COMPAIR

DELIVERABLE

D6.2 Pathways to Behavioural Change

Project Acronym:	**COMPAIR**	
Project title:	Community Observation Measurement & Participation in AIR Science	
Grant Agreement No.	101036563	
Website:	www.wecompair.eu	
Version:	1.0	
Date:	05/09/2024	
Responsible Partner:	M21 > TELR	
Contributing Partners:	VMM ECSA SDA	
Reviewers:	Gitte Kragh Joep Crompvoets Andrew Stott	
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	Organization	Description
0.1	27/02/2024	Wouter F.	TELR	Initial structure
0.2	5/7/2024	Kris V.	TELR	Expanded structure - initial content
0.3	12/8/2024	Kris V. & Wouter F.	TELR	Completed content for chapters ⇒ first draft final
0.4	19/8/2024	Aouefa Amoussouvi	ECSA	Internal review
0.5	21/8/2024	Desislava Todorova	SDA	Internal review
0.6	21/8/2024	Celien Van Gorp	VMM	Internal review
0.7	21/8/2024	Kris Vanherle	TELR	Version for review by external reviewers
1.0	05/9/2024	Kris Vanherle	TELR	Final version

COMPAIR

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List of Abbreviations

Abbreviation	Definition
CS	Citizen Science
ECSA	European Citizen Science Association
NO2	Nitrogen Dioxide
PM	Particulate Matter
PMD	Policy Monitoring Dashboard
VMM	Vlaamse Milieumaatschappij (Flemish Environment Agency)

Executive Summary

The COMPAIR project was, among other goals, developed to explore how citizen science (CS) can influence behavioral change and drive sustainable decision-making in response to pressing environmental challenges, such as air quality deterioration and climate change. The project is motivated by the growing need for community-driven initiatives that not only raise awareness about environmental issues but also empower individuals to take meaningful action. In an era where technology trends are favorable for citizen science and awareness about climate and health are high, COMPAIR aims to bridge the gap between citizen involvement and effective environmental stewardship.

The central purpose of this deliverable in COMPAIR is to assess whether and how active citizen participation in environmental data collection can lead to significant shifts in attitudes and behaviors towards sustainability. The project addresses the problem of insufficient public engagement in environmental issues, where a lack of personal connection to the data often leads to apathy or resistance to change. By involving citizens directly in the monitoring and analysis of environmental factors, COMPAIR seeks to foster a deeper understanding and a stronger commitment to sustainable practices.

We employed a multi-faceted approach, involving various pilot activities across different European regions, as summarized in project deliverables related to WP5 (most notably D5.6: the open round report). These activities were designed to engage citizens in the hands-on collection of environmental data, particularly focusing on air quality. The question this deliverable addresses in particular, is **if indeed we have identified pathways to behavioral change**. We used an eight-phase evaluation framework, also used in other aspects of the project, to systematically measure the impact of these activities on participants' attitudes and behaviors. Key components of the approach included the use of mobile air quality sensors, community discussions, and comparative data analysis.

We find that citizen science can indeed be a powerful catalyst for behavioral change. Participants who were actively involved in data collection demonstrated a greater awareness of environmental issues and were more likely to alter their behaviors, such as reducing car use or supporting local environmental policies. The data generated by the citizens themselves proved to be a crucial element in building trust and driving action. The project also revealed that community involvement and ownership of the process are vital for sustaining long-term engagement and ensuring that the changes in behavior persist beyond the project's duration.

COMPAIR concludes that empowering citizens through science not only enhances their understanding of environmental issues but also motivates them to adopt more sustainable practices. The project recommends that future initiatives continue to focus on community-driven approaches, ensuring that participants have a strong sense of ownership over the data and outcomes. Additionally, the findings suggest that integrating citizen science into broader environmental strategies can significantly amplify the impact of such efforts. Moving forward, it is essential to build on the momentum generated by COMPAIR, expanding its methods and frameworks to other regions and environmental challenges, thereby contributing to a more engaged and environmentally responsible society.

1. Introduction

This deliverable is the result of task 6.2 of the COMPAIR project and is one of the evaluation outputs of the project, along with D6.3 “Pathways to Citizen-driven Environmental Impact”, D6.4 “Key Messages for Environmental Policy Impact”, D7.3 “Citizen Science and its Potential to Policy Ready Data” and D7.4 “Recommendations for new CS tactics in the CS scientific agenda”.

While the scope of the evaluation is broad, this particular deliverable’s aim is to investigate if the project has been able to identify successful pathways to behavioral change; what approaches did work to reach the public and what activities were successful in creating behavioral change.

Specifically for the purpose of the identification of pathways to behavioral change, as a method, we chose interviews with project members. In particular the pilot leads reflected on their activities in the COMPAIR pilot activities to understand if behavior change was observed and what exactly were the enabling factors. In these interviews, members report on their experiences in a structured format, with the discourse analyzed descriptively to gain insights. While these findings have been used throughout the project, in the subsequent pilot activities (in T5.3 and T5.4) to achieve incremental gains with each iteration of experiments, the purpose of this particular deliverable is to reflect on all the activities in COMPAIR, in the context of behavioral change.

