CSI-COP **Citizen Scientists Investigating Cookies and App GDPR compliance**

Deliverable D2.2 [D11]

Guidelines for Diverse Citizen Science Recruitment

Delivery date: 30 June 2020

LEAD Partner for deliverable: NaTE

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Version: 5.3

Project funded funding from the European Union's Horizon 2020 SwafS research and innovation programme under grant agreement Nº873169

30 months January 2020-June 2022

Dissemination Level		
PU	Public	X
R	Report, **DEM**: Demonstrator, pilot, prototype, plan designs, **DEC**: Websites, patents filing, press & media actions, videos, etc., **OTHER**: Other **(**Database, online tools, questionnaires, etc)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	
CI	Classified, information as referred to in Commission Decision 2001/844/EC.	

Version control table

Version Control				
Version	Date	Authors	Institution	Change and reason for change
1	16.04.2020	Mária Hinsenkamp, Dorottya Rigler	NaTE	Initial Draft
2	29.05.2020	Mária Hinsenkamp, Dorottya Rigler	NaTE	Table of Contents. Headings and subheadings. Elaboration on themes: digital divide, demographics of participants in previous CS projects, ensuring diversity. General improvements of text. Integration of Tables. Integration of input from involved Partners CTU, CU, UPAT, TiU, OUOLU, BU, UAB. Sent to Partners for cross-checking.
3	12.06.2020	Mária Hinsenkamp, Dorottya Rigler, Olga Stepankova, Huma Shah, Yiannis Gialelis, Robin Pierce, Ulrico Celentano, Maayan Zhitomirsky-Geffet, Jordi Vallverdú, Deniz Özdemir	NaTE	Integration of further input from involved Partners CTU, CU, UPAT, TiU, OUOLU, BU, UAB. Draft Executive Summary, Draft Introduction. Section on Methodology. Changing headings and subheadings. Inclusion of section on Recommendations. Integration of additional Tables and Figures. Creating and editing Appendices. List of References. Captions, Spell Check, Layout. Sent to Partners for cross-checking.
4	25.06.2020	Mária Hinsenkamp, Dorottya Rigler, Olga Stepankova, Huma Shah	NaTE, CTU, CU	Updates. List of abbreviations, Definition of Terms. Editing sections 1, 5, 6 and Appendices. Updating List of References. Integration of review from CTU, CU.
5	26.06.2020	Mária Hinsenkamp, Dorottya Rigler, Olga Stepankova, Huma Shah	NaTE, CTU, CU	Inclusion of content on immigrants/refugees - editing section 6. Additional references.
5.1	29.06.2020	Mária Hinsenkamp, Dorottya Rigler, Olga Stepankova, Huma Shah	NaTE, CTU, CU	Editing. Final check.
5.2	29.06.20	Mária Hinsenkamp, Dorottya Rigler, Olga Stepankova, Huma Shah	NaTE, CTU, CU	Revised title (addition of ‘diverse’). Removed source numbers in Reference List. Final format check of table and figure numbers.
5.3	30.06.20	Huma Shah	CU	Deliverable number D11 added. Corrected Resolution 20 to 70. (5.2.3)

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European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

List of abbreviations

Abbreviation	Definition
ADA	Americans with Disabilities Act
CAS	Czech Academy of Sciences
COST	European Cooperation in Science and Technology
CS	Citizen Science
CSI-COP	Citizen Scientists Investigating Cookies and App GDPR Compliance
CSO	Czech Society for Ornithology
CSP	Citizen Science Project
D2.2	Project Deliverable 2.2, this report
DESI	Digital Economy and Society Index
DITOs	Doing It Together Science consortium
EC	European Commission
ECSA	European Citizen Science Association
ECRE	European Council on Refugees and Exiles
EGS	European Gigabit Society
EPWS	European Platform of Women Scientists
ERC	European Research Council
EU	European Union
FP7 SIS	EU 7th Framework Program, Science in Society
FP7 SSH	EU 7th Framework Program, Socio-economic Sciences and Humanities
GDPR	General Data Protection Regulation (EU)
H2020	Horizon 2020 (The EU Framework Programme for Research and Innovation)
HAS/MTA	Hungarian Academy of Sciences (Magyar Tudományos Akadémia)
ICT	Information and Communication Technology
ITU	International Telecommunication Union
NAS	National Academies of Sciences, Engineering, and Medicine, USA
NGO	Non-governmental Organisation
NSF	National Science Foundation, USA

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OECD	Organisation for Economic Co-operation and Development
ROSE	Relevance of Science Education project
S&T	Science and Technology
SES	Socio-Economic Status
SIBIS	Statistical Indicators Benchmarking the Information Society
SID	Safer Internet Day
SIP	Safer Internet Program of the European Union
STEM	Science, Technology, Engineering and Mathematics
SwafS	Science with and for Society program (EU Horizon 2020 programme)
T2.2	Task 2.2 of CSI-COP
TCV	The Conservation Volunteers
TFEU	Treaty on the Functioning of the European Union
WP	Work Package

Definition of Terms

Term	Definition
App	A mobile application is a computer program or software application designed to run on a mobile device such as a phone, tablet or watch.
Broadband	In the context of Internet access, broadband is used to mean any high-speed Internet access that is always on and faster than dial-up access over traditional analogue services.
Citizen science (CS)	Public participation in scientific research.
Computer literacy	The knowledge and ability to use computers and related technology efficiently, with skill levels ranging from elementary use to computer programming and advanced problem solving. Computer literacy can also refer to the comfort level someone has with using computer programs and applications.
COVID-19	The COVID-19 pandemic, also known as the coronavirus pandemic, is an on-going pandemic of coronavirus disease, which started in 2019.
Data privacy	Data privacy or information privacy is a branch of data security concerned with the proper handling of data – consent, notice, and regulatory obligations.

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Demographic data	Demographic data includes general statistics about the population and characterise different groups and subgroups. It can refer to a whole country, a region, a city, or an individual. Basic demographic data about individuals consists of such information as age, gender, ethnicity, type of employment, education, marital status, and so on.
Digital divide	It is the gap between those individuals and communities that have access to new forms of information technology and those that do not.
Digital literacy	Digital literacy refers to an individual's ability to find, evaluate, and compose clear information through writing and other media on various digital platforms.
Disability	According to The World Health Organisation (WHO), disability is an umbrella term, covering impairments, activity limitations, and participation restrictions. Disability is thus not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person’s body and features of the society in which he or she lives. Walking, seeing, hearing and cognition are considered essential in determining disability.
Diversity	The diversity definition refers to the existence of variations of different characteristics in a group of people. These characteristics could be everything that makes us unique, such as our cognitive skills and personality traits, along with the things that shape our identity (e.g. race, age, gender, religion, sexual orientation, cultural background).
GDPR	General Data Protection Regulation enacted by the European Union in May 2018 and adopted in EU countries.
Gender	Either of the two sexes (male and female), especially when considered with reference to social and cultural differences rather than biological ones. The term is also used more broadly to denote a range of identities that do not correspond to established ideas of male and female.
Information society	An information society is a society where the usage, creation, distribution, manipulation and integration of information is a significant activity. Its main drivers are information and communication technologies.
Internet inequity	Differential access to the Internet.
Scientific literacy	Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

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Social exclusion	Exclusion from the prevailing social system and its rights and privileges, typically as a result of poverty or the fact of belonging to a minority social group.
Socio-economic groups	Different groups of persons where the members of a particular group are, on the one hand, reasonably homogeneous and, on the other hand, fairly clearly distinguished from members of other groups in respect of their social, economic, demographic and/or cultural circumstances and behaviours.
Socio-economic status (SES)	Socioeconomic status (SES) is an economic and sociological combined total measure of a person's work experience and of an individual's or family's economic and social position in relation to others. When analysing a family's SES, the household income, earners' education, and occupation are examined, as well as combined income, whereas for an individual's SES only their own attributes are assessed.

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Executive Summary

The CSI-COP project will engage citizen scientists to investigate GDPR compliance through exploring cookies in websites and in apps. This document is the second of two deliverables in CSI-COP project work package 2 (WP2) that investigate the best practices that have been used Europe-wide and in international citizen science projects. The previous deliverable D2.1 conducted an exhaustive exploration of literature in order to find the best practices and the most efficient methods in citizen science engagement (CSI-COP, 2020). In the present deliverable D2.2 we explore the means that have been adopted to achieve balanced and diverse participation in citizen science, taking into consideration gender, socio-economic and geographic factors.

To this end, we covered three main factors affecting inclusive citizen science projects, and we present our findings in this report. First, we review a large number of citizen science projects regarding the demographic and socio-economic characteristics of their participants and we draw conclusions about the typical characteristics of those involved in such activities. Secondly, we describe in detail the digital divide phenomenon and its effects on the social participation of different individuals and groups. Finally, we present the diversity factors that influence participation in citizen science projects and explain the identified methods to access different target audiences. The recommendations that we formulate based on our findings in this report will feed into the development of CSI-COP's framework (Deliverable 2.3) for the recruitment, engagement and support of a broad range of CSI-COP citizen scientists.

Keywords: app, citizen science, data privacy, demographic data, digital divide, diversity, equality, European Union, gender, information society, Internet access, Internet usage, social participation, socio-economic factors, voluntary activities.

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1 Introduction

In order to picture the extent of online tracking, who is tracked and for what purpose, it is essential to have a diverse cohort of citizen science project participants. To this end, this report is a result of exploring previous citizen science projects to find the challenges, and how these were overcome, to realise inclusive citizen science engagement.

European citizens are all protected by data protection laws. The most important of these is the General Data Protection Regulation, which was enacted by the European Union in May 2018 and adopted in EU countries; and the national data protection acts, which were covered in detail by the deliverable D2.1 of our project (CSI-COP, 2020). Nonetheless, as Madhumita Murgia pointed out in her TED talk (2017), "online anonymity is a complete myth". Still, in our modern society it is not realistic to stop using social media, search and navigation apps and smartphones to protect our data privacy – all the more so since the post-COVID-19 era will introduce a "new normal" which will inevitably be centred around the digital and online world.

However, the more people begin to realise the extent of their data footprint, the more they will start to demand control of these data. This concept is in the heart of CSI-COP. The project's systematic scientific investigation of hidden trackers on websites (e.g. female health, bank transmission) and apps (e.g. fitness, tourism) will aim to find whether opt-in consent required in GDPR is taking place in the digital world. This is a novel theme in the field of citizen science.

In addition to the data privacy and data protection issues the expansion of cyberspace and the accelerating process of digitalisation have other implications within society, too, especially on some specific social groups. Disparities in the access to digital technologies and in the motivations and skills to use them widen the gap between people of different backgrounds. Vice versa, age, gender and a series of socio-economic factors often determine the extent to which an individual or a group can actively take part in social decisions and processes. Digital divide and social exclusion are intertwining phenomena, and their interaction results in the lack of equal opportunities and an unbalanced social participation.

Citizen science on the other hand is in its nature democratic and participatory. According to the 6th of the ten principles of citizen science, presented by the European Citizen Science Association (ECSA), "citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for. However, unlike traditional research approaches, citizen science provides opportunity for greater public engagement and democratisation of science" (ECSA, 2015).

Still, there is surprisingly little data or research to date on the detail of who takes part in citizen science projects. This perhaps reflects a traditional focus of citizen science on the production and analysis of data, rather than the volunteers themselves who take part in these surveys. However, without an active and engaged volunteer base, citizen science projects cannot work. CSI-COP has a mission to make citizen scientists the real champions for online privacy.

The Treaty on the Functioning of the European Union (TFEU) is one of two treaties forming the constitutional basis of the European Union. According to Article 8 of the Preamble: "in all its activities, the Union shall aim to eliminate inequalities, and to promote equality, between men and women". Furthermore, Article 10 states: "in defining and implementing its policies and activities, the

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Union shall aim to combat discrimination based on sex, racial or ethnic origin, religion or belief, disability, age or sexual orientation" (European Union, 2012).

In perfect accordance with these statements the CSI-COP project integrates diversity with gender mainstreaming, and aligns it with the ambition of including and supporting citizen scientists regardless of background. The aim of the present report is to find the best ways to ensure a balanced cohort of citizen scientists for the CSI-COP project regardless of the above-mentioned characteristics, to push for a democratisation of the development of pro-privacy technologies. In order to meet this objective, this report places a special emphasis on the inclusion, encouragement, motivation and support of women and people of diverse backgrounds, thus enhancing their scientific and social contribution.

Deliverable 2.2 is structured as follows: Chapter 1 gives an overview of the whole document. In chapter 2 we explain the strategies and methods utilised to prepare the Guideline; the specific methodological difficulties we had to face, and the effects the COVID-19 pandemic had on our work. Chapter 3 contains the demographic and socio-economic characteristics of participants in all citizen science projects identified by our research team that have recorded such data in Europe and beyond; as well as a brief summary of the typical demographic and socio-economic characteristics of those involved in these activities.

In chapter 4 we discuss the digital divide phenomenon and its implications for different socio-economic groups in society. We first define the digital divide in detail, and then use statistical data to illustrate the differences in Internet access and usage by country, gender, age, geographical location, covering special groups such as the disabled and immigrants. Finally, we explain the relationship between online privacy and the digital divide, focusing primarily on the gender divide.

Chapter 5 gives a thorough presentation of the diversity factors that affect participation in voluntary activities such as citizen science. We look at how different target groups can be identified, reached and encouraged to participate. This chapter is followed by our conclusions and recommendations for diversity in the CSI-COP project, and the exhaustive list of the references used in the document. The appendices of this report not only contain a series of relevant citizen science projects from Europe and all over the world, but also provide an example of regional digital divide analyses based on the data from one of CSI-COP partner countries (Greece).

2 Methodology of D2.2

The following **CSI-COP Consortium Partners** were involved in the task to produce this report, Task 2.2: Association of Hungarian Women in Science (NaTE), Coventry University, University of Patras, Tilburg University, University of Oulu, Bar-Ilan University, Czech Technical University in Prague, Universitat Autònoma de Barcelona.

Not long after the official launch of T2.2 (M03) the **COVID-19** began to spread in Europe and all over the world. Precautionary measures have been introduced in all Partner countries involved in T2.2 to prevent infection, and the members of our team had to find ways to be able to continue work under the worldwide slogan: 'stay at home'. This inevitably affected the project participants, however they remained focused on their tasks.

In addition to the fact that the situation has hit our research team, it also gave us the task to reflect in the current document on how differently the online presence of male and female European citizens is affected by the epidemic, which is strongly related to the topics of the CSI-COP project. The online

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network provided by Coventry University and the weekly virtual meetings gave our team an opportunity to continuously evaluate the virus situation and consult on the next steps.

In T2.2 we conducted thorough desk and literature research in the following three main areas, exploring book chapters, journal articles, reports, thesis, and also a wide range of online information sources, such as blogs, websites, videos, etc.

1) We strived to give a comprehensive description of the **digital divide phenomenon and its practical implications** on European societies. The latter covers the issues of Internet access and Internet usage. On these dimensions comparative data were needed across countries, gender, age, etc., therefore this line of research included some literature that contained statistical data originating from European and international databases (e.g. Eurostat, OECD).

2) We identified and described several existing CS projects (both on-going and completed) that we found relevant for CSI-COP, either regarding their topic, or their target groups. Our method was to divide Europe into regions and assign a pair of researchers to each region. Besides, the Partners looked into the current citizen science practice in their respective countries. The Task Leader coordinated the process and carried out research regarding one of the assigned regions. What is more, in this area we did not limit the scope of our research to European countries, but extended it to other regions of the world, as well. We did all this in the hope of unearthing relevant **statistical data regarding the demographic and socio-economic composition of participants** in citizen science projects.

However, **despite utilising a wide range of research strategies** CSI-COP researchers encountered **considerable difficulty in identifying projects that had collected data on the demographic and socio-economic characteristics of participants (age, gender, urban vs. rural residence, education, occupation, disability, ethnicity, etc.)**. Our team had anticipated that we might be able to access gender-disaggregate data perhaps more easily given the political prominence of gender issues in the European Union. However, even data regarding gender disaggregated participation in citizen science projects proved to be largely absent.

Some CSI-COP researchers observed that although there is a growing number of citizen science projects currently underway, these **projects were not yet at the point where they would be reporting on the demographic breakdown of project participants**. This was particularly the case in The Netherlands where several citizen science projects have recently been launched but do not yet have the basis for demographic reporting.

A **methodological problem** also arose regarding the demographic analysis of participants in CS projects. Since participation in these programs is voluntary, applicants are certainly not required to provide personal information, so data are only available on those who do so voluntarily. This, in turn, not only has a negative effect on the amount of demographic data, but may also result in that the available data do not reflect the real demographic characteristics of the participation faithfully.

This is mirrored in the explanation given by the representative of the Czech Ornithology Society, which has been running projects aiming to collect census data about birds occurring on the territory for several years. The representative responded to the inquiry of our Czech Partner that they did not collect much personal information about their partner citizen scientists for the very simple reason that: "we have learned from our long-term experience that **with any extra piece of data we want to gather about our citizen scientists we are losing some people originally willing to cooperate**. That is why we limit our data collection about citizen scientists to the ´absolute must´".

