COMPAIR

DELIVERABLE

D2.4 Pilot Operations Plan

Project Acronym:	**COMPAIR**	
Project title:	Community Observation Measurement & Participation in AIR Science	
Grant Agreement No.	101036563	
Website:	www.wecompair.eu	
Version:	1.0	
Date:	15 September 2022	
Responsible Partner:	ECSA	
Contributing Partners:	ATC, DV, Pilot partners (SDA, EAP, inter 3, VMM and DAEM)	
Reviewers:	21c, Pilot partners External reviewers: Gitte Kragh, Joep Crompvoets, Karen Van Campenhout, Andrew Stott, Otakar Čerba, Karel Jedlička, Martine Van Poppel	
Dissemination Level:	Public	X
	Confidential, only for members of the consortium (including the Commission Services)	

This project has received financial support from the European Union's Horizon 2020 Programme under grant agreement no. 101036563

Revision History

Version	Date	Author	Organisation	Description
0.1	15/08/2022	Carolina Doran, Beatriz Noriega-Ortega	ECSA	First draft
0.2	16/08/2022	Marina Klitsi	ATC	Feedback
	16/08/2022	Antonia Shalamanova	SDA	Contributed with content
	16/08/2022	Vlatko Vilović	inter3	Contributed with content
	16/08/2022	Milena Agopyan	EAP	Contributed with content
	16/08/2022	Inge Smets Christophe Stroobants Celien Van Gorp	VMM	Contributed with content
	16/08/2022	Ilia Christantoni, Dimitra Tsakanika	DAEM	Contributed with content
	16/08/2022	Gert Vervaet Lieven Raes	DV	Feedback
	16/08/2022	Jiri Bouchal	ISP	Feedback
0.3	24/08/2022	Carolina Doran, Beatriz Noriega-Ortega	ECSA	Revised document Ready for review
0.4	05/09/2022	Pavel Kogut	21c	Content on how to manage expressions of interest
	07/09/2022	Lieven Raes	DV	Review
	07/09/2022	Antonia Shalamanova	SDA	Review
	07/09/2022	Joep Crompvoets	Expert panel	Review
	07/09/2022	Andrew Stott	Expert panel	Review
	07/09/2022	Gitte Kragh	Expert panel	Review
	07/09/2022	Otakar Čerba	Expert panel	Review
	07/09/2022	Karel Jedlička	Expert panel	Review
	07/09/2022	Martine Van Poppel	Expert panel	Review
	07/09/2022	Karen Van Campenhout	Expert panel	Review
1.0	12/09/2022	Carolina Doran, Beatriz Noriega-Ortega	ECSA	Final version

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviation	Meaning
AQ	Air quality
AR	Augmented reality
BC	Black carbon
CS	Citizen Science
CO2	Carbon dioxide

DEVA	Dynamic Exposure Visualisation app
DEVD	Dynamic Exposure Visualisation dashboard
DIY	Do it yourself
DPO	Data Protection Officer
DT	Digital Twins
EC	European Commission
ECSA	European Citizen Science Association
EEA	European Environmental Agency
EoI	Expression of Interest
EPICS	a large user story which is too big to fit into a sprint
GA	Grant Agreement
GDPR	General Data Protection Regulation
IoT	Internet of Things
KPIs	Key Performance Indicators
MICS	Measuring Impact of Citizen Science
MORRI	Monitoring the evolution and benefits of responsible Research and Innovation
NGO	non-governmental organisation
NO2	Nitrogen dioxide
O3	Ozone
PM	Particulate matter
PMD	Policy Monitoring dashboard
PR	Public relations
SES	Socio-Economic Status
SME	Small and medium-sized enterprise
STEM	Science, Technology, Engineering and Mathematics
TBD	To be decided
UAEG	University of the Aegean
UI	User interface
VMM	Flanders Environment Agency

Executive Summary

The Pilot Operations Plan aims to establish useful guidelines with key stages and recommendations for all pilots to successfully contribute towards **COMPAIR**s mission - increase societal engagement in the fight for clean air. In this deliverable, as we slowly move from the ground work (preparatory activities for the pilots) towards the closed round (where we introduce stakeholders to the pilots planned activities) and open rounds (where public facing activities begin) we build up on the project's previous work to define a robust pathway for overcoming crucial challenges and build bridges between our stakeholder network, policy makers, citizen science practitioners and finally citizen science participants.

The project's methodology strongly builds upon **COMPAIR'**s vision that all stakeholders from the quadruple helix have something valuable and unique to contribute and thus should all be empowered to work together on **COMPAIR'**s mission. Centred around the principles of design thinking the process goes through 5 different phases. Empathise, Define, Ideate, prototype and test. These steps are not linear and have been translated into 4 rounds where each of our pilots (Berlin, Flanders, Sofia, Plovdiv and Athens) has developed a set of actions (Fig1). We further expand on this methodology in the introduction.

Figure 1 - Different phases of the COMPAIR strategy taken from the GA; Ground Work (M1 - M12), Closed Round (M7 - M12), Open Round (M13 - M20) and Public Round (M21 - M32).

Based on the Stakeholder mapping (D2.1), mapping of CS initiatives (D2.2) and policy canvas (D2.3) we were able to create a clear picture of where each pilot stands and where **higher focus is needed** for successfully reaching the project's goals, namely of increasing awareness of local and global air quality challenges whilst fostering change towards more environmentally friendly behaviours and greater inclusion of lower Socio-Econimic Status groups (SES):

- Close **communication with the technical partners** should continue to be fostered as to ensure the technology meets the citizen science participant's needs.
- **Cross pilot communication** is also highlighted as an important action as a way of understanding the different strategies and their outcomes as a whole.
- Another key identified recommendation shared by all pilots is the need to further work on **defining both the terminology and engagement strategies** when it comes to the participation **of lower SES** groups.
- Finally we also highlight the need **to monitor and update our stakeholder networks** throughout the project life.

Given the importance of recruiting lower Socio-Economic Status groups we devoted a section to discuss this (section 3). All pilots already plan or have taken several actions to achieve **COMPAIR**s ambitious aim of having ⅓ of citizen science participants belong to these communities. Here we further define a set of important actions that must also take place, such as better definitions and indicators, together with internal awareness raising through training and workshops.

Finally we summarise a set of inspirations for future work that we wish to share with the citizen science community and all those running projects or showing interest in air quality, and eager to work with an inclusive mindset. More specifically we highlight the importance of ECSA*s 10 principles of citizen science as a way to encourage CS practitioners to take responsibility for moral and ethical concerns and to actively work towards providing inclusive initiatives. A key element of this section is the importance of designing inclusive methodologies. For **COMPAIR** in particular the inclusion of lower SES groups is a core aim, and thus we share our views on the importance of their inclusion for making CS initiatives meaningful and sustainable.

This deliverable is a first starting point to define pilots actions throughout the project. However, it is not meant to be static and throughout the project we will regularly visit it and remind ourselves of our specific aims and update our action tables and KPIs accordingly.

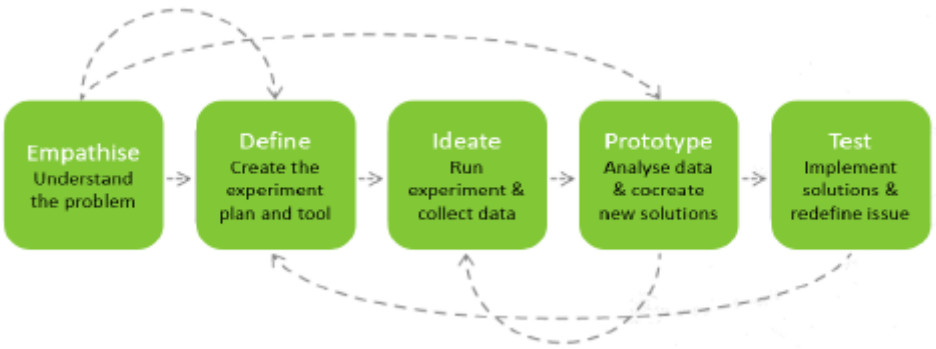
1. Introduction

A key challenge **COMPAIR** aims to address is the need for a greater and fairer societal engagement in the fight for better air quality. Towards that goal, this deliverable sets useful guidelines describing the 'What', 'When' and 'How' for each pilot city to successfully run their citizen science programmes.

COMPAIR pilots a multi-pronged methodology that includes citizen science activities, low-cost air sensors and advanced digital tools in four geographically varied locations across Europe: Sofia and Plovdiv in Bulgaria, the region of Flanders in Belgium, Athens in Greece, and Berlin in Germany. The work described here builds heavily (but not exclusively) on the 3 previous deliverables from WP2. The value network canvas (D2.1) was the starting point where all the pilot partners mapped crucial stakeholders to engage (quadruple helix, including citizen science initiatives) and whose contribution was considered key in order to reach our project's goals. As an obvious follow up a Citizen Science Landscape Review (D2.2) was conducted to assess previous and existing CS initiatives in each of the pilot areas. From this we could learn what had already been done, what challenges had been encountered and overcome and which ones were still a threat (D7.1 - Participation risks and compliance also provided useful insight here). Finally, a Policy Review Landscape (D2.3) was also conducted where relevant European policies and those local to the pilots were identified, together with important features to be considered from **COMPAIR**.
All of these are described in more detail in the groundwork section (2.2)

The **COMPAIR** approach is based on the principle of **design thinking** and puts high emphasis in bringing the **quadruple helix** stakeholders together to work on shared environmental challenges - in this case air quality. The traditional stages of delivery we are following include: Empathise, Define, Ideate, Prototype and Test. These steps are not necessarily linear, instead they build and feedback onto one another (Fig 2).

Figure 2 - Design thinking concept diagram as shown in the Grant Agreement



With this design in mind 4 key pilot stages were identified: Groundwork, Closed Round, Open Round and Public Round (Fig 1). Groundwork involves all the research and setting up activities necessary for the preparation of the pilot activities; the Closed Round (where we are currently) starts internal testing procedures within the consortium; the Open Round marks the beginning of the CS initiatives in all pilots expanding into the Open Round

where there will be a higher focus on prototyping and testing. These phases are better described in the next section (section 2).

We adopted this methodology with the aim of establishing a robust cooperation between all players of the quadruple helix such that a more honest and fruitful discussion is enabled between the different important players. A key aim of the project is exactly that of highlighting where each of the stakeholders process intersects with others and create the space for synergies in particular in the development of methodologies for improving urban air quality and including lower Socio-Economic Status (SES) groups (more on this in section 3). Engaging and maintaining engagement throughout the process is crucial for achieving the projects main goals:

1) Increase awareness of current status of air quality in our pilot cities;
2) Empower participants to think about their day to day lives and adopt more environmentally friendly behaviours;
3) Build a strong stakeholder network including all players from the quadruple helix;
4) Develop robust and inclusive air quality data collection sensors and methodologies;
5) Successfully engage Stakeholders with decision making power to reflect and act upon the data;
6) Include participants from lower SES groups in pilots citizen science initiatives;
7) Successfully influence existing policies that currently fall short of providing solutions to air quality issues to all those affected in a fair and equal manner.

With these project goals in mind this Pilot Operation Plan will:

- Highlight key project milestones with a higher focus on the work of all pilot regions to date that has resulted in building a robust stakeholder network, delivering co-creative workshops and co-defining their pilots needs and actions to take, together with identifying existing challenges;
- Update the milestones that remain to be reached at the moment, but are planned to be completed and at what stage should they be completed;
- Offer an overview of the pilot stages and what is accomplished at each one of them.
- Present the challenges that each pilot location faces, as well as recommendations to overcome them;
- Discuss specific challenges related to the engagement of lower SES groups.
- Provide useful recommendations to overcome the above mentioned challenges.

2. Key Pilot Stages

This section provides a general summary of the different stages that have started and are planned for all the pilot activities together with some important information on our engagement strategy and the technology we are using. From the beginning of the project, pilots and pilot supporting partners have met on a regular basis to co-create the development of several key stages in pilot development described below. This process does not end here and this deliverable should be used as a guide throughout pilots' works. Furthermore, in order to ensure it is kept updated all action tables will be monitored and revised on a regular basis (on our monthly pilot meetings) by all pilot leads and supporters together with the project coordination team.

2.1. The COMPAIR strategy

Our vision is to create a powerful stakeholder network consisting of key players all committed to working towards better policies for everyone in terms of regulations around clean air. We want to make CS results relevant for decision making and future research by bringing together representatives of public administrations (municipalities, regional governments), businesses (start-ups, SMEs, corporations), academia (think-tanks, universities, private institutes) and NGOs (charities working with different target groups).

COMPAIR puts a high focus on stakeholder engagement because we can only produce real change when everyone is equally engaged and motivated. Towards that end it is really important for pilots to have an understanding of the policy agenda and the associated pipeline of initiatives that can be coupled with demonstrations of COMPAIR tools, results and experiences. The expectation is that such display will further increase commitment on the part of policy makers. Policy makers will be asked to provide feedback on what they find most useful, and what additional inputs they would like to see in the future.

At the pilot level, the combined Design thinking - Quadruple Helix approach is transposed into an operational framework that covers 4 phases: Groundwork, Closed Round, Open Round and Public Round each described in detail below.

2.2. Groundwork

The Groundwork involves research and project set up activities needed to develop and prepare for CS experiments. Here, stakeholders **empathise** (i.e. try to understand what each group brings to the process) and define challenges, needs, and a way forward. For example, citizens define target locations and training needs; businesses - market opportunities and needs for business intelligence; researchers - sensor needs, behavioural pathways and CS protocols; policy makers - new measures to be introduced based on priorities, and finally charities help develop the best engagement strategies such that we are able to have a fair representation of society in our participants groups. Naturally this process continues through subsequent rounds.

