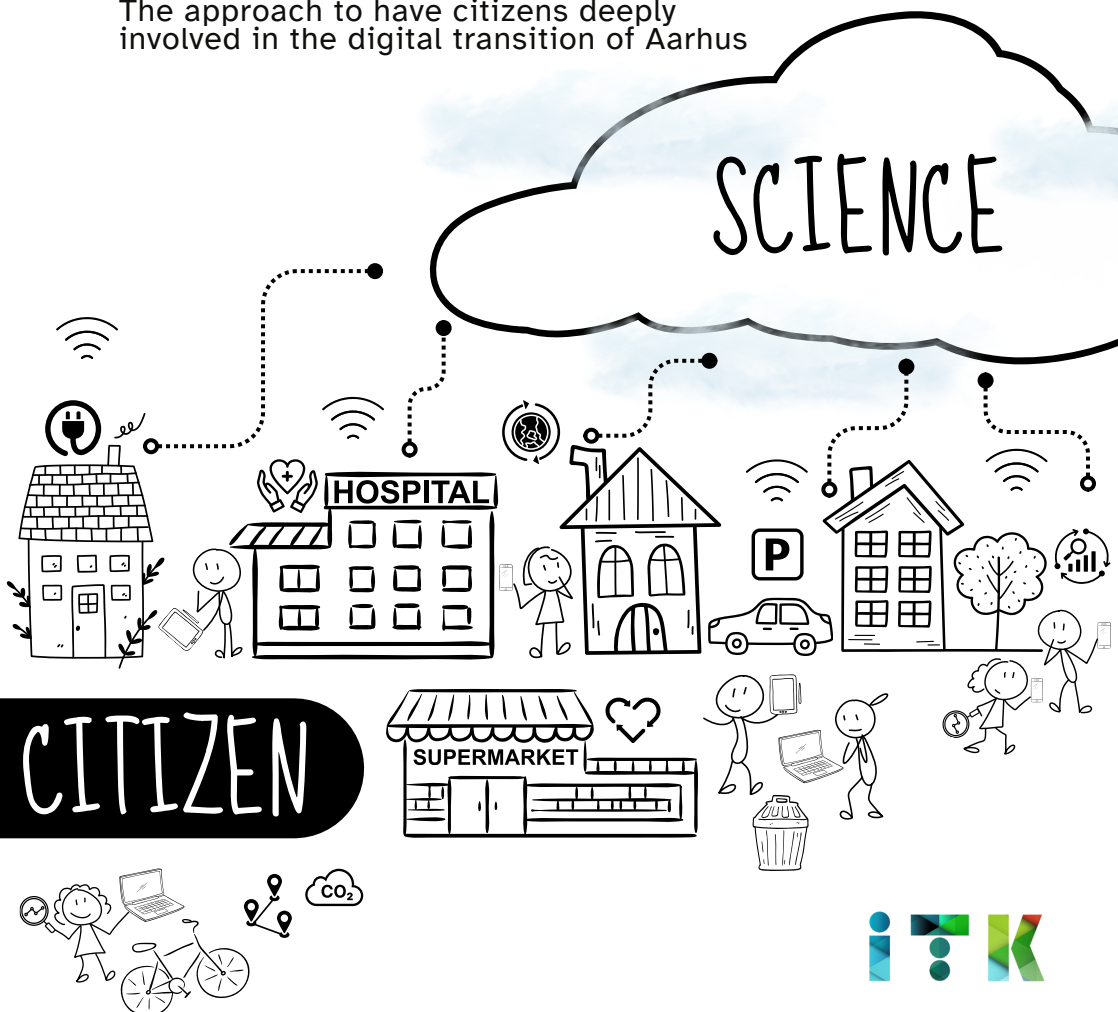


Citizen Science in Smart Cities and Communities

The approach to have citizens deeply involved in the digital transition of Aarhus



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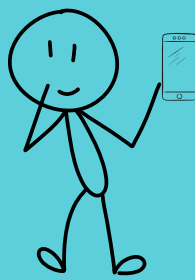
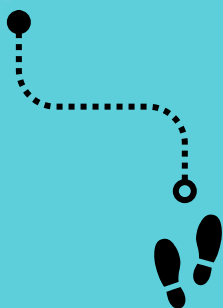
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1 Introduction

Citizen science plays an expanding role in numerous projects globally. The key concept is projects inviting citizens to assist in collecting and analyzing data.

This catalog aims to inspire you and your organization to work with citizen science to ensure a fair and democratic digital transition of your city and community.