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CSI-COP researchers deployed a wide range of strategies to locate any data pertaining to demographics, and discussed alternate strategies in weekly WP meetings. These strategies included **a) examination of traditional academic literature on citizen science projects b) examination of non-academic literature in popular and news journals c) examination of reports on citizen science and d) examination of the citizen science project websites (past and present).**

Consistent with the general observation of a paucity of demographic data, all the above-mentioned strategies still yielded scant illumination of who participates in citizen science projects. We think that **highlighting this gap in our understanding of citizen science early and often is an important step in developing this critical aspect of this field**. We, therefore, have included a post on the CSI-COP webpage that stresses the importance of the collection of demographic information on all citizen science projects.

In spite of all difficulties detailed above, our thorough research made it possible for us to create a **compilation of citizen science projects from all over the world**. The descriptions of these can be found in the Appendices of the current document, and, according to our intentions, can be used as a pool of information by those interested.

3) We carried out intensive research in order to find answers to the following questions. Do different age/gender groups and people of **diverse socio-economic backgrounds** have similar or dissimilar motivations and opportunities to participate in citizen science projects? Are there **specific factors** that affect the participation of certain groups (e.g. people with disabilities, people of ethnic minorities, etc.)? How can these groups be encouraged to participate in citizen science projects? How can a citizen science project **ensure diverse participation**? The answers we found to these questions constitute the base of our recommendations for diversity drawn in the Guideline.

The project shared space, facilitated by Coventry University and the regular virtual meetings allowed the Task Leader and the Partners involved in T2.2 to work together in a constructive spirit, regularly sharing important information, as well as new ideas and visions. The final structure of the Guideline was shaped by these fruitful discussions. After finishing the research phase at the end of M05, all the findings provided by the Partners have been merged into a single draft document. Editing took place in M06, in order to present our findings in the best possible form.

3 Demographic analysis of participants in previous CS projects

It is widely recognised that **citizen science needs to be both inclusive and representative in order to gain credibility and legitimacy as a source of knowledge production** (NASEM, 2018a). Yet, as we mentioned earlier, the data on the demographics of citizen science projects is woefully scarce. A large-scale citizen science project, Thriving Earth Exchange (a 5-year-old community science initiative that supports 70 projects throughout the United States and around the world), has observed, “so many projects have failed to collect and analyse the demographics of participants or document the knowledge they have gained” (Mervis, 2018). Nevertheless, several articles referred to the need for diversity and inclusion, both as a practical matter and as a matter of principle (see e.g. Berntzen and Johannessen, 2016; Mervis, 2018; NASEM, 2018a).

In the following we summarise the demographic data that our research team unearthed on the participants of different citizen science projects carried out in European countries and all over the world.

Larson et al. (2020) examined the diverse motivations of American volunteers (n = 3041) participating in **Audubon's Christmas Bird Count** (CBC), one of the world's oldest ecological monitoring citizen

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(or community) science projects. The overall sample of CBC volunteers was **54% male**. Other demographic attributes generally reflected populations of citizen scientists as a whole. Respondents from the CBC were **primarily white** (97%), much **older than the average** American (mean age = 61.6 years), **highly educated** (50% held an advanced degree), and **high-income earners** (33% reported annual income over $100,000). About 46% of the sample identified as a natural or life science professional, and respondents generally skewed toward the liberal end of the political spectrum.

The biggest bird survey undertaken in the UK (RSPB **Big Garden Birdwatch and Big Schools Birdwatch**) received 19256 responses in Scotland alone and involved 25329 adults (66%) and 12808 children (34%). Some analysis was carried out on the demographic of participants. 60-65% of all survey submitted were from school participants. A predominance of **white, educated people** amongst adult participants was observed. Another report showed that **gender is evenly balanced** amongst citizen scientists, with 51% female. 23% of citizen scientists were non-white UK or Irish (against a total UK population of 16% non-white UK or Irish). **Disabled people were**, however, **less involved** making up only 9% of participants (versus 18% of the total population according to the 2011 census) (TCV, 2014).

The working mechanism of the **German Butterfly Monitoring Scheme** (Tagfalter-Monitoring Deutschland - TMD) is a citizen-based case study (Richter et al., 2018). Using a questionnaire survey paired with a visual social network assessment, it investigates how participants interact within these networks and assess their motivations to engage.

The information obtained from the questionnaire contained demographic parameters (e.g. year of birth, age, occupation). Out of the total number of active participants of the TMD (n=445), 62 participants followed the invitation to draw networks and to fill in the questionnaire (14% of the overall number of volunteers). **About 60% of the respondents were female, while the overall TMD gender ratio is slightly skewed to the opposite with 43% female and 57% male participants**. For this survey, **the average age was 55 years**, while the youngest participant was 13 and the oldest was 76 years old. One-third of the participants of the TMD have been engaged in monitoring butterflies for more than 10 years. The duration of engagement of the respondents varied from 1 to 9 years with an average of 7 years of involvement for women and 8 years for men (Richter et al., 2018).

Israel has a **butterfly monitoring project**, as well (Big Butterfly Count, n.d.), which is a pioneer CS project with dozens of participants around the country and over 9 nine years of activities. 44 participants took part in the survey in 2018, **21 males and 23 females**. **The largest age group was 65 and older (about 33% of the study population).** None were younger than 26. One third were new in the program. Two thirds assessed their knowledge of butterflies as good or very good, men were more confident about their knowledge then women and younger participants were more confident than older ones.

One of the Greek citizen science projects processed and posted demographic data on the participants online. **Scent** is a European Union research project funded under the Horizon 2020 programme, which ran between 2016 and 2019. Its objective was to engage citizens in environmental monitoring and enable them to become the ‘eyes’ of the policy makers. In doing so citizens would support the monitoring of land-cover/use changes using their smartphones and tablets. The **number of male participants exceeded that of females** by not much, and the **majority of participants were employed in the private sector** (Scent, n.d.).

Raddick et al. (2013) analysed results from an online survey of nearly 11.000 volunteers in **Galaxy Zoo**, an astronomy citizen science project with the aim of understanding volunteers’ motivations for

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participating. **More than 80% of the respondents were male and less than 18% female**. Among men, results showed **a deficit of younger volunteers and a clear excess of volunteers between 50 and 65 years of age**, compared to that of the US online population. The ratio between males and females steadily increased with age. The distribution of countries of residence of the respondents was extremely uneven, with two countries (United States and United Kingdom) accounting for more than 65% of responses and 25 countries accounting for nearly 35% of responses. Survey respondents were **educated to a higher level** than the average adult U.S. Internet user, with nearly 70% of survey respondents reporting at least a bachelor's degree.

Sprinks et al. (2017) carried out a UK study on volunteer behaviour in Task Workflow Design for the **virtual citizen science project Planet Four: Craters**. The participants of the project analysed an image taken by the Context camera on NASA's Mars Reconnaissance Orbiter. It was chosen because it contains a variety of landscapes common to the Martian surface. Scientists at the University of Bristol also provided data from their existing analysis of this image, that were used in place of ground truthing, so that comparisons could be made between citizen scientist results and those measured by planetary science experts. **Of the 30 participants recruited through email lists, social media posts and subsequent 'word of mouth' 19 (63%) were male and 11 (37%) female. The age of the participants ranged from 22 to 60, with a mean age of 28. All participants were university educated**.

In the demographic analysis of the citizen scientists who participated in the survey of an **air pollution monitoring project in Israel**, the following distributions were reported (Golumbic et al., 2019). A total of 131 participants took part in the study, who were residents of the neighbourhood hosting sensors in their homes and other active participants in the project website. They ranged in age from 20 to 70, with **an equal representation of men and women. Most participants were highly educated**, only 14% did not have an academic degree.

A publication in review by Golumbic et al. (2020) carried out demographic analysis of a CS project recently conducted in Israel. More than half of the 123 participants (57%) were female. The results of the survey are shown in Table 1.

Table 1 Demographic parameters of participants in an Israeli citizen science project (n=123)

Demographic parameter					
Gender		Male	Female		
	One-time	43%	57%		
	Authentic	44%	56%		
	Total	43%	57%		
Age		18-24	25-30	31-50	51-70
	One-time	4%	23%	58%	14%
	Authentic	10%	29%	45%	16%
	Total	6%	24%	55%	15%

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Tertiary education		None	BA/BSc/Bed	MA/MSc/Med	PhD
	One-time	5%	45%	44%	5%
	Authentic	6%	44%	47%	3%
	Total	5%	45%	45%	5%
Highest level of science education		Middle school	High school	Tertiary degree	
	One-time	18%	22%	60%	
	Authentic	16%	25%	59%	
	Total	17%	23%	60%	

A small study that was conducted by Maayan Zhitomirsky-Geffet, the researcher of Bar-Ilan University (one of the CSI-COP consortium partners) counted the gender distribution of participants in a citizen science project in Israel (Jellyfish project, n.d.). 37 out of 88 distinct participants were female, 42 were male and the gender of the rest could not be identified. It could be concluded that in this project there seems to be **equal gender distribution**.

Zhitomirsky-Geffet also counted the number of male and female observers in the website of iNaturalist (2011), filtered by location, focusing on Israel, and found that out of 100 top-ranked observers in Israel only 25 were identified as women (based on name, picture or text in their profile), while the rest were men (for about 10 of them it was impossible to identify their gender). Many of the top observers are professionals in the field.

In a Lebanese study Baalbaki et al. (2019) referred to a collaborative citizen science approach involving local citizens and university researchers, which was applied **to assess the groundwater quality in a Lebanese village**. Participation was open to all; however, the vast majority of volunteers were women. This gender imbalance may be in response to the composition of the university team, which consisted mostly of women scientists. Another possibility may be that women leading a local women club took the initiative to recruit participants. The university team did not influence participation and hence did not enforce gender balance among the citizen scientist volunteers. **26 citizens, predominantly women** participated in the water quality testing over six sessions. The age of the participants varied between 16 and 62 and **averaged 35 years old**, and their **educational level also varied between primary, secondary and tertiary education**. It is worth noting that female participants were mostly interested in conducting water test analysis, while the male participants were more engaged in the sample collection. This observation may be attributed to the **local culture** where men usually work outdoors while women partake in indoor work activities (Baalbaki et al, 2019).

The study of Weeser et al. (2018) evaluates **the quality and quantity of data generated by citizens in a remote Kenyan basin** and assesses whether crowdsourcing is a suitable method to overcome data scarcity. It installed thirteen water level gauges equipped with signboards explaining the monitoring process to passers-by. Results were sent via a text-message-based data collection framework that

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included an immediate feedback to citizens. A public web interface was used to visualise the data. Within the first year, 124 citizens reported 1175 valid measurements. The telephone survey conducted to collect socio-economic information on the volunteer participants: gender, age, and education. Among the 87 respondents to the researcher's telephone survey **80 (92%) were males and 7 (8 %) females.**

Table 2 presents the age and education of the participants (reproduced from a table in Weeser et al., 2018: p. 1596). The data was divided in answers provided by active observers, which transmitted more than ten values (AO) and observers that reported ten or less observations (Other).

Table 2 Age and education level of 87 observers contacted during a telephone survey campaign in Kenya

		AO (n = 12)	Other (n = 75)
Mean age		40	33.5
Education [%]	Primary	50	20
	Secondary	42	36
	High	8	37
	No answer	0	7

What this table highlights is that **the younger mean age group (aged 33.5) were more likely to have "higher education" than the mean age group (40)**. However, **the older age group were more likely to feedback more observations** to the researchers. Weeser et al. (2018) concluded: "… the active participation is not depending on the actual education level but rather induced by their personal perception of and dependency on their environment. Especially citizens who depend on local water resources are expected to be interested in increasing their understanding of their environment and to participate in local political decisions to ensure a sustainable use of their resources… participants who increase their understanding of local resources, motivate neighbours and form opinions to support local policies".

The National Academies of Sciences, Engineering and Medicine of the United States issued a report in 2018. The aim of the **Learning Through Citizen Science report** was to support science learning by enhancing CS design. The **Appendix A** (NASEM, 2018b) of the document gives detailed demographic analysis of reported participant data on online citizen science aggregator platform **SciStarter 2.0** (SciStarter, 2018). Of the 653 SciStarter profiles completed by the end of 2017, **the majority of individuals were female (64%) and in the 35-44 age range**. Individuals with profiles have the option to join projects through SciStarter and/or bookmark them, allowing some determination of preference as a function of project type. Females represented the vast majority (80%) of bookmarkers (Burgess et al., 2017). However, it is interesting to note that while 68% of females bookmarked hands-on citizen science projects in 2017, this dropped to 57% for online projects (NASEM, 2018a; NASEM, 2018b).

Some researchers study more than one citizen science projects and their participants. The findings of these authors allow demographic comparisons among citizen scientists involved in different projects. For instance, Stepenuck et al. (2018)'s **survey of 345 volunteer water monitoring programs** in the United States was conducted to document their characteristics, and perceived level of support for data

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to inform natural resource management or policy decisions. The response rate of 86% provided information from 46 states. Results suggest that certain programs focused entirely on each of the following age groups: youth under 18, college students ages 18–22, working age adults ages 23–65, and senior citizens (over age 65). **On average, youth under 18 made up 16% of participants, while college students made up the smallest average percentage (8%). Senior citizens represented approximately a quarter of monitoring program participants on average**.

The study of Masters et al. (2016) investigated the development of scientific content knowledge of volunteers participating in five online citizen science projects in the **Zooniverse** citizen science platform. The sample of the final survey available for analysis contained data on 1921 volunteers. According to the demographic make-up of the survey, **44% of respondents were female, 34% rural, 39% unemployed, 34% below a bachelor's degree, 87% white, and 44% with scientific background**. 42% named their religion. Their country of residence was: USA 39%, UK 28%, others 33%.

Curtis (2015a) selected three projects for an online survey of citizen science participants. **Foldit** is a project in which a challenging scientific problem, the creation of accurate protein structure models, has been turned into a multiplayer online citizen science game. **Folding@home** was one of the first distributed computing projects in the biological sciences, and is based at the Chemistry Department at Stanford University in California. The **Planet Hunters** is a distributed thinking project based in the UK, which is part of the Zooniverse group of online citizen science projects.

When considered together, the results from the three online surveys illustrate that the respondents have a number of demographic features in common. They are **predominantly male** (there were only 8% female). Respondents are **mainly from developed countries** (98%). Most of the respondents are **well educated** with the majority having at least an undergraduate degree (60%.) A high proportion of those who are graduates have **qualified in a STEM subject** (81%). 97 respondents of 335 were currently students. Almost one third of respondents work in **IT-related professions** (31,5%). Most of the respondents are engaged with science in some way. Practically almost all had taken part in other science-related activities in the previous year, and just over half (52%) had taken part in other citizen science projects (Curtis, 2015b).

Table 3 presents a sample of the data directly obtained from the thesis of the same author, which compares seven published studies regarding the demographic data of citizen scientists (Curtis, 2015a). The data shows males made up the majority of participants in the studies.

Table 3 Comparison of studies collecting demographic data of citizen scientists

Author(s) / year cited in Curtis (2015a)	Project and sample size (n)	Demographic details of sample
Holohan and Garg, 2005	Various distributed computing projects including SETI@home and GIMPS (Great Internet Mersenne Prime Search), n=323	98.4% were male, and most aged between 26 and 49. 70% based in USA and Canada, and 24% based in Europe.

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SETI@home team, 2006	SETI@home distributed computing project, n=142 000	92.74% were male, and 61% were aged 20- 39.
Krebs, 2010	malariaControl.net distributed computing project, n ranges from 693 -1097	56% were based in Europe and 33% in North America. Most were aged between 20 and 50. 87.8% were male (n=693). Most of the survey participants were IT professionals.
Estrada et al., 2013	Docking@home distributed computing project, n=739	80% were male, and most males were aged between 31 and 35. Female respondents were aged mainly between 46 and 55. Small representation of ethnic minorities.
World Community Grid member study, 2013	World Community Grid collection of distributed computing projects, n=15 627	90% of sample was male, and most have a "technical knowledge base". Most aged between 25 and 44. 36% work in information technology.
Reed et al., 2013	Zooniverse projects, n=199	67.3% were male, with a mean age of 40.7. Most based in USA or UK. Many had a college degree (119 participants provided this info on education).
Raddick et al., 2013	Galaxy Zoo, n= 10 708	82% are male, and the mean age is 43.2 with no clear age trends. Most respondents are from North America and Europe. Over half have at least a bachelor's degree.

Summarising the demographic data of the above studies, we can observe that **a unified picture emerges about the demographic distribution of the participants in citizen science projects in developed countries**. In the vast majority of these projects, participants are typically **white**, have a **high level of education** and belong to the **middle and upper socio-economic classes**. Many of them **have been involved in similar activities before**. With the exception of projects that specifically targeted students and the youth, **middle-aged and older** age groups are more interested in citizen science projects.