The groundwork started at the beginning of the project when all partners were involved in mapping their stakeholder network and inviting them to participate in **COMPAIR**. The results of this mapping can be found on **D2.1 Stakeholder mapping and pilot scenarios**..

To manage such a diverse group, we organised the identified stakeholders in panel circles with end users (beneficiaries) placed at the centre, together with a set of activities detailing when the different stakeholders need to be involved, why, and how. Ideally, all stakeholders should be eager to commit to a deep and extensive engagement; however, realistically some will only want to be informed about the outcomes. Others might be willing to answer an occasional survey or participate in a one-off data collection. A handful might show interest in coming to a "Do it Yourself" (DIY) workshop about data calibration or using one of the **COMPAIR** tools/apps. This commitment level is also acceptable, as we are providing the opportunity for everyone to participate on their own terms. With regards to stakeholders, we categorised them according to the following criteria:

- Their interest into air quality (High-Low-Medium);
- Their political power to affect policies (High-Low-Medium);
- The stakeholder category they represent in the quadruple helix.

D2.1 defined three possible categories citizen science participants could fall into.

- *Ready for change*: (High interest - High political power) These participants are keen to take control of measuring their local air quality either because the situation is really bad where they live or they know someone who is negatively affected by air pollution. This group is likely to have concerns about the health impacts of air quality and will readily participate in CS activities which they believe can empower them to press for change or inform their lifestyle choices;
- *Local enthusiasts*: (high interest - low political power) These participants are not necessarily exposed to air pollution (but can be) to the same extent as someone living in close proximity to a busy road or factory, but they are keen to engage in anything that makes their city better. This group is not difficult to engage provided that benefits of participation are clearly communicated to them. However, participation may be compromised by competing priorities, e.g. other voluntary work.
- *Wider public:* (low interest) Participants belonging to this group might be members of a particular community or just citizens in the broadest sense. Some may even be climate change deniers and so will be most difficult to convince on the benefits of participating in CS activities. Compelling communication and ongoing support will be key to pique and sustain their interest in **COMPAIR**.

More details on this can be found in D2.1 however we highlight these categories here as they should be updated throughout our engagement of CS participants to ensure nobody is being excluded. More categories may be added and/or these definitions expanded.

COMPAIR is a citizen science project, thus an important part of the groundwork was mapping CS initiatives that had taken place in all pilot locations so that we could learn from them. This can be found in deliverable **D2.2 Other CS initiatives in pilot regions**. D2.2 provides a list of CS projects that took place or are still running in each of the pilot's

countries. Together with a detailed list of recommendations based on a critical analysis of each of the countries samples. Deliverable **D7.1 Guidelines and best practices for CS engagement** also conducted during the groundwork phase provides useful strategies, recommendations and techniques to manage participation risks and correct use of the outcomes related to the different types of initiatives. Relevant details from both D2.2 and D7.1 are summarised in the pilot section below (Section 2).

An important aspect of citizen science initiatives such as **COMPAIR** is the potential to successfully effect local and regional policies. As already mentioned, engaging the proper stakeholders is crucial in order to do this. As an effort to further enable the communication with stakeholders with power to influence policies, deliverable **D2.3 Policy Landscape Review** identified relevant public measures (strategies, plans, policies etc.) in each pilot location that can be influenced by citizen science (CS)/**COMPAIR** results. The policy landscape review on the European level contains a review of the reports and guidelines of the European Commission (EC) and European Environmental Agency (EEA) as well as the most relevant citizen science-related policy documents (reports, plans, strategies, white and green papers, etc.).

The policy landscape review for each pilot (Belgium, Bulgaria, Germany, and Greece) is divided into two parts. One dedicated to the most relevant citizen science-related policy documents (at the national/regional and/or local level) where CS is part of a certain specific strategy. The second one is a dedicated analysis of the strategic documents related to air quality, sustainable transport and how they fit into the CS. Once more, relevant details influencing pilot activities are summarised below.

Finally, when working with a diversity of participants it is paramount to consider ethics and data protection aspects. Deliverables **D9.1 Ethics procedures and GDPR** and **D9.2 POPD - Requirement No. 2** (both confidential) bring to our awareness a set of measures we must put in place before we start the open and public rounds. This is particularly relevant when working with minors and lower SES groups. We must choose relevant indicators for categorising participants as lower SES groups and it would be sensible to consider the use of data that is not sensitive. For instance, in the case of Flanders to capture the socio-economic status of the participants, the following indicators have been used in other initiatives:

- Home language of the student;
- Receive a school allowance;
- The mother's highest level of education.

These data can be found in public repositories and thus have fewer ethical concerns. There is bound to be variation for different countries and each pilot should identify their own indicators that are specific to their region whilst in close contact with **COMPAIR**'s data protection officer.

The **COMPAIR** Data Protection Officer (DPO), Vasiliki Diamantopoulou, Assistant Professor at UAEG, ensures that the information is proportional and only supports the research goals. Finally, all citizen science participants will receive an information sheet with all the necessary information the data subjects need to know about the processing of their personal data, and will be asked to sign the informed consent form. Pilot partners are aware

and will consider this when conducting their citizen science activities during the open and public rounds.

The next sections define in greater detail the Closed, Open and Public rounds, including a list of actions each pilot is working towards. These actions (tables 1, 2 and 3) were developed in combination with the project coordination and each pilot at the proposal writing time. As the Ground work started and pilots built their stakeholder network and organised their co-creative workshops (more detail on section 4), further input was provided and a more refined list of actions and KPIs was established. Some pilot leads have more experience than others, thus co-creation amongst the different pilots was also fundamental. This list is not static and will continuously be updated as the project progresses.

2.3. Closed Round

Despite the overlap of this round with the groundwork, during this round there is a higher focus on introducing to CS participants in each pilot to the project, its aims and all the sensor technologies being developed. Currently this process is ongoing in stages with increasing scope and complexity and opportunities for co-design and co-creation are currently running. Specific outcomes of these for each pilot can be found in section 3.

More specific to this round is the equipment testing, initial calibrations and potential target locations are being inspected. In this round we are testing the first technical outputs - the Dynamic Exposure Visualisation App (DEVA), the policy monitoring dashboard and the CO2 dashboard - before we invite citizen science participants to take part in **COMPAIR**. As the closed round is preparatory in nature, data collection at this stage will be limited, and it will be the project partners who will participate following a series of predefined scenarios while in the field.

Table 1 - Actions that are planned for the closed round per pilot. These are further detailed in section 3 for each pilot.

WHAT	HOW	PILOT	KPIs
Benchmark study of commercially available (mobile) air quality sensors for BC, PM and NO2	Under lab conditions and in the field. There is also a limited mobile test phase, in which the mobile performance of the sensors is tested by attaching them to a cargo bike	Flanders	One report from the benchmark study
Make a plan to measure the effect of a mobility plan in Ghent	See which neighbourhood is eligible (diverse neighbourhood with the possibility to reach lower SES groups, timing…)	Flanders	One plan to monitor the effect of the mobility

WHAT	HOW	PILOT	KPIs
Identify locations for schoolstreet	The city of Roeselare was planning to introduce a school street so VMM proposed them to participate to COMPAIR. Roeselare will determine where the school street will be implemented. The case of Herzele was submitted by SOLVA, who decided after a preliminary study that Herzele has suitable locations for implementing a school street.	Flanders	At least one location & monitoring plan for a school street
Identify the pilot locations (which schools will be included, where they are located, etc.)	Field work - walking and investigating the AQ conditions + traffic around the location	Sofia and Plovdiv	● Target 4 city areas not covered by official measurements ● Target 4 neighbourhoods that have problematic air quality
Pilot implementation in locations of the city	Identification of districts within the city that meet the requirements of the pilot and perform actions in these districts for recruitment of end-users and promotion of the project (training, informational visits etc)	Athens	● Target 2 districts taking also into account SES criteria (Kispeli and Neos Kosmos) ● Target a small group of 4-5 end-users in each districts
Demonstrate the impact of local measures/policy on AQ and mobility	By using the right communication tools and messages to spread to citizens; keeping all relevant stakeholders informed and up to date with the project progress and developments thus ensuring acceptance & approval	Sofia, Plovdiv	10 relevant policy measures targeted by the project ● Cloud calibration to uplift accuracy of citizen science data
Experimental design and mockups of COMPAIRs technology	User requirements, functional design, pilot	All pilots	Designs of COMPAIR technology is agreed upon and validated by all

WHAT	HOW	PILOT	KPIs
	city contacts, partners and workshops. Validating user requirements and functional designs with relevant stakeholders and providing timely feedback to tech team		pilot teams
Involve representatives of different SES groups	By communicating and involving in early stage the organisations that work with minority groups and people with SES groups Establish contact with initiatives and organisations advocating for disadvantaged groups	All pilots	● 1/3 of participants from lower SES background ● Varied demographic balances (gender, age, education)
Available sensors tested by the project team at each of the pilot locations within the different scenarios suggested - indoor, outdoor - work -> home, public transport, leisure	workshops/visits	Sofia, Berlin, Plovdiv, Athens	● 3 sensors per pilot location ● Telraam sensors tested on 3 locations (Berlin) ● SODAQ Air and NO2 sensors tested on at least 2 locations (Berlin)
pre-pilot implementation to finetune tools and fix bugs	training of COMPAIR partners to the tools from tech team	Sofia,Plovdiv Athens	● 1 DIY Sensor Citizen Science Lab established ● 50 sensor devices assembled by citizens ● Average DIY device costs around €300 each or less
preparational visits to handover sensors and demonstrate tools	online and in person sessions	Sofia, Plovdiv	● 50 sensor devices assembled by citizens
Testing of Carbon tools (still under development by the technical team)	Demonstration in person/visits	Athens	● internal testing of the Carbon tool development by DAEM

2.4. Open Round

The Open Round marks the beginning of public-facing CS activities in the pilot cities. Here, pilots ideate i.e. try to form a better idea of what's actually happening (with air pollution, traffic, energy use etc.) through continuous communication with their stakeholder network, data collection, analysis and visualisation. So, for example, citizen science participants ideate by collecting data, participating in training and games, and using **COMPAIR** tools to make sense of data. Businesses ideate by using preliminary results to identify market gaps and customer needs. Policy makers ideate by assessing the integrated datasets (CS data plus data from official measuring stations) and their application in existing IoT infrastructures e.g. Digital Twins. The role of researchers at this stage is mainly to support through their participation in continuous training opportunities, although like other stakeholders they too will derive new insights from gathered data. In this round the following steps shall be followed (Table 2):

Table 2 - Actions that are planned for the open round. These are further detailed in section 3 for each pilot.

WHAT	HOW	PILOT	KPIs
Demonstrate robustness of technology, recruitment strategies and data streams visualisations	Integrating relevant datasets and linking with relevant projects, experiments open to partners/colleagues, user testing	All pilots	2 to 3 deployments
Measure the effect of a mobility plan in the neighbourhood "Ghent-Dampoort"	Measuring the effects before and after the mobility plan: - neighbourhood (traffic and AQ measurements) -Street nearby the school that become a one-way traffic street (traffic and AQ measurements) -Traject (school routes-AQ measurements)	Flanders	One report of the measurements campaign campaign
Schoolstreet measurements in Herzele	Measuring the effects of the schoolstreet together with the students and teachers of the school.	Flanders	One report of the measurements campaign
Schoolstreet measurements in Roeselare	Measuring the effects of the schoolstreet together with the students and teachers of the school.	Flanders	One report of the measurements campaign
demonstrate robustness of	Involving partners from other organisations and	Sofia, Berlin	2 to 3 deployments

WHAT	HOW	PILOT	KPIs
technology, recruitment strategies and data streams visualisations	discuss already available data and identify gaps to be filled		
Actual pilots round 1	following the concept of iteration and constant feedback: working with end-users and volunteers for installing the sensors (especially traffic counting) and providing constant support to them when needed. collection and analysis of data gathered by sensors and app.	Sofia, Berlin, Plovdiv, Athens	● 300+ citizens involved in open and public experiments ● 10GB new air quality data collected by citizens ● Cloud calibration to enhance accuracy of citizen science data*
Actual pilots round 2	working with end-users and volunteers for installing the sensors (especially traffic counting) and providing constant support to them when needed. collection and analysis of data gathered by sensors and apps.. Fine Tuning of ethics procedures	Sofia, Berlin, Plovdiv, Athens	● 500 users of AR app (personal, neighbourhood) ● 1000 uses of Dashboards (personal, neighbourhood, city) ● >70% users satisfied with COMPAIR tools*
Identify pilot locations	Workshop 1 outcomes + contact with district offices	Berlin	● Target 4 city areas not covered by official measurements ● Target 4 neighbourhoods that have problematic air quality*
Implement training on air quality (technical training (air quality, sensors, data collection, sensor maintenance)	Workshops and video tutorials	Berlin	● 20 people enrolled in COMPAIR training ● 2 researchers to steer and support each group ● >70% participants happy with researcher support*
Comprehensive communication campaign	Use of AR app, contact with initiatives (minority, gender, etc.), PR material in different languages	Berlin	● 100 people participate in COMPAIR data jams ● 100 people participate in COMPAIR games ● 100 people participate in COMPAIR policy ideathons*

WHAT	HOW	PILOT	KPIs
Comprehensive communication campaign warming up the public	by widely spreading messages and call to action to follow up with project activities and use apps (dashboards)	Sofia	● 500 users of AR app (personal, neighbourhood) ● 1000 users of Dashboards (personal, neighbourhood, city) ● >70% users satisfied with COMPAIR tools*
Record results and use dynamic exposure dashboard		All pilots	
Involve representatives of different SES groups	Establish contact with initiatives and organisations advocating for disadvantaged groups	All pilots	● 1000 citizens targeted in each pilot location ● 1/3 of participants from lower SES background ● Varied demographic balances (gender, age, education)*
Evaluate of CS activities	feedback collection through surveys/questionnaires	All pilots	● Develop metrics from MICS (Measuring Impact of Citizen Science) project[1] ● Align with citizen science indicators from official MORRi list

*we will start actively recruiting during the open round with the expectation that the numbers stated will be reached throughout both open and public rounds, as the main goal is to have citizens engaged throughout the whole process

2.5. Public Round

The Public Round is an extension of the Open Round with two main differences. First, in the Open Round, we will work mostly with end users of pilot partners, whereas in the Public Round, we open **COMPAIR** to the wider public. Second, although ideation activities will continue running at this stage too, here we will introduce two new design thinking methods: prototyping and testing. By prototype we mean contribution to co-innovation activities, such as data jams and policy hackathons (ideathons). Citizen science participants will prototype by using CS data and then **COMPAIR** tools to extract useful insights. They will contribute to the prototyping during data jams, and to policy co-creators during ideathons. Businesses will contribute by providing data for hackathons e.g. energy datasets, anonymised phone data. They will sponsor data jams and develop challenges to be addressed during the event (business need). Additionally, they can use our results and tools to define value offering.