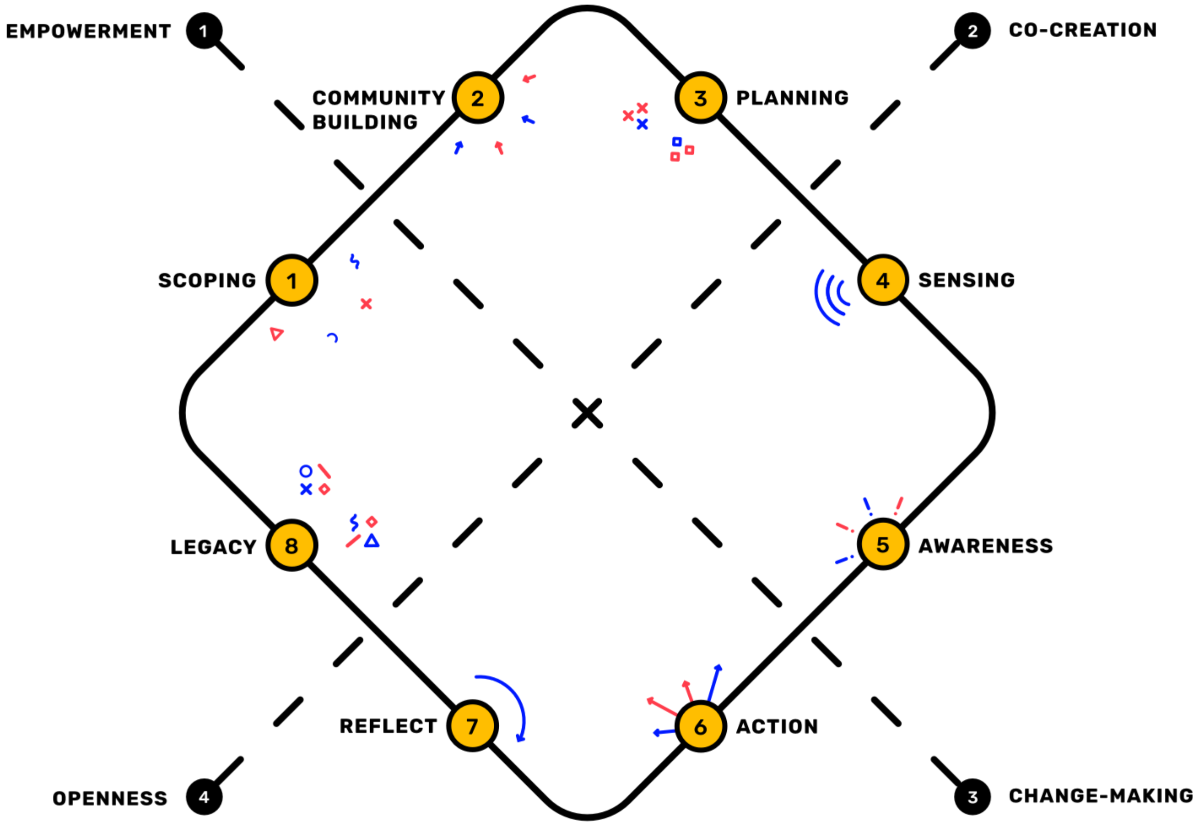
Many approaches to citizen science activities have been tested in the project, but the central component in all pilot activities has been involving citizens in measurement campaigns that expose them to their personal exposure to air pollution and climate change and providing them tools to see the effect of behavioral changes. Citizens are expected to more likely change their behavior (e.g., modal shift, lower energy usage) for the benefit of their health and the environment[1]. Furthermore, as we’ve learned from at least one pilot activity in COMPAIR (the Herzele schoolstreet), citizens understand better the rationale behind certain policy measures, leading to broader support for these measures.

This deliverable consolidates all findings in a comprehensive behavioral impact assessment and participatory impact assessment, scoring and ranking the various strategies and approaches used in COMPAIR’s pilots.

[1] For example:
https://www.undp.org/sites/g/files/zskgke326/files/2023-10/colab_2023_reporte_experimentacion_cc_eng.pdf
https://www.sciencedirect.com/science/article/pii/S0048733320300585

2. Methodology

Throughout the project, COMPAIR has used the citizen sensing framework[2] below to execute citizen science activities in the pilots.



Conversely, we build the evaluation around these phases and formulate questions for each phase, in the scope of its relevance for fostering behavioral change. We're targeting the project members who were involved in the pilot activities as interviewees. These project members were closest to the actual citizen science activities and are best placed to report on the outcomes regarding behavioral change. Most reported descriptive results. In a few cases, quantitative data was available. An extensive report, including detailed results on the pilot activities are summarized in the Open Round report (D5.4) and the Public Round report (5.6).

In this section, we describe the focus of the interviews and key questions to be answered and what we expected to learn from these.

[2] https://docs.smartcitizen.me/Resources/Citizen%20Sensing%20Toolkit/

Phase 1: Scoping

Objective: To assess how effectively the opportunity or problem was identified and scoped.

Evaluation Questions:

- How was the initial opportunity or problem detected?
- What methods were used to determine the scope of the project?
- Who was involved in the scoping process?

Expectations:

In this phase, we expect to see a well-documented and inclusive process for detecting the initial opportunity or problem. Documentation, meeting minutes, and initial surveys or interviews should provide a clear picture of the methods used to identify and define the project's scope. Key stakeholders (project initiators, community leaders, experts) should be actively involved, providing diverse perspectives and insights. The process should engage the community, motivating them to recognize the issue as important and laying the groundwork for collective action and awareness, which are crucial for behavioral change.

Phase 2: Community Building

Objective: To evaluate the strategies and effectiveness of community engagement.

Evaluation Questions:

- How did you engage your community?
- What strategies were employed to build and sustain community involvement?

Expectations:

We expect community-building efforts to be strategic and inclusive, using a variety of outreach materials and engagement strategies. Records should reflect active participation and sustained involvement from a diverse community. Surveys and interviews should indicate increased community awareness and engagement. The process should create a supportive environment that fosters a sense of ownership and responsibility among participants, encouraging behavioral change and long-term commitment to the project's goals.

Phase 3: Planning

Objective: To assess the involvement of the community in planning the experiments.

Evaluation Questions:

- How did you involve the community in planning experiments?
- What roles did community members play in the planning process?

Expectations:

In this phase, we expect to see detailed documentation of community involvement in planning, including meeting notes and collaborative plans. Participants should have clearly defined roles and contribute meaningfully to decision-making processes. Mechanisms for community input, such as forums or committees, should be in place and effective. The planning process should empower participants, fostering a sense of ownership and motivating them to actively shape the project's direction. Transparency and the incorporation of community feedback are key indicators of successful engagement and pathways to behavioral change.

Phase 4: Sensing

Objective: To evaluate the level of participant involvement in data collection and measurements.

Evaluation Questions:

- How involved were participants in measurements?
- What roles and responsibilities did participants have in the sensing activities?

Expectations:

We expect participants to be actively involved in data collection, with clear logs, data sheets, and sensor deployment records. Participants should receive adequate training and support, ensuring they are confident and capable in their roles. The quality and consistency of data collected should reflect high levels of engagement and accuracy. Challenges faced during this phase should be documented and addressed promptly, ensuring participants feel capable and motivated. Active involvement in data collection should positively influence participants' behavior and attitudes towards the project's goals.

Phase 5: Awareness

Objective: To measure the effectiveness of awareness-raising activities and their hands-on nature.

Evaluation Questions:

- How did you raise awareness?
- How hands-on was the awareness-raising process?

Expectations:

Awareness-raising activities should be well-documented, with materials and methods such as workshops, campaigns, and demonstrations effectively reaching and engaging the community. Attendance records and participant feedback should indicate high levels of participation and impact. Surveys or focus groups should show measurable changes in knowledge and attitudes. Hands-on activities should actively involve participants, enhancing their understanding and fostering a deeper connection to the project. These activities should motivate participants to adopt new behaviors and practices aligned with the project's goals.