It is our hope that the catalog will increase your awareness of how to work with citizen science in existing or upcoming projects. It is also an open invitation to collaborate on future citizen science projects with us. To that end, this catalog outlines a general definition of citizen science as well as our own take on citizen science, exemplified by cases from our daily work in the smart city department ITK [Innovation, Technology Creativity] in the city of Aarhus.

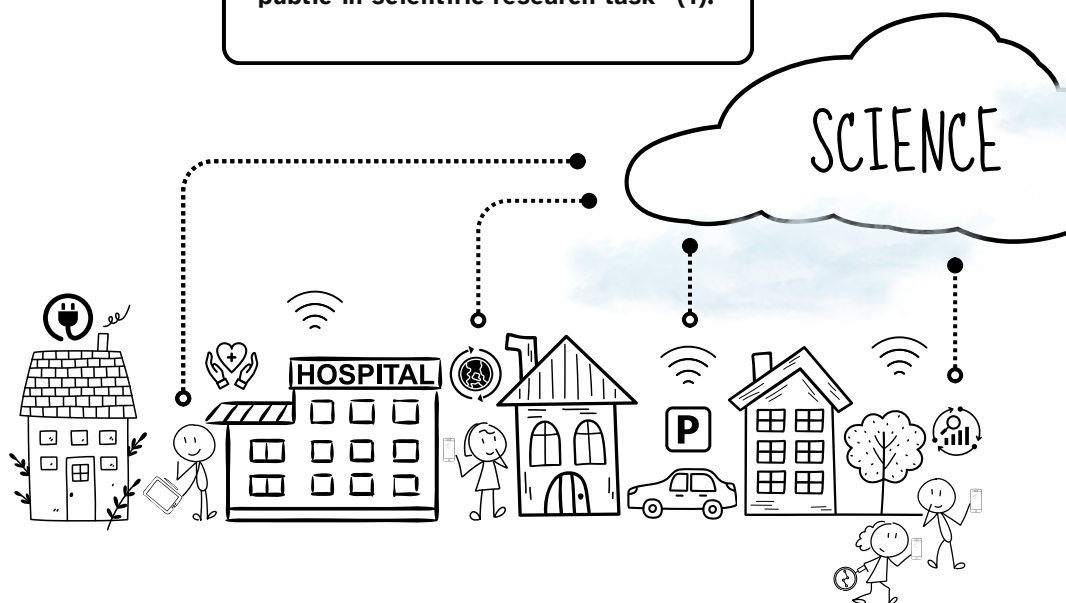
Have fun reading!



2 What is Citizen Science?

So, what is citizen science? Let's try to give you a general definition of the term:

“Citizen Science broadly refers to the active engagement of the general public in scientific research task” (1).



The European Citizen Science Association, ECSA, has made ten principles that they “believe underlie good practices in citizen science” (3). Overall, we, ITK, follow these ten principles as they are commonly agreed upon, and not too restrictive in their definition. These can be seen on the next page.

The Ten Principles of Citizen Science

1. Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.
2. Citizen science projects have a genuine science outcome. For example, answering a research question or informing conservation action, management decisions or environmental policy.
3. Both the professional scientists and the citizen scientists benefit from taking part. Benefits may include the publication of research outputs, learning opportunities, personal enjoyment, social benefits, satisfaction through contributing to scientific evidence e.g. to address local, national and international issues, and through that, the potential to influence policy.
4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process. This may include developing the research question, designing the method, gathering and analysing data, and communicating the results.
5. Citizen scientists receive feedback from the project. For example, how their data are being used and what the research, policy or societal outcomes are.
6. 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.
7. Citizen science project data and meta-data are made publicly available and where possible, results are published in an open access format. Data sharing may occur during or after the project, unless there are security or privacy concerns that prevent this.
8. Citizen scientists are acknowledged in project results and publications.
9. Citizen science programmes are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.
10. The leaders of citizen science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities.

In addition to the definition and ECSA's principles, we are aware that it is challenging to define citizen science. Most definitions are imprecise and open to interpretation as citizen science contains many purposes and approaches, which makes it difficult to create a singular definition that encompasses them all (1).

“

***“Never doubt that a small
group of thoughtful,
committed citizens can
change the world; indeed, it is
the only thing that ever has.”***

- Margaret Mead

”

3 Citizen Science in ITK City of Aarhus

And what is citizen science with the eyes of ITK? Let's try to give you a definition of the term based on how we use the approach in our daily work.