Policy makers can also contribute by opening some hitherto closed data sets, by developing challenges based on policy needs, and by endorsing the events and results. The role of researchers is to mentor citizen science participants during the co-innovation sprints. Toward the end of the Public Round all stakeholders will be expected to test the results by

incorporating them in their daily routine and/or processes. For individuals it means testing more environmentally friendly behaviours; for businesses - new products and services (including those created at data jams) to help citizens and other organisations reach green targets; for researchers - new methods for conducting citizen science, engaging participants, performing data visualisation and simulation, and more; for public authorities - new data and policies recommended by citizens at ideathons. Each of the four stages is supported by a number of tasks that will be described in detail below (Table 3).

Table 3 - Actions that are planned for the public round per pilot. These are further detailed in section 3 for each pilot.

WHAT	HOW	PILOT	KPIs
Evaluate the potential of dynamic exposure towards behavioural change and local policy.		All pilots	●10 relevant policy measures targeted by the project
Involve all SES groups	By communicating and involving in early stage the organisations that work with minority groups and people with low SES groups	Flanders, Sofia,Plovdiv, Berlin, Athens	● 1/3 of participants from lower SES background ● Varied demographic balances (gender, age, education)
Demonstrate the impact of local measures/policy on AQ and mobility		Flanders	● 10 relevant policy measures targeted by the project
Demonstrate data driven approaches to increase citizen engagement		Flanders	● 300+ citizens involved in open and public experiments ● 10GB new air quality data collected by citizens
Demonstrate data driven approaches for policy formulation		Flanders	● 100 people participate in COMPAIR policy ideathons ● 10 relevant policy measures targeted by the project
Demonstrate the impact of local measures/policy on AQ and mobility	By using the right communication tools and messages to spread to citizens; keeping all relevant stakeholders informed and up to date with the project progress and developments thus ensuring acceptance & approval	Sofia, Plovdiv	● Development of 5+ visuals that represent the impact certain measures have or could have on air quality that will be spread via different communication channels

WHAT	HOW	PILOT	KPIs
Demonstrate data driven approaches to increase citizen engagement	By using the right communication tools and messages to spread to citizens and showing the support of local authorities and academia	Sofia, Plovdiv	● Development of 5+ visuals that represent the importance of having citizen science to enhance the available data on air quality that will be spread via different communication channels
Demonstrating data driven approaches for policy formulation	Involving policy makers at the earliest convenient moment to make them feel part of the process and thus ensure better acceptance	Sofia	● 4 Ideathon events focused on policy co-creation
comprehensive communication campaign round 2	widely spreading messages related to the collected data and results from pilot actions, feedback collection through surveys/questionnaires and demographic questionnaires	Sofia	● 300+ citizens benefit from COMPAIR training ● 50 new cities learn about COMPAIR ● Min 4 CS case studies presented through storytelling ● 100 people enrolled in COMPAIR training
Actual pilots round 1	following the concept of iteration and constant feedback: working with end-users and volunteers for installing the sensors (especially traffic counting) and providing constant support to them when needed. collection and analysis of data gathered by sensors and apps	Sofia, Berlin, Plovdiv	● 200 + sensors installed
actual pilots round 2	collection and analysis of data gathered by sensors and apps; working with end-users and volunteers for installing the sensors (especially traffic counting) and providing	Sofia. Plovdiv, Berlin	3 Research organisations benefiting from COMPAIR input ● 200+ citizens involved in experiments ● >5 GB new air quality data collected by citizens

WHAT	HOW	PILOT	KPIs
	constant support to them when needed		
Implement training on air quality ((technical training (air quality, sensors, data collection, sensor maintenance)	Workshops and video tutorials	Berlin	● 30-50 people enrolled in COMPAIR training ● 2 researchers to steer and support each group ● >70% participants happy with researcher support ●2 workshops
Comprehensive communication campaign	Use of AR app, contact with initiatives (minority, gender, etc.), PR material in different languages	Berlin	● 500 users of AR app* (personal, neighbourhood) ● 1000 uses of Dashboards (personal, neighbourhood, city) ● >70% users satisfied with COMPAIR tools
Record results and use dynamic exposure dashboard	Use of the policy monitoring dashboard to visualise results and assist in the interpretation and analysis of collected data	Berlin	● > 200 uses of Dashboards (personal, neighbourhood, city)
Interpret results, propose policy ideas/measures	Ideathons, data jams using PMD, DEVA	Berlin	● >20 people participate in COMPAIR data jams ● >20 people participate in COMPAIR games ● >20 people participate in COMPAIR policy ideathons
Assess behavioural and environmental impact	feedback collection through surveys/questionnaires	Berlin	● 5 pathways to behavioural change elaborated ● >70% participants happy with researcher support ● >70% participants able to extract actionable intelligence ● >70% citizens report positive changes in behaviour
Integration with DT	Technical integration of COMPAIR technologies with DUET Digital Twin	Athens	2 policies from the DT

WHAT	HOW	PILOT	KPIs
	Explore city policies that can be enhances with new environmental CS data		

*Refers to total number of users for all pilots in all rounds

Epics and user stories were used to define user specifications of **COMPAIR** technology. These were defined by the pilot teams and the stakeholders and citizens involved in the co-creative workshops. This list of requirements is shared by all pilots and is not static. It evolves with the project.

Epics are bigger pieces of requirements coming from the pilots. Since epics are very important in our process as they drive all development work, we have given them an identifier. That way, we can refer to them in all deliverables with their identifier and people can find the epic. To make it easier to figure out what software the requirement is about, we have used a string as an identifier and not a number. The first part of the identifier points to the software (Co2 for CO2 dashboard, PMD for Policy Monitoring Dashboard, DyD for Dynamic exposure Dashboard, DEVA for Dynamic Exposure Visualisation App). Epics that are linked to multiple software will have 'All' as the first part. The second part of the identifier is a three letter abbreviation of the functionality that is requested.

Table 4 - EPICS overview

ID	EPICS
AllNf01	As a citizen, I want to use fast and efficient dashboards, so I can analyse situations well
AllExp	As a citizen, I want to be able to export the data from the dashboards in a number of formats, so I can share and work on the data outside the COMPAIR tools
AllL&f	As a citizen, I want to use pleasing, clear, consistent dashboards, so I can analyse situations well
Co2Cal	As a citizen, I want to know the current and historic contribution of my different activities to my Carbon Footprint, so I can maximise the impact of changes to my behaviour
Co2RRe	As a citizen, I want to get a list of recommendations on how to reduce my contribution to Co2 creation
Co2Man	As an admin, I want to manage the dashboards I am responsible for, so I can help my users be efficient
Co2Sce	As a citizen, I want to be able to create scenarios of citizen and government actions that show me how emissions can be reduced to a certain target.
DyDAoR	As a citizen, I want to see the output of air quality sensors that were worn on trips, so I can analyse the exposure of people to air pollution
AllDis	As a citizen, I can access information about air quality, best practices, ... from the COMPAIR tools and dashboards
DyDMan	As a researcher, I want to be able to manage experiments done
DisSha	As a researcher, I want to be able to share information, so my users know how to use COMPAIR tools efficiently
DEVAAnn	As a citizen, I can annotate and share information about exposure on my trips

ID	EPICS
DEVAHis	As a citizen, I want to get historical information about trips so I can assess the exposure
DEVARea	As a citizen, I want to get realtime information about trips so I can assess the exposure
DEVAUI	As a citizen, I want to use pleasing, clear, consistent dynamic exposure visualisation app, so I can analyse situations well
DEVAGam	As a citizen, I want to interact with the app and simulate how my actions would lead to reduced/increased pollution
DEVAMan	As a researcher, I can monitor how the app is being used so I can assess if actions need to be taken
DEVAUsI	As a user, I can update my settings in the app, so my characteristics, my sensor,.. is taken into account
DEVAViz	As a citizen, I want an intuitive and clear visualisation of the data
AllUMa	As a user, I can login to the tools, so my settings and personal info is used
PMDCom	As a citizen, I want to compare the output from different projects using the policy monitoring dashboard against each other
PMDAir	As a citizen, I want to see realtime and historical information about air pollution, so I can assess the impact of policy decisions
PMDCon	As a citizen, I want to see context data like weather, roadworks, so I can take this context into account when assessing the impact of policy decisions
PMDMap	As a citizen, I can use a map interface to see the location of sensors so I have an understanding where measurements are done
PMDTra	As a citizen, i want to see realtime and historical information about traffic, So I can assess the impact of policy decisions
PMDGam	As an admin, I can trigger behaviour using the dashboard by using gamification techniques, so I can increase take up of the dashboard
PMDMan	As an admin, I can manage dashboards during the lifecycle of projects so people can use the dashboards to assess impact of policy decisions
PMDUI	As a user, I get a user friendly, pleasing, intuitive UI, so I know how to use the dashboard and I'm motivated to use it

Writing these has been a tremendously useful exercise to enable us to predict and be prepared for engaging a fair representation of society. In addition these requirements are also crucial in informing the technical partners when developing their products. Moving forward, pilots will now further expand on these throughout the project lifetime as a feedback loop. The more people we engage, the more we learn about what is working and what is not.

2.6. The COMPAIR technology

COMPAIR has six user oriented technical enablers that will support the CS Lab activities in the pilots to test replicability. The components can be integrated in different combinations, including into a CS App depending on the experiment and user needs. The elements are:

(a) Dynamic Exposure Visualisation App (DEVA): In our society SmartPhones are almost ubiquitous, therefore apps can increase the reach and engagement of the project. The idea of this app is to enable people to explore their surroundings via their smartphone or

tablet camera, so they see a visual overlay of environmental information, including air quality. Through games, users will be able to "perform tasks" and, for example, see changes in environmental information when they make certain decisions, such as walk rather than drive or provide additional context information). By entertaining and educating at the same time, **COMPAIR** will be able to convert the interest of many people into joining citizen science experiments. The use of this interface can be integrated with other components e.g., CS Dynamic Exposure Dashboards to display new citizen science findings/data. During the co-creative workshops actual users will be involved in testing and developing ideas for the app.

(b) Citizen Science Sensors: **COMPAIR**'s sensors are filling the existing gaps in the sensor market (more on this can be found on deliverable **D3.2 - Sensor Device Functional and Technical Design Report**). The sensors that will be used in the pilots are:

- Telraam for traffic measurements;
- SODAQ for static and dynamic air quality measurements (PM10, PM2.5, NO2).

(c) CS Dynamic Exposure Visualisation Dashboard: This easy-to-understand visual dashboard will be used to show both city and CS data (with a GIS identifier) on a map and in various charts. Data sources include fixed city sensor data along with CS sensor data, and other citizen captured data e.g., feelings, smells, actions etc. Citizen Scientists, no matter their educational background, will be able to look at and understand their own data, and at anonymised group data, so through simple but powerful visualisations they can better understand air quality information and local context.

(d) Carbon Footprint Simulation Dashboard: This Dashboard is designed to support specific experiments around carbon footprints or indeed footprint for any chosen air molecule. Algorithms will help users see and compare how future CO2 and other levels will change based upon different individual actions e.g., washing during day or night, driving or cycling, recycling food, plastic, paper, glass etc. The aim is to guide user behaviours towards more environmentally friendly choices like limiting waste and maximising recycling, replacing polluting stoves and ovens with less energy consuming household appliances, opting for a more environmentally friendly car use (car sharing).

(e) Policy Monitoring Dashboard: This Dashboard helps users to understand and compare how environmental situations change under different actions. By collecting a large amount of CS information in a particular setting, the Dashboard will be able to simulate future impacts for different variables e.g., time of road closures, differing routes to school, staggered start times for work or schooling.

(f) Digital Twin Dashboard: For cities with a Digital Twin (Flanders and Athens), citizen generated ideas for new policies will be able to be simulated and reviewed in a systematic manner against other policies. The dashboard is targeted primarily towards policy makers but open to citizens and businesses too.

Table 5 - Technical enablers supporting CS activities which will be used per pilot. When it is planned it is marked with an 'x'.