The **gender distribution** of the participants **depends largely on the topic of the project**. In the case of initiatives dealing with biodiversity and environmental protection, the participation of men and women is broadly balanced, and in some cases the proportion of female participants is even higher than that of males. ICT and astronomy, on the other hand, attract predominantly male citizen scientists, who often have a degree in STEM fields. In cases where the vast majority of participants were women, the

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local cultural specificities and the characteristics of the given project were clearly visible behind this disproportion.

These observations are consistent throughout the literature (Soleri et al., 2016; Theobald et al., 2015; NASEM, 2018b) and show that the inclusivity and representativeness mentioned at the beginning of the chapter are not typical in the world of citizen science.

4 Digital divide and CS projects

4.1 Definition of the digital divide

The **digital divide** commonly refers to the gap between those individuals and communities that have access to new forms of information technology (e.g. computers and their networks, mobile telephony, digital television) and those that do not (Molinari, 2012; van Dijk, 2006). In a broader context the digital divide means the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities (OECD, 2001). Previous research from North America and Europe gives a striking example of information as a source of inequality by reflecting a 'digital divide', whereby socio-economic and demographic factors such as age, income, education and health status were able to predict people's likelihood to access and use the Internet to seek health information (Estacio et al., 2019).

Within the above-mentioned context, physical access to computers, networks and other technologies has achieved the biggest attention for a long time. However, in the new millennium the focus of attention has gradually shifted to capabilities and skills (van Dijk, 2006). An increasing number of researchers suggests to go **'beyond access'**, to reframe the overly technical concept of the digital divide and **to pay more attention to social, psychological and cultural backgrounds**. Media or technology access should be seen as a process with many social, mental and technological causes and not as a single event of obtaining a particular technology (Bucy and Newhagen, 2004).

4.1.1 Motivational access

Prior to physical access comes the wish to have a computer and to be connected to the Internet. Many of those who remain at the 'wrong' side of the digital divide have motivational problems. With regard to digital technology, it appears that there are not only 'have-nots', but also 'want-nots' (van Dijk, 2006).

A primary social explanation for this is that the Internet does not have appeal for low-income and low-educated people (Katz and Rice, 2002). However, most pronounced are mental and psychological explanations. Here the phenomena of **computer anxiety and technophobia** come forward. Computer anxiety is a feeling of discomfort, stress, or fear experienced when confronting computers (Brosnan, 1998; Chua et al., 1999; Rockwell and Singleton, 2002). Technophobia is a fear of technology in general and distrust in its beneficial effects. Computer anxiety and technophobia are major barriers of computer and Internet access, especially among **seniors, people with low educational level and a part of the female population**. These phenomena do not completely disappear with a rise in computer experience, which is partly explained by personality characteristics (van Dijk, 2006).

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4.1.2 Material access

The concept of material access comprises physical access and other types of access that are required to reach complete disposal and connections such as conditional access (subscriptions, accounts, pay-per-view). It appears that the most important background characteristics of the physical access divide are the highly correlated variables of **income, education and occupation**. With the declining costs of computer equipment in recent years the importance of income has been somewhat reduced, but it remains an important factor for material access because total computer and Internet access costs (peripherals, printing costs, software, subscriptions and connection costs) barely diminish. Differences in physical access are related to a distribution of resources (temporal, mental, material, social and cultural) that in turn can be accounted for by ascribed categories such as **age, sex, intelligence, personality and ability and positions in society (labour, education and household position) (**van Dijk, 2006**)**.

The main consequence of the digital divide, defined in this way, is more or less participation in the most relevant fields of society, such as economy, politics, culture, spatial mobility, social institutions, social networks and communities (van Dijk, 2006). According to Katapally (2019), Internet inequity could be defined as differential access to the Internet based on the **wealth of a country** (high-, low- or middle-income); **geographic region** (urban, rural, or remote); **socioeconomic status**, **gender, age, and ethnicity**.

In recent years, the increased role **broadband connectivity** plays in economic and social interaction has made this aspect of the digital divide a key matter. Broadband technologies offer users the possibility to rapidly transfer large volumes of data and keep access lines open. Therefore, widespread and affordable broadband access is one of the means of promoting a knowledge-based and informed society (Eurostat, 2019). A question that invariably arises when considering the measurement of high-speed network availability is the definition of broadband itself. The baseline speed for a service to be considered broadband for the purpose of collecting subscription data was established by the OECD in 2001 at 256 kbps (OECD, 2001). In 2012, tiers were introduced for the reporting of broadband subscriptions (e.g. 256 Kbps to 1.5/2 Mbps; 1.5/2 Mbps to 10 Mbps and so forth with increasing tiers of service to above 1 Gbps) (OECD, 2018).

Almost all OECD countries have specific **national goals for broadband availability**. In terms of access, the European Union commitment is that by 2020, there should be 30 Mbps to 100% of households (coverage) (OECD, 2018). The target set by the European Union for usage by the Digital Agenda for Europe is 100 Mbps subscriptions to 50% of households (uptake) (OECD, 2018). In 2016 the European Commission added to its previous broadband objectives that by 2025 all schools, transport hubs and main providers of public services, as well as digitally intensive enterprises should have access to Internet connections with download/upload speeds of 1 Gbps.

In addition, all European households, rural or urban, should have access to networks offering a download speed of at least 100 Mbps, which can be upgraded to 1 Gbps. Furthermore, by 2025, all urban areas as well as major roads and railways should have uninterrupted 5G wireless broadband coverage, starting with fully-fledged commercial service in at least one major city in each European Union State by 2020 (European Commission, 2017). These initiatives aimed at closing the digital gap between **urban and rural** areas.

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As for **smartphones**, the Pew Research Centre's Internet Project (2014) conducted a study to explore how smartphone dependence (e.g. when one's only means of accessing the Internet is via a smartphone) and smartphone use differ between key demographic groups in the United States. Results showed that **minority groups and younger, lower income, and less educated users** are more likely to be dependent on smartphones. These findings suggest that **smartphones can symbolise both equity and inequity** depending on access to the Internet (Tsetsi and Rains, 2017).

4.1.3 Skills access

The most popular view is that skills problems are solved when these skills are mastered. However, many scholars engaged with information processing in an information society have called attention to all kinds of **operational, information and strategic skills** required to successfully use computers and the Internet (van Dijk, 2006). The general impression of skills investigations, both surveys and tests is that 1) the divides of skills access are bigger than the divides of physical access, and 2) **while physical access gaps are more or less closing in the developed countries, the skills gap, in particular regarding information skills tends to grow**. A striking result is that those having a high level of traditional literacy also possess a high level of digital information skills (de Haan, 2003).

Another striking result from digital skills research is that people learn more of these skills in practice, by trial and error, than in formal educational settings (van Dijk, 2005). The **social context** and social networking of computer and Internet users appear to be decisive factors in the opportunities they have for learning digital skills (van Dijk, 2006), which again points to the intertwining of digital skills and social inclusion.

4.1.4 Usage access

The ever-shifting Internet population focuses our attention on the assumption that those who have a computer or Internet connection are actually using it. However, **having sufficient motivation, physical access and skills to apply digital media are necessary but not sufficient conditions of actual use**. Usage access is the final stage and ultimate goal of the process of technological appropriation in the shape of particular applications. Usage has its own grounds or determinants.

Many presumed users use the computer or the Internet only once a week or a couple of times a month, and a few people never use them. Measuring computer and Internet access in survey questions often conflates possession or connection with use or usage time. Time use studies and the like show much larger differences or divides between groups of people. For instance, **the physical access gender gap appears to be closed in some Western countries, but regarding actual computer and Internet usage gender differences are getting more pronounced** (van Dijk, 2006). Some investigators (Bonfadelli, 2002; Cho et al., 2003) perceive a so-called usage gap between people differing in **social class and education** that is comparable to the phenomenon of the knowledge gap that has been observed from the 1970s onwards.

While the knowledge gap is about the differential derivation of knowledge from the mass media, the usage gap is a broader thesis about a differential use of whole applications in daily practices. Van Dijk (2005) observes **a usage gap between people of high social position, income, and education using the advanced computer and Internet applications for information, communication, work,**

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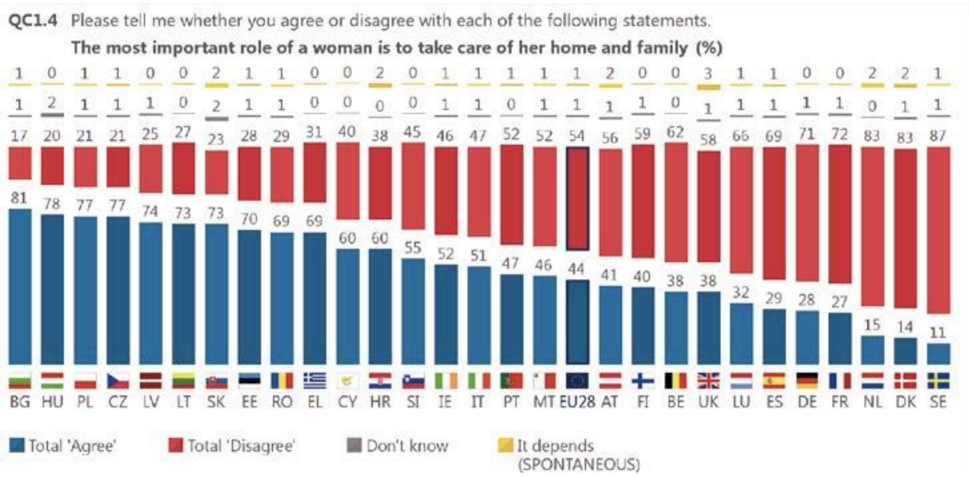
business, or education and people of low social position, income, and education using simpler applications for information, communication, shopping, and entertainment.

Time – or more correctly the **lack of time** seems to be one another crucial factor **affecting gender disparities** in Internet usage. Over the past decades, women's roles have changed dramatically; the dual-earner family model is now the most common family structure in Europe, due to the increased labour participation of women and increased living costs (van Belle, 2016). Yet, the social organisation of work and family life has not changed much. The **typical gendered division of labour**, based on the **male breadwinner model**, in which men have the primary responsibility to earn and women to care for young children and for elderly or disabled family members, is still valid in most EU member states (Lewis, 2001).

Figure 1 presents an opinion from people in the 28 EU countries (before Brexit), on the following statement “The most important role of a woman is to take care of her home and family”. In Sweden, only 11% of the respondents to the question ‘Do you agree?’ agreed with the statement.

Figure 1 Share of those who agree with the following statement: “The most important role of a woman is to take care of her home and family” by countries (%)



Source: Special Eurobarometer 465 survey, 2017

Consequently, the gender distribution of care within the family is still unequal and women represent the majority of carers, with great impact on their paid employment and their economic status. Even in the countries with a high uptake of parental leave by fathers, women still do most of the unpaid domestic work (European Parliament, 2014).

By exposing the disparity in available time females have, compared to males for extra activities outside home schooling, home working and home maintaining, the current **COVID-19 pandemic** gives a striking proof of this. As Ferguson (2020) reports, “research carried out by economists from the universities of Cambridge, Oxford and Zurich between 9 and 14 April, indicates that a woman who is at home – whether or not she is formally working – is affected by this **gender divide**. Both employed and unemployed mothers are typically spending around six hours providing childcare and home schooling every working day. By contrast, the average father at home is only spending a little over four hours on childcare and home schooling each working day, regardless of his employment status”.

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This of course has consequences on women's **academic contribution and performance** too. Sadasivam (2020) observed in the spring, "while women academics have struggled, research papers published by men have soared". According to Kitchener (2020), "six weeks into widespread self-quarantine, editors of academic journals have started noticing a trend: women — who inevitably shoulder a greater share of family responsibilities — seem to be submitting fewer papers. This threatens to derail the careers of women in academia". Flaherty also confirmed this, stating that there were **unusual, gendered patterns in submissions** and solo-authored articles by women were down substantially. "Female academics, as a group, also struggled more with work-work balance, as well: numerous studies show they take on more service work than men and are less protective of their research time, to their detriment. The coronavirus has simply exacerbated these inequities by stripping away what supports women had in place to walk this tightrope, including childcare" (Flaherty, 2020).

In summary, a general conclusion from a number of investigations of Internet usage is that, increasingly, all familiar social and cultural differences in society are reflected in computer and Internet use.

4.2 Statistical analysis

4.2.1 Internet access

As of 2019, there was an estimated 4.13 billion **Internet users worldwide (Statista, 2019a)**. This accounts for more than half of the global population. The **number of mobile devices** worldwide is forecast to grow to 16.8 billion in 2023 (Statista, 2019b).

Digital connectivity is considered a social right in the European Union (European Commission, 2019). **ICTs have become widely available to the general public** in Europe, both in terms of accessibility as well as cost. Figure 2 shows that by 2018 the share of EU-28 households with **Internet access had risen** to 89%. The highest proportion (98%) of households with Internet access in 2018 was recorded in the Netherlands, while the United Kingdom, Germany, Finland, Denmark, Luxembourg and Sweden also reported that more than 9 out of every 10 households had Internet access. The lowest rate of Internet access (72%) among the EU Member States was observed in Bulgaria (Eurostat, 2019). Figure 2 compares Internet access by households by country in 2013 and in 2018.

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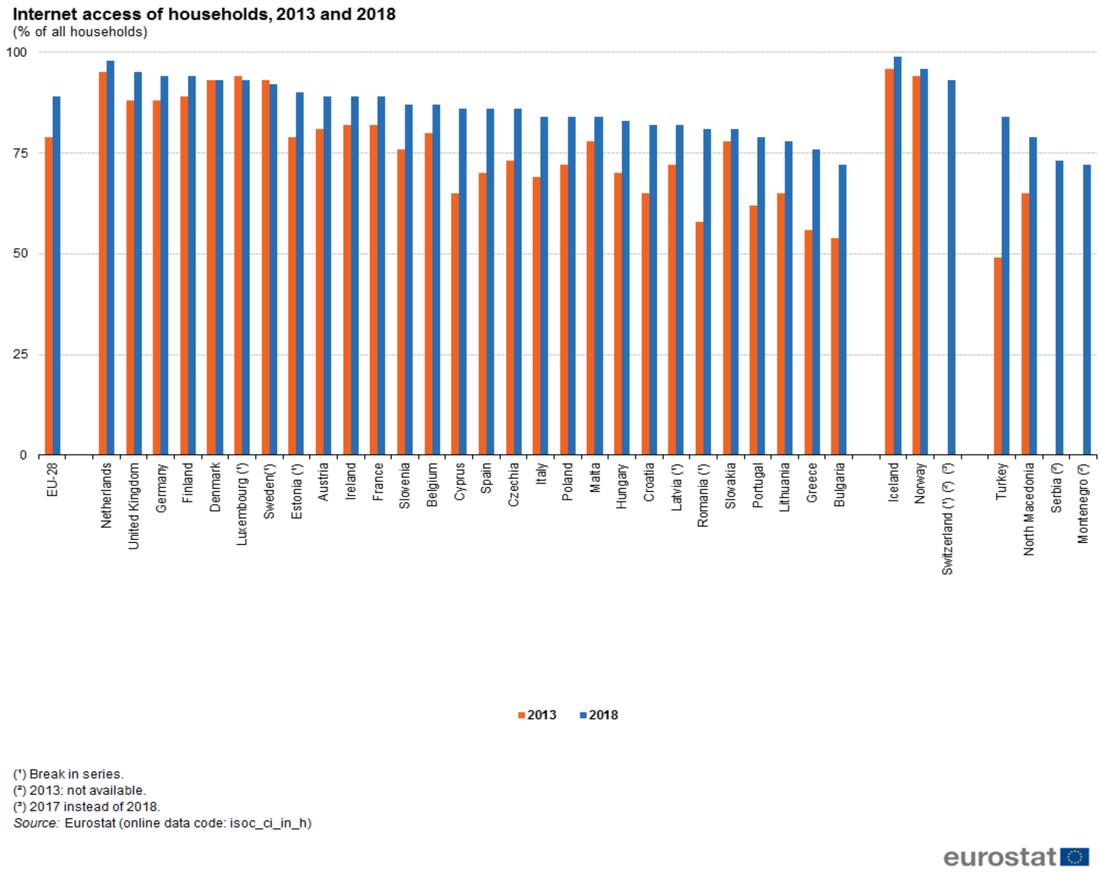
Figure 2 Internet access of households by country, 2013 and 2018 (%)



Source: Eurostat, 2019

Broadband was by far the most common form of Internet access in all EU Member States. The **Connectivity Report** of the European Commission's **Digital Economy and Society Index (DESI)** assesses the availability as well as the take-up of fixed broadband, that is, basic, fast (providing at least 30 Mbps) and ultrafast (at least 100 Mbps) broadband. Basic broadband is available to practically all homes in the EU, while coverage of fast broadband reached 83% in 2018. Ultrafast broadband mainly covers urban areas. 60% of homes in total had access to at least one of the ultrafast technologies in 2018 (European Commission, 2019). A comparative assessment of fixed broadband (basic, fast and ultrafast) shows the Netherlands and Luxembourg as the best performers. In contrast, Greece, Poland and Croatia are shown to be among the worst performers.