Phase 6: Action

Objective: To evaluate community involvement in defining and taking actions based on the project's findings.

Evaluation Questions:

- How did you involve the community in defining or taking actions?
- What actions were taken, and how were they implemented?

Expectations:

We expect to see thorough documentation of the decision-making processes and action plans. Community members and project leaders should collaboratively define actions, with clear evidence of inclusivity and transparency. Actions taken should reflect community input and be effectively implemented. Follow-up activities should measure the impact of these actions, showing evidence of successful implementation and sustained behavioral changes. The process should encourage participants to take concrete steps towards the project's goals and maintain long-term engagement.

Phase 7: Reflection

Objective: To assess the involvement of participants in interpreting and reflecting on the project data and outcomes.

Evaluation Questions:

- How involved were participants in interpretation?
- What processes were used for reflection and analysis?

Expectations:

Reflection sessions and data interpretation meetings should be well-documented, with active participation from the community. Participants should contribute meaningfully to interpreting data and reflecting on project outcomes. The methods used for collective analysis, such as workshops or discussion forums, should be effective in fostering critical thinking and self-assessment. Reflection should lead to a deeper understanding of the project's impact and inspire changes in direction or new research questions. This phase should demonstrate that participants are engaged in ongoing learning and critical evaluation, driving continuous improvement and behavioral change.

Phase 8: Legacy

Objective: To evaluate the potential for sparking additional experiments or follow-up actions and sustaining the project's impact.

Evaluation Questions:

- What options do you see to spark additional experiments?
- How can the project's legacy be sustained?

Expectations:

Plans and strategies for future projects or extensions should be well-defined and documented. Project leaders and participants should have a clear vision for sustaining the project's impact. Infrastructure and resources for continued community involvement and experimentation should be in place, such as ongoing training programs, access to equipment, or established networks. The project's legacy should include evidence of new initiatives inspired by the current project, ensuring sustained impact and clear pathways to future experiments. This phase should show that the project has established a lasting foundation for ongoing citizen science activities and behavioral change.

This eight-phase approach to a citizen science project centered around sensor technology, evaluation methodology is our “pole star” to evaluate the pilot activities. While this evaluation framework is overarching in nature, with the evaluation questions selected, we aim to narrow down to the identification of the pathways to behavioral change in particular.

The following section will dwell on the pilot performance evaluation.

3. Findings from the pilots

In this chapter, we undertake a cross-sectional evaluation of our pilot activities by systematically addressing each evaluation question outlined in Chapter 2, the methodology.

Answers to these questions were gathered from the project members directly involved in the pilot activities, ensuring an accurate reflection of their experiences and insights. By analyzing these responses, we aim to present a detailed understanding of the processes, engagement strategies, and outcomes for each specific use case.

The activities in the pilots themselves are extensively described in D5.4 (Open Round Report) and D5.6 (Public Round Report). The project members' feedback in this report unavoidably refer to specific activities they executed in their pilots (either Athens, Berlin, Flanders, Plovdiv or Sofia). For the full context of these replies, we refer to both other project deliverables.

All in all, we collected feedback from 15 project members, about 3 per pilot activity. Note that different team members were involved in the different activities in the pilots and responses were aggregated at the level of the pilot. In some cases, details of particular use cases are highlighted as examples. For clarity, in terms of terminology, we identify a "pilot" as one of the 5 cities/regions where citizen science activities were executed in context of the project. We use "use case" or "case" for specific activities within each pilot as there were multiple activities (up to 10) in each individual pilot..

Following this, Chapter 4 will shift to a longitudinal evaluation, where we will synthesize the findings from all pilot activities to identify overarching patterns and common themes. This analysis will focus on determining what aspects of the pilot activities were effective and which ones faced challenges. The insights derived from this comprehensive evaluation will serve as a foundation for the concluding sections, where we identify 5 pathways and will draw broader conclusions and offer recommendations based on the collective experiences and results of the pilots.

3.1 Athens

Q1: How was the initial opportunity or problem detected? What methods were used to determine the scope of the project?

The need for more localized air quality data in Athens was identified through the limitations of existing broad-level sensing stations, which highlighted the necessity for neighborhood and street-level measurements. This gap in data prompted the initiation of a pilot project aimed at addressing this deficiency and exploring citizen science in the city. Initially, the project focused on one area of Athens to test the feasibility of this approach.

Following the initial pilot, the project extended to another area of Athens, building on the citizen science community established in the first use case. This allowed for a broader application of the citizen science model and provided additional data to refine the approach.

Use Case 3 emerged from a recognized challenge in Athens's Climate Adaptation Plan, which identified stationary energy from buildings as a significant source of CO2 emissions. This use case was designed to involve citizens in understanding and mitigating their carbon footprints. By utilizing a CO2 calculator, the project aimed to increase awareness of daily activities' impact on carbon emissions and gauge public willingness to adopt various policies to achieve climate neutrality.

Q2: How did you engage your community? What strategies were employed to build and sustain community involvement?

Engagement strategies varied depending on the use case and target demographic.

For Use Case 1, the focus was on low Socio-Economic Status groups, particularly elderly citizens. Engagement was facilitated through "Friendship Clubs," which are community centers administered by the city with high participation rates among seniors. The approach involved on-site introductory meetings, workshops, and follow-up visits to ensure active participation. This method aimed to integrate seniors into the air quality monitoring process and build a supportive community around the project.

In Use Case 2, the community engagement approach mirrored that of Use Case 1, focusing on similar demographic groups and utilizing comparable methods to foster participation and maintain involvement.

For Use Case 3, which targeted a broader audience, engagement was primarily driven through online communication channels. Social media campaigns were launched to reach citizens with basic IT literacy, including professionals and organizations involved in environmental and sustainability issues. This approach sought to involve a diverse group of stakeholders, including the Ministry of Environment, NGOs, and academic professionals, in using the CO2 calculator and contributing to climate policy discussions.

Q3: How did you involve the community in planning experiments? What roles did community members play in the planning process?

Community involvement in planning varied across use cases.

In Use Cases 1 and 2, community members participated in informative sessions and hands-on demonstrations of the sensors. Volunteers were actively involved in installing devices and assisting with the monitoring process. Personal contact and follow-up communication ensured that participants were well-informed and engaged throughout the project.

For Use Case 3, the planning process included two workshops during the preparatory phase, where community members provided feedback on the design and development of the CO2 calculator and associated tools. City officials also participated in these workshops, overseeing the planning and ensuring alignment with municipal goals.