Technical enabler	Athens	Berlin	Flanders	Sofia	Plovdiv

DEVA	x	x	TBD*	x	x
Telraam traffic sensors		x	x	x	x
SODAQ static sensors	x	x	x	x	x
SODAQ wearable sensors		x	x	x	x
CS Dynamic Exposure Visualisation Dashboard	x	x	x	x	x
Carbon Footprint Simulation Dashboard	x		TBD**	x	x
Policy Monitoring Dashboard	x	x	x	x	x

*To be decided once the app is further developed.
** Flemish cities are part of the 100 cities participating in EU Mission for climate neutral and smart cities by 2030

3. Inclusion of Lower Socio-Economic Status Groups

COMPAIR was designed to bolster citizens' capacity to monitor, understand, and change their environmental impact, both at a behavioural and policy level. It unlocks the power of the wider public, including people from lower-socio economic groups, to provide broad granular data around a central theme of air quality, complementing and improving the quality of official datasets and making new information useful for helping to meet environmental aims.

Successfully including communities such as lower SES is one of the greatest challenges citizen science projects have to overcome, however it is paramount that we do so. They often fall under the label 'Hard to reach' as more often than not they are not present in many initiatives, such as citizen science projects, where decisions that are likely to impact their day to day lives are taken.

We, as a consortium are committed to contributing to changing that, thus we have defined an important KPI of ensuring a minimum of ⅓ of our pilots participants to be part of this community. As an important step to achieve this we conducted a mapping exercise at the last plenary meeting to gather ideas each of the pilots were pursuing towards this goal:

- Involve organisations/charities working with lower SES groups;
- Target communities where you expect lower SES groups;
- Work through intermediaries or influencers and community leaders;
- Produce learning graphical material;
- Identify best locations and prioritise schools;
- Involve academia as ambassadors of trusted data (verification);

- Differentiate between lower SES and vulnerable groups;
- Reward recognition certificate for participation;
- AR app suitable for primary school kids;
- Increase teaching of STEM topics in schools;
- Engage elderly communities.

Based on this action list we have developed several thinking points and recommendations each of the pilots are encouraged to follow:

1) Each pilot should develop their own definition of lower SES groups in their area. Often the terms lower SES, vulnerable and hard to reach are used interchangeably but there are many examples when these do not overlap. For instance older communities might be vulnerable (in particular to poor air quality) and not be lower SES. Or a single mum might be a teacher and thus not hard to reach but be both vulnerable and lower SES. Thus, in order to move forward it is paramount that each pilot has a clear definition of who exactly they will work towards engaging and what indicators they will use.
2) The inclusion of charities and/or organisations with experience in working with the identified groups is a simple and yet effective way to both reach and communicate and raise awareness about the project. We highly encourage all pilot partners to do another mapping focussed on these institutions that should be invited to co-creative workshops discussing engagement and participation.
3) Simultaneously, it might be important to think beforehand on what are the messages we want to deliver to these groups that focus on the benefits for them in taking part in **COMPAIR**. For this we will need to spend some time mapping the different motivations that these communities might have to participate and work on them.
4) Making content accessible increases overall participation (and diversity) but doesn't necessarily target lower SES groups. So it is important and we must do it to make sure we are not excluding anyone, but it is not enough.

Finally as a consortium in order to support our efforts of engaging lower SES groups we propose some internal additional actions:

- Internal training on unconscious bias (propose timeline - M13);
- Internal training on ethical engagement strategies of vulnerable groups such as lower SES groups (Before the start of the public round);
- Workshop with all the pilot partners to co-define lower SES and further stakeholder mapping and engagement strategies (propose timeline - M14, in person combined with review meeting);
- The establishment of an internal diversity and inclusion committee to contribute with gathering relevant information, reviewing inclusion statements on all consortium communications and supporting the organisation of the above mentioned actions (M12);
- Selected consortium members should attend a training focusing on societal impact assessment, so that we can learn from the outcomes of this project and continue working on inclusion in future projects.

4. Pilots Operational Plans

The central theme for all **COMPAIR** experiments is the impact on air quality. This impact can be direct (impacting behavioural change) or can be indirect via awareness-raising (showing the local air quality exposure). Both complementary approaches can be collective (for example, an AR application (DEVA) showing the current air quality or a model simulation of the air quality impact of a new city development) or can be personal oriented by measuring your personal air pollution exposure or calculating the effect of personal behavioural change (Fig 3). These approaches complement each other and pilots have been designed to cover both squares of the quadrant, so evaluation can determine which type of CS activities have the most success.

Figure 3 - Spread of CS pilot types for assessment on best environment for success

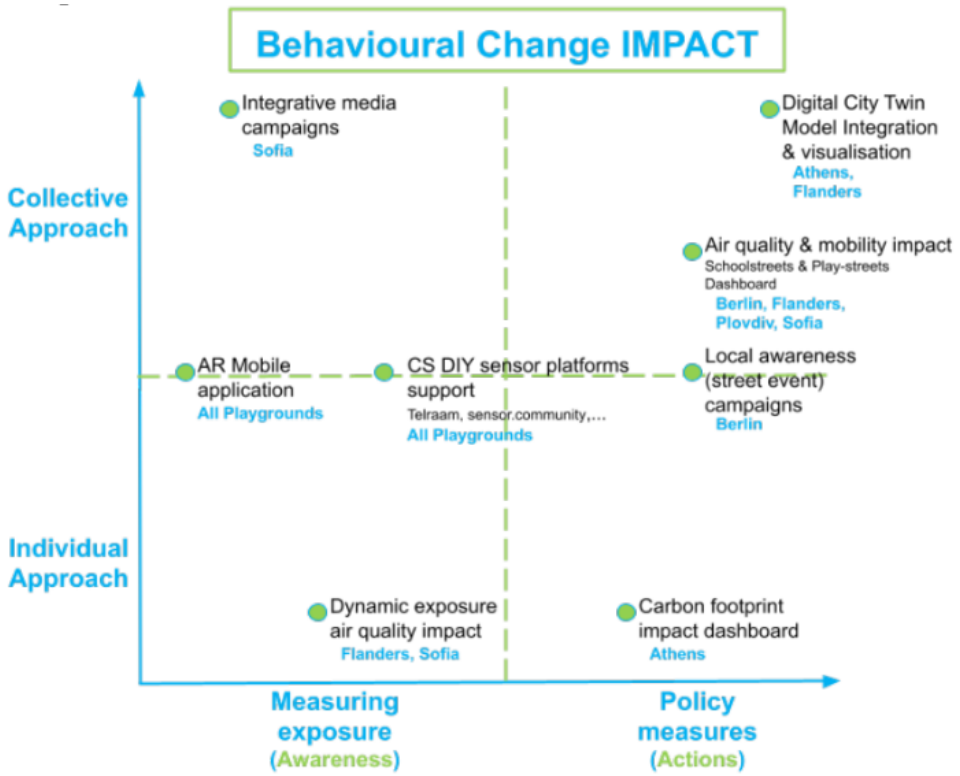


Figure 3 is a simplified representation of the different pilot initiatives and what approaches they are using. The intention here is not to showcase the differences each strategy has on impact but to showcase the spread of strategies **COMPAIR** is using.

This section provides more in depth information regarding the operation plan for each pilot. We go through milestones already reached, some challenges and recommendations that are pilot specific. There are however milestones and challenges shared by all pilots.

Shared Milestones:

- All pilots successfully mapped relevant stakeholders to be invited to each pilot's co-creative workshops (section 2.2 on groundwork).

- Every city ran 2 co-creative workshops. This milestone was very important in the designing of future pilot activities. Two co-creative workshops were successfully organised in a span of five months. The goal of the first workshop was, on the one hand, to contextualise **COMPAIR** in light of each city's air pollution situation and its planned air quality measures and, on the other, to present the project and its ambitions to the participants as a solution to the city's air quality issues.

Shared Challenges & Recommendations:

Table 6 - Challenges and corresponding recommendation for all pilots

Challenges	Recommendations
Defining lower SES groups.	Finding communities that are likely to participate yet are still considered socioeconomically disadvantaged will rely on a careful definition of lower SES communities (often referred to as vulnerable or hard to reach - these terms should be disentangled and carefully expanded upon in each pilot). Pilot partners should receive some training on this topic before working on this very important challenge.
Digital literacy or lack thereof.	This is a common and complex challenge, especially when present in communities we aim to engage. Ultimately the goal is to make everyone feel included and important so the best recommendation is that we provide the necessary training so that everyone is able to use **COMPAIR**s technology and adjust our aims and expectations. It is more important to be inclusive than to have the most advanced app.
Encourage/convince citizen science participants to use technology.	All pilots should conduct several training initiatives in a variety of settings and formats in order to empower everyone to share their concerns and doubts freely and actively engage in the project. Openly incorporating feedback from end users will be crucial here.
Pilot operation plan evaluation and monitoring.	All pilots should do their best to increase cross communication amongst other project pilots. We already do this as part of our pilot calls, now let's strengthen our efforts in

	communicating also our challenges and shortcomings so as to enable co-creation of solutions and prevent pilots from making the same mistakes (more on this in section 4.5). Pilot partners and technical partners should also strengthen their communication. As we learn more about our users and what they want/need the better we will know what is needed for our sensors and apps. Technical partners should be flexible and open to these requests.
Defining a plan for how the outputs of the project will be monitored and evaluated during the open and public rounds starting from small, dedicated user-groups to public testing.	This strategy should include a way to determine whether our environmental monitoring capacity has improved, whether we managed to involve and reach our target groups and whether citizen science participants effectively changed their behaviour to lower their environmental impact. Some of the KPIs are currently being assessed at project level, others at pilot level or at both levels and will be presented as part of deliverable 6.1 - Impact Evaluation planning to be released in October 2022.
Having a methodology that is actively inclusive (not only regarding lower SES participants).	Project results, communication campaigns, and any citizen engagement strategy need to be communicated in an open and accessible manner across all stakeholders and citizens. This means taking care in the language used, like avoid jargon, and also making sure we are communicating in inclusive ways in our choice of colours, using ALT text whenever possible (eg. Twitter and Linkedin), provide subtitles with captions for deaf and hard of hearing whenever possible, etc.. It is important to maintain an inclusive mindset during all phases of the pilot operations. Again consortium partners should participate in trainings tailored at developing inclusive mindsets.

Active and long lasting participation of policy makers.	Policy makers are a stakeholder particularly hard to engage. Thus several actions should be taken in order to increase their interest and availability to participate longer term: ● Nurture existing contacts with local policy makers ● Nurture these contacts by keeping them informed throughout the project ● Make it clear which parts of the project can't happen without their input ● Asking for their constant feedback on pilot projects' implementation to avoid risks ● Seeking advice on actions that need their approval and acceptance

The information contained in the next 4 sections was collected as part of an in person workshop at the Projects plenary meeting in Samos. The information was then expanded together with those contributing to the deliverable.

4.1. Berlin

Berlin is the capital of Germany, as of 2019 has a population of >3.6 million people and over 6 million in the metropolitan area. One-third of the city's area is composed of green areas and water bodies (Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin, Referat Freiraumplanung und Stadtgrün, 2021). The population of Berlin is highly diverse, with >700,000 foreign residents and >500,000 German citizens with migration background (Amt für Statistik, 2020)

The Berlin **COMPAIR** pilots will focus on citizen engagement to bring citizens together to increase neighbourhoods' liveability and create a resilient and climate-friendly environment. This will be done through a combination of liveable spaces with evidence-based data delivered by citizens and local communities (open data). Berlin/Brandenburg is already one of the regions with the highest number of DIY air quality sensors installed. Using these sensors and networks for evidence-based policymaking combined with other city datasets will lead to smarter cities and smarter citizens.

The first pilot case is about creating more liveable city environments awareness-raising campaigns in Berlin neighbourhoods by extending existing proven formats like "Tag des guten Lebens', and KiezConnect. A second pilot will focus on the effects of local car traffic-free zones, taking advantage of already established "Temporäre Spielstraßen" (temporary play streets).

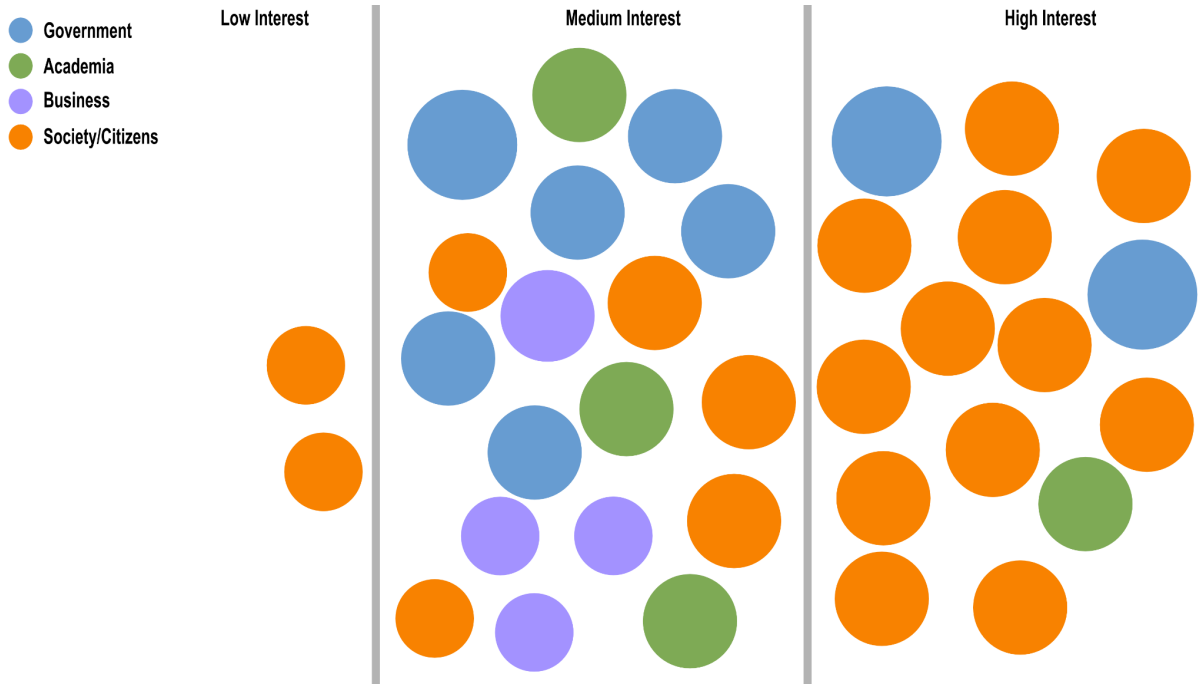
The mapping exercise conducted as part of D2.2 found that the vast majority of German initiatives are actually initiated, funded and managed by domestic actors together with a few examples of CS data impacting policy and regulations. This demonstrates the existence of good local support for CS initiatives and thus we encourage the further contact of relevant initiatives mapped. The mapping of existing relevant policies conducted in D2.3 shows the existence of several initiatives related to urban planning and transportation in Berlin as part of the official political agenda and included in its development participation of residents. Though not directly related to air quality, all of this is evidence of good collaboration between policymakers, scientists and citizens, however the latter could have been more involved in data collection activities. This sets the perfect opportunity for **COMPAIR** as we can rely on this good relationship amongst different actors whilst also working towards overcoming existing shortcomings.

