not high quality, largely due to vast differences in expertise among researchers"*.

However, it is important to note, these researchers see data quality issues as part of this process that citizen science need to address, rather consider it as demotivation, *"any citizen science research should invest in training for researchers and/or find a way to filter data for quality and accuracy. This not a drawback but is a necessary part of these studies"*. Some researchers the data quality is trade off with the amount of data generated, *"for large-scale citizen science efforts, the amount of data often outweighs these quality issues"*.

Ethical concern: For this group of researchers, ethical concerns are an essential issue that needs to be addressed, but these are not seen as demotivation to not use citizen science. One of the researcher says, *"The ethical concerns are certainly many and important to consider and act upon. I don't think that this should put people off citizen science*

because if addressed adequately, this process can make the research a lot better". These researchers also think following ethical procedures can minimise the ethical risk on the citizens, *"Following the ethical procedures and FPIC will ensure that researchers are not exploited"*.

Intellectual property: For this group of researchers intellectual property of data is not an issues as they believe the data is not their and it belong to the community which collected the data, that is citizens "I am not trying to retain 'control' over my data, in fact the data is not mine but belongs to the communities, so this is not a concern. The whole process is science and produces scientific output, so this is not a concern."

Funding opportunities: For these researchers funding is not the driver of the research in citizen science, where some of researchers says, *"Funding opportunities are of course important, but this does not guide the research direction." And "funding is not a motivator for me to include citizens"*.

Compensation to researchers: This researcher's group think, compensation in citizen science is question that still needs to be address because researcher perform varied roles in citizen science. The open statements expresses it more explicitly, *"There are still many open questions in citizen science, e.g. to value the effort of citizens and extra work the professional has in community work, communication, management, organisation, etc. which are NOT paid in scientific currencies (publications, funding, etc.). This extra work also be reducing scientific output"*.

4.2.2. INTERPRETATION OF FACTOR 2

Demographic information: Six researchers load significantly on this factor. Out of the six, five are experienced in citizen science and one is not experienced in citizen science, based on which we can consider this factor also as voice of researchers experienced in citizen science.

Motivation statements:

	Motivation statements with standardised scores	
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	2.2
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	1.3
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	1.4
M6	I am or would be motivated to involve citizens in my research because this type of research may lead to new funding opportunities.	0.8
M4	I am or would be motivated to involve citizens in my research because I can reach out to a broader audience worldwide.	0.8
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	-2.3
M10	I am or would be motivated to involve citizens in my research because this increases the validity of my research compared to other research methods.	-1.4

Table 4.3: Standardised factor scores for motivation statements of *Factor 2*

Demotivation statements:

	demotivation statements with standardised scores	
D5	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	1.0
D12	I am or would be demotivated to involve citizens in my research because it is time-consuming	1.2
D11	I am or would be demotivated to involve citizens in my research because of long-running projects, I need to continually look for new volunteers to keep my project going .	0.3
D16	I am or would be demotivated to involve citizens in my research because the motivation of the citizen's declines as time progresses.	0.3
D7	I am or would be demotivated in involving citizens in my research because this has a lot of ethical concerns.	-1.8
D13	I am or would be demotivated to involve citizens in my research because this leads to data that is hardly reusable for other researchers.	-1.0
D18	I am or would be demotivated to involve citizens in my research because my motivation reduces as time progresses.	-1.2

Table 4.4: Standardised factor scores for demotivation statements - *Factor 2*

LINKING TO THEMES IDENTIFIED IN LITERATURE

Common benefits: These researchers acknowledge citizen science provides broader reach to their research and increases scientific literacy. These researchers see citizen science as tools to change attitudes of the people about science by making science more meaningful for them. A researcher says *"Involving citizen researchers has the advantage of increasing potential coverage of your research while providing tools for education and change of attitudes within communities. It is also a good way to make research or its results and purposes, appealing to a wider public"*. Additionally, this group of researchers consider citizen science as a tool that can change the perception of people about contested topics such as climate change and others. Researcher says *"Teaching through experience is a good way to educate and change perceptions, and more scientific literacy is important for global issues like climate change and conservation""*. Besides, for these researchers citizen science brings balance to both scientific research and scientific education is of high motivation, researchers says *"My citizen science project (Bauhinia Genome) was all about education and science literacy and saw the benefits of this first-hand"*.

Data: This group of researchers, acknowledge the benefits like citizen science can give border coverage and reach to diverse audience. A research says, *"citizen science projects do help reaching a bigger/more diverse audience - depending on the setup of course"*. These researchers further say citizen science can provide the wide range of data and better understanding about the topics of research. A research says, *"I am interested in citizen science mostly for two reasons: to process/reduce large amounts of data for analysis and to broaden understanding of conservation and nature and to broaden experience that might lead to changes in career"*.

However, these researchers agree data quality is an issue with citizen science and it takes lot of effort and time to coordinate with citizens to improve the quality. A researcher says, *""Data quality and sometimes detailed scientific precision can be lost. Coordinating citizen researchers takes a lot of time and effort to do it properly"*. Moreover, they also say that researcher needs to spend an additional time in ensuring data integrity when involving citizens. However, researchers do not think quality of research is impacted by citizens involvement in data collection. A researcher says, *"I don't think involving citizen researchers reduces the quality of the research"*.

Ethical issues: Towards ethical concerns these researcher say, ethical concerns are there in citizen science and it needs to be addresses. However, it cannot be reason not to use citizen science. A researcher says, *"In terms of ethics and exploitation concerns, these are important to recognise in terms of potential and that they need to be protected against - but it is not a reason not to use citizens in research"*. These researchers think that role of researchers is essential to ensure volunteer's rights and ethical concerns are safeguarded, these thoughts are similar to *factor 1*.

Funding opportunities: It is important to note that, for these researchers, increases funding opportunities is motivation to participate in citizen science for their research. A researcher says. *"funding opportunities are difficult to find and involving citizens can make some opportunities available that would otherwise not be"*.

About Volunteers: This group of researchers mention *"volunteers are only unpaid in monetary terms, but in fact should get considerable value from the experience"*. There-

fore, there is no need to compensate the volunteers and citizens should not be seen as free labourers.

4.2.3. INTERPRETATION OF FACTOR 3

Demographic information: Six researchers load significantly on *factor 3*. Out of six, four researchers have experience with citizens science and two researchers with no experience. We can consider this factor as voice of both experience and no-experienced researchers. The researchers with experience in citizen science are from domains of social science humanities, environmental science and Information science public administration. With the citizens participation level in these researchers' projects are of Level 3: 'Participatory science' and Level 4: 'Extreme Citizen Science' as per 'ladder of participation'.

Motivation statements:

Motivation statements with standardised scores		
M10	I am or would be motivated to involve citizens in my research because this increases the validity of my research compared to other research methods.	1.2
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	1.1
M14	I am or would be motivated to involved citizens in my research because this helps me to promote intra-group coordination.	0.7
M8	I am or would be motivated to involve citizens in my research because this allows me to address both scientific and societal concerns in my research.	0.6
M2	I am or would be motivated to involve citizens in my research because the data collected by citizens is of high quality.	0.5
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	0.4
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	-1.0
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	-0.2

Table 4.5: Standardised factor scores for motivation statements - *Factor 3*

Demotivation statements:

	demotivation statements with standardised scores	
D16	I am or would be demotivated to involve citizens in my research because the motivation of the citizen's declines as time progresses.	1.3
D18	I am or would be demotivated to involve citizens in my research because my motivation reduces as time progresses.	0.8
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	0.8
D10	I am or would be demotivated to involve citizens in my research because this has long-running projects.	0.4
D12	I am or would be demotivated to involve citizens in my research because it is time-consuming.	0.4
D6	I am or would be demotivated in involving citizens in my research as unpaid volunteers, I feel like I am making use of them as free labourers.	-2.5
D7	I am or would be demotivated in involving citizens in my research because this has a lot of ethical concerns.	-1.9
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	-1.6
D9	I am or would be demotivated in involving citizens in my research because this can lead to exploitation of volunteers.	-2.8

Table 4.6: Standardised factor scores for demotivation statements - *Factor 3*

LINKING TO THEMES IDENTIFIED IN LITERATURE

Common benefits & Data: Similar to Factor 1 and Factor 2 these researchers acknowledge the benefits that citizen science brings in the form of widespread data. Where a researcher say, *"Data is information. Having audience from a varied demographic would help gathering a wide range of information across borders"*. Further these researchers endorse the benefits citizen science brings to societies through participation from local communities. In an open statement a researcher says. *"citizen science helps me fill the research gap, enhance my knowledge (conceptual theoretical, technical and empirical methods). Also, I address the important questions for the society"*. Moreover, researchers of this group say the local people start caring more about their research subject which allows them to reach more audience. *"Citizen science not only allows active participation but makes people to care more about the research topic/subject"*. These researchers agree citizen science can give them massive and wide spread data.