Q4: How involved were participants in measurements? What roles and responsibilities did participants have in the sensing activities?

Participants' involvement in measurements was somewhat limited, particularly for seniors who found it challenging to engage with complex atmospheric data. Instead, they primarily interacted with the sensors through simple signal indicators.

In Use Cases 1 and 2, volunteers were responsible for installing the sensors outside their homes and maintaining them. The engagement level was high, with minimal drop-offs reported, indicating strong community interest and commitment.

For Use Case 3, the CO2 calculator was used by 173 individuals in Greece, with 83 creating accounts and 80 actively reporting their household carbon footprints. While the direct involvement in measurements was limited compared to other use cases, the tool's usage provided valuable data for analyzing public engagement with CO2 reduction efforts.

Q5: How did you raise awareness? How hands-on was the awareness-raising process?

Awareness-raising efforts varied across use cases, with different methods employed to engage the target audiences effectively.

For seniors, awareness was raised through educational sessions about the health impacts of poor air quality. Live demonstrations of the sensors near pollution sources, such as kitchens or cigarette smoke, helped illustrate the sensors' functionality and the effects of air pollution. This hands-on approach aimed to make the abstract concept of air quality more tangible for the elderly.

In Use Case 3, the CO2 calculator's awareness-raising efforts involved reaching out to groups already familiar with environmental issues and sustainability. Online campaigns and targeted communication with professionals and organizations in the field helped to disseminate information about the calculator and encourage its use. This approach aimed to engage a more tech-savvy audience and integrate them into broader climate policy discussions.

Q6: How did you involve the community in defining or taking actions? What actions were taken, and how were they implemented?

Community involvement in defining and taking actions was a key focus of the project.

In Use Cases 1 and 2, the plan was to engage senior citizens in actions related to air quality by informing them about their measurements and discussing potential actions with the municipality. This approach aimed to empower seniors to contribute to local air quality improvements through their involvement and suggestions.

Use Case 3 included a policy simulation tool in the CO2 calculator that allowed users to express their preferences for various climate policies. This feature enabled the community to indicate their willingness to support specific actions for CO2 reduction and contribute to the city's climate goals. Users' responses were used to inform policy development and measure public support for different strategies.

Q7: How involved were participants in interpretation? What processes were used for reflection and analysis?

The level of participant involvement in data interpretation varied by use case.

In Use Cases 1 and 2, elderly participants had limited involvement in interpreting complex data due to difficulties understanding detailed dashboards. However, they could interpret the simple color-coded signals from the sensors, which provided basic information about air quality levels.

For Use Case 3, the CO2 calculator included a reporting dashboard that allowed users to view and compare their data against municipal, national, and EU standards. This tool also enabled city officials to export reports and analyze data at various levels. The dashboard facilitated interpretation for both users and officials, supporting informed decision-making and public engagement in climate policies.

Q8: What options do you see to spark additional experiments? How can the project's legacy be sustained?

The innovative scope of citizen science in Athens offers opportunities for further experimentation. Future projects could explore alternative methodologies, such as involving municipal employees or schools in environmental measurements, or expanding the scope to measure other environmental factors.

Use Case 3, with its CO2 calculator, has the potential to inspire additional experiments by extending the calculation of CO2 emissions to various building types, including offices and commercial spaces. This expansion could broaden the impact of the project and contribute to ongoing efforts to reduce CO2 emissions and promote sustainability in Athens and beyond.

3.2 Berlin

Q1: How was the initial opportunity or problem detected? What methods were used to determine the scope of the project?

The initial opportunity for the project arose from the need to address gaps in Berlin's air quality monitoring network. While high-end air quality stations provided broad-level data, they left significant "blind spots" in between these fixed locations. To address this, the project aimed to gather localized data through mobile measurements. The mobile survey was designed to measure the air quality experienced by cyclists during their commutes, thereby filling the gaps between fixed sensors and simulating data where direct measurements were unavailable. The goal was not only to enhance the dataset but also to engage citizens in the process, raising their awareness about air quality and demonstrating actionable insights.

In addition to mobile measurements, static measurement campaigns were conducted in two distinct Berlin districts: Bellermannkiez and the Donau- and Flughafenkiez neighborhoods. The Bellermannkiez, known for its traffic-calming measures, was compared with the non-calm neighborhoods of Donau- and Flughafenkiez to assess the impact of traffic management on air quality and traffic flow. This part of the project sought to supplement sparse residential air data and evaluate the performance of inexpensive, often DIY, measuring devices. By involving residents directly, the project aimed to foster awareness of air quality and mobility issues while familiarizing them with technical measurement tools.

Q2: How did you engage your community? What strategies were employed to build and sustain community involvement?

Community engagement strategies varied between the mobile and static measurement campaigns.

For the mobile measurements across Berlin, participants were recruited primarily through online channels. The project team connected with well-established initiatives focused on mobility, cycling, and sustainability, leveraging their social media platforms, newsletters, and mailing lists to attract participants. Regular communication through workshops and emails was maintained to keep participants engaged and motivated. This approach ensured a steady flow of information and support throughout the project, fostering a strong connection between the project and its participants.

In contrast, the static measurement campaign employed a more traditional, localized approach to community engagement. Flyers were distributed directly to residents in the target neighborhoods, and the project team reached out to local initiatives and published small articles in neighborhood newspapers. This grassroots approach aimed to establish a personal connection with residents and build support within the communities. Similar to the mobile campaign, workshops and email communications were used to involve participants and facilitate networking throughout the project.

Q3: How did you involve the community in planning experiments? What roles did community members play in the planning process?

In both the mobile and static measurement campaigns, community involvement in planning was crucial.

For the mobile measurements across Berlin, the research design was initially established, but participants played a significant role in refining the DEVA app and other technical tools used in the project. Their feedback was instrumental in adapting the app and measurement devices to better meet their needs, enhancing the functionality and usability of the tools. This iterative process ensured that the technology was aligned with participants' experiences and requirements, increasing their engagement and investment in the project.

Similarly, in the static measurement campaign, although the research design was set before the campaign began, participants provided valuable feedback on the technical devices used, such as the bcMeter soot measuring device. Their input helped address technical challenges and improved the overall research process. This involvement allowed participants to influence the experiment and contributed to the effectiveness of the measurement tools.

Q4: How involved were participants in measurements? What roles and responsibilities did participants have in the sensing activities?

Participant involvement varied between the mobile and static measurement campaigns.

In the mobile measurement campaign, participants were highly engaged, with 45 out of 57 initially recruited individuals actively measuring particulate matter during their commutes by the end of the project. This group was notably motivated and played an essential role in collecting data across different routes, providing a comprehensive view of air quality experienced by cyclists in Berlin.