Figure 3 shows the access of households to the different dimensions of digital connectivity by country.

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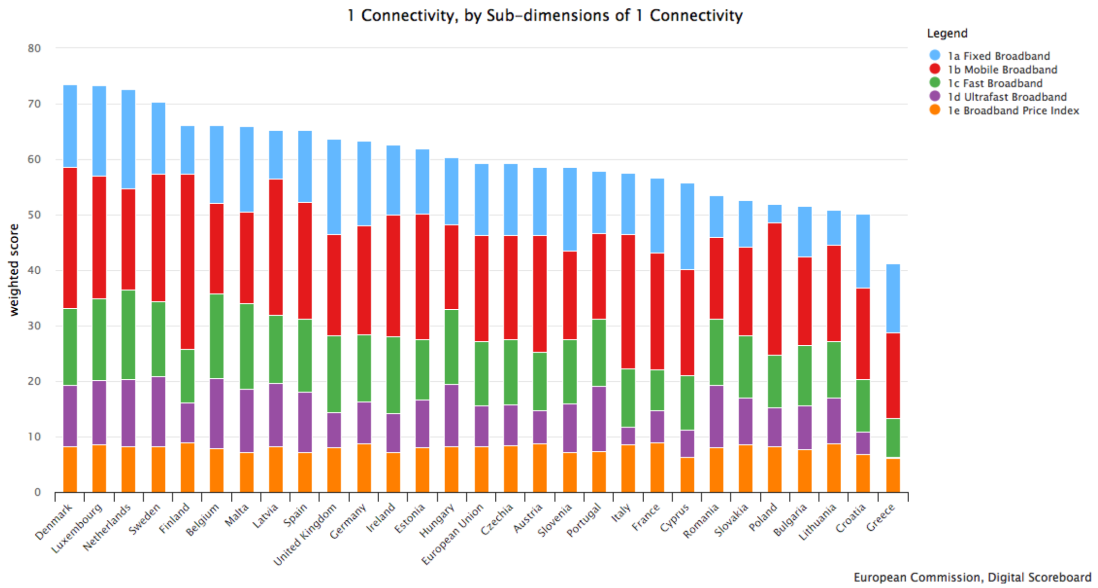
Figure 3 Digital connectivity of EU member states



Source: DESI 2019, European Commission

Mobile broadband includes the availability of 4G, the take-up of mobile broadband and a new indicator on 5G readiness. **Mobile broadband availability** went up slightly in 2018, although mobile is still mainly used as a complementary technology rather than a substitute to fixed technologies. As for mobile broadband, Finland, Denmark, Latvia and Italy lead Europe, while Romania and Hungary registered the lowest scores (European Commission 2019).

4.2.1.1 Urban and rural areas

Despite advances in recent years, **gaps between urban and rural areas remain present** within the EU-28 regarding digital connectivity. Whereas households in cities as well as towns and suburbs have comparatively high access rates — 91% in cities and 89% in towns and suburbs — Internet access is somewhat lower in rural areas (85%). The rural coverage of ultrafast technologies stands at 16 % of homes (European Commission, 2019). In 23 EU Member States, the proportion of households in rural areas with Internet access is lower than the equivalent proportions of households in cities or in towns and suburbs (Eurostat, 2019). The divide between rural and urban areas is particularly strong in Greece, Hungary and Portugal. By contrast, in Belgium, Israel, Luxembourg and the United Kingdom, the proportion of households with Internet in rural areas is higher than in urban areas.

Population distribution patterns, both in terms of density and dispersion, **geography** (difficulty of terrain) and the existence of legacy communication infrastructure are among the most important factors affecting the availability, and consequent take-up of broadband services. Countries with flat terrains, such as Belgium and the Netherlands, certainly have an advantage, in comparison to countries like Greece, with more challenging terrain (OECD, 2018).

4.2.1.2 Socio-economic differences

The first nation-wide surveys in the developed countries at the end of the 1990s and the turn of the century all showed growing gaps of access between people with high and low income or education, as

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well as majority ethnicities and minority ethnicities. From the years 2000–2002 onwards the physical access divides in the northern developed countries started to decline as the groups with high income and education reached a partial saturation and people with lower income and education started to catch up (van Dijk, 2006).

However, the digital divide among households still appears to depend primarily on two variables, **income** and **education**. Through its effects on income, **the higher the level of education, the more likely individuals are to have access to ICTs**. Other variables include **household size** and **type**, **age**, **gender**, **racial and linguistic backgrounds. Location** also plays an important role. The **majority of people on the losing side of the divide are composed of the poor and the elderly**, along with those who are **disabled**. Large-scale surveys conducted later also show significant differences in access to the Internet across socio-economic status (Büchi et al., 2016).

Income plays an important role in broadband take-up, as well, which tends to be lower in Member States where the cost of broadband access accounts for a higher share of income, but this correlation is not strong. The lowest income quartile has a take-up rate for fixed broadband of just 60% as opposed to 90% in the highest income quartile. The take-up in the EU for average income is 76.6%. Prices of fast broadband access tend to decrease over time but vary widely between member states (European Commission, 2019).

The European **gender physical Internet access divide almost completely closed in recent years. Considering age, the relationship is curved**: physical access culminates in the age group of 25–40 to sharply decline afterwards. Within the online community, evidence for a **democratic divide** is emerging between those who do and do not use Internet resources to engage, mobilise and participate in public life (van Dijk, 2006).

4.2.2 Internet usage and skills

As of the beginning of 2018, **more than four fifths (85%) of all individuals in the EU-28, aged between 16 and 74 years, used the Internet at least once within the three months prior to the survey date**. At least 9 out of 10 individuals in Denmark, Luxembourg, the Netherlands, the United Kingdom, Finland, Germany and Sweden used the Internet during the three months prior to the survey. By comparison, slightly less than three quarters of all individuals aged 16 to 74 used the Internet in Italy (74%), Greece (72%) and Romania (71%), with the lowest share in Bulgaria (65%) (Eurostat, 2019). Table 4 shows the Internet usage across EU Member States by age groups, with mild gender differences.

Table 4 Internet users aged 16–74 years in the EU countries in 2018, by age groups and gender (%)

Territory, country	*Total (16–74 years)*		*By age group*					
			16–24		25–54		55–74	
	F	*M*	*F*	*M*	*F*	*M*	*F*	*M*
EU28 average	**84,5**	**86,0**	**97,5**	**97,6**	**93,3**	**92,6**	**64,9**	**68,8**
Belgium (BE)	87,3	90,1	98,2	98,5	94,7	93,9	70,0	79,1
Bulgaria (BG)	63,4	66,2	89,9	94,6	79,4	78,3	33,1	34,2

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Czechia (CZ)	85,7	87,3	99,4	98,9	97,0	96,4	62,1	66,0
Denmark (DK)	97,4	97,8	100,0	99,6	98,6	98,9	94,3	95,0
Estonia (EE)	89,3	89,5	99,3	99,5	98,1	96,4	72,5	70,4
Finland (FI)	94,9	93,9	100,0	100,0	99,4	98,4	86,9	84,5
France (FR)	88,0	88,4	97,9	96,5	94,3	94,0	73,9	75,1
Croatia (HR)	73,3	77,3	100,0	99,6	90,3	88,6	42,0	51,6
Ireland (IE)	82,8	81,6	92,9	99,9	96,0	92,9	55,9	53,2
Italy (IT)	71,5	76,9	92,0	92,3	82,9	84,9	46,5	56,6
Cyprus (CY)	84,6	84,3	99,6	99,0	95,6	93,4	52,9	56,7
Lithuania (LT)	79,9	79,5	99,4	99,6	92,1	88,1	55,6	52,4
Latvia (LV)	84,0	83,1	98,6	98,9	95,3	92,7	63,1	57,1
Luxembourg (LU)	95,3	97,7	100,0	100,0	99,2	98,8	83,6	94,0
Hungary (HU)	74,8	77,4	93,5	96,7	91,6	87,8	42,6	47,8
Malta (MT)	81,5	81,3	100,0	100,0	95,2	91,0	50,8	54,9
Germany (DE)	91,0	93,7	98,9	99,1	98,1	97,8	76,4	83,8
Netherlands (NL)	94,5	94,8	97,8	97,0	97,0	96,3	89,0	91,4
Poland (PL)	77,3	77,8	99,1	99,0	91,5	89,0	46,0	46,2
Portugal (PT)	73,0	76,4	99,2	99,6	87,5	88,2	41,0	46,2
Austria (AT)	85,4	89,5	99,2	99,0	94,8	96,2	63,1	72,3
Romania (RO)	69,6	71,8	95,6	93,1	82,3	81,5	38,2	40,7
Greece (EL)	70,5	74,1	98,5	96,6	86,7	85,4	34,3	45,5
Slovakia (SK)	80,4	80,5	97,7	98,7	92,6	91,1	52,0	48,7
Slovenia (SI)	77,6	81,9	99,1	99,3	91,0	91,7	48,9	57,6
United Kingdom (GB)	95,1	94,4	100,0	100,0	99,2	97,5	85,8	85,7
Spain (ES)	85,6	86,6	98,7	98,3	95,6	94,1	62,2	66,8
Sweden (SE)	93,0	88,7	93,4	100,0	93,3	95,1	92,3	60,6

Source: Eurostat, 2019

In 2018, 83% of Europeans used the Internet at least weekly and about 76% daily or almost every day; compared with 81% and 72% respectively a year earlier. For data on those who used the Internet at least once a week, see Figure 4.

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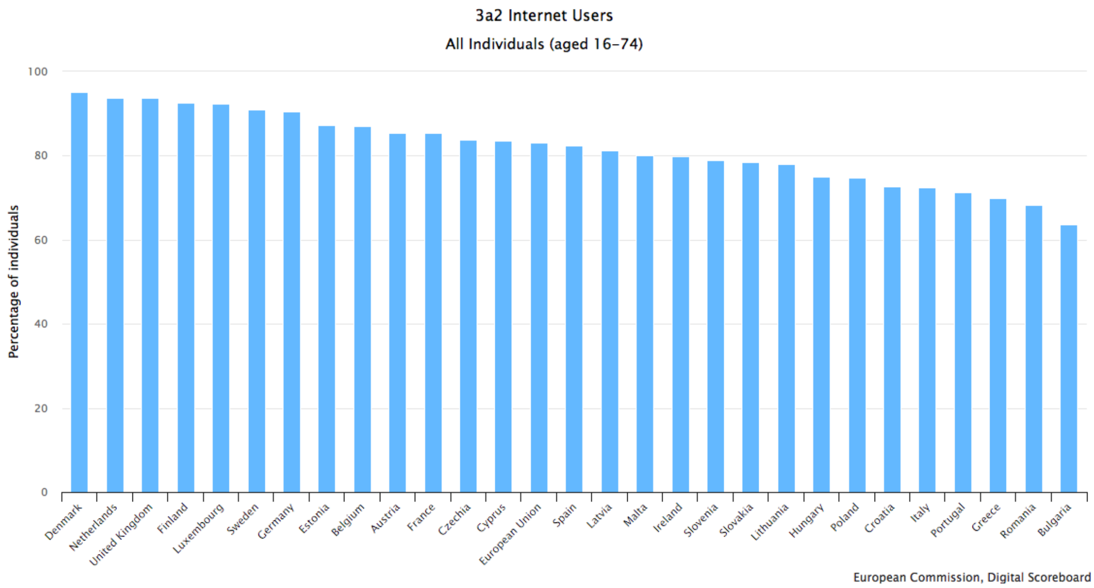
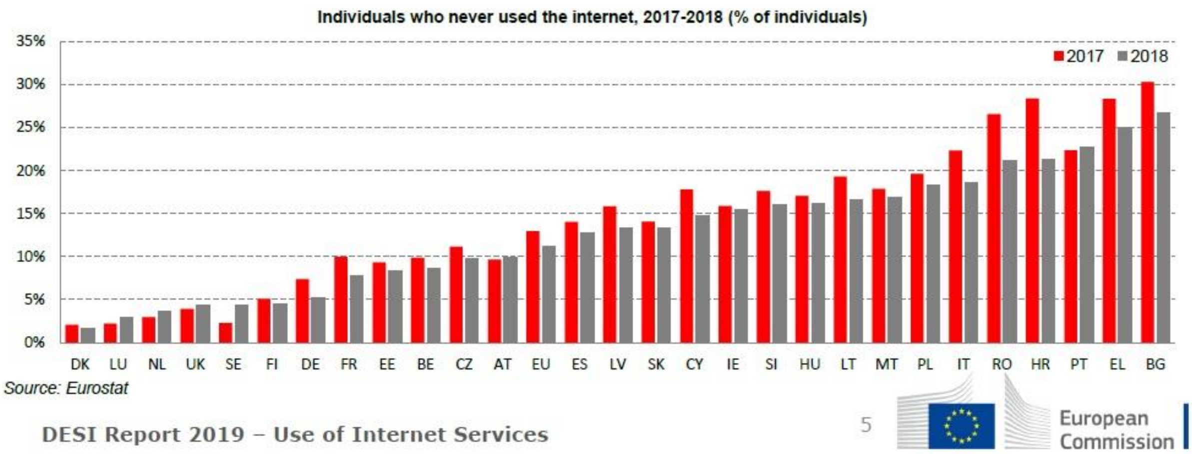
Figure 4 Share of all individuals aged 16-74 who use the Internet at least once a week by country (%)



Source: Eurostat, 2019

By contrast, **the proportion of the EU-28's population that had never used the Internet was 11% in 2018**, with this share falling to one third of its level in 2008, when it had stood at 33% (Eurostat, 2019). Figure 5 shows the proportion of people who never use the Internet.

Figure 5 Share of individuals who never use the Internet by country (%)



Source: DESI 2019, European Commission

According to the European Commission's **Digital Economy and Society Index (DESI) Report on Human Capital – Digital Inclusion and Skills**, the lack of relevant user skills remains by far the fastest-growing factor deterring households from having Internet access at home. In turn, not practising

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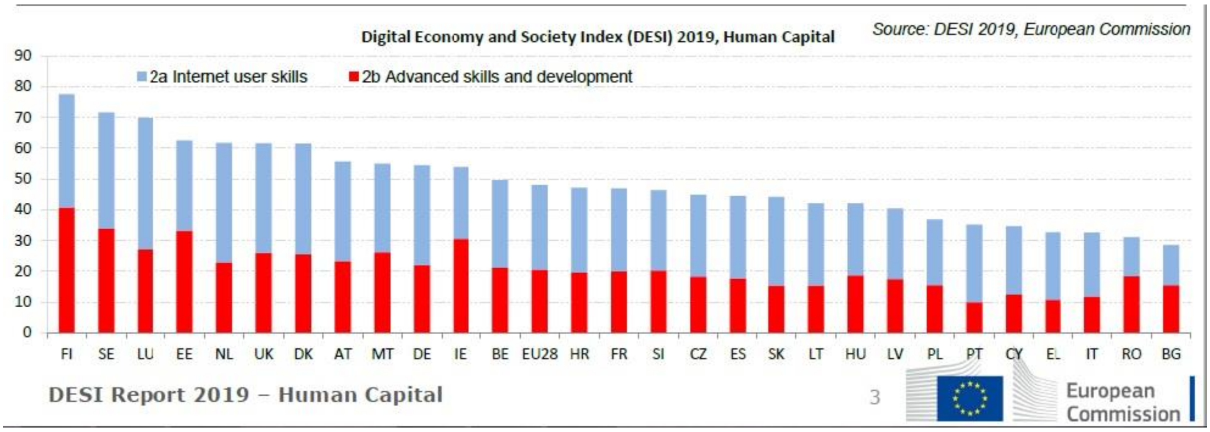
Internet use leads to a lack of skills, too. According to the digital skills indicator, a composite indicator based on the digital competence framework for citizens, the main reason of the EU population for not having digital skills was being non-users. Figure 6 shows the proportion of the population with Internet user skills and advanced skills (European Commission, 2019).

Figure 6 Internet user skills and advanced skills in the population by country (%)



Source: DESI 2019, European Commission

4.2.2.1 Socio-economic differences

Büchi et al. (2016) conducted structural modelling using data from representative surveys from 5 countries (New Zealand, Sweden, Switzerland, UK, and USA) to show that **socio-demographics independently account for 50% of variance in Internet usage, with age as the strongest predictor**.

Proportionately, men use the Internet more than women do (at least weekly: 84% against 82%; daily or almost: 75% against 77%), although the difference is narrowing. **The gender gap persists but continues to narrow**, reaching 1.7% in 2018 against 6.4% in 2010 (Eurostat, 2019; European Commission, 2019).

The share of individuals who never use the Internet is the highest among 65-74 year olds (37%), while among 16-24 it is less than 1%. Similar proportions are seen based on the education level – 27% of individuals with no or a low-level of education and 1% of individuals with a high-level of formal education. **People with low education levels or low incomes, as well as the elderly, the retired or the inactive tend to use the Internet comparatively less, which means these groups continue to be at a high risk of digital exclusion** (European Commission, 2019).