Citizen science democratizes science by giving voice to and empowering citizens to create new knowledge about our cities and other places. Today's technology allows everyone to contribute to research voluntarily, even from our own homes and as part of our daily life. In ITK Futures Lab we use technology in citizen science projects to e.g. collect data and then use the knowledge we gain to develop the technologies of the future.

In ITK Futures Lab, we focus on citizen science in the context of smart cities and communities, and we make use of citizen science to secure a just and democratic digital transition of Aarhus. We are part of a technology department, and we recognize that:

1) Technology is empowering the public to participate in science - collecting and analyzing data

2) With a user experience (UX) approach (which refers to understanding end-user needs and their requirements), we can include the citizen into the development of new or existing technologies.



4 Different Degrees of Participation Are More Than OK!

There can be different degrees of participation; From lowest to highest, it goes from 'contributory' to 'collaborative' to 'co-created' projects (5).

Table 1. Models for Public Participation in Scientific Research

Step in Scientific Process	Steps included in Contributory Projects	Steps included in Collaborative Projects	Steps included in Co-created Projects
Choose or define question(s) for study			X
Gather information and resources			X
Develop explanations (hypotheses)			X
Design data collection methodologies		(X)	X
Collect samples and/or record data	X	X	X
Analyze samples		X	X
Analyze data	(X)	X	X
Interpret data and draw conclusions		(X)	X
Disseminate conclusions/translate results into action	(X)	(X)	X
Discuss results and ask new questions			X

X = public included in step; (X) = public sometimes included in step

Models of Public Participation in Scientific Research (5).

As seen in the figure above, the lowest degree of participation, the contributory projects, only has citizens participating in collecting the data or samples, and they may also analyze and disseminate whatever is concluded.

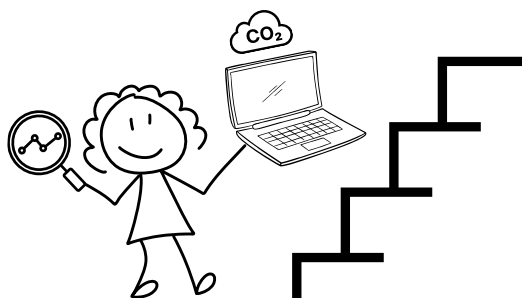
In collaborative projects, the citizens are more involved and may also help design the methodologies for the data collection and interpret the data and draw their own conclusions. At the highest level, the co-created projects has citizens participating in all aspects of the project.

Different projects require different degrees of participation to fulfill their needs. When designing a citizen science project, you therefore must have decided how much you need the participation of citizens. In your design, you can add a step-by-step approach. In a series of steps, you develop a citizen science project and understand exactly how and when in the process you need the citizens (6). See the steps in the figure below:

Box 1. Model for developing a citizen science project.

1. Choose a scientific question.
2. Form a scientist/educator/technologist/evaluator team.
3. Develop, test, and refine protocols, dataforms, and educational support materials.
4. Recruit participants.
5. Train participants.
6. Accept, edit, and display data.
7. Analyze and interpret data.
8. Disseminate results.
9. Measure outcomes.

Model for developing a citizen science project (6).



5 Citizen Science Cases in Aarhus

Try and find some inspiration for your city or citizen science project among some of our cases below:

1

DivAirCity

Aiming at diversifying the access to urban areas of relatively good air quality, citizens themselves have asked the city to raise awareness and give better guidance on where to travel in the city. Therefore, we have engaged citizens in mapping their usual routes, investigating alternatives with mobile sensors, and local residents are involved in implementing the routes, e.g., by designing signs and take part in campaigns on

To scale and bring up the traffic on these routes, we also test and develop an app based on blockchain technology which will reward users of the route with price reduction on coffee at local coffee shops.



DivAirCity: Citizen engagement



DivAirCity: Tracking data

2

crea.visions of Aarhus

To bring in citizens in open ended and cross sectoral discussions on 7 wicked problems that the city of Aarhus faces amidst the global poly crisis, we developed a generative AI computer game of visually envisioning the future of Aarhus. The outcomes are not solutions to the problems – 'cause these are not even possible to pin down individually – but thousands of AI generated future-graphics that illustrate a very important element of citizen science in a smart city: increasing public participation and strengthening local democracy.



crea.vision: Public participation.