4.1.1. Milestones

Milestones reached:

- Two co-creative workshops that happened in February and June 2022.
    - The outcome of the first workshop was a collection of ideas for the development of **COMPAIR**'s sensor and visualisation tools. Participants also shared their views on suitable locations and target groups for the two pilot projects.
    - The second workshop was narrower in scope and focused on receiving feedback and inputs on the Policy Monitoring Dashboard and the Dynamic Exposure Visualisation App mockups.
- Building a community of stakeholders
    - From the very onset of the project, first contacts were established with different interest groups in order to start building a community around air quality, sustainable neighbourhoods and social inclusivity. The stakeholders were initially identified as part of D2.1 Value Network Canvas but are, apart from the aforementioned workshops, being regularly engaged via bilateral exchanges in order to make them a part of a steadily growing **COMPAIR** community. Stakeholders include various neighbourhood, sustainability and social justice initiatives, researchers as well as municipal district offices (Fig 4).

Figure 4 - Berlin pilot stakeholder network



The size of the bubble of each stakeholder is determined by their level of power, as provided by the pilots, each section a different interest level and each colour represents a different Quadruple Helix group. (adapted from D2.1 - original can be seen here).

Table 7 - Planned milestones of Berlin pilot activities at each pilot stage

Closed round	Expected timeline	COMPAIR products
3 Telraam site tests at different locations and during different time periods. Traffic data is collected and analysed	August - September 2022	Telraam
Sodaq Air and Sodaq NO2 site tests at different locations. Air quality data is collected and analysed	September 2022	Sodaq Air & NO2
Exchange with Telraam and Sodaq: training, calibration, fine-tuning and general support	September - October 2022	NA
Report and presentation of results: the collected data, handling of the sensor installation and calibration process and general experiences are documented in a report. This will serve as the main input for D5.1 Identification of stakeholders: a narrowed down Stakeholder list is created based on D2.1, including actors from different initiatives,	October 2022	NA

researchers and municipal policymakers		
Open round	Expected timeline	COMPAIR products
Draft of experimental design and KPIs: a first draft of the experimental setup will be created, which will include aspects such as sensor locations and distance, data collection and KPIs based on D6.1	November 2022	NA
Deployment and placement of sensors based on experimental design: initial field tests of experiments, gathering of experiences	November - December 2022	Sodaq Air & NO2, Telraam
Application and test of the first version of the PMD and DEVA in an experimental setting	December 2022 - January 2023	Policy Monitoring Dashboard and Dynamic Exposure Visualisation App
Draft of final experimental design: a final draft of the experimental setup is created based on experiences from the first experimental design	January - February 2023	NA
Involvement of stakeholders from different backgrounds (political, lower SES, researchers, etc.)	February - April 2023	NA
Training of involved groups: air quality, traffic, sensor use and calibration, data interpretation	February - April 2023	Sodaq Air & NO2, Telraam, Policy Monitoring Dashboard and Dynamic Exposure Visualisation App
Deployment and placement of sensors based on final experimental design: field tests of experiments with involved stakeholders, gathering of experiences • Deployment at two potential play streets • Deployment at one dynamic measurement campaign	February - May 2023	Sodaq Air & NO2, Telraam, Policy Monitoring Dashboard and Dynamic Exposure Visualisation App
Assessing performance based on quantitative and qualitative KPIs from D6.1	May - June 2023	NA
Public round	Expected timeline	COMPAIR products
Establishing contact with district offices to receive permits to close down streets for traffic in selected	June - September 2023	NA

areas as well as with Berlin Partner for Business and Technology to receive permits to post air quality sensors on public property		
Further involvement of stakeholders from different backgrounds (political, lower SES, researchers, etc.) via targeted engagement campaign (described in section 2)	October 2023 - February 2024	NA
Signed consent forms from CS participants	October 2023 - February 2024	NA
Deployment and placement of sensors based on final experimental design: field tests of experiments with additional involved stakeholders, gathering of experiences • Deployment at at least two play streets • Deployment at one dynamic measurement campaign	February 2024 - June 2024	Sodaq Air & NO2, Telraam
Measurement of data: car-free streets and dynamic measurement	February - July 2024	Sodaq Air & NO2, Telraam
Application of the final version of the PMD and DEVA in citizen science experiments	March - June 2024	Policy Monitoring Dashboard and Dynamic Exposure Visualisation App
Assessing performance based on quantitative and qualitative KPIs from D6.1	May - July 2024	NA
Further identification and contact of stakeholders from the business sector	August - September 2024	NA

4.1.2. Challenges & Recommendations

Table 8 - Challenges and corresponding recommendations for the Berlin pilot

Challenges	Recommendations
Limited time span for play streets: depending on the selected area's local traffic situation, it may prove difficult to close down a street for a longer time period, which could greatly impact the validity of the results gathered during the car-free streets pilot.	Valid play streets should be identified based on project requirements. This will primarily include examining past temporary play streets (their successes and challenges), specifically in district management areas (germ. Quartiersmanagement) that promote neighbourhood inclusion.

	In order to measure the impact of street closures for as long as possible, sensors may be deployed at established and returning events (e.g. Karneval der Kulturen, Autofreie Sonntage Schloßstraße) where roads are closed down for traffic.
Administrative time delay: in order to close down a street, the local district office needs to issue a permit to the applicant. This process may take time and delay the car-free streets pilot.	If feasible, district offices could be contacted earlier so as to counteract the potential administrative time delay associated with permit issuance for car-free streets: If possible include those administrative members who might help reduce delays as part of the stakeholder network. Foster a sense of agency and get them invested in the project's cause.
Establish a robust stakeholder network: building a community from ground up is a difficult process that requires continuous engagement of key stakeholders. Many communities with similar goals are fragmented, so the challenge will lie in rallying the different interest groups behind common goals related just and sustainable neighbourhoods.	Joining forces with CS initiatives mapped in D2.2 to achieve common goals is always a good idea. This also has the potential to help find more stakeholders who are already committed to taking part in projects such as this. Connect the project to the German CS network Bürger schaffen Wissen. The platform offers various services related to Citizen Science, such as the organisation of the CS Forum and other events, communication through different social media formats, and advice and support for CS projects to strengthen citizen research sustainably.
Access to lower SES communities who are more exposed to air pollution will be challenging due to language barriers, different priorities and potential distrust.	The following groups (potentially identified as from lower SES) should be targeted: students with children (as a group receiving government assistance), members of neighbourhood initiatives (as a group likely to be adversely affected by sustainability issues), residents living close to traffic-heavy areas (likely to be adversely affected by noise and traffic issues).

	Furthermore, in order to successfully engage lower SES groups we recommend the further engagement with schools and/or school associations and of local community members who could both translate and help bridge other communication barriers.
Time availability of engaged citizen science participants.	Develop a methodology such that you can expert participants to have a range of interests/time available. If this is expected already at the design level it does not have to be seen as a problem but as a feature. Nevertheless work towards fine tuning your map of interests and motivation to increase as much as possible participation. Be mindful and respectful of the participant's time. Provide information in a way that is easily accessible and streamlined. And accept that people will participate on their own terms, decide in advance what is acceptable and what is not.
Training and interpretation of data: in order to train participants, the pilot lead will need to understand the main aspects of the sensors (installation, calibration, etc.). Given the pilot lead's non-expert background, some issues may not be solved immediately and will require the assistance of the project's expert partners.	A training session organised by technical partners will instruct the pilots on the proper installation, usage and maintenance of sensors. Maintain open communication with the technical team throughout the pilot operation phases.

4.2. Flanders

Flanders is one of the three Belgian regions and with 6 million inhabitants it is the most populated region in Belgium. 9% of households in Flanders are at risk of poverty. Those born outside the EU and those unemployed are at higher risk of this (Population below the poverty threshold, statistics Vlanders). In Belgium, foreign-born residents make up less than one-tenth of the population, including EU-born migrants and people from North and Central Africa, the Middle East, and Southwest Asia (Ethnic groups and languages, Britannica)

In Flanders three **COMPAIR** pilots are planned:

The first Flanders pilot aims to assess the effect of school streets (streets that are blocked for cars around a school during the moments that children go to or leave the school). Results will be shared amongst policy makers in the city, schools and parents. This pilot case will help vulnerable road users around schools and aims to be an excellent showcase of how Citizen Science sensors can be clustered and combined for Policymaking on a local level.

The second case will take an exposure assessment of air pollution from a static to a dynamic level, i.e., taking the behaviour of citizen science participants into account rather than just their home address (dynamic exposure). The goals are: (1) improving existing air quality models and their ability to estimate population exposure (better monitoring) & (2) engaging citizens in a behavioural change process targeted at reducing their exposure and reducing their emissions.

The third Flanders pilot case will integrate air quality and traffic CS data into the Flanders Digital City Twin as a proof of concept by pinpointing the measurement stations on a 3D map and by combining the CS IoT data streams with air quality and traffic models to test the impact of CS IoT data on the models on a neighbourhood, city, and regional level. The results will be analysed by experts in multiple policy domains such as environment, mobility, and spatial planning. Then results will be evaluated to the added value for evidence-based multi-policy domain policies on different geographical levels neighbourhood city, region, and decision levels as operational to strategic long-term decision making.

Once more, the mapping of CS initiatives conducted as part of D2.2 found great support for establishing both local and international citizen science projects with a lot of information of how impact was measured and how communication across different policy and decision makers was established. This is further demonstrated by looking at the number of times CS is mentioned in policy related documents. One of the most important documents is the Citizen science roadmap for local government that outlines what citizen science can mean for local government, explains how to get started, and identifies success factors. All of this combined, shows a perfect ground for **COMPAIR** with plenty of opportunities to break further barriers and move both CS and air quality related measures forward.

4.2.1. Milestones

Milestones reached

- Benchmark: VMM organises a benchmark study of commercially available (mobile) air quality sensors for black carbon (BC), particulate matter (PM) and nitrogen dioxide (NO2). Through this study we try to find out how well the sensors perform under lab conditions and in the field. In this way we can frame the performance of **COMPAIR** devices in light of available technologies and determine the suitability of both **COMPAIR** and other devices for the next phases of the project in which we will conduct mobile air quality measurements with citizens.
    - Sensor selection for benchmark study: from a list of commercially available AQ sensors, a selection was made of sensors that we wanted to include in the study, taking into account the presence of an internal GPS functionality, the portability, cost price, delivery time, etc.
    - Start of the lab tests:

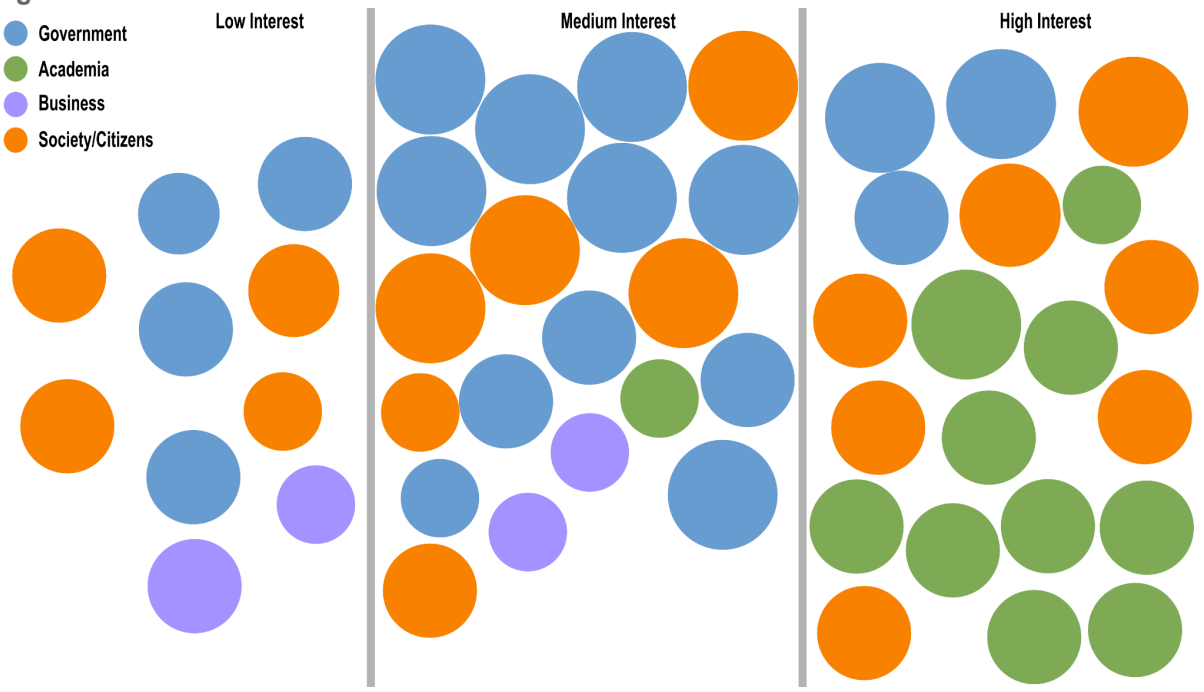
        - For the NO2 sensors, following tests are performed: Lack of fit test, effect of relative humidity, effect of temperature, interference with O3, response time
        - For the BC & PM sensors, a linearity test is performed