Data on digital skills also imply serious risks of digital exclusion in a context of rapid digitisation. There are proportionally more men than women with at least basic digital skills (respectively, 60% and 55%). In addition, only about 31% of people with low education levels or no education have at least basic digital skills. 49% of those living in rural areas have basic digital skills compared with 63% in urban areas (European Commission, 2019). Figure 7 shows the digital skills level of European citizens in urban and rural areas.

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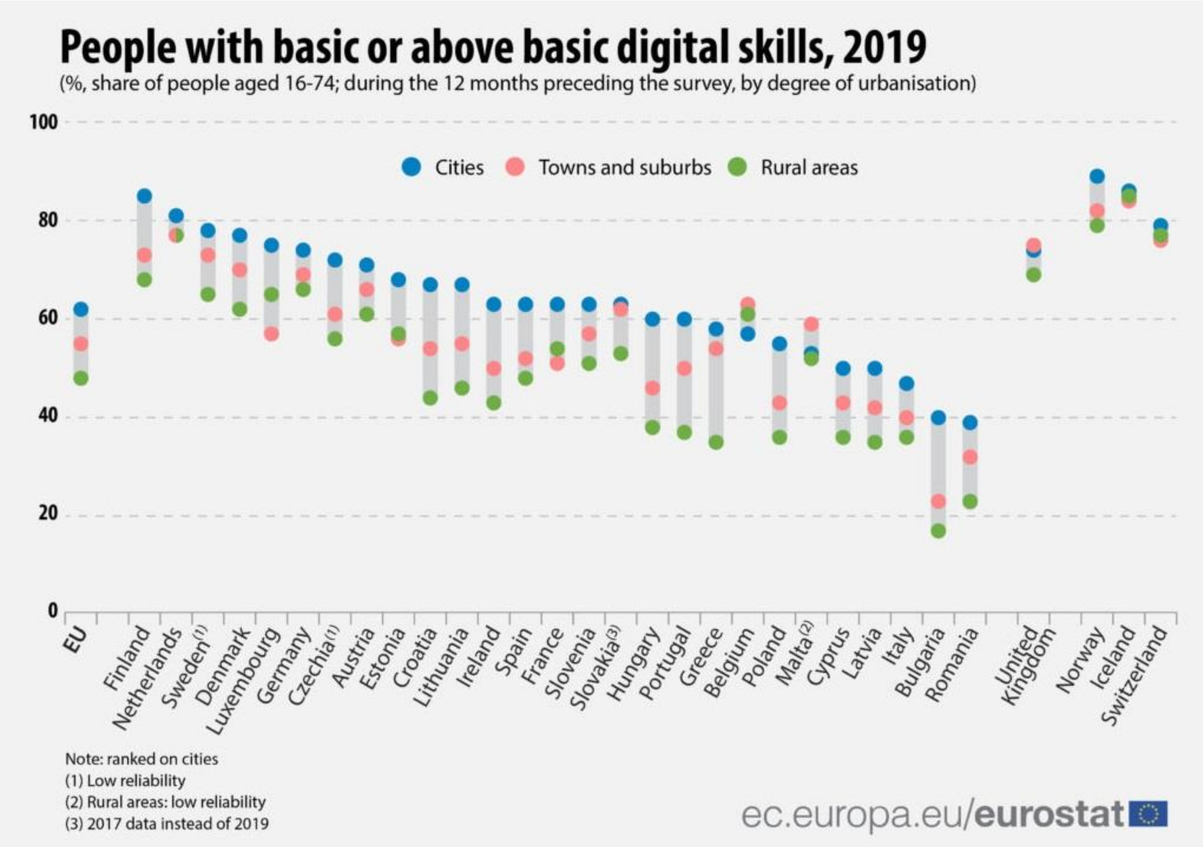
Figure 7 Share of the population with basic or above basic digital skills by country and degree of urbanisation (%)



Source: Eurostat, 2019

Interestingly, in addition to the intertwining socio-economic factors such as gender, age, education, income, and the lack of motivation or skills, **Internet usage can also be related to religion**. According to the survey of the Israeli Internet Society (2017), 8.5% of the Jewish participants did not use Internet. 61% of them explained this by religious reasons, 21% said that the Internet did not interest them; about 4% reported that they did not use Internet since they did not know how to use it. There was no difference between men and women in Internet use.

In the Arabic population of the survey, 15.2% reported that they did not use Internet. 37% of them said that they did not have enough computer skills and digital literacy to do so, 41% of them claimed that the Internet did not interest them and only 4% mentioned religious reasons. While Internet use was a bit higher in the Jewish population (91.5% vs. 84.8%), social network usage was higher for the Arabic sector (73% vs. 61%). In contrast to the Jewish sector, in the Arab sector there were significant differences between men and women, where only about half of women used social networks, compared to 70% of men (Israel Internet Association, 2016).

4.2.2.2 Disability and health

People with disabilities are another group of society facing the risk of digital exclusion. The nationwide study of Poland in 2013 conducted by Duplaga (2017) focused on the analysis of factors determining **Internet usage** and undertaking specific activities online **among people with disabilities.** Many

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available assistive technologies for people with disabilities are based on the use of ICT assuring improved communication, learning opportunities or computer-based speech recognition and synthesis. ICT is one of the key areas of development of assistive technologies. The analysis included the data of 3,556 respondents, confirmed being disabled in the 2013 in the “Social Diagnosis” study. Table 5 reproduces Duplaga (2017) data on gender, age, residence, education, occupation, mobile phone use and Internet use (from Table 1 in Duplaga, 2017: p. 9).

Table 5 Characteristics of the study group of people with disabilities (n=3,556) performed in 2013 in Poland

		n =	%
Gender	Female Male	1646 1580	51,02 48,98
Age	45-59 years	927	26,10
	60-64 years	492	15,27
	65+	1204	25,19
Residence	Rural	1141	35,39
	Urban < 20,000	419	13, 00
Education	Primary	953	29,65
	Lower secondary	1071	33,32
	Upper secondary	831	25,86
Occupation	Employee	405	12,60
	Retired or on disability pension	2308	71,81
	University or school student	91	2,83
	Unemployed	363	9,37
Mobil phone use	Yes	2352	73,27
Internet use	Yes	2151	66,95

People with disabilities belonging to the youngest category were consistently more likely to use Internet than persons belonging to older age categories. **The highest differences in Internet use observed were dependent on education level.** The probability of the use of the Internet among people with disabilities who achieved at least a post-secondary level of education was nearly 18 times higher. Nearly 82% of respondents using the Internet declared that the most frequent online activity performed was checking and sending emails. The impact of socio-demographic, economic, and occupational factors on the use of the Internet by people with disabilities is obvious and corresponds to the trends seen in the general population (Duplaga, 2017).

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The study of the ADA (2010) found that among all working-age (18-64) **people with disabilities**, only **21-% said that they were employed** full or part-time, compared to 59% of working-age without disabilities; **17% of people with disabilities** reported that they **had not completed high school** (vs. 11 % of people without disabilities); only 54 % of adults with disabilities claimed **to use a computer** or other electronic device to access the Internet from home (vs. 85% of adults without disabilities). People with disabilities were **much less likely to say that they were very satisfied with life** in general than are people without disabilities (34% vs. 61%).

The Internet can also play an important role in the education and **recruitment of patients** for specific services or programs (Lake et al., 2004; Salo et al., 2004). Data collected by Lake et al. (2004) included the patients' age, gender, level of education, zip code, the type of clinic visited and information on the respondents' Internet use. 20% of the respondent patients visiting the clinics had used the Internet to **research the medical condition** that prompted their visit. **Highest-grade level completed, age, type of clinic and household income were all found to be associated with any prior use of the Internet whereas gender was not.** Among Internet users, only household income and frequent use of the Internet were associated with searching the Internet for medical information. Patients more likely to want medical links were younger, college educated and in higher salary ranges (Salo et al., 2004).

4.2.3 Gendered online data privacy

Theorists have hailed the Internet as a tool of empowerment that reduces the inequality in various domains of civic life (Anderson, 2007; Negroponte, 1996). However, other scholars (Park et al., 2012) have worried whether the Internet can fully function as an equaliser in the domain of information privacy. The less skilful users can be inadvertently excluded from the benefit of Internet, as they cannot efficiently avoid data pitfalls, whereas those who are aware of a wide range of privacy issues may effectively manage personal data (Park, 2015).

Several scholars (Boyd and Hargittai, 2010; DiMaggio et al., 2001; Hargittai and Shafer, 2006) have also raised a concern that the digitalisation of personal data may bring about a **persistent gender gap**. Advanced research (Wasserman and Richmond-Abbott, 2005) has consistently indicated that **women may not benefit from new technology as much as men** and potentially be among the most disadvantaged user segments. The notion that the personal privacy in the Internet can be 'gendered' suggests the proposition that privacy may mean a different functioning norm to men and women. As the socialisation of gender guides men and women into different paths of choices and values, they may make different decisions in information environments (Lally, 2002).

Women are generally more concerned with their privacy on the Web than men (Fogel and Nehmad, 2009; Graeff and Harmon, 2002; Milne et al., 2004; O'Neill, 2001; Sheehan, 1999). Several studies have shown that although women tend not to disclose sensitive personal details, e.g., telephone numbers and home addresses (Acquisti and Gross, 2006; Feng and Xie, 2014; Fogel and Nehmad, 2009; Tufekci, 2008), they do disclose more personal details than men do (Hoy and Milne, 2010; Tufekci, 2008). Thus, **despite a high level of privacy concern among women, they rarely adopt the privacy protection behaviour that men do** (Milne et al., 2004; Sheehan, 1999).

This is in line with the phenomenon of **"privacy paradox"**. The term refers to the widely recognised discrepancy between individuals' intentions to protect their privacy and how they actually behave in the online marketplace. Individuals' intentions to disclose personal information and their actual

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personal information disclosure behaviours are often very different (Norberg et al., 2007; Dienlin and Trepte, 2015).

Some studies claim that this gender disparity originates in women's general lack of technological literacy (Park, 2015) and low digital self-efficacy (Hargittai and Shafer, 2006). According to the findings of Park (2015), who studied a sample of 419 Internet users (aged 18 and older), **men were significantly better equipped than women with privacy technical sets, and broader confidence** in the privacy protective matter was also significantly associated with being a male. Hargittai and Shafer (2006) found that **women are less likely to perceive themselves as competent, regardless of their actual skill levels, which may in turn negatively influence their ability to pursue benefits from the Internet in diverse domains**.

Nevertheless, this gender disparity displayed a divergent pattern, as the **significant difference between men and women was manifest only in the technical, not social, aspect of the privacy protection** (Park, 2015). No reported gender difference in the social behaviour gives rise to nuanced insights. In one aspect, it can be that men tend to be skilful at various technical tasks (Schumacher and Morahan-Martin, 2000) related to Internet privacy. In another aspect, we can interpret that women may be as responsive as men to socially available modes of protection, while keen to exercise personal data management that is not necessarily intrinsically technical. The study of Youn and Hall (2008) showed that **women do adopt social privacy protection strategies, but they do it differently than men**. For example, female respondents protected themselves by providing inaccurate information as their privacy concerns increased, while male respondents refrained from registering on Websites.

Tests for the interaction effects shed additional light on these matters by revealing how **the gender difference intersects with age and marriage status** in subtle and distinctive ways. For instance, the interplay between gender and marriage suggests that marriage may tend to adversely affect women more than men in their preparation of technical skill. The disparity also appears to be reinforced when the age was taken into account, as women's confidence tends to be lower regardless of age, while the confidence gap magnifies when they are younger (Park, 2015).

In conclusion of this chapter, it is evident that although digital connectivity is considered a social right in the EU, and indeed, internet penetration has been approaching saturation in member states, other **conditions required for true digital inclusion**, such as motivational access, skills and usage access to digital technologies, and personal data protection skills **continue to be highly dependent on the socio-economic status of the individual, the household or the social group. In turn, a low level of access has a repercussion on this status**; those who remain in the "wrong side" of the digital divide become increasingly marginalised within society. It must be emphasised that **digital literacy, socio-economic status and social inclusion are interacting dimensions** that determine the position of individuals and groups in the fabric of modern information society.

5 Encouraging diverse engagement

5.1 Diversity factors affecting participation in CS and other voluntary activities

Although some researchers suggest that socio-economic characteristics explain only limited variance in people's decisions to volunteer in any organisations (Roggenbuck, 2001), these factors may present barriers to participation. Some clear patterns can indisputably be observed regarding the frequency of

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volunteering across social groups.

The **gender** balance of volunteers varies considerably across European countries. In general, however, most countries tend to have either a greater number of male volunteers than female (11 countries) or an equal participation between men and women (9 countries). There are a greater number of female volunteers than male in Bulgaria, Czechia, Malta, Slovakia and the United Kingdom (GHK, 2010).

Reasons behind **a male dominated voluntary sector** vary between countries. For example, a survey carried out in Hungary found than more men (43%) than women (37%) take part in voluntary activities because women are responsible for a larger share of the housework (including looking after the family), which limits their time availability (GHK, 2010). Several countries have recorded that **age** has an effect on the gender balance of volunteers. The difference in the volunteering rate between men and women is particularly significant for individuals aged between 45 and 75 years. Among younger age groups, there is no significant difference between the genders with the share of female volunteers being even slightly higher among 16-25 year olds (GHK, 2010).

According to Eurostat, **social isolation in general increases in old age and it is higher among those who are at risk of poverty** (Eurostat, 2010). However, in a substantial number of countries the number of older people volunteering is increasing. The **increased involvement of older people in volunteering** might be due to the fact that old people now make up a large share of the population, as well as the fact that older people now enjoy better health and are more active. Longer life expectancy and the emphasis on active ageing have meant that older people (who are still relatively young) have free time to spare (for example in retirement) and have a high level of skills, which can be transferred to voluntary activities (GHK, 2010).

As far as the **geographical** trends are concerned, there appears to be a tendency toward greater levels of volunteering in rural areas and smaller towns, cities and villages than in larger metropolitan areas. This is the case in old member states such as Austria, Denmark, Estonia, Finland, France, the Netherlands and Sweden. In contrast, higher levels of volunteering can be found in urban areas and in big cities than in rural areas in Greece, Hungary, Lithuania, Poland and Slovakia. Many of the countries, which fall into this category, are located in Eastern Europe (GHK, 2010).

An analysis of the national surveys highlights a clear trend between the level of volunteering among the population and an individual volunteer's highest attained level of education. The national reports of 20 EU countries have illustrated that there is a **positive correlation between education levels and the tendency to volunteer**. In short, the better-educated people are, the more likely they are to volunteer. This is in line with the findings of several international studies that have shown that volunteers tend to come from better-educated segments of the population (GHK, 2010).

Volunteers tend to have a middle-class background, relatively more money and more time, e.g. retired people or those without parenting responsibilities (Heidrich, 1990). Buyx et al. (2017) warns that **recruiting participants** for population studies **from marginal or vulnerable groups seems particularly difficult**, because there is a public mistrust in research: studies have become more burdensome for participants and there is a general decrease in volunteerism in Western countries. West and Pateman (2016) also confirm that **people with disabilities, people of minority ethnic origin, unemployed and low-income people tend to be under-represented** e.g. in environmental monitoring schemes, particularly where there is financial implication for the participation.

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Individuals with **disabilities** were five times more likely to report dissatisfaction with their lives than were their non-disabled counterparts, and a majority of those surveyed said that **lack of a full social life** was a reason for this dissatisfaction (Steinfeld et al., 2009).

Winter et al. (2016) studied **citizen scientists among Latinos**, who are insufficiently active, partly due to neighbourhoods with little environmental support. The study demonstrated that with minimal training, low-income Latino adolescent and older adult citizen scientists can: 1) use innovative technology to gather information about features of their neighbourhood environment that influence active living; 2) analyse their information and identify potential solutions, and 3) engage with stakeholders to advocate for the development of healthier neighbourhoods.

Ridgeway and Yerrick (2018) examined afterschool programming in citizen science from the perspective of Critical Race Theory. The study explored the **role of race and ethnicity**, and the ways in which marginalisation could manifest itself with **black urban youth and teachers**. White participants shared different experiences from the Black participants and filtered many of those experiences through racial interpretations.

5.2 Reaching diverse target groups

Accessing diverse groups that are often not included in mainstream science can help in establishing personal relevance of science and a common ground between scientists and volunteers. Nonetheless, one of the key challenges of citizen science projects is **the involvement of citizen scientists representing a broad spectrum of society**. An important factor in maximising recruitment, retention and compliance is to develop strategies that are specific to different studies, cohorts, and demographic groups. **Target audiences should be clearly identified in order to be able to find the most appropriate ways to engage different audiences** (Varner, 2014).

5.2.1 Motivators

According to the findings of Müller et al. (2017), **leaders at workplaces** and schools were the most active in encouraging their employees and students to participate in a CS program (46.1% for female and 49.9% for male participants). Family, friends, and acquaintances that have already participated in a CS program were a similarly strong driving force (45% for both women and men). Further, 8% of women and 9% of men were available through different information channels, media and the Internet.