Ethical concerns:These group of researchers strongly believe that the volunteers are not exploited or used as free labourers in citizen science. These researchers find citizen science increases trust among the citizen on scientific studies, but the validity of the method is still a concern due to poor standards and practises.

About Volunteers: Researchers of this group acknowledge that citizen motivation drops as the duration of the project increases. A researcher mentions, *"It is hard to keep citi-*

zen researchers motivated, dropout rates are high". To compensate these dropouts, they need to look for new recruit of citizens to get the project going. Moreover, sometimes it also gets challenging for researchers to find citizens who are interest to get involved, this can make the process time consuming, researchers says *"It can be difficult to find citizens who are willing to be involved in scientific research. Therefore, I stated it is time-consuming"*.

Funding opportunities: Researchers of this group think there is lack of scientific appreciation to citizen science and there are low funding opportunities available for the research at the institutional level.

4.2.4. INTERPRETATION OF FACTOR 4

Demographic information: Four researchers load significant on *Factor 4* and all four of them have no experience with citizen science, for which these perspectives can be considered as perspectives of researchers who has no experience with citizen science.

Motivation statements:

	Motivation statements with standardised scores	
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	1.4
M2	I am or would be motivated to involve citizens in my research because the data collected by citizens is of high quality.	1.4
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	0.6
M6	I am or would be motivated to involve citizens in my research because this type of research may lead to new funding opportunities.	0.6
M14	I am or would be motivated to involved citizens in my research because this helps me to promote intra-group coordination.	-0.9
M9	I am or would be motivated to involve citizens in my research because they can bring new ideas into the study.	-0.3

Table 4.7: Standardised factor scores for motivation statements - *Factor 4*

Demotivation statements:

	demotivation statements with high standardised scores	
D10	I am or would be demotivated to involve citizens in my research because this has long-running projects.	1.6
D11	I am or would be demotivated to involve citizens in my research because of long-running projects, I need to continually look for new volunteers to keep my project going.	1.6
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	0.9
D18	I am or would be demotivated to involve citizens in my research because my motivation reduces as time progresses.	0.8
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	0.5
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	-2.1
D3	I am or would be demotivated in involving citizens in my research because this leads to reduced scientific output.	-2.0
D4	I am or would be demotivated in involving citizens in my research because this adds no value to my research; instead, it reduces my research quality.	-1.7
D5	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	-1.7

Table 4.8: Standardised factor scores for demotivation statements - *Factor 4*

LINKING TO THEMES IDENTIFIED IN LITERATURE

Common benefits: For this group of researchers, citizen science can be beneficial to science and society. A researcher says, *"This would make the research beneficial for entire world"*. With involvement of citizen in the research, the researchers feel they can design new ways to address the societal concerns. Moreover, researchers also stated, *"citizen science can enriches the research with the community perspective, including valuable information about how they would like to address the situation that is being studied"*. Additionally, citizen science research can entice interest among the citizens, which can inspire them to pursue careers in the fields of research.

Data: Researchers feel that in certain cases, citizen science cannot to be solution for them to collect data, for example a researcher said, *"In my research area of earth sciences, most of the data can be gathered by experts only. Therefore, involving citizens may not help me much"*. Moreover, researchers expressed that data collected by citizen science is not of the quality, which they need for research, so they cannot use citizen science for their research. *"I required a long time series of hydroclimatic variables of high quality and data collection by citizens may not have the requirements that I need to complete my studies"*. Further researcher also stated, *" Common citizen may not be able to maintain the protocol for data collection in my research"*. Besides, some research projects needs

skilled and trained people to collect details sampled information. A researcher revealed, *"Data quality in is one of the most important parts of my research and only trained people can collect them. Therefore, involvement of common people may lead to compromise with the quality of the data. I need many detailed information of the samples for my research which a common person may not provide"*.

4.2.5. INTERPRETATION OF FACTOR 5

Demographic information: Fours researchers significant load on *Factor 5* and this perspective is considered as perspective of researcher with no experience in citizen science as all these researchers have no experience with citizen science, which is identical to *factor 4*.

Motivation statements:

Motivation statements with standardised scores		
M15	I am or would be motivated to involved citizens in my research because this allows me to address a wide range of research questions.	1.3
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	0.9
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	0.7
M9	I am or would be motivated to involve citizens in my research because they can bring new ideas into the study.	0.7
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	0.3
M2	I am or would be motivated to involve citizens in my research because the data collected by citizens is of high quality.	-2.7
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	-0.9
M7	I am or would be motivated to involve citizens in my research because that allows me to keep my research question flexible, as I can collect almost any type of required data.	-0.7

Table 4.9: Standardised factor scores for motivation statements - *Factor 5*

Demotivation statements:

	demotivation statements with standardised scores	
D1	I am or would be demotivated in involving citizens in my research because I lose control over my data, as data is collected by many volunteers.	2.1
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	1.4
D7	I am or would be demotivated in involving citizens in my research because this has a lot of ethical concerns.	1.0
D13	I am or would be demotivated to involve citizens in my research because this leads to data that is hardly reusable for other researchers.	0.8
D8	I am or would be demotivated in involving citizens in my research because this includes too much paperwork.	0.5
D4	I am or would be demotivated in involving citizens in my research because this adds no value to my research; instead, it reduces my research quality.	-2.1
D5	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	-1.6
D6	I am or would be demotivated in involving citizens in my research as unpaid volunteers, I feel like I am making use of them as free labourers.	-1.4

Table 4.10: Standardised factor scores for demotivation statements - *Factor 5*

LINKING TO THEMES IDENTIFIED IN LITERATURE

common benefits : The researchers of this group agree citizen science promotes scientific literacy among the local people and local people can bring new ideas and insights to their studies. A researcher says, *"I think that involve citizens helps to find another point of view to my research that I may not include before their opinion"*. And researchers also thinks, *"involving citizens and by providing a background of the research may ignite their interest in the concerned field and address certain societal problems, by interactive sessions"*. Which is alike the thoughts of the researcher from the *factor 4*. Moreover researchers of this group also think citizen science can help to democratise science, *"To democratise science is also a challenge, a guy in a developing country can be interested in research carried out in developed countries. It helps that knowledge flows"*.

Data: For these researchers, the strong motivation for using citizen science is that this allows them to collect widespread massive data and through which they can address number research questions. A researcher says, *"Involving citizens in scientific research at data collection level, may enable us to collect enormous amount of data which may address a number of research questions"*. However, data quality issue is of more concerns in citizen science and this low quality can lead to poor research output, *"Reliability of data is a question, when collected by citizens, who are not aware of the importance of it and this may lead to low standard of research"*.

However, researcher of this group think citizen science data can be standardised with the available methods, but it needs lot of coordination among the researchers community, *"There are exiting methods to standardise the information. I don't think everybody*

needs the data in the same structure, but at least the protocol to organise and make it accessible need the coordination with other researchers". Moreover, poor quality of data collection is not due to broader involvement of the public; instead it reflects poor design of research from the researchers. *"Lack of standardisation and of re-usability of the data is a reflection of poor design by the researchers rather than of mistakes made by citizen researchers"*.

Intellectual property & About volunteers: Researchers of this group do not see loss of control over the data as issue. These researchers think citizens motivation reduces due to long duration of projects and may force to look for new volunteers. *"Citizens may lose their interest over time, leading to search for new volunteers"*. And further, it gets difficult to get funding if duration of project increases and citizen science can act as alternative source to get data in low costs. *"Long time projects are not funded by many leading to alternative source to make up for the expenses"*.

INTERPRETATION OF FACTOR 6

Demographic information: Five researchers load significantly on *factor 6*, out of which three have experience with citizen science, and two do not have experience with citizen science.