- 2 Co-creative workshops that happened on February and June 2022:
    - The first workshop took place in February and explained the project to potential stakeholders and questioned their expectations regarding the project.
    - In the second workshop that took place in June, the mockups of the **COMPAIR** tools were presented to and commented on by the participants. We also questioned them about several practical aspects we have to take into account in order to make the experiments with citizens a success later on in the project.
        - How to recruit participants? (in general & specifically lower SES groups)
        - How to motivate them?
        - What are the desired characteristics of AQ sensor devices?
        - Privacy aspects

    We also discussed the possibilities for collaboration.
- Building a community of stakeholders (Fig 5):
    - For the workshops, representatives of the triple helix structure were consulted;
        - local governments
            - Ghent, Leuven, Roeselaren, Mechelen, Leidal
            - Province of Antwerp, Agency for Innovation & Entrepreneurship, Department of Education and Training, Agency for Domestic Governance, Department of Environment, SOLVA
        - citizens/society
            - Movement.net, Environment movement (milieufront)
        - knowledge institutions
            - Flemish Foundation for Traffic Science, Provincial centre for Environmental Research, Knowledge centre for Citizen Science in Flanders (Scivil)

- During the workshop, the project was presented to the stakeholders (Fig 5), mutual expectations were harmonised. The products developed within the project were presented and feedback collected, it was also a moment to share results. In addition, the workshops resulted in a collaboration with Ghent (introduction of a school street in Ghent + measurements of the effect of the circulation plan).

Figure 5 - Flanders Stakeholder Network



The size of the bubble of each stakeholder is determined by their level of power, as provided by the pilots, each section a different interest level and each colour represents a different Quadruple Helix group. (adapted from D2.1 - original can be seen here)

Table 9 - Planned milestones of Flanders pilot activities at each pilot stage

Closed round	Expected Timeline	COMPAIR product
Benchmark: lab tests finished	August 31st 2022	SODAQ NO2
Benchmark: field tests finished	November 30th 2022	SODAQ NO2
Draft of experimental design	November 2022	NA
Benchmark: report of final results	Mid-december 2022	COMPAIR website
Open round	**Expected Timeline**	**COMPAIR product**
Political agreement and support towards school street on their territory and agree to take care of the practical matters.	September 2022	NA
Sensor deployment in at least 2 schools	March 2023	SODAQ NO2 and Telraam
Deployed at least 2 school streets	Following Easter holidays 2023	Herzele and maybe Roeselare
Deployed at least 2 dynamic measurement campaigns	October 2023	SODAQ NO2 & Air

Involved at least 1 school with students of lower SES	June 2023	Ghent
Public round	**Expected Timeline**	**COMPAIR product**
Sensor deployment in at least 3 additional schools	March 2024	SODAQ NO2 and Telraam
Deployed at least 3 school streets	Following Easter holidays 2024	NA
Involved at least 3 schools with students of lower SES	June 2024	NA
Deployed at least 3 dynamic measurement campaigns	October 2024	SODAQ NO2 & Air
Demonstrating results and initiating discussion with businesses through platforms like "Smart Region Flanders"	October 2024	Policy dashboard

4.2.2. Challenges & Recommendations

Table 10 - Challenges and corresponding recommendations for the Flanders pilot

Challenges	Recommendations
Time availability of engaged schools.	Include school and/or teacher associations as part of your stakeholder group to provide support (and share the burden) in empowering schools to take part.
Draw up a good survey to assess whether the KPIs are reached.	Short surveys, questions sub-sampled of the participants, not too frequent.
Optimise sensor calibration.	Maintain close contact with the technical team, perhaps even by creating a system where feedback from cs participants and stakeholders is provided, dealt with and updated throughout the project.
Data interpretation.	Organise workshop for the participants about the use of the dashboards, the final interpretation together with COMPAIR partners or only by the COMPAIR partners. Invite scientists to take part.

Staff time for non technical follow up ○ Coordination: Timing + parallelisation: Defining the timings for when we will roll out which school street. Can we do more than one school street at a time, or do we need to do this consecutively? This mainly depends on the availability and need of the sensors ○ Recruiting sensor hosts, schools, citizen, etc.. (taking into account GDPR-issues)	With such a strong baseline of citizen science activities and such strong evidence of successful engagement of policy makers it might be a good idea to reach out to citizen science practitioners to learn from their experience, perhaps also by including them on your stakeholder network. This can help with easing many challenges such as GDPR related issues and sensor deployment (timing) issues.
Sensors have to stay up and running, without bugs (as this is time consuming).	Involve CS participants also in the trouble shooting related challenges, so that if and when they do arise it is not seen as a nuisance necessarily but as a learning opportunity.
Involvement of participants from lower SES as they are harder to reach (e.g. due to a language barrier) and yet often more exposed to air pollution.	Not all lower SES groups will have a language barrier, but for those that do, invite local, trusted members of their community to act as translators.

4.3. Sofia and Plovdiv

Sofia is the capital of Bulgaria with over 1.2 million people. 87.9% are recorded as ethnic Bulgarians, with Romani, and Turks being the biggest minorities (1.5% and 0.5% respectively). Sofia is located at the Sofia Valley, which limits the flow of air masses, increasing the chances of air pollution by particulate matter and nitrogen oxide. Plovdiv is the second largest city in Bulgaria with a population of 346 893 people.

The **COMPAIR** pilots in Bulgaria aim to enhance citizen science to cope with environmental problems related to commuting behaviour, sustainable mobility for students and choice of transport in general. Integrating government, private sector and citizen science data with impactful (personalised) awareness. Three pilot cases are planned in Bulgaria:

The first pilot is about creating a mobile dashboard accessible to telecom subscribers and subscribers of the official communication channel of Sofia Municipality, where users can share anonymised information about their usual way of daily commuting. Participating volunteers will be equipped with personal air quality sensors (for a period) and automatically

upload them to a shared platform with their consent. The volunteer sensor information will be combined with data from public transport (cards & tickets), scooter operators, bike, and e-car-sharing providers.

A second pilot will measure air quality around schools to create environmental awareness amongst children and their families. Air quality sensors and GPS sensors hooked on school students' backpacks using different transport modes (car, public transport, walking, bike) will be used to measure dynamic exposure. Flanders and Sofia/Plovdiv will test replicability and roll-out as a highly innovative and low-cost concept in Europe with a real impact on policy making.

A third pilot case will focus on an integrative, comprehensive information campaign "We are the drivers of the city" focussing on positive examples of people using sustainable means of transportation for a daily commute and more sustainable living in general. The campaign will be supported by a gamification app rewarding sustainable behaviour.

Both D2.2 and D2.3 show a recent increase in citizen science initiatives in Bulgaria and an eagerness to invest more in setting up more initiatives. So once more **COMPAIR** arrives at a perfect time to highlight the power of participatory research and further infiltrate the policy making world.

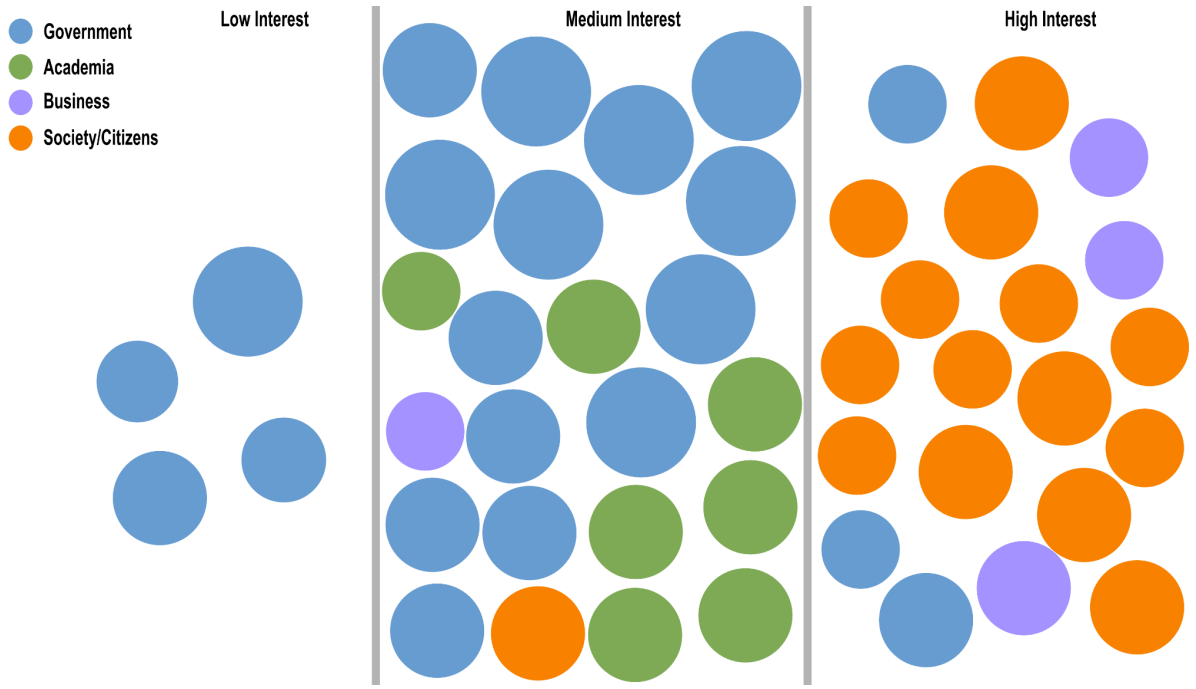
4.3.1. Milestones

Milestones reached

- Feedback on mockups gathered - both pilot teams of Sofia and Plovdiv gathered extensive feedback on the mockups of **COMPAIR** dashboards and DEVA app.
- 2 workshops took place - in the first 8 months of the project two workshops for each location were organised in January and June 2022. During the first workshop in the beginning of 2022 the identified stakeholders (Fig 6) were invited to get acquainted with the **COMPAIR** project and provide initial feedback on how they can get involved. The second workshop that took place in June was dedicated to gathering feedback and suggestions for improvement on the mockups that were prepared from the **COMPAIR** Technical Team to showcase the software that will be supporting the data gathering and its visualisation for the project.
- Survey on lower SES groups - EAP conducted a survey with 11 responses from NGOs, municipality representatives, academia and businesses. Despite being limited in the number of responses, the survey shows that a good way to reach lower SES groups is through Agencies for Social Assistance, municipal department "Social Policy" and different NGOs. Furthermore, opportunities for learning and gaining new skills and knowledge was the main reason identified as a motivator for these groups to join.
- Stakeholders identified - during the work for D2.1 Value Network Canvas stakeholders were identified and work has started in terms of engaging them and turning them into missionaries for the **COMPAIR** project.
- Awareness Raising on the local news - Bulgarian partners published information about the project on their websites. Also the information about the project, workshops and futured activities were published in local newspapers and other on-line media.

The EAP presented the project during the annual meeting of Bulgarian Energy Agencies in Burgas, Bulgaria, on 18/07/2022.