Analysis by age also showed that leading personalities at the workplace or in the personal environment were the most inspirational for 14-60+ year olds. The circle of friends had a slightly greater impact on young people (14-49) than on those over 50. 14-30 year olds are the easiest to reach at high schools and colleges. Both young people and the elderly can be scouted through information channels, the media and the Internet (Müller et al., 2017).

The analysis of Füchslin et al. (2019) shows that **the most accessible are usually men around the age of 55, with higher education, who are already interested in scientific topics** (senior "sciencephiles"), browse scientific websites and enjoy going to lectures, conferences, museums, zoos, etc. The effective recruitment and retention of older cohorts (aged 65+) requires continuous engagement and in-person deployment of mobile apps to minimise social isolation and potential technology anxiety (Katapally, 2019).

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When asked about their motivation, **women tend to emphasise pleasure or social aspects, while men usually mention material and non-material benefits, influence and professional advancement**. Women rarely want to get into leadership positions. Enjoyment is the most, while pay is the least important factor for both sexes (Müller et al., 2017).

Less educated people are more socially oriented. Those with secondary and tertiary education are more likely to mention pleasure seeking as their main motivation, while for those with the highest level of education, belonging to a good community and, in some cases, creating a company are the most important encouraging factors (Müller et al., 2017).

5.2.2 Age

Young people on the other hand are more profit-oriented; they wish to connect the citizen science activity with further education, or to become freelancers. People aged 30-49 like to be in company or even start a business. **For the elderly the social network is the most significant motivating factor** (Müller et al., 2017).

Young people who are interested in science (young "sciencephiles") are mostly men with higher education, 26 years old on average. They are mostly available via YouTube, video ads, or meet-ups on various topics (Füchslin et al., 2019). With respect to marginalised populations such as **indigenous youth**, apart from in-person group deployment through peer-to-peer interaction, incentives such as free data plans play a key role in the success of mobile health interventions (Katapally, 2019).

The **Relevance of Science Education** (**ROSE)** is a cooperative research project with wide international participation, addressing mainly the affective dimensions of **how young learners relate to science and technology (S&T).** The purpose of ROSE is to gather and analyse information from the learners about several factors that have a bearing on their attitudes to S&T and their motivation to learn S&T. About 40 countries have been taking part in ROSE. In most countries the target population is the whole national cohort (those who are still attending school at the age of 15 years). The children in most countries agree strongly that science and technology are important for society (60% of girls, nearly 70% of boys).

Norwegian authors (Sjoberg et al., 2010) conducted a study on the ROSE project in which they examined **attitudes to and education about science and technology**. The results allow interesting comparisons between the young generation and the adults. Sjoberg et al. found that

- In the richest countries (Northern Europe, Japan) young people are more ambivalent and sceptical than the adult population.
- There is a growing gender difference, with girls, in particular in the richest countries, being more negative (or sceptical, ambivalent) than boys.
- Attitudes to science and technology among adults and young people are mainly positive.

5.2.3 Gender: reaching females

In the case of women, there is a stronger interest in engaging in scientific research on the part of freelancers above the age of 40, with flexible working arrangements. **Women with children or working full time are more difficult to reach.** They can be a bit more easily scouted in social places, online media (e.g. blogs, Facebook), via television and radio, or with flyers e.g. in zoos and botanical gardens**. Working parents** usually have confidence in science in general, but only moderate interest in

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CS. **Those who are willing to participate are mostly men, 46 years old on average, and working full time**.

The strategy of the EU Horizon 2020 funded **Doing It Together Science project** (DITOs, 2016), was to reach female audiences by "making sure they feel represented in the communication. (...) It is important to make videos and photos that show best practices of women in science and use women as role models in participatory science." Additionally, DITOs (2016) spread its project message "on channels on which (young) women are active." This enabled DITOs project to cover "social media channels" and "also printed materials" to find the right partnerships" (2016: p.26). EPWS (2019) pointed to the concluded DITOs project (2016-2019), which found that the culture of a country appeared to have more impact on women participation in citizen science than the discipline.

Leveraging birthdays of famous and unknown female scientists, as well as International Women's Day, 8 March and International Women's Engineering Day, 23 June (also anniversary of the birth of mathematician and codebreaker, Alan Turing), **and Ada Lovelace Day, the second Tuesday in every October**, will aim to inspire an "if they can do it, so can I" attitude. This will be especially important to turn the tide on the extent of privacy intrusion through tracking-by-default in digital technologies and communication tools.

There is a series of further events that might serve the recruitment purposes of the CSI-COP project by catching the attention of and attracting girls and boys, women and men. The **World Science Day for Peace and Development proclaimed by the UNESCO** in 2001 and celebrated for the first time in 2002, **is an international day** that highlights the important role science plays in society. It is celebrated each year on **10th of November**. It also highlights the **need to engage the wider public in debates on emerging scientific issues**. The Hungarian Academy of Sciences celebrates this day with a large-scale series of scientific events every year.

The Women in the Research Career Presidential Committee of the Hungarian Academy of Sciences brings Hungarian female scientists to the forefront once a year, by commemorating the women (e.g. the first Hungarian female doctor, Vilma Hugonnai in 2017) who came a long way to gain recognition in science; and by emphasising the importance of reaching a balance between women’s opportunities in scientific research and leadership and their role in the family.

The annual **Girls’ Day event**, which is held on the **last Thursday of April**, is an excellent opportunity to recruit new citizen scientists among young people in European countries. The event serves two purposes. First, it arouses high school girls' interest in engineering, IT and other future-oriented professions through visits to various stakeholders, and secondly, it addresses the industry's need to employ a greater proportion of women in the engineering and IT sectors.

International Girls in ICT Day is an initiative backed by International Telecommunication Union (ITU) Member States in Plenipotentiary0 (ITU, 2014) to create a global environment that empowers and encourages girls and young women to consider studies and careers in the growing field of information and communication technologies. **International Girls in ICT Day** has been organised for the first time in 2011. Resolution 70 calls for all ITU members to celebrate International Girls in ICT Day on the **fourth Thursday of April** every year.

One of the opportunities for face-to-face meeting with potential citizen scientists is the national **SCIndicator science communication competition organised every year by the Association of**

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Hungarian Women in Science. The competition aims to activate talented and creative undergraduate and PhD students in technology-oriented fields, and make them more visible and successful. Year after year, an increasing number of young girls and boys choose role models among the competitors and support their favourites at the final event and award ceremony of the competition.

Safer Internet Day (SID) is organised by the joint Insafe-INHOPE network with the support of the European Commission. From cyberbullying to social networking, each year Safer Internet Day aims to raise awareness of emerging online issues and chooses a topic reflecting current concerns. On 11th February 2020, the 17th edition of SID was celebrated, with events and activities taking place in over 170 countries, supported by many organisations. The theme was „**Together for a better Internet**", and all stakeholders joined together to make the Internet a safer and better place for all, **especially for children and young people** (Safer Internet Day, n.d.).

The activities carried out by citizen scientists have a number of benefits that can make them attractive for working women and socio-economically disadvantaged people, as well, as can be seen in Table 6.

Table 6 Benefits of CS activities for diverse participants

- Participation is open; there is no need for a certification.
- Remote work, flexible hours and digital publication are possible (Wessels, 2019).
- There is flexibility with regard to time and place of participation (Curtis 2015a); work can be done when and where it is the most comfortable.
- The CS activity can even be performed with small children, e.g. during maternity leave.
- It is possible to do the tasks in a family circle, with friends, in teams, or even in a competition setting, discussing what results participants got and what they make of it.
- These activities are an excellent occupation for retired or disabled people (Steinfeld et al., 2009).

Women and physically or socially disadvantaged people can be encouraged to participate by the following opportunities after the research has been completed (Table 7).

Table 7 Opportunities for participants after the research has been completed

- Women with children can return to their workplace or seek new job opportunities with fresh knowledge and experience.
- There is extra encouragement for female scientists to research careers (EPWS, 2008).
- Encouragement for female researchers with the slogan: „Family scientists are especially encouraged to apply" (EPWS, 2008).
- Unemployed, physically or socio-economically disadvantaged people might get the opportunity to find work in the primary labour market (Steinfeld et al., 2009).
- For elderly and retired people, CS activities carried out either in a group or alone can be a meaningful pastime, with which they can even earn money in some cases.
- They can get inspiration to pay more attention to their personal data security and be encouraged to pass on their knowledge among their friends, family members and co-workers.

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5.2.4 Reaching marginalised groups

It is important to be inclusive of communities (and sensitive to their values and motivations), including those that are commonly under-represented in science (Varner, 2014). Since communities are unique, no single template applies to all. The CitizenScience.gov website provides tools to help understand the potential partners and choosing the best ways to make sure everyone gets what they need from the project. It is important to be sensitive to the social and cultural beliefs, concerns, and practices of the recruited volunteer citizen science community.

Underrepresented groups can include marginalised individuals due to geographical location (rural), lack of Internet access, and **immigrants** or **refugees**. To understand how to "acculturate and settle in the host community" (Hodes et al., 2018, p. 390) immigrants and refugees fleeing famine, war or for economic reasons might refer to digital services for legal, welfare and other advisory information. In the West before covid-19 lockdown migration was seen through Turkey and Greece progressing towards "resettlement countries" including Germany, the UK, Sweden, Norway (Hodes et al., 2018, p.390). Like others, immigrants and refugees might use apps on smart devices they possess, hence might also succumb to tracking with or without their informed consent. Location data technology is available for border security. In the US, the roll out of **Locate X** "a powerful tool that uses data from popular mobile phone apps" enables security forces to "pinpoint mobile devices … see where else those devices have travelled going back months" (Levenson, 2020). The CSI-COP project would aim to reach immigrant and refugee organisations in order for CSI-COP's cohort of citizen scientists better represent the European population.

6 Recommendations for diversity in CSI-COP

Ten recommendations have been identified from the research conducted for this report. The recommendations will be further elaborated in the next deliverable D2.3: CSI-COP framework for best practices in diverse citizen science engagement and retention. The aim of this report, D2.2 is to present findings of any methods used in previous citizen science projects to ensure balanced cohort of citizen scientists. For the CSI-COP project this means attracting and engaging citizen scientists regardless of gender, socio-economic background, geographical location, refugee or immigrant to collaborate with CSI-COP researchers pushing for the development of pro-privacy technologies. To address a balanced cohort, CSI-COP will follow, among other guidelines, Article 8 and 10 of the Treaty on the Functioning of the European Union (EU, 2012), and the Principle 6 of the European Citizen Science Association (ECSA 2015). The recommendations are:

1. In all its activities, the CSI-COP project will aim to eliminate inequalities, and to promote equality between men and women (Article 8)

2. CSI-COP will combat any discrimination based on sex, racial or ethnic origin, religion or belief, disability, age or sexual orientation. (Article 10)

3. Target special events, including those organised by international organisations, and women organisations to recruit curious girls and women

4. Explore and target the circle of social media users and to use the motivations of diverse groups to persuade their friends, 'neighbours'

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5. Contact institutions working with and/or for disabilities to engage possible participants.

6. Invite and involve health care institutions, medical universities, private clinics might facilitate reaching potential CSI-COP participants

7. Target organisations to engage refugees and immigrants, for example, European Council on Refugees and Exiles (ECRE), and Refugee Women's Groups

8. Ensure CSI-COP provides an opportunity for greater public engagement and democratisation of science.

9. Take note of the culture of CSI-COP partners' country and beyond

10. Due to the digital divide, including between rural and urban areas, take into consideration the Internet penetration levels in different countries: rural areas in western countries and bigger towns and cities in southern and eastern countries.

Looking forward to the next CSI-COP deliverable: the framework for CSI-COP project's CS recruitment and engagement. The areas we will consider in the CSI-COP CS project organisers include:

- "**Sanctity of place**" – Consider cultural and religious attitudes about particular locations, such as sacred sites. Be aware of restrictions on who can visit some places, requirements for how to behave, and the need to ensure historical, cultural, and environmental preservation."
- "**Gender and age**" **-** In certain communities, some people may be restricted from participating in certain activities or in certain places; for example, leadership roles in citizen science projects may be restricted to men or to those of a certain age. Interactions with certain age groups may require special cultural sensitivity; for example, it is considered extremely rude to interrupt an elder from many communities.
- "**Ethnicity and race**". The project may benefit from including individuals from those groups; it can gain skills and unique insights needed for success.
- "**Language**" – Provide the participants with information, tools, and **instruction in their native language(**s). You may need local facilitators or members of the community to translate information.
- "**Literacy"-** The community partners might have a range of literacy skills. Provide materials in several formats (such as visual representations and audio instructions) so that those with low literacy can access and discuss the same information you've made in available in writing.
- "**Educational level and scientific knowledge**" **-** Learn how much education your participants have and what they know about your project topic. Those with more scientific training may contribute needed skills and knowledge; they may even serve as full partners with academic researchers. Those with less may need additional training - but may also contribute new understanding of the community or project site or ask questions that highlight gaps in your research planning.
- "**Income and employment levels**" – Some participants may have limited time to devote to the project or require funding to help them cover the cost of transportation, childcare, materials or meals.
- "**Focus on listening**" – Get to know your project participants, the culture of their community, and the best ways to communicate with them. Avoid assumptions, listen carefully, respect

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> different ways of contributing to a project and be open to local needs and preferences" (CitizenScience.gov, 2016).

Concluding this document, CSI-COP project's aim is to involve a representative cohort of citizen scientists regardless of age, gender, socio-economic background, or living in a less developed region of a country. Through informal education and the opportunity to collaborate in scientific research CSI-COP's citizen scientists will become aware of online privacy preservation by exploring cookies in websites they visit, and Android apps they use. The CSI-COP project aims to reach and motivate females to participate in the project, to investigate for themselves what kinds of, and how many, trackers are specifically targeted at females (such as female in health websites, menstruation apps). The challenge to be addressed by the CSI-COP is to build and sustain a trustworthy relationship with a diverse CS community, which will include people (regardless of background, gender and age) with many different things to contribute and reasons for participating.

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Appendices

CS in Europe

United Kingdom

Involvement in Citizen Science projects is impressive and growing in the UK. For example, over 44,000 people took part in **Butterfly conservation's** Big Butterfly Count in 2014, undertaking more than 43,500 counts on butterflies and moths right across the UK with 94,000 people visiting the big butterfly count website between April and August (TCV, 2014).

The "Doing It Together science" **DITOs** is a consortium committed to publish accurate and up to date information and take the greatest care to do so. The DITOs project has received funding from the EU Horizon 2020 Programme. DITOs represents a step change in European public engagement with science and innovation. The goal is to elevate public engagement with science across Europe from passive engagement towards an active process of developing science (DITOs, 2016).

After three years DITOs has come to an end. During the 36-month DITOs had 11 partners from 10 countries, organised 500 events with altogether 290,000 participants (female participants 50,8%) and 1.300.000 online participants. The European round table workshop (October 29, 2019) summarised the results achieved and the new types of interactions between science and society, which they called "participatory investigation" and showed how such interactions can contribute to the empowerment of civil society (DITOs, 2016).

Sweden

Sweden has a long tradition of collaboration between researchers and volunteers. At least since the 1850s, Swedish researchers have been helped with observations and classification of weather, birds and astronomical phenomena. There are a number of modern examples of such cooperation, e.g.:

- **Art Portal** at the Swedish University of Agricultural Sciences (SLU) is one of the largest portals for citizen research in the world through which several millions of nature observations have been collected.
- **Luftdata** project wants to build and distribute cheap instruments for measuring particle concentrations in the air by citizen scientists.
- In 2018 **Uppsala University** (UU, Departments of Earth Sciences, Physics and Astronomy) and the Swedish University of Agricultural Sciences (SLU, Department of Forest Mycology and Plant Pathology) joined their forces in an interdisciplinary project dedicated to study of radioactivity. In this project, there were involved 135 secondary school classes (pupils of age 13–16) who participated by collecting mushrooms, soil samples, and animal droppings. The pupils prepared samples from their collected material and performed preliminary analyses before submitting their samples and results to Uppsala University (UU) and the Swedish University of Agricultural Sciences (SLU) for further compilation and analysis. The results are presented in a dedicated paper (Andersson-Sundén et al., 2019).
- In a project originated from **Stockholm University** the general public across Sweden can help researchers find bat roosts by using a website to report sightings of summer bat roosts or bats themselves. The purpose of finding the roosts is to study them and understand how seasonal micro-climatic conditions in the roost affect occupation and fidelity.

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- **University of Gothenburg** is one of the partners in the international project **SPOTTERON** – The platform for citizen science & volunteer monitoring apps. SPOTTERON is a fully customizable and affordable solution for citizen science, environment protection and volunteer monitoring projects. It can be fully adapted to any projects' needs and is constantly updated and maintained. All projects powered by SPOTTERON feature their own custom Smartphone Apps for iOS and Android and an interactive embeddable map application for the project homepage.