3

Active Cities

From denser traffic to healthier people - the Active City project walks urban planning in a new direction. In the project, we are looking for new ways of engaging citizens with the mobility meeting point. By creating a baseline using edge cameras that track the users' behavior and which form of mobility they are using, the plan, among others, is to involve citizens in the analysis process. They can help us understand mobility data and learn more about their needs and behavior.

In that way, we are better qualified to design user-centered mobility meeting points of the future.



Active Cities: Mobility meeting point, Tangkrogen (before)



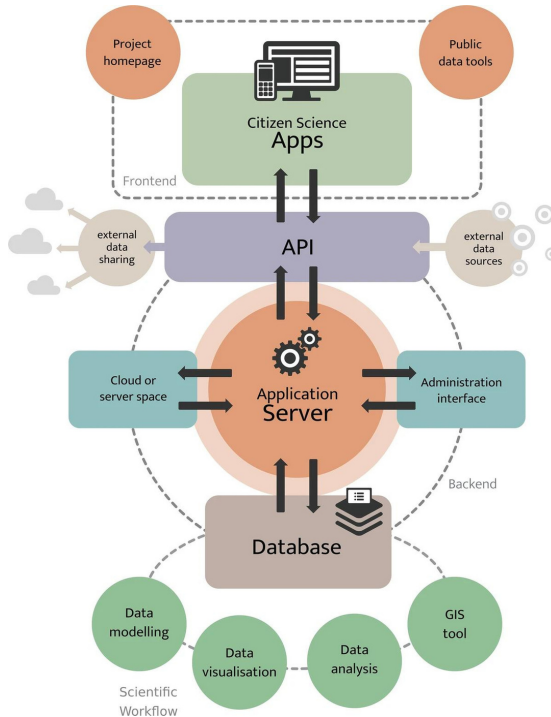
Active Cities: Futures Lab and Mobility



6 Citizen science using technologies and digital tools

Looking for more inspiration about citizen science? We are very motivated by this book, *The Science of Citizen Science* (1). Let's dive in and see how the digital book has inspired us! We'll give you a few ways to include, envision or work with citizen science using technologies and digital tools: :

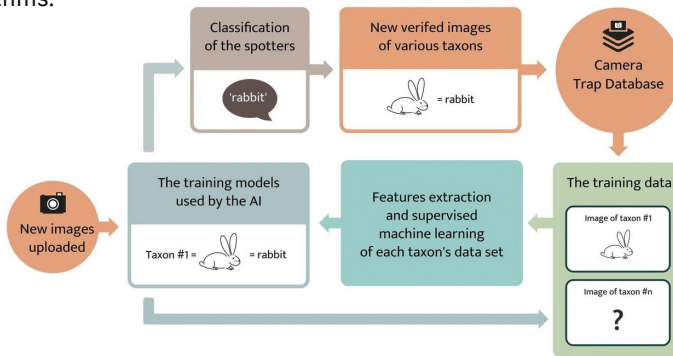
1. **Citizen Science in the Digital World of Apps** (chapter 23): Do you use an app to collect data? The widespread use of smartphones has created new opportunities in the field of citizen science. Here an example of good practises:



An app/server system with a common online infrastructure

2. Machine Learning in Citizen Science (chapter 10):

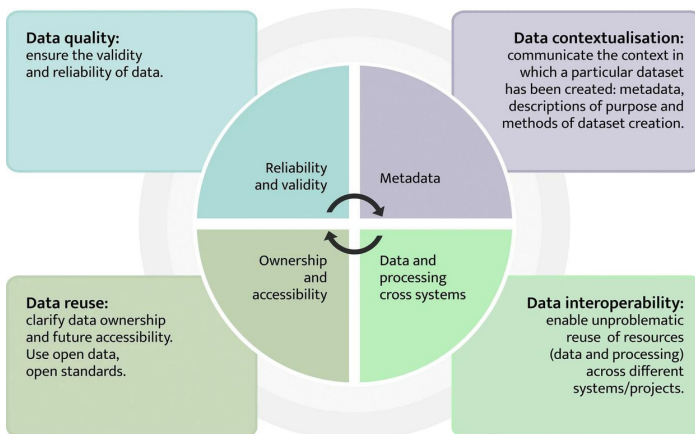
Human and artificial intelligence can be recombined in citizen science in numerous ways. For example, citizen scientists can be involved in training machine learning algorithms:



The interaction between spotters and ML processes during image classification within the camera trap database

3. Data Quality in Citizen Science (chapter 8):

How about envisioning data accuracy in citizen science – e.g., using data-interoperability in your data collection and enable reuse off resources across different projects?:



An app/server system with a common online infrastructure

7 Background

It's no secret that technology and the digital transition have transformed the way we live, work, and communicate on a global scale in many ways. We believe that Aarhus can use emerging technologies and data analytics to improve the quality of life for the citizens, increase the efficiency of infrastructure and services, and promote sustainable economic growth. ITK is leading the way in smart city development, and we believe in testing and implementing innovative, sustainable, and integrated solutions to become greener and more efficient – it is also a way in which we can give the citizens co-influence and hopefully a better city to live in!