Motivation statements:

	Motivation statements with standardised scores	
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	2.5
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	1.8
M4	I am or would be motivated to involve citizens in my research because I can reach out to a broader audience worldwide.	1.9
M8	I am or would be motivated to involve citizens in my research because this allows me to address both scientific and societal concerns in my research.	1.3
M9	I am or would be motivated to involve citizens in my research because they can bring new ideas into the study.	0.6
M7	I am or would be motivated to involve citizens in my research because that allows me to keep my research question flexible, as I can collect almost any type of required data.	-1.6
M5	I am or would be motivated to involve citizens in my research because I can make a balance between scientific research and science education at the same time.	-1.2

Table 4.11: Standardised factor scores for demotivation statements - *Factor 6*

Demotivation statements:

	demotivation statements with standardised scores	
D3	I am or would be demotivated in involving citizens in my research because this leads to reduced scientific output.	0.9
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	0.8
D14	I am or would be demotivated to involve citizens in my research because this has poor standardisation for reporting and presenting data.	0.4
D6	I am or would be demotivated in involving citizens in my research as unpaid volunteers, I feel like I am making use of them as free labourers.	0.2
D1	I am or would be demotivated in involving citizens in my research because I lose control over my data, as data is collected by many volunteers.	-2.0
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	-1.2
D16	I am or would be demotivated to involve citizens in my research because the motivation of the citizen's declines as time progresses.	-1.4

Table 4.12: Standardised factor scores for demotivation statements - *Factor 6*

LINKING TO THEMES IDENTIFIED IN LITERATURE

Common benefits: Researchers stress on better communication between the citizens and the researchers, *"Because I believe that it is important to better communicate to citizens what researchers are doing"*. Beside, for these researchers involvement of citizens can bring new ideas to the research, and can provide a better understanding of the problem, as public concerns are addressed through citizen science research. Moreover, citizen science can position the scientific research in a unique way that can lead a path to advanced scientific discoveries, that would not have been possible. Researcher says, *"Citizen science enables the design of projects that are uniquely positioned to advance discovery in ways that I could not do alone, and to be relevant to the volunteers engaged in the project"*. These thoughts are is similar to thoughts of researchers from *factor 3*.

Data: This group of researchers think data quality issues are a concern in citizen science, due to which publishing research conducted in citizens science is challenging. researcher says, *" I find it more challenging to publish research discoveries from citizen science than conventional methods."*

Ethical concerns: These researchers acknowledge that there are ethical concerns related to participation of the citizen and which requires lot of paperwork to be done for approval and which is cumbersome process. A researcher mentions, *"I've cancelled two citizen science projects before because of the amount of paperwork involved related to studies of human subjects"*. Moreover, these researchers also think citizen science projects are time consuming and of long-duration projects that needs lot of effort, *"It is definitely a big investment of time, energy, multiple types of skills, etc, that make it challenging, especially over long term. As researchers, I'm accountable to more people when I run a citizen science project"*.

About Volunteers: This group of researchers emphasise there is need to compensate the citizens with recognition, *"The needs of the stakeholders may be met by the project but they still need to be compensated for their and given credit for the outcomes"*

4.2.6. INTERPRETATION OF FACTOR 7

Demographic information; Three researchers significantly load on Factor 7 and all the researchers are experienced in citizen science. One researcher is from discipline of Environmental science, one from Health and well being discipline and one form Biological Sciences discipline.

Motivation statements:

	Motivation statements with standardised scores	
M13	I am or would be motivated to involve citizens in my research because this allows me to collaborate with local people in addressing real societal problems.	1.4
M11	I am or would be motivated to involve citizens in my research because it enables me to promote scientific literacy among the public.	1.1
M4	I am or would be motivated to involve citizens in my research because I can reach out to a broader audience worldwide.	1.0
M8	I am or would be motivated to involve citizens in my research because this allows me to address both scientific and societal concerns in my research.	0.5
M12	I am or would be motivated to involve citizens in my research because this increases citizens' trust in scientific research compared to other forms of research.	0.4
M1	I am or would be motivated to involve citizens in my research because this allows me to collect massive widespread data, without additional funding.	-3.4
M7	I am or would be motivated to involve citizens in my research because that allows me to keep my research question flexible, as I can collect almost any type of required data.	-2.1
M3	I am or would be motivated to involved citizens in my research because it enables me to conduct research projects that would otherwise not have been possible.	-1.0

Table 4.13: Standardised factor scores for motivation statements of *Factor 7*

Demotivation statements:

	demotivation statements with high standardised scores	
D12	I am or would be demotivated to involve citizens in my research because it is time-consuming	1.1
D17	I am or would be demotivated to involve citizens in my research because this is confusing due to no standard terminologies.	0.9
D15	I am or would be demotivated to involve citizens in my research because the long duration reduces the funding from investors as they lose the excitement about the project as time progresses.	0.8
D9	I am or would be demotivated in involving citizens in my research because this can lead to exploitation of volunteers.	0.7
D14	I am or would be demotivated to involve citizens in my research because this has poor standardisation for reporting and presenting data.	0.6
D1	I am or would be demotivated in involving citizens in my research because I lose control over my data, as data is collected by many volunteers.	-2.1
D2	I am or would be demotivated in involving citizens in my research because this leads to data quality issues.	-0.6

Table 4.14: Standardised factor scores for demotivation statements of *Factor 7*

Common benefits & Data: Researchers of this group acknowledge that citizen science provides them with massive widespread without less funding, *"I can use large volume of data both at temporal and spatial scale without having any proper research funding"*. These researchers also find citizen science projects as *win-win* situation, where researchers can achieve their research goals and citizens can learn about science, *"Citizen science projects are win-win situation both for researchers and project investigators"*. Moreover, these researcher also acknowledge the democratic nature of citizen, where a researcher says, *"Increasing the awareness and learning of citizens about the research process as well as enabling me to outreach to all communities regardless of demographic and social background"*. And empowering the people with science is true motivation for these researchers, *"What motivates me is making science accessible to all and the empowerment of people not only to become involved but for them to lead research"*.

These researchers see citizen science as an opportunity to collaborate with citizens, and this encourages the citizens to get inspired, which promotes the volunteers to pursue careers in the field of interest. These researchers also express the importance of coordination and mutual benefit between researchers and citizens, *" would feel guilty if there was no gain for those involved and it only benefited me"*.

Ethical concerns: With all the above-discussed benefits, these researchers also agree there are ethical concerns are there with citizen science and it is demotivating for them, *"Yes, there is some ethical issues regarding copy right of photographs, data and they are the only demotivating areas relates to the exploitation of volunteers"*.

About volunteers: Researcher also express that it is more work to involve citizen in research which makes projects of long. In turn reduces the motivation of citizens, *"Yes, I noticed that volunteer's loose interest once they learn research technique"*.

4.3. DISTINCT PERSPECTIVES OF RESEARCHERS ON PARTICIPATION IN CITIZEN SCIENCE

In this section the interpreted factors are given perspective names and are summarised based on what each perspective express about participation of researchers in citizen science.

PERSPECTIVE 1 : LEADERS OF SCIENTIFIC PROCESS

These researchers reveal that, they are more enthusiastic and optimistic about using citizen science in their research. They see themselves as leaders of scientific process and they want to maintain this status. These researchers want to use citizen science to promote scientific literacy in the society, so it can increase scientific trust among citizens. These researchers do not find any in citizens science to be potential blockers or inhibitors, that can impact their participation in citizen science. One of researcher states *"The statements that I've disagreed with are all statements that I think citizen science has potential to address so they are not demotivating factors for me"*.

PERSPECTIVE 2: COMMUNICATING SCIENCE IN BETTER WAY

For these researchers, citizen science provide balance with science and education. Also present science in a better way among the citizens, that change citizens attitudes towards contested topics. Strong motivation to choose citizen science is to promote the education among the citizens and young generation. Researchers feel citizen science can provide the students with more practical information about scientific research. Where researcher reveal, *"Since in Indian Education system, we do lot of classroom teaching and students hardly get enough field exposure. So being a Citizen researcher give them immense motivations and learn actual scientific process"*.

PERSPECTIVE 3: UNDERSTAND CITIZENS PROBLEM IN BETTER WAY & COMPENSATING CITIZENS IN BETTER WAY

For these researchers citizen science provides an opportunity to directly get feedback from the citizens, which allows them to better understand the problems that citizens face. A researcher says *"citizen science allows me to better understand the problems they face and what improvements still need to be made"*. These researchers also thinks citizens needs to be compensated for their efforts. Researcher mentions, *"I do wish there were more opportunity to compensate citizen researchers. I would wish to do this if I regularly worked with a specific set of individuals"* Moreover, they also believe that long duration of projects reduces their personal motivation and the motivation of the citizens. Besides long duration also reduces the funding from the investors.

PERSPECTIVE 4: CITIZEN SCIENCE IS NOT SUITABLE FOR ALL RESEARCH

These research clearly state that citizen science is not suitable method for their research and citizen science cannot provide them the required data they need for research. Researchers have no motivation to involve citizens in research as they think citizens are not equipped to collected data which they require for their research. A researcher expresses this in an open statements, *"Not all types of data can be collected involving citizens. Citizens are knowledgeable in many areas, but usually not regarding scientific problems or other problems I address in my research"*.