Figure 6 - Sofia/Plovdiv Stakeholder Network



The size of the bubble of each stakeholder is determined by their level of power, as provided by the pilots, each section a different interest level and each colour represents a different Quadruple Helix group. (adapted from D2.1 - original can be seen here)

Table 11 - Planned milestones of Bulgaria pilot activities at each pilot stage

Closed round	Expected timeline	COMPAIR products
Sensors' training for internal staff is performed. Staff is acquainted with the devices and can use them appropriately	September 2022	TELRAAM sensors for traffic count and SODAQ Air and NO2 sensors
Pilot actions locations (sensors' preliminary locations) are identified and agreed upon	September - October 2022	N/A
Sodaq Air and Sodaq NO2 sensors site tests at different locations. Air quality data is collected and analysed	September - October 2022	SODAQ Air and Sodaq NO2 sensors
Telraam sensor site tests at different locations and during different time periods. Traffic data is collected and analysed	September - October 2022	TELRAAM sensors for traffic count and SODAQ Air and NO2 sensors
Re-evaluation of the pilot actions' locations is performed based on the gathered results from the sensors' testing	October - December 2022	N/A

Open round	Expected timeline	COMPAIR product
Draft of experimental design and KPIs: a first draft of the experimental setup will be created, which will include aspects such as sensor locations and distance, data collection and KPIs based on D6.1	January - March 2023	N/A
An active campaign for gathering volunteers is undergoing	Spring 2023	COMPAIR website
Application and test of the first version of the PMD, CO2 dashboard and DEVA in an experimental setting	Spring 2023	PMD, CO2 dashboard and DEVA
Training of involved groups / volunteers: air quality, traffic, sensor use and calibration, data interpretation; information spreading / awareness raising campaign especially in areas where lower SES groups are living	Spring 2023	N/A
Deployment and placement of sensors based on final experimental design: field tests of experiments with involved stakeholders, gathering of experiences: • Deployment in at least 2 schools • Deployment of one dynamic measurement campaign with at least 15 volunteers	Spring 2023	TELRAAM sensors for traffic count and SODAQ Air and NO2 sensors, DEVA app, Policy monitoring dashboard
Deployment and placement of sensors based on experimental design: initial field tests of experiments, gathering of experiences	March - May 2023	TELRAAM sensors for traffic count and SODAQ Air and NO2 sensors
Draft of final experimental design: a final draft of the experimental setup is created based on experiences from the first experimental design	May 2023	N/A
Assessing performance based on quantitative and qualitative KPIs from D6.1.	June - July 2023	D6.1 suggested metrics
Public round	**Expected timeline**	**COMPAIR product**
Established good relationships with the already involved stakeholders and opportunities to attract new ones are identified, including those from the business sector	January 2022 - October 2024	N/A
All GDPR regulations are met when volunteers are involved	January 2023 - October 2024	N/A

Sensors' deployment in all the selected locations	September - October 2023	TELRAAM sensors for traffic count and SODAQ Air and NO2 sensors
Data measurements and analyses are presented to policy makers	November 2023	N/A
An assessment on the results is performed based on quantitative and qualitative KPIs from D6.1	Spring 2024	D6.1 suggested metrics

4.3.2. Challenges & Recommendations

Table 12 - Challenges and corresponding recommendations for the Bulgarian pilots

Challenges	Recommendations
Change burning behaviours (i.e. heating habits of lower SES communities), specially when not living in legal housing there is no access to existing incentives - providing the necessary information and tools to change behaviours and raise awareness among people with low educational status.	We recommend directly recruiting members from communities who still participate in illegal burnings. This is easier said than done of course and few things need to be considered: ○ Members of these communities might fear contact with anything related to official entities ○ They have been doing it for a while ○ Simply telling them that what they do is wrong won't get them on board. So probably focussing on engaging 'local champions' and work with specific stakeholders to develop potential alternatives/solutions are good strategies here.
Convincing schools to participate - we should identify the right time to start communication with schools, e.g. not during the very start of the school year when both students and teachers are overwhelmed by tasks and workload.	Reachout to teachers/teacher associations and co-define with them best timings, approaches to engaging with schools
Political situation - in the past more than 2 years there has not been a stable national government in Bulgaria which inevitably affects the situation on a local level as well.	There isn't much one can do with politically unstable situations. Perhaps inviting local advocacy political groups could be a way to foster connections with political bodies that

Parliamentary elections are expected to take place in early October. In 2023 there will be local elections (for mayors and city councils). This might affect existing relationships.	remain stable and have a certain amount of both knowledge and influence. Regardless of political inclinations, everyone needs clean air.
Digital skills of the older population - usually in Bulgaria people above the age of 80 do not possess a smartphone and do not have internet access at home.	The survey conducted is a good start to the process of understanding the local reality. We recommend expanding on this with a better distinction between vulnerable and lower SES communities and with an attempt of reaching a bigger and more diverse audience. Perhaps advertising through partners social media and other already established channels, the project's social media channels and the ECSA newsletter. This might facilitate this process. Reaching out to charities/organisations already working with these communities might help in increasing trust and in developing successful engagement strategies.
Temporal resolution of reported data.	We recommend reaching out to scientist and experts of air quality (sensors) to better understand the trade-offs of different temporal resolutions. This balancing between benefits and costs of each should be analysed co-creatively with other pilot partners and relevant stakeholders.
Standardised data so its useful for policy making - in order for the data from low-cost sensors to be comparable and accepted by local policy makers it needs not only to be calibrated in certain way but also to be turned into the standardised EU-format for data gathering - e.g. hourly average, daily average, yearly average, etc.	These processes have to be done together with the relevant policy makers. This is another area where their input will be crucial. Finally writing policy briefs will ensure that the data reaches and is used by policy makers, and thus accepted by decision makers. Any data set has to be accompanied by a how to read set of instructions so as to be accessible and clear to everyone regardless of their level of expertise.

4.4. Athens

Athens is the capital of Greece. With 3 million people living in the city and the urban metropolitan area. In terms of demographics, Athens population is relatively homogeneous, with a few minorities, the biggest one being the Muslim minority. There are also Jews, Armenians, Romani, Pomaks, and Turks in the city. Athens has one of the biggest Romani concentrations in Greece. (Hellenic Statistical Authority). The objectives of the **COMPAIR** pilot cases in Athens is to accelerate behavioural change at a household level for the first pilot case and inviting citizens to play a role in a public dialogue for the second case.

In **COMPAIR**'s first pilot case in Athens, we will engage end-users/citizen science participants in participating in the behavioural change towards a reduced carbon footprint and better air-quality. This will be achieved through the development of a CO2 Simulation Dashboard combined with distributed air quality sensors.

A second pilot will combine the outputs from the first pilot with the Athens Digital City Twin that will be used for simulations by using AI and performing “What-if” scenarios to support evidence-based decision making. Thus, the interactive map of the city developed by the Digital Twin approach will promote the verification of policies targeting behavioural change of residents on environmental household-habits. The outputs generated by the app, the air quality sensors and the Digital City Twin simulations aim to create a living lab in Athens connecting Public Administration, citizens, and the science community in a robust network.

According to the CS mapping from D2.2 there is a lack of local initiatives in Greece overall, however there are a lot of EU based ones focussing on a great variety of topics. Furthermore, several of the existing projects were able to recruit a huge number of participants, in some cases including schools, showing how there is great interest in citizen science. D2.3 found a few strategic documents containing measures related to citizens' involvement but unlike in other countries no documents were found in which CS was considered in the context of a strategy or plan. We are currently observing a momentum of increase in the number of CS initiatives in Greece. **COMPAIR** comes thus at the perfect time to break new ground.

4.4.1. Milestones

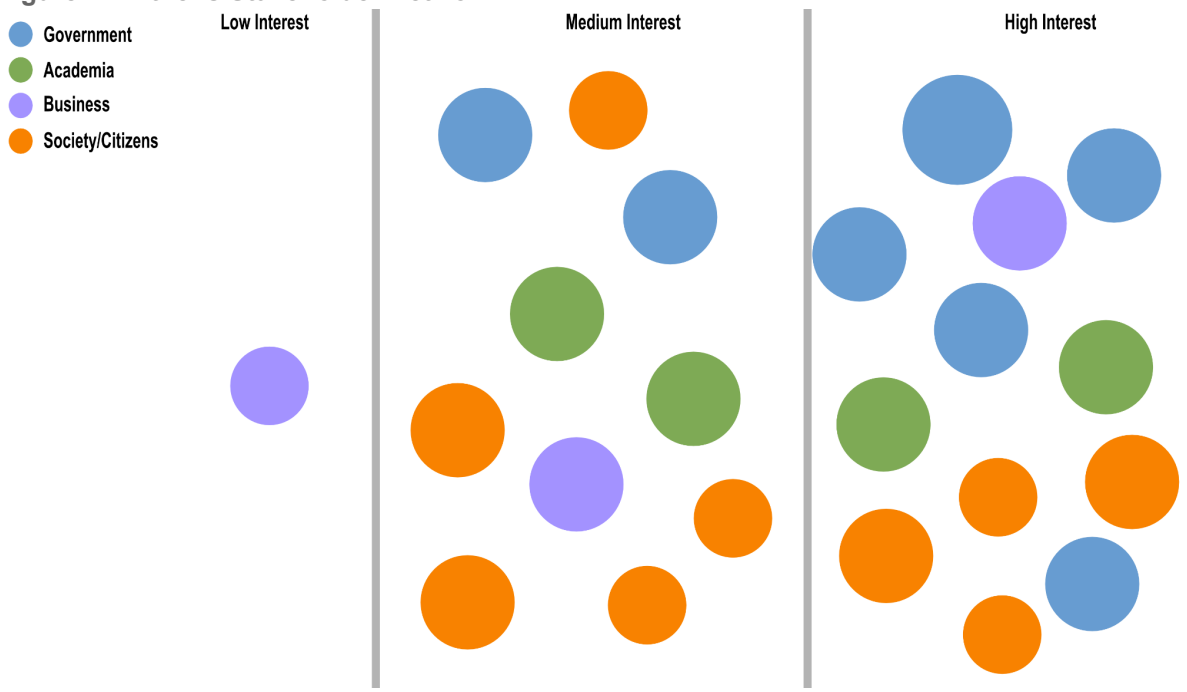
Reached milestones:

The activities in both the preparation phase and the pilot execution are distributed in the following main steps identified as reached milestones for the pilot operation, and each of the points refers to different groups of stakeholders.

- Regarding the stakeholders engagement for the Athens pilot, figure 7 represents the initial mapping of the existing network in Athens. The majority of stakeholders are from the city and its contacts, agencies and various initiatives as well as from the society/citizens. This network is planned to be further expanded for the mobilisation of the end-users in the 2 foreseen districts that are initially identified to be Kipseli and Neos Kosmos according to socioeconomic criteria.

- Currently the Athens team has been following the demonstrations of the sensors' providers both in the Plenary meeting and the KickOff (Telraam and SODAQ). It is planned to receive 1 sensor per type from both partners for the closed testing that will take place in September-October 2022. SODAQ sensors are under production at the moment while Telraam are expected to be tested in the forthcoming period.
- The Carbon CO2 calculation Dashboard has been presented by UAEGEAN in both workshops organised by Athens pilot and despite there being no hands-on sessions since the tool is currently being developed, however a co-creation approach was followed. In the 1st workshop - organised in February 2022 hybrid - the audience stated their preferences in terms of functionalities, tools and operations to be included in the tool, while in the 2nd workshop - organised in July 2022 hybrid- mockups of the current development were presented following up the comments and suggestions. Both events included fruitful feedback collection sessions from participants in the format of structured questions (on Mentimeter) and as an open discussion. The audience of the 1st workshop included mainly residents of Athens, city officials, employees of the municipality and academic partners, while the 2nd workshop exploited the IT-audience of the Samos Summit 2022 including mainly IT students, professors and academics. However, representatives of the Municipality of Athens followed the 2nd workshop.
- Similarly to the CO2 Calculation tool, the AR App of **COMPAIR** (DEVA) and the decision support tool (mockups) have been presented in both consortium meetings and internal meetings but are not tested yet hands on. Hence this milestone is ongoing.

Figure 7 - Athens Stakeholder Network



The size of the bubble of each stakeholder is determined by their level of power, as provided by the pilots, each section a different interest level and each colour represents a different Quadruple Helix group. (adapted from D2.1 - original can be seen here)

Table 13 - Planned milestones of Athens pilot activities at each pilot stage

Closed round	Expected timeline	COMPAIR product
Familiarisation with the technical solutions developed by the project, both software tools and hardware e.g. sensors	November 2022	Telraam sensors SODAQ sensors Carbon Footprint Simulation Dashboard DEVA CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard
Continue to follow demonstrations of the sensors' (Telraam and SODAQ)	November 2022	Telraam sensors SODAQ sensors
Receive one sensor per type for internal testing	November 2022	Telraam sensors SODAQ sensors
Test Carbon CO2 calculation Dashboard	November 2022	Carbon Footprint Simulation Dashboard
Testing sensors and testing software	November 2022	Telraam sensors SODAQ sensors DEVA Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard
Distribution of sensors	December 2022	SODAQ sensors
Open round	**Expected timeline**	**COMPAIR product**
Training meeting with 2 Athens districts	December 2022	DEVA Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard
Distribution of sensors and deployment in 1 of the districts	January 2023	SODAQ static sensors
Login of a group of users to the COMPAIR dashboard	January 2023	Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard

Public round	Expected timeline	COMPAIR product
Open call to citizens to login in COMPAIR dashboard and use/download the COMPAIR tools (CO2 calculation, Policy dashboard, AR DEVA App)	August 2023	DEVA Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard
Installation of NO2 sensors in public building in the 2 districts (6 in total)	August 2023	SODAQ sensors
Engagement of city officials	August 2023	Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard DEVA
Active participation of SES groups	August 2023	SODAQ sensors Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard DEVA
Full deployment of the pilot in the 2 districts	September 2023	DEVA SODAQ static sensors Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard
Distribution of all SODAQ sensors (50 sensors for both 2 districts)	September 2023	SODAQ static sensors
Follow ups with end-users and participants	December 2023	SODAQ sensors Carbon Footprint Simulation Dashboard CS Dynamic Exposure Visualisation Dashboard Policy Monitoring Dashboard DEVA

4.4.2. Challenges & Recommendations

Table 14 - Challenges and Recommendation for the Athens pilot

Challenges	Recommendations
Convince citizens to participate in a pilot project by installing sensors in households, by contributing to a dashboard and by using a relative application. Citizens, although nowadays, are aware of climate change and air pollution emissions and participate in several initiatives to this direction, should be convinced of the added value of their contribution to air pollution diminution.	Consider ECSA's ten principles of citizen science when thinking of incentives offered to citizens willing to participate in the pilot activities. Further mapping with specific stakeholders working with the lower SES groups you want to engage will be crucial for better understanding specific motivations for participation. This information is necessary not only for lower SES groups but for all participants.
Proper use of sensors is another important challenge. Not all citizens groups are familiarised with technology and equipment and it must be taken into consideration problems or possible damages by the use of sensors. Hence, the maintenance of the equipment should be provisioned for a smooth operation including for example the replacement of batteries, potential reboots and bug fixing etc.	A deep training session prioritising the importance and benefits of their contribution, as well as their cooperation with the city in policy making in environmental issues making their voice to be heard, will be an asset. A provision of incentives supports the process and it stimulates active participation. Accessibility of the training workshops, from the location to the language used, to the colours and technology used, should be prioritised in order to achieve true inclusion and active participation of all SESs.
Ethical issues regarding users' participation are also a challenge to be tackled. Letters of consent should be prepared and localised in order to ensure the procedures of data collection – not sensitive, but personal as is demographics for instance and their maintenance within project's duration.	Work in close contact with the above mentioned charities and the project DPO
Finally, especially for the AR Application of COMPAIR, a potential challenge refers to the compatibility of devices with the AR functionality, since not all end-users have	Further communication with the technical partners regarding different ways in which users could be more involved in troubleshooting. This should not be seen as

up-to-date mobiles. Also AR function is not responsive in all outdoor environmental conditions, such as under direct sunlight or during the night.	a caveat but as a useful opportunity of how things work for all those involved.