In the static measurement campaign, 22 out of 31 participants continued their involvement throughout the project. However, technical issues with the soot measuring device led to frustration and reduced participation. Despite this, other devices, such as the Telraam traffic counter and the SODAQ fine dust sensor, performed well, and participants were able to contribute valuable data on air quality in their neighborhoods.

Q5: How did you raise awareness? How hands-on was the awareness-raising process?

Awareness-raising strategies were implemented through various methods in both campaigns.

For the mobile measurements, awareness was heightened through workshops where results were presented, and direct exchanges with participants took place. A final panel discussion involved practical actors such as administrators and local initiatives, providing participants with actionable insights and tools to address air pollution. This hands-on approach helped participants understand the implications of the data and encouraged them to engage in air quality and mobility issues actively.

In the static measurement campaign, awareness-raising efforts were similar, involving workshops and direct communication with participants. The aim was to ensure that residents understood the impact of traffic management on air quality and could apply the knowledge gained to their daily lives.

Q6: How did you involve the community in defining or taking actions? What actions were taken, and how were they implemented?

Community involvement in defining and taking actions was a key focus of both measurement campaigns.

For the mobile measurements, interim and final workshops provided a platform for participants to explore ways and tools to become active in air pollution control and sustainable mobility. These sessions facilitated discussions on actionable steps participants could take and encouraged them to implement these strategies in their communities.

In the static measurement campaign, similar methods were used to involve residents in defining actions. Workshops and direct interactions helped residents understand the data and consider how they could influence local air quality and traffic management strategies.

Q7: How involved were participants in interpretation? What processes were used for reflection and analysis?

Participant involvement in data interpretation varied between the campaigns.

In the mobile measurement campaign, participants played a crucial role in interpreting the data. Their feedback was essential in understanding the context of the measurements, such as high fine dust levels near barbecue areas or highways. The color-coded LED lights on the sensors provided immediate feedback on air quality, aiding in data interpretation and making it more accessible for participants.

In the static measurement campaign, participants also contributed to data interpretation, though their involvement was less direct due to the nature of the static setup. Residents occasionally provided anecdotal insights, such as noting higher fine dust levels near construction sites or barbecues, which complemented the quantitative data collected.

Q8: What options do you see to spark additional experiments? How can the project's legacy be sustained?

To spark additional experiments and sustain the project's legacy, several approaches can be considered.

For the mobile measurements, future citizen science projects should collaborate closely with local administration and initiatives from the start. This collaboration will help create research designs and datasets that are valuable for policy-making and ensure high impact and relevance. Leveraging the strong interest in mobile measurements can drive further experimentation and engagement.

Similarly, in the static measurement campaign, working with local administration and initiatives is crucial for generating useful data. Investing time in mobilizing residents and reaching diverse social groups will enhance the project's effectiveness and sustainability. By building on the existing interest and involvement, the project can continue to influence air quality and traffic management practices in Berlin.

3.3 Flanders

Q1: How was the initial opportunity or problem detected? What methods were used to determine the scope of the project?

This was addressed in multiple ways. 4 examples below:

- **Case Herzele**: The opportunity was identified when SOLVA, a local intermunicipal agency, sought a data-driven solution to improve traffic safety and health. Leveraging prior experience from the EU PoliVisu project, we proposed a school street initiative.

Through desk research conducted by a knowledgeable SOLVA volunteer, potential locations were identified across three municipalities. The first municipality contacted quickly agreed to pilot the initiative, involving three schools to refine the project's scope.

- **Case Mobile school measurements**: The opportunity emerged while searching for a school to study the impact of policy measures like those in Herzele and Ghent. Simultaneously, we received an inquiry from Geel University of Applied Sciences to provide air quality insights to their life sciences master's students, presenting a dual opportunity for research and educational outreach.
- **Case Validation Telraam Gent**: The opportunity was detected through ongoing collaboration with Ghent, where there was a demand from policymakers and citizens to evaluate the impact of planned circulation plans on traffic and air quality. By aligning with the implementation timeline, we focused on the Sint-Amandsberg-Dampoort district circulation plan, ensuring timely and relevant validation.
- **Case Winter Walk Hove**: The opportunity was identified when our VMM wood-burning expert, already interested in testing the SODAQ sensor's ability to detect wood burning, engaged with Hove's environmental council. The expert suggested conducting wood-burning walks with the council, linking community involvement with sensor performance evaluation.

Q2: How did you engage your community? What strategies were employed to build and sustain community involvement?

This was addressed in multiple ways. 4 examples below:

- **Case Herzele**: Community engagement was initiated through a structured stakeholder analysis, with the municipal government, schools, and SOLVA playing key roles. A public information campaign was launched using various communication channels, including direct letters to families and students, posters, and leaflets. A public meeting was held to address citizen concerns, which were documented and followed up. The community was further engaged through targeted communication with specific stakeholders like teachers and the municipal Climate Committee.
- **Case BC Meter**: Engagement efforts focused on identifying schools interested in participating in the project, with an emphasis on those with diverse socioeconomic backgrounds. Despite challenges due to high school workloads, participation was secured from one school in Herzele and one in Ghent, though no schools in Sint-Niklaas were willing to participate, highlighting the difficulties in sustaining community involvement under constrained conditions.
- **Case Telraam Validation Gent**: The community in Ghent was engaged by distributing a convocation letter inviting citizens to install TELR sensors. A workshop was organized to distribute the sensors and provide guidance. The locations for NO2 sensors were chosen collaboratively with Ghent's environmental officer and VMM experts, ensuring a blend of community participation and expert input.
- **Case Mobility Plan Sint-Niklaas**: Initial community engagement involved sending out a convocation letter to recruit citizens for installing TELR sensors. Due to a poor response, a more direct approach was taken, with DV and VMM colleagues personally visiting bus stops and going door-to-door to encourage participation. The

NO2 sensor locations were selected through collaboration between the city's environmental officer and VMM experts, combining grassroots engagement with professional guidance.

Q3: How did you involve the community in planning experiments? What roles did community members play in the planning process?