To democratize and socially sustain the digital transition in Aarhus, Futures Lab brings a variety of applied methods of citizen science into play. We engage citizens and civil stakeholders to define the problems we solve, to plan and carry out research activities and to participate in analyzing the data gathered and in reaching the right conclusions about our city and citizens.

In this regard, the city of Aarhus has signed the declaration 'Join, Boost, Sustain' (4) and supports the initiative, which is about finding a common 'European way' for the digital transformation of sustainable cities and communities by ensuring data and technological sovereignty in the European Union. And inspired by the European Citizen Science Association (3), our citizen science activities are guided by principles of openness and accessibility, citizen education, mutual acknowledgement between partners, sustaining local democracy and assessing both societal and political impact.

Futures Lab is focused on bringing Aarhus to the forefront of the development of European smart cities by making digital technologies a central component in many of our citizen science endeavors.



But you might be asking yourself: “In what way can technology serve both the city of Aarhus and its citizens without pushing its way to the fore?” Our response to that would be “Let’s push citizen engagement to the fore seeing the citizen as co-creators in the digital transformation”. We believe that citizens can play a crucial role in identifying or actively intervening in the development of the public sector and administration of cities, often providing new perspectives and solutions.

Well, do you have a problem in a project that you need to see from the perspective of the citizens? Now is the time for you to realize that this could be a chance to tackle the problem together using citizen science!

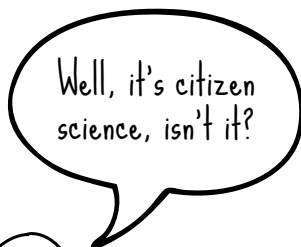
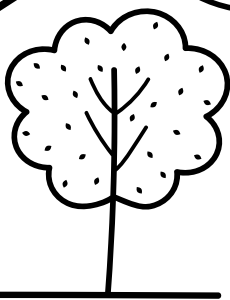
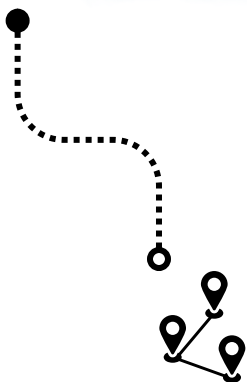
So, how about co-creating with the citizens in your community - and inspire and discover new things together, adding value for policy and governance in cities and municipalities?

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***“... citizen science offers
the power of science to
everyone, and the power of
everyone to science.”***

- Jennifer Shirk

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(1) Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R. & Wagenknecht, K. (2021). The science of citizen science. Springer Nature: <https://link.springer.com/book/10.1007/978-3-030-58278-4>

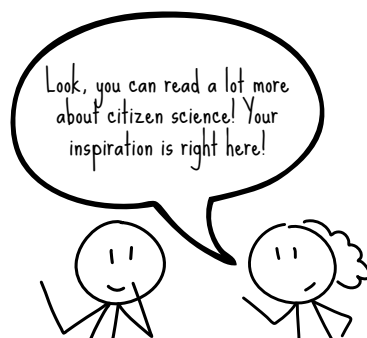
(2) Onkamo, M. (2022). Digital Citizen Science Enhance participatory in citizen science projects. ResearchGate

(3) ECSA (European Citizen Science Association) (2015). Ten Principles of Citizen Science. Berlin. <https://osf.io/xpr2n/wiki/home/>

(4) Living-in.EU (2019). Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU. <https://living-in.eu/declaration>

(5) Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., and Wilderman, C. C. (2009). Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education (CAISE). <https://www.informalscience.org/sites/default/files/PublicParticipationinScientificResearch.pdf>

(6) Rick Bonney, Caren B. Cooper, Janis Dickinson, Steve Kelling, Tina Phillips, Kenneth V. Rosenberg, Jennifer Shirk, Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy, BioScience, Volume 59, Issue 11, December 2009, Pages 977–984, <https://doi.org/10.1525/bio.2009.59.11.9>



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