Vinnova – Sweden's innovation agency supports the project ARCS (ARenas for Cooperation through citizen science) in which the University of Gothenburg, the Swedish University of Agricultural Sciences, Umeå University and the civil society organisation VA (Public & Science) join forces to build and maintain a national web portal for everyone in Sweden who is interested in citizen science. The aim of the project is to help Swedish universities to use citizen science in a responsible and sustainable way, to interact with society. The portal was officially launched in May 2019. It offers, among other features, tools, guidelines and forums for researchers, citizens and other stakeholders who want to get involved in citizen science. Moreover, there is an interactive directory of all citizen science projects currently running in Sweden (ARCS, n.d.).

Denmark

A very successful citizen science initiative **ScienceAtHome** has been started in 2010 at the Department of Physics and Astronomy at Aarhus University. The main objectives of the Department are to carry out research at the highest international level, to offer research-based teaching at Bachelor of Science, Master of Science and Ph.D. levels and to exchange knowledge with other areas of society. Currently ScienceAtHome joins a diverse team of scientists, data scientists, game developers, designers and visual artists who create fun scientific games, with the aim of revolutionising scientific research and teaching by game-play. In 2019 the project team reported that their games have been played 8 million times by more than 300k players (Science at Home, n.d.).

Portugal

A Portuguese online journalistic project dedicated to news about nature analysed the contributions of Portuguese citizens to the knowledge of biodiversity in 2017. The analysis contained the results of various projects in which contributions were made by citizens, together with naturalists and researchers. According to the findings, **more than 1,188 Portuguese citizens joined citizen science actions in 2017**, helping to build the portrait of biodiversity in Portugal, with the help of experts. Most of these citizen scientists, 847, were present in nine bioblitzes (species registration), all carried out along the coast - such as the bioblitzes of the Aveiro Campus and the Parque da Paz, in Almada. Participants observed birds, reptiles, mammals, fish, insects and invertebrates, as well as plants (Wilder, n.d.).

Some citizen science projects called for the use of new technologies by the general public, to help understand how different species are evolving in Portugal. One of these projects is **GelAvista**, which was developed in order to obtain data on gelatinous organisms that occur in Portugal, involving the public in data collection. The project intends to use the data collected by the public to increase knowledge about the diversity, distribution, dynamics and role of gelatinous organisms in marine ecosystems and to model and predict the occurrence of their rapid resurgences. It also has a great commitment to the public; therefore it promotes ocean literacy, shares the necessary information to identify the species that drop to the coast, informs about their occurrence on the country's beaches and the precautions to be taken (Ciimar, n.d.).

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Spain

Spain occupies a prominent place in world citizen science. The reasons for this may be due to numerous factors, from ability to obtain funds, social tradition of collaboration, access to private natural environments, consolidated training programs, etc.

In 2016 **Ibercivis**, which is a private non-profit foundation that aims to carry out and promote citizen science, was supported by the main state instrument for financing citizen science in Spain (FECYT) to create a website that brings together resources of public utility, including information and guides. It serves as a showcase for all the experiments, developers, researchers and other facilitators of citizen science in Spain. It also features a map where anyone can position their CS project. Besides, citizens can record in a common repository their involvement in one or more projects, too. In order to promote coordination between citizen science in Spain mailing lists have been set up, popular articles are published weekly and work sessions have been organised for conceptualization, promotion, discussion and analysis of citizen science on Twitter. These are called #CitSciChatES. Each #CitSciChatES has a theme related to citizen science and about 10 questions which people can answer in an interactive form. One of the several sessions held and recorded was about the role of women in CS (Ciencia ciudadana en Espana, n.d.).

In 2017 Ibercivis has published the first report of the **Observatory of Citizen Science in Spain**. According to the report, **the country had 177 catalogued citizen science projects and actors**, covering a wide range of branches of science (e.g. astronomy, biodiversity and environment, health, human behavior, biotechnology, food, etc.) (Fundación Ibercivis, 2017).

The enormous scientific and technological activity that takes place in and around Barcelona creates an ideal environment for the development of citizen science projects. Acknowledging the fact that every person has knowledge, tools and resources that can contribute to the advancement of science, the Barcelona Citizen Science Office brings together groups from the metropolitan area which have projects and which are interested in sharing experiences and methodologies in this area. The office was created in 2012 by the Institute of Culture of the Barcelona City Council with the aim of consolidating existing citizen science projects and working with them to address the socio-environmental challenges facing the city and to create a common learning space for new initiatives. In recent years, numerous scientific groups have joined this channel and have opened their research to the public.

France

The “Sciences participatives” or “Sciences citoyennes”, as Citizen Science is named in France, are very common, according to the leading scientific role that still maintains France at international level. Following similar patterns observed in other countries French CS are built around astronomy, health sciences, and biosciences, with special interests in agriculture, biodiversity and environmental studies. **The scientific publications on CS places France into the top 3 European ranked countries (after UK and the Netherlands)**. The number of CS projects in this country has been increasing constantly year after year, being mainly motivated by the interests on producing knowledge, passion about the topic, general curiosity, or ecological debates. Thanks for the recent changes into data access and spreading of technologies available through mobile phones apps, such participation has been increasing constantly.

We cite two leading examples of CS in this country:

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- 65 million d'observateurs [Biological biodiversity] held by the Muséum national d'histoire naturelle. It is an ambitius project, involving millions of citizens using several tools provided by the project.
- « C3 » Climate Change Challenge, (Météo France, IGN, CNES & Etalab), is a climate project, deeply devoted to the several challenges of climate change. Inspired by the hackatons and datacamps spread throughout the country, this project connects plenty of diverse activities in relation to the citizen participation into debates on climate issues.

The organisation **Sciences Citoyennes** collects a big amount of electronic resources both in French and English about CS in France. It must be said that due to the healthy democratic and republican culture present in France, there is a fundamental support to CS as a way of empowering democracy and public values.

Italy

Historically, Italy was the centre of the opening of scientific knowledge to main audience, when their Renaissance scientists started using vernacular language to write science, instead of Latin (only accessible to experts). CS is also expressed in Italian as "scienza aperta", "ricerca partecipata" or "scienza dei cittadini". Several universities offer their support and electronic platforms (materials, websites, mobile apps) collecting the help of citizens. Several public debates are related to this new way of doing science: the rights if CS, the necessity of connecting citizens and scientific research, or the strengthening of civic values, among others.

Examples include the "School of ants", an entomological site collaborating with all kind of public, including specially schools, and "CS at Museo Civico Di Storia Naturale Di Ferrara", monitoring several animal and vegetal species.

The first Italian CS Conference was held in 2017, Rome. Due to specific tragedies in relation to **earthquakes**, Italy has an own and widespread project on such topic (Earthquake Network, n.d.). It is a clear example about how local and situated necessities contribute to the creation of trends among CS communities. Such specialisation must also help us think about how to manage upper-level cross-national CS projects, sometimes far from local or ground interests of some communities.

Malta

Greenhouse Malta (GH) is an interdisciplinary, non-profit and voluntary research organisation that applies holistic and creative methods in its undertaking to safeguard the Maltese environment. Through **scientific research**, engaging citizen scientists and developing national and international partnerships, GH will provide open-access data and establish long-term monitoring schemes of some of Malta's most threatened flora and fauna. **By communicating research** to a range of audiences the organisation promotes environmental awareness and improve the condition of the Maltese landscape (Greenhouse Malta, n.d.).

Greenhouse, in collaboration with the Belgian organisation BINCO designed the **Wild4Orchids** project, which established an on-going monitoring scheme for orchid species across the Maltese Islands in 2017. Each interested participant is trained to collect data in a standardised manner through grid surveys across the Maltese islands. The data is uploaded to a database where it is then verified by two local specialists. The verified data will then be used to update the local Red data list and help guide

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future policy. With the current data at hand Wild4Orchids was able to contribute towards the publication of a book about orchids found across the Maltese islands (Greenhouse Malta, n.d.).

Citizen science is at the heart of another project in Malta, too. **Project Akustika** aims to improve local knowledge of bat species within the Maltese community by using scientific evidence. Since its launch in August 2018, Akustika has recruited more than 200 citizen scientists, who have contributed to the research by providing logistical support, helping in data collection, data validation and developing outreach materials as a few examples. Regular public and private bat walks, talks, stakeholder workshops, kid's workshops and social media campaigns are organised within the project, with the aim of sensitising the general public to these species and raising awareness about local conservation efforts. The response to these events has been substantial in Malta (Greenhouse Malta, n.d.).

Slovenia, Croatia, Serbia, Albania and Greece

OpenAire is an organisation whose vision is to transform society through validated scientific knowledge, to allow citizens, educators, funders, civil servants and industry to find ways to make science useful for themselves, their working environments and the society. Their partners over the years include a total of 65 European universities, research centres and institutions. Among them are Croatia, Cyprus, Greece, Serbia, Slovenia and Turkey (OpenAIRE, n.d.).

An organisation called **"Discover the mammals of Europe"** which is about the sustainable preservation of mammal populations and species diversity in Europe, is using citizen science as a means to their objective. A meeting was held in May 2018 in Sofia with representatives of 10 Balkan countries including Albania, Bosnia & Herzegovina, Croatia, Greece, Montenegro, Serbia and Slovenia. One of the targets of the meeting was the involvement of citizens in activities to protect mammals and to learn more about their needs, as successful nature conservation depends heavily on the goodwill of the society for the implementation of actions and funding (Discover the mammals of Europe, 2018).

The **University Alekander Moisiu Durres in Albania** offered its expertise to participate as a Partner in a project in the field of exploring and supporting citizen science (SwafS-15-2018-2019). UAMD "could be participant in a wide range of participation from raising public knowledge of science, encouraging citizens to participate in the scientific process by observing, gathering and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies. It could also involve publication of results and teaching science" (UAMD Albania, n.d.).

A Swiss-Croatian Cooperation named **Digital Libraries for Local Development (DL4LD)** will be creating centres of digital innovation and citizen science in 100 Croatian and 5 Swiss libraries, empowering citizens to become developers of advancement from below and become the creators of initiatives that contribute to a sustainable development of local communities (IRIM - Institute for Youth Development and Innovativity, 2019).

The **Models of Patient Engagement for Alzheimer's Disease (MOPEAD)** project is designed to assess different patient engagement models across Europe, to identify efficient approaches of earlier identification of mild Alzheimer's disease dementia and prodromal AD patients. MOPEAD Citizen Science is designed to reach a large number of citizens through online campaigns adapted to each country. It is currently an on-going project in Spain, Sweden and Slovenia (MOPEAD, n.d.).

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One of the projects of The Slovenian Forestry Institute is the project **LIFE ARTEMIS** about awareness raising, training and measures on invasive alien species (IAS) in forests of Slovenia. The role of citizen science in tree health in Slovenia is crucial as in a three-year period they collected more than 13.500 data on IAS (plants, fungi and animals) via mobile and web app with the help of professionals and citizen scientists (LIFE ARTEMIS, 2012).

Germany and Austria

The **GEWISS - Green Paper Citizen Science Strategy 2020 for Germany** presents the understanding, the requirements, and the potential of citizen science in Germany. Three core fields of action are identified as essential to the development of citizen science. These include the strengthening, creation, and integration of citizen science into science, society, and policy. (GEWISS_CS_Strategy, 2016).

Bürger schaffen Wissen (citizens create knowledge) is the central platform for citizen science in Germany since 2013. Its main purpose is to give an overview of citizen science projects to illustrate the concept of citizen science to further develop the landscape of citizen science and so increasing its visibility within the German public and discourse. Currently, more than 60 projects are registered on the platform (GEWISS_CS_Strategy 2016). The number of participants involved varies from some few to several thousand ranging in age from 8 to 80. The disciplinary diversity represented on both platforms is also greater than has been previously acknowledged. The main research areas include ecosystems, health, humanities, urban planning, distributed computing, computational science or so-called @home projects.

The **Zentrum für Citizen Science** (Center for Citizen Science), which was established in 2015 in Wien serves as a service and information centre, supporting both scientists and practitioners in the development and implementation of citizen science projects as well as the science ministry in conception and implementation of appropriate funding measures. Another task of the centre is to establish a network in Austria and beyond. The new brochure “**Citizen Science Initiatives, Networks, Platforms and Funds**” **of the Zentrum für Citizen Science** offers an overview on national and international networks, associations, and funding opportunities for citizen science, as well as maps on the international citizen science landscape and recommendations for the support of citizen science **in Austria** (Zentrum für Citizen Science, n.d.).

Hungary

Popular science has a history of nearly 180 years in Hungary. The **Hungarian Society of Natural Sciences** was established in 1841 and brought together several Hungarian physicians and natural scientists who wished to study and propagate natural sciences in the country.

On behalf of Hungary, the Meridián Opinion and Market Research Ltd participated in the “**Citizen Visions on Science, Technology and Innovation” (CIVISTI**) Project (2009-2011), funded by the FP7 SSH Program. The aim of the project was to identify new emerging issues for European Science and Technology uncovering European citizens’ visions of the future and transform these into relevant long-term science, technology and innovation issues, which were of relevance for European policies of S&T and for the development of FP8 (Horizon 2020).

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The National Széchényi Library was the Hungarian partner in the **CIVIC Epistemologies Development of a Roadmap for Citizen Researchers in the Digital Culture**" project, funded by the FP7 SIS Programme. The project's aim was to develop and validate a Roadmap for the use of e-Infrastructures to support the participation of European citizens in research on cultural heritage and digital humanities. The Roadmap will offer support for improved social cohesion arising from the sharing of knowledge and understanding of European citizens' common and individual cultures.

The **Environmental Social Science Research Group (ESSRG)**, as **a platform** is the most active in the field of citizen science. The ESSRG is a research and development enterprise working on the boundaries of environmental and social sciences with a transdisciplinary approach. It nourishes a collaborative and cooperative research approach, involving various communities and stakeholder groups while paying attention to those voices that are typically marginalised or voiceless, thus striving toward social justice and ecological sustainability. The ESSRG is a Contact Point of the Living Knowledge Network, and it is also a member of the European Citizen Science Association (ECSA).

The **Hungarian Institute of Transdisciplinary Discoveries (ITD)** is a member organisation of the ECSA. "How are you performing research on citizen science, taking part in citizen science activities and/or supporting citizen science?" was the title of the Brain Awareness Week in 2018 to connect brain research to the public. The mission of the ITD is to create a space that encourages, mediates, and hosts transdisciplinary exchanges, not only within the academia, but also by developing effective communication between the academia, business sector and society.

Czech Republic

Duží et al. (2019) offer very interesting view at some **hidden characteristics of CS projects in the Czech Republic**. They show that the structure of institutions coordinating CS projects significantly differs from that in English speaking countries – for example much **more NGOs are engaged in CS** projects in the Czech Republic. To map the Czech citizen science landscape, three potential sources of recruitment for citizen science can be identified and investigated in the Czech Republic. The first is from traditional hobby and amateur organisations, the second from social movements and bottom-up initiatives, while the last one consists of the application of participatory methods in social research (Duží et al., 2019).

The Czech Republic has 4 member organisations in the ECSA.

- The **Czech Society for Ornithology (CSO)** is an NGO, leads several citizen science projects, the oldest one – the Common Bird Monitoring Scheme – since 1982. It manages the database birds.cz. offering a platform for several scientific and conservational citizen science projects. more than 600 citizen scientists take part in the projects regularly and many more irregularly.
- The **Institute of Geonics of the Czech Academy of Sciences (CAS) /Department of environmental geography** is a non-profit research institute. They launched a Czech national citizen science platform, where you can find best practices, projects and some articles regarding the theory of CS. The aim of CAS is to continue filling the existing database with on-going (or even un/successfully finished) projects and learn from it.
- The **National Museum** is the biggest museum in the Czech Republic. It is a Museum, a Science Center, an Aquarium and a Zoo at the same time. They are running City Nature Challenge project in Prague and they have also coordinated a huge community (more than 400 people)

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who are ringing the birds in the Czech Republic. The National Museum is also responsible for organising several activities during the year focused on education and popularisation.

- The **Tomas Bata University in Zlin** is a non-profit Research Institute, having six faculties offering students the possibility of studying humanities, natural sciences, technology and art. With about 9,200 students, TBU ranks among the medium-sized Czech universities.

Estonia

The **University of Tartu** is a member organisation of the ECSA. It hosted the Citizen Science Workshop "Biodiversity research for and by citizens in Eastern Europe – tools, information services and public engagement" in 2016. The Workshop presented EU BON results of citizen science mobilizing efforts for biodiversity research, provided training for citizen science tools, and showcased some examples of Estonian projects and European initiatives. The Building the European Biodiversity Observation Network (**EU BON**) project presents an innovative approach towards integration of biodiversity information needs in a timely and customised manner. It was funded under the EU 7th Framework Programme (EU BON, n.d.).

University of Tartu Natural History Museum and **the Botanical Gardens** hold geological, zoological, botanical, and mycological collections. These collections include more than one million specimens of minerals, rocks, fossils, meteorites, invertebrate and vertebrate animals, algae, mosses, vascular plants, fungi, and lichens. The University of Tartu Natural History Museums has on-going projects funded by the Environmental Investment Centre (http://kik.ee/en). The objectives of these programs and the activities supported are determined by the Ministry of the Environment Regulation and base on the aim to develop and implement of environmental educational activities based on active studies, and to organize the environmental awareness-increasing activities and campaigns for different target groups (Environmental Investment Center, n.d.).