4.5. Communication between pilots

Throughout this deliverable and previous ones from this work package we have identified key differences in each of the pilot locations. Each has a very unique stakeholder network, different citizen science landscape and different policy agendas. However as a consortium we share a common goal. We want to achieve clean air by engaging a fair representation of society to adopt more environmentally friendly behaviours.

Towards that goal each pilot is putting forward different scenarios composed of different action points as stated in tables (1, 2 and 3 in section 2). For instance some pilots have already identified pilot location as part of the ground work whilst others will soon do that as part of the Open Round. This difference between pilot strategies is not only natural but a perfect opportunity for us to learn from one another. This section is devoted to the many ways we plan to take advantage of this variation and turn them into learning opportunities that can both enrich our current pilot development but also our overall expertise of implementing CS initiatives in our local communities. Furthermore we want to also emphasise amongst not only the pilot partners but also the entire consortium the importance of co-design and co-creation not only as a project activity but as a project philosophy. We already have several measures established towards this end:

- Bi-weekly calls with pilots where both project and technical coordinators are present with the clear goal of informing, exchanging challenges and ideas and learning from each other
- The availability of the coordinator and tech coordinator assures a continuous translation of the development cycles.
- Several ad hoc meetings between sensor and app developers and pilot leads take place as necessary

Moving forward we will keep with this ongoing dynamics with a few additions:

- Towards the end of each round (M12, M20 and M32) we will organise a cross communication workshop between pilot partners and update the Pilot Operations Planning for the next rounds
- Once a month, as part of the pilot bi-weekly calls we will do a pilot action mismatch exercise. This works as follows:

All pilot actions are placed on a shared interactive spreadsheet (Fig 8).. Pilots are then asked to justify or think about why their pilot is not performing a certain action. This could be easily explained due to inherent differences in pilot design (Blue warning) but sometimes its simply because one pilot has different expertise and thus different design strategies (red warning)

Figure 8 - Subsection of the mismatch table: Here only the closed round actions are shown as this is for representation purposes only.

WHAT	Sofia	Plovdiv	Berlin	Flanders	Athens	Warning
CLOSED ROUND	x	x	x	x	x	x
Benchmark study of commercially available air quality sensors				x		Warning
Identify locations for schoolstreet				x		Makes sense
Identifying the pilot locations	x	x				Makes sense
Pilot implementation in locations of the city					x	Warning
Demonstrating the impact of local measures/policy on AQ and mobility	x	x				Warning
Experimental design and mockups	x	x	x	x	x	Complete
Involve representatives of different SES groups	x	x	x	x	x	Complete
Available sensors tested	x	x	x		x	Warning
pre-pilot implementation to finetune tools and fix bugs	x	x			x	Warning
preparational visits to handover sensors and demonstrate tools	x				x	Warning
Testing of Carbon tools					x	Makes sense

Each pilot has an ‘x’ for actions they have planned. The warning column will raise a warning whenever there is a pilot without the ‘x’. This warning will be blue when the mismatch is due to differences in pilot design or red when pilots need to justify it. The action tables presented as part of section 2 have already gone through the first round of justifications and have been updated accordingly. As we move forward we will dive deeper into the nature of these differences and what we can learn from the different outcomes. These learning will then be considered when updating the pilot operation plan.

- The Pilot Operation Plan will be discussed in all pilot calls so we can monitor pilot development. Pilots will be asked to provide an overview of what has been completed, what is delayed and needs further work and how likely it is that what is planned will be accomplished.. The authors of this deliverable will ensure that all actions are accounted for and updated whenever necessary.
- Together with the communication team we will invite pilot leads to share their experiences through participation in CS webinars, production of social media content for the project channels and blogs for the website.

.

4.6. Managing expressions of interest

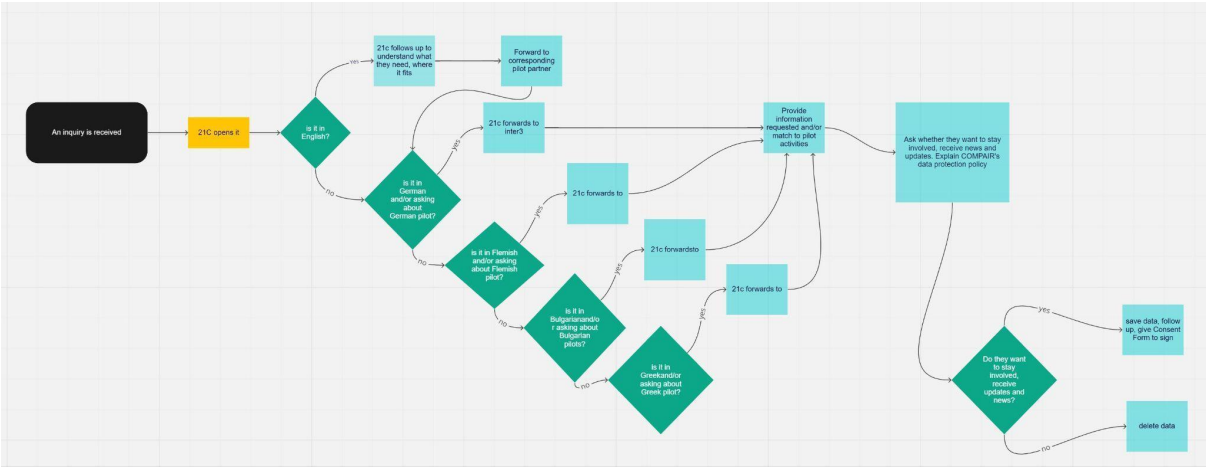
Periodically, the communications team (21C) receives external interest in volunteering opportunities announced on the project website. People submit a contact form and usually say in which city they want to volunteer, but sometimes they do not. When this happens, pilot preference can be deduced from the language of the message or included contact details e.g. phone number. The standard procedure followed so far has been this: Upon receiving an expression of interest (EoI), 21C forwards the message to the relevant pilot lead (if preference is known) or follows-up with the sender to clarify their preferred city, and then forwards the message. What happens afterwards with EoI and personal data has not been defined in any of the previous deliverables. The pilot operations plan is a good place to set out an algorithm for processing future EoIs, which one can expect will only grow in number as the project unfolds.

As the project progresses through the different rounds the need to adjust or update this process might appear, however currently this is what we propose:

- 21C receives an EoI and determines whether a) it is valid – we did receive job inquiries in the past so some filtering will be needed, and b) any clarification is required as regards location. Valid EoIs with a clear city preference will be forwarded to a relevant pilot lead. When the preferred city is not clear, 21c will clarify this.
- Local teams send a welcome email to the volunteer, in national language if necessary, and use the opportunity to:
    - Find out about participant's motivation, skills, capacity, level of interest i.e. are they interested in taking air quality measurements, coming to a workshop, using an app, or simply staying informed about the outcomes? Or maybe all of the above. For consistency and cross-border comparison, we may want to create a standardised survey for pilots to use in this initial outreach.
    - Explain **COMPAIR**'s data protection policy and how individual data will be handled i.e. what records will be kept, for how long, where, who will have access to this information, and so on. A copy of our data protection policy may need to be included in the email.
    - Introduce informed consent procedures. An informed consent form will need to be signed if a person opts for active participation e.g. attending workshops, installing sensors, taking measurements, as opposed to simply following the project as a newsletter subscriber. The form will provide key information about **COMPAIR** and planned citizen science activities in a chosen pilot, including what will be expected of them, to help individuals decide whether they should volunteer or not. This will be done in consultation with the project's DPO.

A Miro collaboration board where this process is captured is available in figure 9.

Figure 9 - Snapshot of the MIRO Collaboration dashboard regarding the flowchart of expression of interest. Original can be found here.



5. Conclusion

The Pilot Operations Plan defines useful guidelines with key stages and recommendations for all pilots to successfully contribute towards **COMPAIR**s mission - increase societal engagement in the fight for clean air. This deliverable, part of WP2 summarises relevant work previously done throughout the groundwork together with freshly collected input from all the pilot partners to define the next steps for both the closed, open and public rounds.

With this document we established useful guidelines and recommendations for all **COMPAIR** pilots, to align with **COMPAIR**'s vision, mission and overarching objectives. We present a detailed account on milestones reached, challenges and useful recommendations to overcome them, both general and pilot specific. Together with the pilot partners we defined the next milestones to reach as we move forward to the next rounds. These focused mainly on training, sensor matching, engagement events and awareness raising, among others.

Importantly, we found the preparation of this deliverable a successful exercise of fostering pilot cross communication. This communication among pilots has been active since the beginning of the project with biweekly meetings where pilots share with each other their milestones, successes and challenges. Given its importance we devoted a specific section (4.5) on this very topic highlighting current effort to foster cross communication between pilots together with recommendations of further actions aiming at strengthening it throughout the project. An important exercise developed as part of this section is the mismatch table (Figure 8). This table gives us a clear overview of the actions that are not part of every pilot and provides an opportunity for pilots to consider their own action plan and ways of improving it. In addition, as a way to ensure the aims and recommendations identified/developed as part of this deliverable are achieved, we commit to discuss it and analyse it often in our regular pilot meetings. We will update, whenever needed, our action tables and KPIs and will strive to overcome our challenges through co-creative processes. The tables presented in this deliverable will continue to be relevant as living documents where pilot leaders can expand on their planned/achieved milestones.

A key aim of **COMPAIR** is the engagement of lower SES groups. This is an important goal defined in our GA and further developed on D9.2 where we state our commitment of each pilot ensuring ⅓ of their citizen science participants from lower SES groups. This means as a consortium we need to work together in definitions, engagement strategies and ethical considerations whether referred to in the GDPR or not. Section 3 is devoted to this topic where a set of recommendations targeted at this very important goal were developed. These focus on efforts to better define what we mean and who we need to involve to make that a reality. We also state the need and intention to put in the effort to learn as a consortium the necessary skills to successfully carry out our plan.

As we move forward in **COMPAIR** and in citizen science projects, we realise how important it is to follow certain guidelines that ensure CS practitioners take responsibility for moral and ethical concerns and do not put in place activities that accidentally exclude parts of society. The 10 principles of citizen (ECSA 2015) science co-created by ECSA and colleagues exist precisely for this and this is why we think in the future all citizen science projects should read and internalise them already during the proposal writing phases. The 10

principles of citizen science are not a checklist, but rather a code of conduct that helps us remain reliable and accountable. Furthermore they also provide a useful mindset when working towards not only achieving but maintaining high engagement.

Furthermore **COMPAIR** is explicitly and actively trying to reach all SES. Ensuring a fair representation of society is ever more important if we truly want to contribute to the improvement of existing policies and regulations. This is a challenge in itself, engaging diverse audiences and ensuring everyone can participate is very time consuming and takes a lot of effort.

With the recommendations offered in this deliverable we aim to build a collective mind-set in boldly going forward with the workload and tackling these challenges. We are certain that we will set the stage for current and future European CS projects, especially reaching those that traditionally are “hard(er)” to reach. This should serve as inspiration to all citizen science projects as we move forward to more democratised and inclusive science.

COMPAIR pilots have a unique opportunity to impact everyone's current view of how they affect and are affected by air quality and all the local policies around it. As a consortium we have mapped existing local and global initiatives, we have mapped the existing contribution of CS in policy recommendations and have set for ourselves an ambition goal for generating democratic and inclusive solutions for improving air quality. We are committed to sharing both our challenges and our successes openly as we move forward and both contribute to this important conversation with the CS community and build upon these in all our future projects.

6. References

Amt für Statistik. (2020, February). Einwohnerinnen und Einwohner im Land Berlin am 31. Dezember 2019 [Statistischer Bericht] https://download.statistik-berlin-brandenburg.de/3d9a920b0980bd0f/01f3c6a853b2/SB_A01-05-00_2019h02_BE.pdf

ECSA European Citizen Science Association (2015). Ten Principles of Citizen Science.

Education in Flanders

https://www.onderwijs.vlaanderen.be/en/node/1028

Ethnic groups and languages, statistics Flanders

https://www.britannica.com/place/Belgium/Ethnic-groups-and-languages

Population below the poverty threshold, Britannica

https://www.vlaanderen.be/en/statistics-flanders/income-and-poverty/population-below-the-poverty-threshold

Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin, Referat Freiraumplanung und Stadtgrün. (2021, December 31). Anteil öffentlicher Grünflächen in Berlin. [Statistischer Bericht] https://www.berlin.de/sen/uvk/suche.php?q=Bericht+Nr.+05+B

Statistics about Greece population, hellenic Statistical Authority

https://www.statistics.gr/en/home