For this part of the process, for the Flander pilot, we focus on the different approach taken in different schools:

- **Sint-Paulus Instituut**: The community was actively involved by allowing students to design their own experiments using the SODAQ sensor. Students were tasked with taking measurements on their route from home to school and could choose from four different experiments—source research, building their own PM (Particulate Matter) sensor, creating a wood-burning map of a chosen neighborhood, or identifying the cleanest route to school. This approach empowered students to take an active role in planning and executing the experiments.
- **The Krekel**: Teachers at The Krekel took the lead in selecting activities from the JOAQUIN educational package[3], deciding which aspects of air quality to teach and which experiments to conduct. Students followed a structured measurement plan: using the SODAQ sensor to take readings from home to school, discussing the data in class, recording results in a logbook, and recharging the sensor for evening measurements. After a week of data collection, the results were reviewed and evaluated in collaboration with the VMM. Additionally, a walk around the school, organized by VMM at the teachers' request, further involved the community in the experiment.
- **Students from HoGeel & University of Leuven**: University students were given the SODAQ sensor for approximately three weeks, with the freedom to choose their own routes for data collection using the DEVA app and DEVD dashboard. After collecting the data, they participated in discussions with VMM to analyze the results and explore the tools available, ensuring that they played an integral role in both planning and executing the experiments. The students also tested COMPAIR's tools and gave their suggestions for improvements. These have been transferred to the team working on these tools within COMPAIR.

In most cases, citizens & students were involved in the timing & site selection of sensor measurement campaigns. For the Herzele case, the implementation of the school street was planned during coordination meetings with the municipal government, SOLVA, and the three participating schools. These key stakeholders made the decisions collaboratively. All other participants were informed of the planning details afterward. Finally we performed specific co-innovation activities with citizen scientists who participated in the Herzele case to further develop a sensor (bcMeter). Citizens provided feedback on the device throughout the first campaign, discussed the developments during a workshop, worked on their own improvements (e.g. 3D printed case), tested devices once more and provided their final recommendations in a workshop again.

[3] https://www.vmm.be/tips/joaquin_edupack_vl_v02_tw.pdf/view

Q4: How involved were participants in measurements? What roles and responsibilities did participants have in the sensing activities?

This is the core element of COMPAIR: involving citizens in the measurements directly. COMPAIR used multiple sensors, yet ALL required self-installation by citizens. For Flanders, in particular:

- **Herzele**: While the planning of the school street implementation was decided in coordination meetings with the municipal government, SOLVA, and the three participating schools, other participants were informed of the plans rather than directly involved in the decision-making process. However, all participants ran the sensors on their own and reported issues which - mainly in the case of bcMeter - they tried to fix together with technical experts.
- **Sint-Paulus Instituut**: Students played an active role in the measurements by using the SODAQ sensor on their routes from home to school. They were responsible for designing and conducting their own experiments, choosing from options such as source research, building their own PM sensor, mapping wood-burning in a neighborhood, or identifying the cleanest route to school.
- **The Krekel**: Teachers selected air quality experiments from the JOAQuin educational package and provided students with a clear measurement plan. Students were responsible for taking measurements with the SODAQ sensor, discussing results in class (a daily morning activity), logging data, logging special events in a logbook (for example, a lot of rain, dropping a sensor, etc), recharging the sensor, and repeating measurements. The data collected over a week was then analyzed with the VMM, and a follow-up walk was organized at the teachers' request. The VMM also performs field excursions with them in the vicinity of the school with a sensor. This ensured students who could not take a sensor home for the school-home route for privacy reasons could also take measurements with the sensor themselves.
- **Students from HoGeel & University of Leuven**: University students were highly involved, using the SODAQ sensor for three weeks and selecting their own routes for measurement with the DEVA app and DEVD dashboard. They were responsible for data collection and analysis, with results and VMM tools discussed collaboratively afterward.
- In all cases where **Telraam** sensors were used, participants were responsible for self-installing the sensor and in some cases provided manual validation counts (Ghent).

Q5: How did you raise awareness? How hands-on was the awareness-raising process?

To raise awareness about air quality, traffic, and the implementation of the school street, a comprehensive, hands-on approach was employed, involving multiple stages and communication channels. The process began with a public information campaign seven months before the action, using municipal communication channels, direct letters to families and students, and widespread distribution of posters and leaflets. A public meeting followed six months before implementation, and a press event was held two months before, coinciding with the launch of Telraam sensors. A workshop on air quality was organized just before the launch of the school street, during which devices were also distributed. This workshop covered air quality, typical sources and actionable insights on the individual level.

As the school street was installed, community events and education sessions for students were conducted to deepen understanding. Intermediate results were discussed at a "School Street Café" event, where citizens, scientists, and policymakers interacted, with findings published in the municipal newsletter. Finally, a public survey and presentation of the final results with recommendations were shared with all involved parties. Specifically in the schools:

- At **Sint-Paulus Instituut**, awareness was raised through a series of educational sessions led by teachers and VMM, where students learned about air quality and conducted their own measurement projects using the SODAQ sensor. The process was highly interactive, with students presenting their findings and suggesting improvements.
- At **The Krekel**, awareness was similarly hands-on, with students engaging in air quality experiments, a real-time demonstration using the SODAQ sensor, and a walk to observe dynamic air quality changes. The week culminated in a workshop where students created posters to present their findings.
- For **students from HoGeel and the University of Leuven**, the process involved using the VMM tools for measurement and analysis, with a focus on discussing the results and providing feedback for tool improvement.

Q6: How did you involve the community in defining or taking actions? What actions were taken, and how were they implemented?

In **Herzele**, the community was actively involved in defining and taking actions through a structured follow-up process. After addressing concerns raised at the public kick-off meeting, the project team implemented several measures: six individual Policy Monitoring Dashboards were created to track traffic in specific streets, SOLVA counted parked cars before and during the action to assess parking pressure, and traffic jams during rush hours were monitored on Graaf du Parclaan. Citizens were able to provide remaining challenges and solutions either directly during the data café or indirectly through a survey. These observations, along with citizen feedback, were documented in reports and presented to the municipal government, the principal school, the local police, and discussed with the community at events like the school street café and via video calls. This process resulted in a proposition to implement flanking measures to mitigate unwanted side-effects of the school street implementation.