PERSPECTIVE 5: CITIZEN SCIENCE IS TOO MUCH OF EFFORT

These researchers think citizen science is time consuming and it needs lot of effort from the researcher's end. *"It requires additional efforts that probably are not considered beforehand. So, planning is affected the most. The time and how people are involved in the projects can represent a major challenge. Research depends on tightly agendas, so the data gathered needs to be also part of the planning. Or even more planning"*.

PERSPECTIVE 6: ESTABLISH EQUAL STATUS BETWEEN CITIZENS AND RESEARCHERS

The researcher stress need of equality and balance in relations between the stakeholders, especially among the citizens and researchers. A researcher's states, *"Equality is my largest concern; the needs of the stakeholders may be met by the project"*. Moreover, they say robust communication between the researcher and citizens is needed for success of citizens science projects. Open statement says, *"As a conservationist, I know that without the buy-in of local populations success is likely limited"*.

PERSPECTIVE 7: EMPOWERING CITIZENS & ADDRESSING THE CONCERNS

For these researchers empowering citizens by promoting knowledge and awareness among the citizens is chief motivation. However, they are demotivated by the ethical concerns and long duration in citizen science projects, that is stopping theses researchers from participating in citizen science projects.

4.4. GROUPS IDENTIFIED BASED ON INCLINATION TO PARTICIPATE

Over all these seven perspectives are grouped under three distinct group based on their inclination towards participation in citizen science. Moreover, it is interesting to see these groups exactly coincide with the experience of researchers group with participating in citizen science projects.

GROUP 1: INTRINSIC MOTIVATION TO PARTICIPATE

These researchers have intrinsic motivation to participate in citizen science projects. These researchers want to participate in citizen science projects due to their enthusiasm and interest to promote the benefits that citizen science promises to offer. They also see themselves as the drivers of scientific knowledge and they see it is their job to promote scientific research.

GROUP 2: NO MOTIVATION TO PARTICIPATE

These researchers, do not want to involve citizens in their research or participate citizen science projects, as they do not find citizen science to be suited for their research. They think citizens are not well trained or equipped to collect or analyse data for them. Moreover, they also see that involving citizen has lot of effort in coordination and planning, which they do not want to put in.

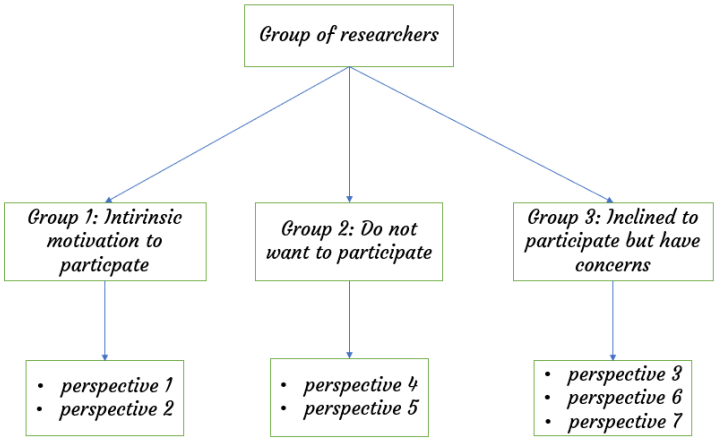

Figure 4.1: Group of researchers identified based on perspectives

GROUP 3: INCLINED TO PARTICIPATE BUT STOPPED CONCERNS

These Researchers are interested to participate in citizen science projects, because of their interest to use the benefits of citizen science to empower the citizens. However, they are inhibited by potential concerns involved in citizen science. Especially related to data quality issues, ethical concerns and exploitation of citizens.

4.5. APPLICATION OF RESULTS TO ENHANCE PARTICIPATION

In this section results are applied to enhance participation of researchers in citizen science, which is the main motive the research. Three group of researchers are identified, among the three different groups it is clear that, group 1 - has intrinsic motivation to participate in citizen science and they want to participate in citizen science project with their desire to promote the benefits of citizen science among the society and the citizens. They also want to maintain the status as leaders of scientific process. Therefore, these researchers are going to participate in citizen science. The group 2 - researchers do not have any motive to participate in citizens science, as they do not see any motivation to use citizen science as research method in their projects. This implies that these researchers are not going to participate in citizen science projects. The group 3 - researchers are inclined to participate in citizen science projects, however they have certain inhibitors that prevent them from participation in citizen science. If these inhibitors can be address participation from these group of researchers can be increased. Therefore, there is need to focus on this researchers' group.

Moreover, the compensation of researchers and the compensation of the citizens in citizen science projects is controversy identified in the perspectives that needs to be addressed in future citizen science projects. As these controversies can impact participation in citizen science projects. Few researchers think there is need to compensate the citizens for their effort in citizen science, while other researchers think there is no need to compensate them, as they are learning valuable skills through citizen science. However,

other group researchers argue that, even researchers take up tasks like coordination and mentoring in citizen in these projects which is an extra work for researchers. The extra load on researcher reduces their quality of work. For taking up extra load the researchers are not compensated. Therefore, there is need to address these kind of controversies

4.6. SUMMARY

Sub-question-3 of the research is answered in this chapter, *What distinct perspectives are identified among researchers to participate in citizen science projects?*. Factors identified form *Q-factor analysis* are interpreted in detail based on the information available and are linked to five themes: (1) common benefits, (2) data, (3) about volunteers, (4) new funding opportunities, (5) intellectual property ethics, identified in the literature review (see section 2.3). These seven factors reveal the perspectives of researchers to participate in citizens science projects. These seven perspectives are classified in three broad groups based on their inclination to participate. It is interesting to these groups exactly coincide based on experience of the researchers in citizen science. **Group 1**: Intrinsic motivation to participate in citizens science projects, revealed by combination of *perspective 1 and perspective 2*, associated to researchers who have experience with citizen science. **Group 2**: No motivation to participate in citizen science projects, revealed by *perspective 4 perspective 5* , associated to the researchers who have no experience with citizen science. **Group 3**: researchers interested to participate in citizen science projects, but are inhibited by potential concerns, this is revealed by combination of *perspective 3, perspective 6 and perspective 7*, associated to both researchers with experience and no experience in citizen science. These results are applied to see how participation of researchers in citizen science projects can be enhanced. After answering all the question of the research, in next chapter conclusion of the research is presented.

5

CONCLUSION

This chapter concludes the research by presenting all finding of the research. The chapter is divided into six sections. Section 5.1, presents the findings and conclusion related to specific sub-questions and main research question. Section 5.2 provides policy recommendations to actors, namely, citizen science associations, policy institutions and researchers. Section 5.3, discusses contribution of the research. Section 5.4 and 5.5 discusses the limitations of the research and future recommendations respectively. Finally, section 5.6, shows an association of this research to the MSc programme of the Engineering Policy Analysis (EPA)

5.1. CONCLUSIONS REGARDING THE RESEARCH QUESTIONS

This section summaries answers to the sub-questions and the main research question.

Sub-question 1: How citizen science is defined according to the literature?

Seven different types of citizen science projects are identified based on engagement between *high-level involvement* actors. These projects were classified by combining two criteria: (1) who are the knowledge creators and (2) goal of the project. These projects are (1) *Contributory projects* where researchers play major role in knowledge creation, citizens basically perform data collection activity and they are focused on traditional way of answering scientific questions. (2) *Contractual projects* are like contributory projects, but they are focused towards answering societal issues faced by citizens. (3) *Collegial projects* were knowledge producers are citizen and role of researchers is to primarily support citizens. Focus of the projects is to answer traditional scientific questions. (4) *Action-projects*, these projects are similar to collegial projects in locus of knowledge creation, but they are focused towards answering societal problems. (5) *Education projects* were knowledge producers are citizen, role of researchers is to primarily support and facilitate educational activities. (6) *Collaborative projects* (7) *Collaborative projects* where both scientist and citizens are equal contributors of knowledge and these projects are example of higher model of collaboration. The actors equally contribute and assist each

other, throughout the span of project. These projects can be used to solve both societal and scientific questions.

Sub-question 2: What factors (aspects) motivates researchers to participate in citizen science projects?