CS beyond Europe

USA

The **West Oakland Environmental Indicators Project (WOEIP)** is a resident-led, community-based environmental justice organisation that has been a strong voice of reason in the West Oakland community over the last decade. The project engages citizens to measure and improve air quality. Due to the significant truck traffic needed to move goods through the Port of Oakland, which is located in a high population area of West Oakland, outdoor air quality is very poor and has a significant impact on the overall health of community residents. Using research and data collection as tools, WOEIP advocates for an improved quality of life, as it relates to public health, air quality, land-use, and equity development. WOEIP uses science research to help convince policymakers that environmental changes are needed to decrease diesel particulate pollution originating from the Port of Oakland (Gordon, 2013).

Buman et al. (2013)'s project aimed to develop and evaluate the utility of a computerised, tablet-based **participatory tool designed to engage older residents in identifying neighbourhood elements that affect active living opportunities.** Following formative testing, the tool was used by older adults (aged ≥65 years, in 2011) to record common walking routes (tracked using built-in GPS) and geocoded audio narratives and photographs of the local neighbourhood environment. Residents (N=27; 73% women; 77% with some college education; 42% used assistive devices) from three low-income communal senior

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housing sites used the tool while navigating their usual walking route in their neighbourhood. Data were analysed in 2012. The profile of environmental elements identified was distinct, reflecting the importance of granular-level information collected by the tool. Additionally, consensus among residents was reached regarding which elements affected active living opportunities.

The study of Parrish et al. (2019) used **Coastal Observation and Seabird Survey Team (COASST)** to quantitatively explore the relationships among participant effort, task performance, and social connectedness as a function of the demographic characteristics and interests of participants, placing these results in the context of a meta-analysis of 54 citizen science projects. COASST is an active citizen science project, recruiting residents of coastal communities along the northwest coast of the continental United States as well as Alaska.

Initially, the highest retention rates (>90% participation beyond the first survey) were associated with participants who had previously been involved in other citizen science projects, already had some expertise in identifying birds, and were older than 40 when they joined. One year later, these patterns had become more pronounced. After 5 years, age and prior bird identification skill were the only influential demographic characteristics affecting retention. The highest levels of accuracy were achieved by younger participants, followed by middle-aged (40–60 year old) participants and those with birding expertise. Gender was the least influential demographic characteristic in retention or accuracy, although males were marginally more persistent than females as a function of time (one survey, 0.9%; 1 y, 2.5%; 5 y, 3.6%) (Parrish et al., 2019).

Canada

Ferster et al. (2017) analysed the **geographic age and gender representation in volunteered cycling safety data**. There has been growing interest in using volunteered geographic information (VGI) for transportation planning, such as route data from fitness tracking applications and route mapping smartphone applications, as a compliment to traditional data collection approaches. In particular, cycling safety data from traditional sources are limited since bike crashes are under-reported and there are no central mechanisms for recording near misses. BikeMaps.org is a globally available website for cycling safety VGI, with a focus on spatial analyses of previously unrecorded near misses and collisions. The goal of this paper is to understand how age and gender are related to the use of BikeMaps.org compared to broader ridership and the geographic distribution of incidents for the Capital Regional District (CRD), British Columbia, Canada (Ferster et al., 2017).

The majority of trips were made by males (68%), and people over 35 years of age (70%). Overall, the most frequent age category for trips was 35–44 years of age. Females had higher ridership in younger age classes, while males had higher ridership in the older age classes. The majority of web visits to BikeMaps.org were by males (62%) and people over 35 years of age (66%). For web visits, the most common age category was 25–34 years of age overall, 45–54 years of age for males, and 25–34 years of age for females. In general, younger people were involved with higher levels of interaction with BikeMaps.org (i.e., submitting data vs. viewing maps) (Ferster et al., 2017).

For incidents submitted to Bike Maps.org, most were submitted by males (70%) and the median age (35 years) was lower than for the data and web visits. For incidents reported to BikeMaps.org, the overall median age was lower for males at 34 years of age and higher for females at 37 years of age. Within the incidents submitted to BikeMaps.org, there were geographic differences between some age

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and gender groups. The MNN was similar for both males and females, while the MNN was higher for people over 35 years old, indicating that the incidents they submitted were more dispersed. Females reported more incidents in the city centre, in particular for collisions. People under 35 years of age reported more incidents in the city centre, in particular for near misses. People over 35 tended to report incidents outside of the city and covering a broader extent. Incidents reported by males were more numerous and included more incidents outside of the city centre (Ferster et al., 2017).

Mexico

The **"Nuestra Voz (Our Voice)"** is a CS project that involves neighbourhood residents acting as "citizen scientists" to systematically gather information on the barriers and facilitators of physical activity in their neighbourhoods and then use their data to collectively advocate for local environmental and policy-level changes to support active living. Rosas et al. (2016) recruited 32 adults and 9 adolescents to participate as citizen scientists in the pilot study. The response rate from the door-to-door recruitment procedure was 38% for adults and 43% for adolescents. The response rate was highest in the low SES/low walkability neighbourhood (58%) and lowest in the low SES/high walkability neighbourhood (14%). Both high SES neighbourhoods had similar response rates, with 44% for the low walkability neighbourhood and 42% for the high walkability neighbourhood.

Participating adult citizen scientists were **primarily women (75%)** and had a **mean age of 57 years**. The sample represented adults from **various education levels**, including those with less than an elementary school education (19%) and those with some college education (25%). Eighteen (**56%**) of the 32 adults **owned a cell phone**, two of which owned a smartphone. Youth citizen scientists included five girls and four boys with a mean age of 13 years. Seven of the nine youth reported owning a cell phone, two of which owned a smartphone. The citizen scientists' initial overall self-efficacy for using the Discovery Tool across varying levels of assistance was higher among adolescents compared to adults (9.3 vs. 7.7, $p < 0.01$). Adolescents were "sure" or "very sure" that they could use the Discovery Tool with no help or instructions from others (mean score of 9.4 on a scale of from one [not at all sure] to 10 [very sure]). Adults reported an average rating of 7.1 for using the Discovery Tool with no help or instructions, 7.7 if the device was similar to one used before, and 7.5 if they could see someone use the tablet first (Rosas et al., 2016).

Israel

Our investigation of citizen science activities in Israel has revealed the following active initiatives:

- **TCSS Excellence centre** - the meaningful learning centre sponsored by Israeli Science Foundation (2017-2022) aiming "to **take citizen science to school**" (led by Haifa University and Technion). The researchers develop curricula and learning materials aiming to involve school pupils and educators in CS activities, thus enhancing their learning processes. Some of the TCSS centre's projects are as follows: measuring the level the Radon gas in public buildings, monitoring people's sleep behaviour, collaborative mapping of optimal walking paths for blind people, and monitoring the air pollution level.
- Additional CS projects in the country are generally related to bio-diversity and include reporting "small tracks" (animal's tracks), observing and reporting various wild animals and plants, counting and sorting bird types butterflies and jellyfish, and reporting animals killed on Golan heights' roads.

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Japan

In Japan: "**ecologists, the public, and decision makers have not fully recognised the significance and potential of citizen science** as a way to monitor and understand some of the public's grand challenges for science and society, such as rapid global environmental change and the loss of biodiversity. There is good reason to believe that engaging the public with these problems in a hands-on way will lead to productive partnerships in science and problem solving, and that it will help to ensure that scientific information can be appreciated and understood across a broader sector of society" (Kobori et al., 2016).

Nationwide citizen science projects in Japan, like those in other countries, are managed primarily by national NGOs, such as the Wild Bird Society of Japan, the Sea Turtle Association of Japan, The Nature Conservation Society of Japan, and Japan Bird Research Association. These projects have been now integrated into one national project **"Monitoring Sites 1000 Satoyama"**, collaboration among the Ministry of Environment, NGOs, university scientists and many volunteer citizens (Kobori et al., 2016)

One of the few studies that reviewed citizen science activities across Japan found that one of the biggest challenges facing most CSPs and organisations was a lack of young volunteers and the loss of older volunteers as they age. Lack of staff is often associated with lack of funding. The lack of young participants in citizen science project and difficulty of recruiting them was also mentioned by interviewees from two organisations. To foster the participation of the younger who may be busy with school or raising families, citizen science activities must meet their needs and pique their interest. "Citizen science organisations might collaborate with universities so that students can participate in citizen science projects as part of their coursework" (Kobori et al., 2016: p.14)

Table 8 presents the name of the organisations, number of staff, participants, way of the recruitment, the barriers for continuing the projects. (Reproduced from Table 4. in Kobori et al., 2016).

Table 8 Name of organisations, number of staff, participants, way of the recruitment and barriers for continuing the projects in Japan

Name of organisations	NACS-J	Center for ecological education	Bird research
Number of staff	28	Full-time: 6, part-time: 3	6
Participants	Citizen: majority is more than 40- year-old	Most of them are members of Sekisui House (a homebuilding company)	Citizen: majority is 40 and 50 years
Way to recruit participants	Fliers, advertisement in newspaper	Distribute information on webpage and mailing list	Advertising through webpage, emails, magazines, and books

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Barriers for continuing the projects	Lack of participants of next generation (successors)	Lack of enough staff to increase communication with participants /maintain quality of data applicable for scientific research	Lack of young participants/lack of trust on data citizen collected by government

"Studies have found that citizen science projects in Japan must consider cultural norms that may differ from Western cultural norms - e.g. a sense of collective responsibility is common in East Asian cultures whereas Western cultures generally place greater emphasis on individual identity and responsibility – when designing recruitment and retention strategies for citizen science projects" (e.g. Krasny and Tidball, 2012; Svendsen and Campbell, 2008).

Australia

A common feature of many citizen science projects is the collection of data by unpaid contributors with the expectation that the data will be used in research. Mitchell et al. (2017) reports a teaching strategy that **combined citizen science with inquiry-based learning to offer first year university students an authentic research experience**. A six-year partnership with the Australian phenology citizen science program **Climate Watch** has enabled biology students from the **University of Western Australia** to contribute phenological data on plants and animals, and to conduct the first research on unvalidated species datasets contributed by public and university participants.

Students wrote scientific articles on their findings; peer-reviewed each other's work and the best articles were published online in a student journal. Surveys of **more than 1500 students** showed that their environmental engagement increased significantly after participating in data collection and data analysis. Evaluation of the project has shown that by embedding a research process within citizen science participation, university students are given cause to improve their contributions to environmental datasets (Mitchell et al., 2017).

Metro South Health and Griffith University's Hopkins Centre have launched a citizen science project **allowing people with disabilities to share their experiences and stories to improve the services that these people need and use.** The **Dignity Project is a digital engagement platform** that allows people with disabilities to share, reinterpret and analyse collective experiences by removing the physical and attitudinal barriers they may face. The project will initially focus on people with acquired brain and spinal injury. Microsoft Australia, a project sponsor, will help to ensure that people can be easily connected with each other and that people with communication challenges can tell their stories. **The project is running in partnership with key consumer disability organisations and the corporate sector (Bionics Queensland, 2019).**

Digital divide in Greece

In terms of Human Capital, the Digital Economy and Society Index (DESI) for Greece is 32,7 bringing the country to the 25th position among the 28 countries of EU. That index is calculated based on two

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indicators: “Internet user skills” and “advanced skills and development” (Directorate General CONNECT, 2019a).

Greece's performance is well below the EU average (48,0) but it is slightly progressing. In 2017, while 57% of individuals aged between 16 and 74 in EU had at least basic digital skills, Greece’s percentage only reached 46%. Moving up on expertise, Greek ICT graduates add up to 3,2% as for 3,5% in EU. Moreover, the employed ICT specialists reach only 1,6% as opposed to EU’s average of 3,7%, but the smallest rate is that of employed female ICT specialists 0,4%, way below the average of EU 1,4%. Greece is part of the low performing cluster of countries in EU (Directorate General CONNECT, 2019c).

Gender-wise, Greece regrettably still possesses one of the last places among EU ranking. According to Women in Digital Scoreboard 2019 the percentage of women in Greece regularly using the Internet adds up to 68% against 71% of men, with the rates in Europe being 82% and 84% respectively (Table 9). The gender gap is also present in digital skills with women’s percentages always lesser than those of Greek men and the EU average (Directorate General CONNECT, 2019d).

Table 9 Internet use and user skills in Greece and the EU by gender

	Greece			EU	
	Women		Men	Women	Men
	value	rank	value	value	
1 Use of internet					
1.1 Regular internet use % individuals, 2018	68%	26	*71%*	82%	84%
1.2 People who never used the internet % individuals, 2018	27%	27	*23%*	12%	11%
1.3 Online banking % internet users, 2018	33%	26	*42%*	63%	64%
1.4 Using professional social networks % internet users, 2017	7%	23	*9%*	13%	18%
1.5 Doing an online course % internet users, 2017	7.0%	11	*7.2%*	8.1%	9.5%
1.6 Online consultations or voting % internet users, 2017	4.8%	21	*5.5%*	9.9%	10.6%
1.7 eGovernment users % internet users submitting forms, 2018	33%	28	*40%*	64%	65%
1 Use of internet Score (0-100)	31.6	27		53.1	
2 Internet user skills					
2.1 At least basic digital skills % individuals, 2017	44%	25	*49%*	55%	60%
2.2 Above basic digital skills % individuals, 2017	20%	24	*23%*	28%	34%
2.3 At least basic software skills % individuals, 2017	50%	24	*55%*	58%	62%
2 Internet user skills Score (0-100)	42.4	24		53.1	

Source: DESI 2019, European Commission

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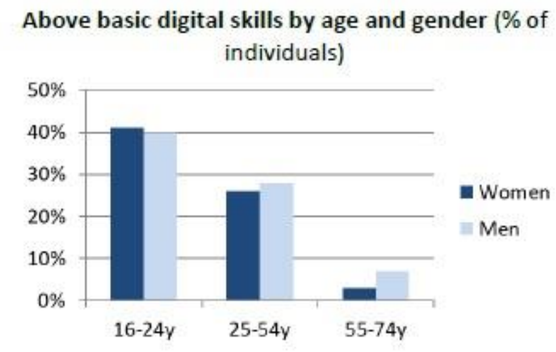
The situation seems to be changing when we look into digital skills by gender combined with age. Younger women are slightly outnumbering young men (Directorate General CONNECT, 2019d). Figure 8 presents the share of the Greek population with above-basic digital skills by age and gender.

Figure 8 Share of the Greek population with above basic digital skills by age and gender %)



Source: DESI 2019, European Commission

The number of non-users of Internet is decreasing in almost all member states of EU in 2018. Nevertheless, there is still an almost 8% resisting the charms of Internet. The non-users and less frequent users are mostly old, retired or inactive people and people of low income and low education. Although Greece shows a small recession, the outcome still places her in one of the last positions in the EU (Directorate General CONNECT, 2019b).

According to the Proceedings of the 8th International Conference on the Economies of the Balkan and Eastern European Countries in the Changing World, age and socio-economic status (defined by education, employment status, income) have the most significant impact on Internet access and use in Greece. Thus, the profile of a Greek person who does not use the Internet tends to fit the description of old, undereducated, poor and rural resident. Gounopoulos et al. (2018) acknowledges digital divide as an impediment to the socio-economic development of Greece, deeming the non-use of Internet a new order of exclusion.

Again, as far as Greek women are concerned the number of non-users of Internet is decreasing over time, still being more than men but the gender gap is slowly decreasing (Directorate General CONNECT, 2019d). Figure 9 presents share of Greek people who never use the Internet.

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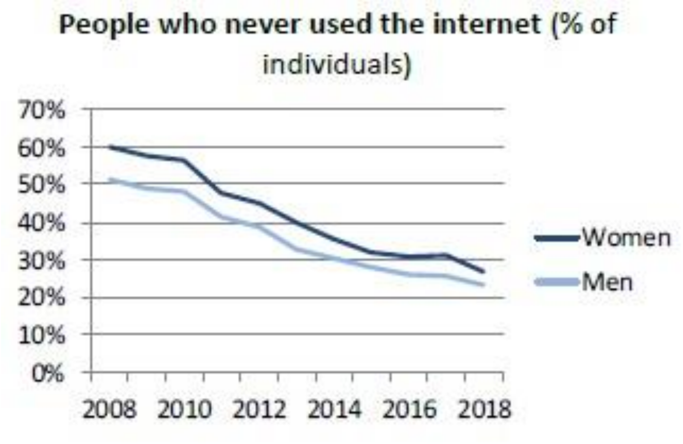
Figure 9 Share of Greek people who never use the Internet by gender (%)



Source: DESI 2019, European Commission

Aside from the gender gap, there also seems to be a regional gap digitally speaking. Greece, along with Bulgaria, Croatia and Portugal have the highest digital skills divide between those who live in cities, towns and suburbs and those living in rural areas (Eurostat, 2020).

Digital divide in Greece is still very much present nowadays and it seems to be dissipating in a quite slow pace, positioning Greece bottom-most among the EU member countries.

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