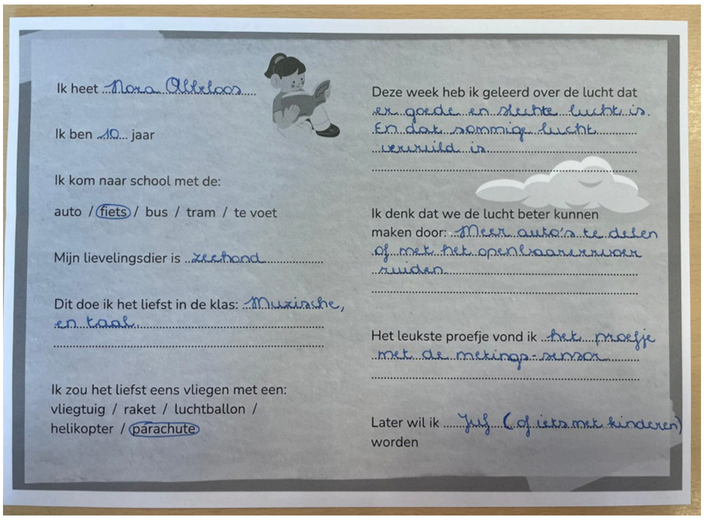
At the **schools**, students participated by discussing the measurement results and proposing tool improvements, which were communicated to the IT team. Students also engaged in discussions, either live or through surveys, about personal actions they could take to enhance air quality.

Q7: How involved were participants in interpretation? What processes were used for reflection and analysis?

Participants were actively involved in the interpretation of the results through surveys and reflection processes. Throughout the experiments we applied a LEARN-DO-REFLECT approach to stimulate reflecting on the experiments, results, solutions and behavior. At **Sint-Paulus Institute**, surveys conducted before and after the project revealed a 20%

decrease in car use and a 7% increase in the use of active and collective transport modes due to this approach, independent of any effect stemming from the school street itself.. Additionally, there was a 71% increase in the number of behavioral actions reported to improve air quality. These results demonstrate that the learn-do-reflect approach helps in reinforcing behavioral change and increase the actionable options perceived by participants.

At **The Krekel**, teachers conducted a post-project survey and observed heightened awareness among students about air quality issues, further amplified by media coverage and additional educational activities. The school incorporated the project into its curriculum, including guest lectures on environmental topics.



For **students from HoGeel & University of Leuven**, the before-and-after survey yielded limited results, mainly because the group of participants was small (n=6) and the location of the school was poorly connected to alternative modes of transport. However, the students extended their use of the SODAQ sensor to explore additional routes, driven by their interest in further data collection.

Q8: What options do you see to spark additional experiments? How can the project's legacy be sustained?

Schools have shown significant enthusiasm for using SODAQ sensors, initiating their own measurement campaigns. COMPAIR's supporting material (D5.1) has proven ready-to-use by teachers, facilitating the LEARN-DO-REFLECT approach. For instance, **Sint-Paulus** Institute proactively engaged with its students and environmental council to set up an additional measurement campaign tracking the route from school to home. This initiative underscores the schools' eagerness to participate in air quality monitoring and use the data collected for educational purposes.

Additionally, the impact of the Karrewiet report at The **Krekel** generated considerable interest, creating a ripple effect across other schools and communication channels. This increased awareness has led to further inquiries about what the VMM can offer regarding air quality management, reflecting the broader community's growing engagement and demand for involvement in air quality initiatives. All involved schools have explicitly asked COMPAIR to support them in further implementing these elements after the project's end.

3.4 Plovdiv

Q1: How was the initial opportunity or problem detected? What methods were used to determine the scope of the use case?

Primary School Dimitar Talev: The problem of traffic-induced air pollution was identified around Primary School Dimitar Talev, which lacked official air quality (AQ) monitoring. To address this, a mobile laboratory was set up in the schoolyard to measure nitrogen dioxide (NO2) and particulate matter (PM10). Additionally, Telraam v1 traffic sensors and DIY sensors were installed in a classroom to gather data. The scope of the use case included organizing workshops for students on air quality topics and providing hands-on experience with the mobile laboratory.

Primary School Vasil Levski: For Primary School Vasil Levski, the focus was on raising awareness about traffic impacts on air pollution and seasonal variations of PM10. This use case involved working with volunteers who installed DIY PM10 sensors around the school. The presence of an official AQ station provided additional data, enriching the study.

Q2: How did you engage your community? What strategies were employed to build and sustain community involvement?

Primary School Dimitar Talev: The engagement strategy involved collaboration with the municipality of Plovdiv. The deputy mayor of Ecology and the deputy mayor of Education signed an invitation letter to the school director, who then selected a 5th-grade class for the experiments. This top-down approach ensured that the school administration was on board and that students would actively participate in the initiative.

Primary School Vasil Levski: The engagement strategy for Primary School Vasil Levski focused on recruiting volunteers, particularly from low-income households and the elderly. This approach aimed to include diverse community members, enhancing the project's reach and impact. Volunteers were selected through outreach and engagement efforts.

Q3: How did you involve the community in planning experiments? What roles did community members play in the planning process?

Primary School Dimitar Talev: Students were actively involved in the experimentation process by regularly checking data from the sensors. Workshops (WS) were tailored to the subjects studied, and the results were discussed in these workshops. Students and teachers provided suggestions and feedback, making them integral to the planning and adjustment of the experiments.

Primary School Vasil Levski: Involvement in planning included organizing workshops to present results and gather suggestions. Volunteers and stakeholders were engaged in discussions about data analysis and improvement measures. This participatory approach ensured that the community had a say in shaping the outcomes and actions.

Q4: How involved were participants in measurements? What roles and responsibilities did participants have in the sensing activities?

Primary School Dimitar Talev: Students were responsible for regularly checking data from the installed sensors and participating in workshops related to air quality. Their involvement provided practical experience with data collection and analysis, aligning with their studies.

Primary School Vasil Levski: While specific details on participant roles in measurements were not provided, volunteers and stakeholders were involved in data analysis and feedback processes. This involvement likely included assisting with the DIY sensor installation and interpreting results from the AQ station and PM10 sensors.

Q5: How did you raise awareness? How hands-on was the awareness-raising process?

Primary School Dimitar Talev: Awareness was raised through a series of workshops:

- **Students:** Workshops introduced air quality topics, discussed the current AQ situation in Plovdiv, and presented measurement results.
- **Stakeholders:** Dissemination of activities and results through local media and public presentations increased visibility. These efforts were hands-on, with direct engagement of students and dissemination through media.

Primary School Vasil Levski: The awareness-raising approach included:

- Workshops with volunteers and stakeholders to present data analysis.
- Introduction of tools like the PMD (Policy Monitoring Dashboard) and CO2 calculator.
- Collecting feedback and promoting sustainable actions. This process was interactive and involved direct participation from the community in evaluating and discussing results.

Q6: How did you involve the community in defining or taking actions? What actions were taken, and how were they implemented?

Primary School Dimitar Talev: Actions were defined through workshops and discussions with students and school staff. Suggestions from these discussions helped shape the direction of the initiative and potential improvements.