Overall, the aspects that were predominantly discussed in the literature of citizen science are grouped in *five themes* for easy understanding and simple presentations. Theme 1: *common benefits*, this theme comprises of aspects with benefits of citizens that are commonly discussed in the literature of citizen science such as: Citizen science promotes scientific literacy, democratisation of science, increases trust about scientific research in society and address societal problem of the citizens. Theme 2: *data*, aspects related to the benefits and challenges of data in citizen science projects are grouped here. For example vast and diverse quantity can be collected by citizens. Citizen science data has low quality as it is collected by non-experts (citizens). Theme 3: *new funding opportunities*, aspects related to funding opportunities towards citizens science projects are grouped under this theme. Theme 4: *about volunteers (citizens)*, aspects pertaining to citizens involved in these projects are gathered in this theme. For example, volunteers are like 'free labours', volunteers needs to be compensated in citizen science initiatives, motivation reduces as duration of projects increases. Theme 5: *intellectual property ethics*, aspects related to issues that comes with involvement of citizen's in research are grouped in this theme. For example, privacy issues, ethical concern and concerns related to data ownership, data sharing are gathered in this group.

However, it is important to note, these themes may seem abstract and overlapping with each other to some extend, which is did on purpose, to capture as much as heterogeneity as possible. . As the principal aim of these themes were to develop concourse for the Q-method. Form the concourse a set of 33 Q-statements are formed, that can bring out the attitude of the researchers to participate in citizen science.

Sub-question 3: What distinct perspectives are identified among researchers to participate in citizen science projects?

Overall, seven distinct perspectives are identified, these perspectives are grouped into three distinct groups, based on inclination of researchers to participate in citizens science projects. **Group 1**- perspective of researchers who have intrinsic motivation participate in citizen science projects, it is seen that these researchers will participate in citizens science by their own. These researchers already have experience in citizen science projects and interested to be part of it in future. **Group 2**- perspective of researchers do not find citizens science appropriate for their research and they cannot answer their research questions with citizen science. Therefore, researcher of this group are expected not to participate in citizen science projects. It is obvious these researchers do not have experience in citizen science and find no motivation to participate in future. **Group 3**- perspective of researchers are inclined to participate in citizen science projects and they want to and are using citizen science projects to help citizens in better way. Additionally, they also want to empower citizens and establish equal status between researchers and citizens. Besides, they want to compensate citizens for their effort in citizen science projects. However, these researchers find concerns such as ethical issues and exploitation of volunteers as inhibiting factors that reduces their participation. This group of re-

searchers have combination of both experienced and non-experienced researchers with citizens science projects.

Main research question: What latent perspectives of researchers in citizen science can be identified, which motivates them to participate in citizen science projects?

Perspective 1 – participation of these researchers is seen as enthusiasm and optimism towards citizen science. Researchers of this group want to establish and maintain themselves as leaders of the scientific process. Moreover, this group of researchers do not find concerns in citizen science to inhibit their participation in citizen science projects. One of participant states his opinion towards concerns in citizen science: *" think Citizen Science has the potential, so they are no demotivating factors for me"*. ***Perspective 2*** – participation of these researchers is to promote science in better way, that can change attitudes of citizens towards contested topics. Besides, for these researchers citizen science allow them to main balance between science and education. One of researchers say, *"Teaching through experience is a good way to educate and change perceptions, and more scientific literacy is important for global issues like climate change and conservation"*. ***Perspective 3*** – these researchers want to participate in citizen science projects to understand citizen's problem in a better way. For these researchers getting direct feedback from the citizens allows them to better understand the problems that citizens face. Researcher say, "it allows me to better understand the problems they face and what improvements still need to be made." These researchers want to find ways to compensate citizens in better way. A researcher says, *"I wish there were more opportunity to compensate citizen researchers. I would wish to do this if I regularly worked with a specific set of individuals"*.

Perspective 4 – researchers of this group do not want to use in citizen science projects for their research. As they think citizen science is not suitable method for their research and citizens are not well equipped for collecting data. Moreover, these researchers think citizen science is not suitable for all kind of research. One scientist says, *" In my research most of the data can be gathered by experts only. Therefore, involving citizens may not help me much"*. ***Perspective 5*** – Researchers of this group do not want to participate in citizen science projects because it is lot of effort from the researchers side. One scientist says *" this requires additional efforts that be considered beforehand and most of the time and how people are involved in the projects can represent a major challenge"*.

Perspective 6 – these researchers want to establish an equal relationship between citizens and researchers. These researchers emphasise on the building equality among the citizens and researchers. They also express the need of better compensation to citizens in form of recognition. One of the researchers say, *"Equality is my largest concern; the needs of the stakeholders may be met by the project, but citizens still need to be compensated for their and given credit for the outcomes"*. ***Perspective 7*** – These researchers want to participate in citizens science projects to empower citizens, but exploitation of citizens and ethical issues are their big concern. Researcher say, *"Yes, there is some ethical issues regarding copy right of photographs, data, etc." and "The only demotivating areas relates to the exploitation of volunteers"*.They are also demotivated by long duration of citizen science projects.

5.2. POLICY RECOMMENDATIONS

In this section, the insights gained from perspectives of researchers to participate in citizen science, are framed in form of generalised policy suggestion to actors namely: CSA, policy intuitions, researchers. These suggestions are framed in focus to CSA more, as they are identified as problem owners, who want to encourage use of citizen science. However, it is essential to note these suggestions can vary based on the specifics of the projects. These suggestions are discussed in following:

CITIZEN SCIENCE ASSOCIATIONS

(1) Promote citizen science through common benefits and science education

In this section two general idea which citizen science association can use to promote participation from researchers are discussed. One, use common benefits of citizen science as key banner to promote participation in citizen science projects. The reason for this is, researchers of all groups predominantly agree on common benefits that citizen science brings to science and society. Two, promote citizen science through practitioners of science communication, as these researchers see citizen science as effective way to promote science communication. This will present citizens science from institutional level, to young budding researchers. Moreover, this can motivate even citizens to take research in topics of their interest.

(2) Reduce the paperwork and other efforts involved in citizen science

Researchers participating in the research said, they had cancelled quite a few projects due to the large amount of paperwork which comes by involving citizens in research. Citizen science association needs to find new ways to ease the paperwork and other burdens similar to this from researchers. Either by setting up a third party outsourcing platforms or setting up proper guidance and information centres. Where researchers can get their paperwork and other formalities be taken care of. These suggestions can reduce the load from researchers and promote participation.

(3) Increase scientific appreciation for citizen science

Citizen science association should ensure that enough support to citizen science is given at institutional level, so that researchers and citizens participating in citizen science are rewarded for participation. Researchers also feel that there is a lack of funding and support for citizen science at an institutional level. Moreover, researchers mentioned, promoting citizen science from school can give students more chance to understand science in better way.

(4) Address data quality issues

Data quality issues in citizen science is primary concerns for researchers who wish to use citizen science. Therefore, citizen science association needs to address this data quality issues by either effectively assist in training of citizens by providing training sessions or involving data quality analyst team in the initiatives to reduce the burden on researchers that comes with data quality.

INSTITUTIONS FRAMING ETHICAL POLICIES

Researchers perceive the ethical issues as one of demotivation that impacts their participation in citizen science, which needs to be addressed to see enhanced participation. In

ethical concerns, institutions framing policy related to this must frame strict, clear and transparent compliance policies. Through a dialogue involving researchers and citizens. As researchers think that the ethical issues are due to poor support from the researchers to the citizens. Therefore, a dialogue with researchers while framing the ethical polices can make researchers feel their views are considered. That can give them confidence that they are contributing to improve the ethical concerns in citizen science.

RESEARCHERS

Researchers need to be vocal about the extra burden that comes with long duration citizens science projects. Especially in long running projects, where volunteers drop rate is high, researchers mentioned, long duration makes it challenging for them, to make up for citizens, when more citizens drop out in between projects. Moreover, long duration also, affects motivation of individual researchers.

5.3. CONTRIBUTIONS OF THE RESEARCH

This section discusses contribution of the research towards science and society. The section is divided in two subsections, 6.4.1 discusses scientific contributions, then follows the societal contributions in the 6.4.2

5.3.1. SCIENTIFIC CONTRIBUTION

This research offers critical scrutiny of available literature on perspective of researchers in citizen science. As this research compares what is said in the literature about researchers participation in citizens science projects with the on ground thoughts of researchers. In literature the participation of researchers is seen as drive to enhance scientific literacy and increase awareness in the society, our identified perspectives acknowledges the same. The *perspective -1* is consistent with the literature findings.

Moreover, this research adds valuable literature to field of citizen science that provides independent look into perceptive of researchers to participate in citizen science. Three latent perspectives of researchers are discussed, that are not much discussed in the literature of citizens science. One, researchers find, additional work that they have to do in citizens science projects demotivating and few researchers have cancelled their projects due to these burdens. Two, there is disagreement among the researchers about the compensation of the citizens involved in citizen science projects. Three, citizen science projects are known to be of Long duration, however the long duration is affecting the motivation of both researchers and citizens in citizen science projects.

Furthermore, this research identifies two controversies that can be scope of new research by itself. One, controversy of compensation of citizens in citizens science projects. Some researchers agree there needs to be compensation for citizens, some disagree on that. Two, different models of science communication is identified in citizens science. In perspectives 6 & 7, many researchers voices about the importance of establishing equal relationship between researchers and citizens. In contrary perspective 1, researchers want to establish themselves as leaders of scientific process, which shows there still exists hierarchy in science between researchers and citizens. It will interesting to research how to blend these two models.

Finally, use Q-methodology in this research and rich results produced form this method can open door for future studies in citizen science to use mixed research methods.

5.3.2. SOCIETAL CONTRIBUTION

The policy recommendations for citizen science associations and other policy making institutions, give insights on how improve participation of researchers in citizen science. As we know, the improved participation from researchers is essential to achieve ambitious targets set by policymakers, towards solving complex and grand challenges of the present time. Through achieving an improved participation this research will avert wastage of resources that are invested by policy makers on citizen science projects and support thriving ongoing benefits of citizen science to the society.

5.4. LIMITATIONS OF THE RESEARCH

Results reported in this research should be considered in the light of some limitation. The limitations are grouped under three: (1) Research focus, (2) literature choices, (3) Methodology choices.

Research focus: focus of research was kept broad, by considering different disciplines and accommodating both researchers (experience and not experienced) in citizen science across the world. That led to no concrete conclusions to be drawn from the research, towards specific discipline or locations.

Literature choices: focusing on Bonney (1996) definition of citizen science, that is on engagement between the high-level involvement actors in citizen science, led to exclusion of citizen science projects that fall under Irwin (1995) definition of citizen science. Moreover, choice of focusing on five themes of aspects, that were prominently discussed in literature has preceded to possibility that some of the aspects of motivation and lack of motivation (demotivation), to be left out.

Methodology choices: choice of using free distribution over forced distribution to reduce the time of the survey, has led to low variance between perspectives, which shows the researchers were not much involved in answering the survey. Moreover, choice of conducting online surveys and 66% completion rate of survey, shows online surveys have low completion rate.

5.5. RECOMMENDATIONS FOR FUTURE RESEARCH

To overcome the limitations of the research, three potential recommendations for future are discussed under this section. First, targeting either specific discipline of science, like, ecology, nature conservation, astronomy etc. Or specific level of participation in M. Haklay (2013) *'ladder model'* of participation. These can get results that can make concrete conclusions to specific discipline or level of engagement. However, targeting specific disciplines or specific level of participation can reduce the number of participants for the research. This leads to second recommendation, that is to use in-person surveys and forced sorting over Q-grid, compared to online surveys and free sorting, used in this research. These can ensure participants are actively involved in research and provide enrich result.

Third, conducting post interpretations interviews with the significant loading researchers of each factor can lead to sounder verification of the conclusions. As it can be argued, that there will always be some amount of bias from researcher in interpretation of the data, based on his own subjective viewpoints. It is important to note, these recommendations can be time expensive.

5.6. CONNECTION TO THE ENGINEERING & POLICY ANALYSIS MSC PROGRAMME

The research is related to Engineering & Policy Analysis (EPA) explicitly and implicitly, four reasons are argued in its support. First, this research is based on a *multi-actor environment*, where different actor's that are *researchers, citizens, policymakers, citizen science associations and private institutions*, Interact with each-other at social and scientific levels to achieve a desired goal or purpose (Enserink et al. 2010). Two, this research investigates perspective of the researchers, and suggest policy to decision makers such as citizen science associations and policy institutions, to make informed and improved decisions to enhance researcher's participation in citizen science projects. Which is core notions of EPA, to assist decision makers to make informed and improved decision making.

Third, *Q-method* that is used in the research is directly not related to courses thought in EPA programme, yet the essence of the method is analytical and interpretations of factors to identify the perspectives of the actor is on the ground teaching of EPA. Fourth, the research in its own address a grand challenge, by enhancing participation form researchers in citizen science. That is crucial for the success of these projects and avert wastage of resources that were invested on citizen science. As more policy making institutions such as US National Science Foundation (NSF), European Union programs (e.g., Horizon 2020) are investing in high proportion towards citizen science (Chari, Blumenthal, and Matthews 2019), to promote projects that build effective cooperation between science and society.

REFERENCES

Akhtar-Danesh, Noori, Noeman Mirza, et al. (2017). "Relation between manual rotation and abductive reasoning in Q-methodology". In: *Open Journal of Social Sciences* 5.03, p. 198.

Anderson, David P et al. (2002). "SETI@ home: an experiment in public-resource computing". In: *Communications of the ACM* 45.11, pp. 56–61.

Barry, John and John Proops (1999). "Seeking sustainability discourses with Q methodology". In: *Ecological economics* 28.3, pp. 337–345.

Benessia, Alice et al. (2016). *Science on the Verge*. Consortium for Science, Policy & Outcomes Tempe, AZ and Washington, DC.

Besley, John C, Sang Hwa Oh, and Matthew Nisbet (2013). "Predicting scientists' participation in public life". In: *Public understanding of science* 22.8, pp. 971–987.

Bhattacharjee, Yudhijit (2005). "Citizen scientists supplement work of Cornell researchers: a half-century of interaction with bird watchers has evolved into a robust and growing collaboration between volunteers and a leading ornithology lab". In: *Science* 308.5727, pp. 1402–1404.

Boden, Rebecca and Debbie Epstein (2006). "Managing the research imagination? Globalisation and research in higher education". In: *Globalisation, Societies and Education* 4.2, pp. 223–236.

Bonney, Rick (1996). "Citizen science: A lab tradition". In: *Living Bird* 15.4, pp. 7–15.

Bonney, Rick, Heidi Ballard, et al. (2009). "Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report." In: *Online Submission*.

Bonney, Rick, Caren B Cooper, et al. (2009). "Citizen science: a developing tool for expanding science knowledge and scientific literacy". In: *BioScience* 59.11, pp. 977–984.

Brouwer, Marten (1999). "Q is accounting for tastes". In: *Journal of Advertising Research* 39.2, pp. 35–35.

Brown, Steven R (1980). *Political subjectivity: Applications of Q methodology in political science*. Yale University Press.

— (1993). "A primer on Q methodology". In: *Operant subjectivity* 16.3/4, pp. 91–138.

Caruana, Rich et al. (2006). "Mining citizen science data to predict orevalence of wild bird species". In: *Proceedings of the 12th ACM SIGKDD international conference on Knowledge discovery and data mining*, pp. 909–915.

Cavalier, Darlene and Eric B Kennedy (2016). *The rightful place of science: Citizen science*. Consortium for Science, Policy & Outcomes.

Chari, Ramya, Marjory S Blumenthal, and Luke J Matthews (2019). *Community Citizen Science: From Promise to Action*. RAND Corporation.

Cooper, Caren B et al. (2007). "Citizen science as a tool for conservation in residential ecosystems". In: *Ecology and society* 12.2.

Cornwall, Andrea and Rachel Jewkes (1995). "What is participatory research?" In: *Social science & medicine* 41.12, pp. 1667–1676.

Crall, Alycia W et al. (2013). "The impacts of an invasive species citizen science training program on participant attitudes, behavior, and science literacy". In: *Public Understanding of Science* 22.6, pp. 745–764.

Cronje, Ruth et al. (2011). "Does participation in citizen science improve scientific literacy? A study to compare assessment methods". In: *Applied Environmental Education & Communication* 10.3, pp. 135–145.

Dickinson, Janis L, Benjamin Zuckerberg, and David N Bonter (2010). "Citizen science as an ecological research tool: challenges and benefits". In: *Annual review of ecology, evolution, and systematics* 41, pp. 149–172.

Dörnyei, Zoltán (2001). "New themes and approaches in second language motivation research". In: *Annual review of applied linguistics* 21.1, p. 43.

Enserink, Bert et al. (2010). *Policy analysis of multi-actor systems*. Eleven International Publ.

Frickel, Scott et al. (2010). "Undone science: charting social movement and civil society challenges to research agenda setting". In: *Science, Technology, & Human Values* 35.4, pp. 444–473.

Fritz, Steffen et al. (2019). "Citizen science and the United Nations Sustainable Development Goals". In: *Nature Sustainability* 2.10, pp. 922–930.

Gallo, Travis and Damon Waitt (2011). "Creating a successful citizen science model to detect and report invasive species". In: *BioScience* 61.6, pp. 459–465.

Göbel, C, Victoria Y Martin, and MD Ramirez-Andreotta (2016). "Stakeholder analysis: international citizen science stakeholder analysis on data interoperability final report". In: *Washington DC: Woodrow Wilson International Center for Scholars*.

Golumbic, Yaela N et al. (2017). "Between vision and reality: A study of scientists' views on citizen science". In: *Citizen Science: Theory and Practice* 2.1.

Golumbic, Yaela Naomi (2015). "What makes citizen science projects successful, and what can we learn from them for future projects". In: *Technion Citizen Science Project (TCSP) report*, pp. 1–56.

Good, JMM (2000). "William Stephenson, Cyril Burt and the demise of the London school". In: *History and Philosophy of Psychology section of the British Psychological Society, Annual conference, University of Ripon and York St John, UK April*.

Goodchild, Michael F (2007). "Citizens as sensors: the world of volunteered geography". In: *GeoJournal* 69.4, pp. 211–221.

Grindstaff, Laura, John R Hall, and Ming-Cheng M Lo (2010). *Handbook of cultural sociology*. Routledge.

Haklay, Muki (2013). "Citizen science and volunteered geographic information: Overview and typology of participation". In: *Crowdsourcing geographic knowledge*. Springer, pp. 105–122.

Hermans, Leon and Scott W Cunningham (2018). *Actor and Strategy Models*. Wiley Online Library.

Hochachka, Wesley M et al. (2007). "Data-mining discovery of pattern and process in ecological systems". In: *The Journal of Wildlife Management* 71.7, pp. 2427–2437.

Ioannidis, John PA (2015). "How to make more published research true". In: *Revista Cubana de Información en Ciencias de la Salud (ACIMED)* 26.2, pp. 187–200.

Irwin, Alan (1995). *Citizen science: A study of people, expertise and sustainable development*. Psychology Press.

Kullenberg, Christopher and Dick Kasperowski (2016). "What is citizen science?–A scientometric meta-analysis". In: *PloS one* 11.1.

Lee, Tracy, Michael S Quinn, and Danah Duke (2006). "Citizen, science, highways, and wildlife: using a web-based GIS to engage citizens in collecting wildlife information". In: *Ecology and Society* 11.1.

Ligtvoet, Andreas et al. (2016). "New future perspectives through constructive conflict: Exploring the future of gas in the Netherlands". In: *Futures* 78, pp. 19–33.

Lukyanenko, Roman, Andrea Wiggins, and Holly K Rosser (2019). "Citizen science: An information quality research frontier". In: *Information Systems Frontiers*, pp. 1–23.

Mankowski, Trent A, Stephanie J Slater, and Timothy F Slater (2011). "An interpretive study of meanings citizen scientists make when participating in Galaxy Zoo". In: *Contemporary Issues in Education Research (CIER)* 4.4, pp. 25–42.

Marlanne, E (2005). "Environmental education through citizen science and participatory action research". In: *Environmental education and advocacy: Changing perspectives of ecology and education*, p. 292.

Martın-Sempere, Marıa José, Belén Garzón-Garcıa, and Jesús Rey-Rocha (2008). "Scientists' motivation to communicate science and technology to the public: surveying participants at the Madrid Science Fair". In: *Public Understanding of Science* 17.3, pp. 349–367.

Montanelli, Richard G and Lloyd G Humphreys (1976). "Latent roots of random data correlation matrices with squared multiple correlations on the diagonal: A Monte Carlo study". In: *Psychometrika* 41.3, pp. 341–348.

Moseley, Philippe (2017). "EU support for innovation and market uptake in smart buildings under the horizon 2020 framework programme". In: *Buildings* 7.4, p. 105.

Raddick, Jordan et al. (2007). "Galaxy Zoo: an experiment in public science participation". In: *AAS* 211, pp. 94–03.

Raddick, M Jordan et al. (2009). "Galaxy zoo: Exploring the motivations of citizen science volunteers". In: *arXiv preprint arXiv:0909.2925*.

Rask, Mikko Tapani et al. (2016). *Innovative public engagement: A conceptual model of public engagement in dynamic and responsible governance of research and innovation*.

Rauws, G (2015). "Public engagement as a priorty for research". In: *Edward Andersson, SB and Davis, H.,(eds.), Science, Society and Engagement, An e-anthology*, pp. 22–24.

Resnik, David B and Caitlin E Kennedy (2010). "Balancing scientific and community interests in community-based participatory research". In: *Accountability in research* 17.4, pp. 198–210.

Riesch, Hauke and Clive Potter (2014). "Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions". In: *Public understanding of science* 23.1, pp. 107–120.

Risdon, Andrea et al. (2003). “How can we learn to live with pain? A Q-methodological analysis of the diverse understandings of acceptance of chronic pain”. In: *Social science & medicine* 56.2, pp. 375–386.

Rotman, Dana et al. (2012). “Dynamic changes in motivation in collaborative citizen-science projects”. In: *Proceedings of the ACM 2012 conference on computer supported cooperative work*, pp. 217–226.

Roy, Helen E et al. (2012). “Understanding citizen science and environmental monitoring: final report on behalf of UK Environmental Observation Framework”. In:

Schäfer, Teresa and Barbara Kieslinger (2016). “Supporting emerging forms of citizen science: A plea for diversity, creativity and social innovation”. In: *Journal of Science Communication* 15.2, Y02.

Shirk, Jennifer L et al. (2012). “Public participation in scientific research: a framework for deliberate design”. In: *Ecology and society* 17.2.

Silvertown, Jonathan (2009). “A new dawn for citizen science”. In: *Trends in ecology & evolution* 24.9, pp. 467–471.

Soleri, Daniela et al. (2016). “Finding pathways to more equitable and meaningful public-scientist partnerships”. In: *Citizen Science: Theory and Practice. 1 (1): 9* 1.1.

Stephenson, William (1953). “The study of behavior; Q-technique and its methodology.” In:

— (1978). “Concourse theory of communication”. In: *Communication* 3.1, pp. 21–40.

Strasser, Bruno et al. (2019). “" Citizen Science"? Rethinking Science and Public Participation”. In: *Science & Technology Studies* 32.ARTICLE, pp. 52–76.

Theobald, Ellinore J et al. (2015). “Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research”. In: *Biological Conservation* 181, pp. 236–244.

Trumbull, Deborah J et al. (2000). “Thinking scientifically during participation in a citizen-science project”. In: *Science education* 84.2, pp. 265–275.

Tulloch, Ayesha IT et al. (2013). “Realising the full potential of citizen science monitoring programs”. In: *Biological Conservation* 165, pp. 128–138.

Watson, David and Luciano Floridi (2018). “Crowdsourced science: sociotechnical epistemology in the e-research paradigm”. In: *Synthese* 195.2, pp. 741–764.

Watts, Simon and Paul Stenner (2012). *Doing Q methodological research: Theory, method & interpretation*. Sage.

Wiggins, Andrea and Kevin Crowston (2011). “From conservation to crowdsourcing: A typology of citizen science”. In: *2011 44th Hawaii international conference on system sciences*. IEEE, pp. 1–10.

Wildschut, Diana (2017). “The need for citizen science in the transition to a”. In: *SCHOOL FIELD* 11.1, pp. 21–40.

Zabala, Aiora, Chris Sandbrook, and Nibedita Mukherjee (2018). “When and how to use Q methodology to understand perspectives in conservation research”. In: *Conservation Biology* 32.5, pp. 1185–1194.

A

APPENDIX A: ONLINE SURVEY

Defining citizen science for participants: Citizen science refers to all practices of where there is "public participation in scientific research". The use of citizen science for your research could include (but is not limited to) involving citizens as data gatherers, data analysts, question posers, question framers and amateur scientists. For more information please see https://www.youtube.com/watch?v=fQqkbH4h6YM

There are many successful citizen science projects in the various disciplines of science, some of them are: The Galaxy Zoo Milky way in the field of Astronomy; Penguin Watch in the field of Ornithology; Birds and Windows Project in the field of Ornithology, Conservation, Ecology; and many more. In case, you want to see more projects and their disciplines, please see https://en.wikipedia.org/wiki/List_of_citizen_science_projects

A.1. CATEGORISING QUESTION

These question are to categorises the researchers based on criteria: do they have previous experience with citizen science or not.

Question 1: Based on the above definition, have you ever involved citizens in your research?

- Yes
- No

(If answer to the above question = Yes, then the following questions are asked)

Question 2: What is your overall experience in years, involving citizens in your research? (e.g. as data collectors, data analysts, or question posers)

- 0-2 years
- 2-4 years
- 4-6 years
- 6-8 years
- 8-10 years

- Above 10 years

Question 3: Which topic areas does your project cover? (multiple answers possible)

- Space Science
- Applied Engineering Science
- Environmental science
- Social science Humanities
- Other, namely: .....

Question 4: What is/was the level of participation of volunteers in your research? (can have multiple answers)

- Level 1: *'crowdsourcing'*. Citizens are involved as sensors and/or conducting volunteered computing.
- Level 2: *''Distributed Intelligence'*. Citizens as basic interpreters and/or volunteered thinking.
- Level 3: 'Participatory science'. Participation in problem definition and data collection.
- Level 4: 'Extreme Citizen Science'. Collaborative science (problem definition, data collection and analysis)
- Other, namely: .....

A.2. SORTING QUESTIONS & OPEN STATEMENTS *(these questions are common for both group of researchers)*

Sorting questions are presented in section **??**3.5.1(see: Descriptive statistics of responses by the participants). The attitude of the participant is measured on 7-point *Likert scale*[1] from strongly disagree to strongly agree, the numbers signify attitudes as listed: *1-Strongly Disagree, 2-Disagree, 3-Slightly Disagree, 4-Neutral, 5-Slightly Agree, 6-Agree, 7-Strongly Agree.*

Open statements (OS): *After sorting set of statements participants are asked to share their reason for sorting statements in specific way*

OS for motivation: Please look at the statements that you have 'strongly agreed' or 'agreed' with. These are the motivations that strongly drive or would drive you to involve citizens in your research. What is your motivation behind agreeing or strongly agreeing with these statements?

OS for demotivation: Please look at the statements that you have 'strongly agreed' or 'agreed' with. These are the de-motivations that strongly drive or would drive you not to involve citizens in your research. What is your motivation behind agreeing or strongly agreeing with these statements?

[1] A Likert item is simply a statement that the respondent is asked to evaluate by giving it a quantitative value on any kind of subjective or objective dimension.

A.3. DEMOGRAPHIC QUESTIONS *(these questions are common for both group of researchers)*

These questions are to get background information of respondents.

Question 1: What is your age?

- 20 or younger
- 21-30
- 31-40
- 41-50
- 51-60
- 61-70
- 71 or older

Question 2: What is your gender?

- Male
- Female
- Prefer not to say

Question 3: Which category or categories best describe(s) your role? (multiple answers possible)

- Academic researcher
- Non-Academic researcher
- Other, namely .....

A.4. END OF SURVEY

Thank you for your time and input. Your response is invaluable.

If you would like to receive a summary of the findings of this survey, please provide your e-mail address below. Your e-mail address will only be used to send you a summary of the findings and it will be removed from our records after this has been done.

Email: .....

Your personal data will be deleted after completing this study. Furthermore, the (anonymity) findings of this study will be shared openly through the repository of the 4TU.Center for Research Data (see https://researchdata.4tu.nl/en/

B

APPENDIX B: DESCRIPTIVE STATISTICS

The table shows, the responses of individual participants towards the 33 sorting questions. The maximum and minimum say what has been the range of the section of choices ranging from 1 to 7 on *Likert scale*. The numbers on the scale signify attitudes as listed: *1-Strongly Disagree, 2-Disagree, 3-Slightly Disagree, 4-Neutral, 5-Slightly Agree, 6-Agree, 7-Strongly Agree.*

Participants	Minimum	Maximum	Mean	Std. Deviation	Variance
Par01	1.0	7.0	3.5	2.8	7.7
Par02	2.0	7.0	4.8	1.5	2.3
Par03	1.0	7.0	3.9	1.7	2.7
Par04	1.0	7.0	3.6	1.7	2.9
Par05	1.0	7.0	4.3	1.8	3.2
Par06	1.0	7.0	4.9	1.5	2.3
Par07	2.0	7.0	4.5	1.7	3.0
Par08	1.0	7.0	3.3	2.5	6.4
Par09	2.0	7.0	4.5	1.4	1.9
Par10	1.0	7.0	4.2	1.6	2.5
Par11	2.0	7.0	4.9	1.3	1.6
Par12	1.0	7.0	4.8	2.0	3.9
Par13	2.0	7.0	5.1	1.6	2.5
Par14	4.0	7.0	5.2	1.0	1.0
Par15	2.0	7.0	4.4	1.9	3.5
Par16	2.0	6.0	4.1	1.5	2.1
Par17	1.0	7.0	4.3	2.1	4.4

Participants	Minimum	Maximum	Mean	Std. Deviation	Variance
Par18	1.0	7.0	3.7	1.7	2.8
Par19	2.0	6.0	4.1	1.7	2.7
Par20	1.0	7.0	3.7	2.0	4.1
Par21	2.0	6.0	4.2	1.3	1.7
Par22	1.0	7.0	3.9	1.9	3.7
Par23	1.0	7.0	5.0	2.0	3.8
Par24	1.0	7.0	4.2	1.5	2.3
Par25	1.0	7.0	3.7	1.8	3.2
Par26	1.0	7.0	4.6	2.1	4.4
Par27	3.0	6.0	4.7	1.0	1.0
Par28	2.0	6.0	3.9	1.5	2.1
Par29	2.0	7.0	4.5	1.3	1.7
Par30	3.0	7.0	5.7	0.9	0.9
Par31	1.0	6.0	3.9	1.8	3.3
Par32	3.0	5.0	4.8	0.5	0.3
Par33	1.0	7.0	4.2	1.7	3.0
Par34	3.0	7.0	4.3	1.4	1.9
Par35	2.0	7.0	4.9	1.2	1.5
Par36	3.0	6.0	4.0	0.9	0.9
Par37	2.0	7.0	4.6	1.6	2.5
Par38	1.0	7.0	5.2	1.9	3.5
Par39	1.0	7.0	3.3	2.4	5.5
Par40	2.0	7.0	4.9	1.5	2.4
Par41	2.0	7.0	5.2	1.4	2.0
Par42	1.0	7.0	3.6	2.5	6.2
Par43	2.0	7.0	4.8	1.5	2.3
Par44	1.0	7.0	4.7	1.7	3.0
Par45	2.0	6.0	3.8	1.1	1.1
Par46	2.0	7.0	4.6	1.5	2.1
Par47	2.0	7.0	4.3	1.7	2.7
Par48	1.0	7.0	4.5	1.3	1.8
Par49	3.0	6.0	4.3	0.8	0.6
Par50	2.0	7.0	5.1	1.4	1.9
Par51	1.0	7.0	5.2	2.2	4.7
Par52	1.0	7.0	4.2	1.8	3.4
Par53	2.0	7.0	5.0	1.4	1.9
Par54	1.0	7.0	3.9	1.7	3.0
Par55	2.0	7.0	4.2	1.7	2.9
Par56	2.0	7.0	4.5	1.1	1.1
Par57	1.0	6.0	4.2	2.0	3.9

C

APPENDIX C: SIGNIFICANT LOADING OF PARTICIPANTS

The below tables show the participants that significant load for respective factors. The term *VR* represents participants that is treated as variable in Q-factor analysis.

VR01	VR07	VR08	VR12	VR15	VR17	VR18	VR20	VR25	VR26	VR31
0.908	0.626	0.576	0.598	0.803	0.897	0.673	0.654	0.732	0.521	0.695

VR33	VR34	VR38	VR40	VR42	VR44	VR51	VR53	VR54	VR55	VR57
0.673	0.75	0.743	0.655	0.818	0.508	0.507	0.578	0.746	0.845	0.556

Table C.1: Significant loading of Factor - 1

VR19	VR21	VR22	VR24	VR39	VR49
0.8	0.759	0.831	0.53	0.524	0.639

Table C.2: Significant loading of Factor - 2

VR03	VR09	VR10	VR13	VR28	VR45
0.575	0.694	0.654	0.678	0.521	0.623

Table C.3: Significant loading of Factor - 3

VR14	VR16	VR29	VR48
0.512	0.591	0.603	0.649

Table C.4: Significant loading of Factor - 4

VR11	VR35	VR37	VR41
0.82	0.843	0.511	0.644

Table C.5: Significant loading of Factor - 5

VR05	VR36	VR43	VR47	VR56
0.581	0.624	0.631	0.53	0.714

Table C.6: Significant loading of Factor - 6

VR23	VR32	VR50
0.697	0.704	0.734

Table C.7: Significant loading of Factor - 7