Primary School Vasil Levski: Actions were defined through workshops with volunteers and the collection of suggestions via a Google form. This approach facilitated community input into air quality improvements and helped integrate feedback into the project's implementation.

Q7: How involved were participants in interpretation? What processes were used for reflection and analysis?

Primary School Dimitar Talev: Students were involved in interpreting results through workshops where data was presented and explained. This process allowed students to understand and reflect on the data, contributing to their learning experience.

Primary School Vasil Levski: Participants, including volunteers and stakeholders, were involved in interpreting results and suggesting actions. Workshops facilitated discussions on data findings, and feedback was gathered to promote further actions and improvements.

Q8: What options do you see to spark additional experiments? How can the use case's legacy be sustained?

Primary School Dimitar Talev: To sustain and expand the use case, teachers were trained to assemble DIY sensors and use them in future workshops. This ongoing capability allows the school to continue education on air quality and sensor usage with other classes. Additionally, presentations and results can be leveraged for future educational purposes.

Primary School Vasil Levski: Volunteers can participate in other citizen science projects, extending the impact of their involvement. This continued engagement helps maintain interest and involvement in environmental monitoring and community science initiatives.

In summary, both use cases effectively engaged their communities through targeted strategies, hands-on activities, and active participation in data collection and interpretation. These efforts not only raised awareness but also provided mechanisms for ongoing involvement and future experiments.

3.5 Sofia

Q1: How was the initial opportunity or problem detected? What methods were used to determine the scope of the use case?

The initial opportunities for the use cases were identified based on specific needs related to air quality, traffic management, and sustainability in Sofia:

1. **School Bus Service Use Case:** This use case aimed to address air quality issues and traffic congestion around schools. The scope was determined by selecting two major schools in Sofia and designing bus routes based on addresses provided by parents of students in grades 1 through 4. This approach sought to reduce traffic and improve air quality by providing a dedicated bus service for school commutes.
2. **Kindergarten Air Quality Use Case:** The focus was on measuring indoor air quality in a kindergarten, with the goal of installing window meshes to prevent particulate matter (PM) from entering classrooms. The scope involved evaluating indoor air quality and assessing potential improvements to protect children from outdoor pollutants and came as a need during the first workshop with stakeholders when Sofia pilot was defining the whole COMPAIR activities scope.
3. **CO2 Calculator Use Case:** This use case aimed to promote a CO2 Calculator and Dashboard to gather data on citizens' habits and willingness to adopt more sustainable practices. The goal was to collect insights that could inform city sustainability indicators and encourage more eco-friendly behaviors among the public. This case directly relates to the raising awareness campaign.
4. **Information Campaign Use Case:** The campaign aimed to raise public awareness about sustainable behaviors and encourage citizens to adopt more environmentally friendly habits. The scope involved educating the public and promoting actions that

could enhance overall sustainability in Sofia. It was an answer to the lack of visibility of many programs, measures and activities focused on sustainability of Sofia Municipality and its entities that are not very recognisable by the citizens. COMPAIR developed products were also included in the raising awareness campaign.

Q2: How did you engage your community? What strategies were employed to build and sustain community involvement?

Community engagement strategies were tailored to each use case:

1. **School Bus Service Use Case:** Engagement started with direct outreach to school administrations to secure their participation. A questionnaire was then sent to parents to gauge interest and collect data on addresses. Collaboration with Sofia Municipality's Transport Department led to the development of bus routes and a proposal for the City Council. Promotion included posters, flyers, surveys, and direct communication with parents and stakeholders in order to be in a constant and direct connection with the main stakeholders.
2. **Kindergarten Air Quality Use Case:** The team worked with the Digitalisation Department of Sofia Municipality, which had already installed the Canary air quality system. Engagement involved collaboration with kindergarten administration and teachers. However, due to budget constraints and election-related delays, the project was put on hold. Efforts focused on maintaining the sensors and keeping stakeholders informed.
3. **CO2 Calculator Use Case:** The calculator was promoted through social media, events, and stakeholder workshops and a following feedback form with questionnaire. These platforms and methods were used to demonstrate the tool's features, gather feedback, and encourage public and municipal engagement.
4. **Information Campaign Use Case:** The campaign aimed to increase public awareness about air quality and sustainable behaviors. Strategies included using various media channels like billboards, city lights and posters in the metro stations. The content and the distribution of the visuals was aligned with municipal plans to ensure coherent messaging. This was achieved via several private meetings and constant direct communication with the key decision makers in Sofia Municipality in order to validate and finalize the media campaign.

Q3: How did you involve the community in planning experiments? What roles did community members play in the planning process?

Community involvement in planning varied by use case:

1. **School Bus Service Use Case:** The community was involved by providing data and feedback during route planning. Parents and school administrators contributed with recommendations that were a starting point to discussions with the Transport Department in the process of decision-making. Their input also helped shape the final proposal presented to the City Council that aimed to prolong and expand the school bus service.
2. **Kindergarten Air Quality Use Case:** Community involvement included participation in meetings and sharing information about project goals and progress. Although the

project faced delays, ongoing communication kept stakeholders engaged in the planning process.

3. **CO2 Calculator Use Case:** Stakeholders provided feedback on the tool's functionalities through meetings, direct conversations and feedback form, which was then used to refine the tool and enhance its relevance for both the public and municipal officials.
4. **Information Campaign Use Case:** Experts from the PR team from the Environmental Division in Sofia Municipality, the Waste Department and the Urban Mobility Centre participated in defining campaign messages and ensuring alignment with municipal plans. Then focus groups tested and refined campaign messages to ensure effective communication.

Q4: How involved were participants in measurements? What roles and responsibilities did participants have in the sensing activities?

Participant involvement in measurements varied:

1. **School Bus Service Use Case:** Participants, including students and parents, were involved in training and using DIY sensors. While some participants were prepared to use mobile sensors, technical issues limited this aspect. Participants provided feedback and data through surveys.
2. **Kindergarten Air Quality Use Case:** Kindergarten staff were responsible for monitoring the Canary system's alerts and managing indoor air quality by opening windows as needed. Children, being too young to understand the technical aspects, were less involved, though they showed enthusiasm for learning about air quality.
3. **CO2 Calculator Use Case:** Participants used the tool to voluntarily provide data about their habits. This data was used by city officials for policy development, but participants did not engage directly in measurement activities. Up to now the users of the dashboard are 314 individual visitors.
4. **Information Campaign Use Case:** Measurement involvement was not applicable as the focus was on raising awareness rather than collecting data.

Q5: How did you raise awareness? How hands-on was the awareness-raising process?

Awareness-raising efforts included:

1. **School Bus Service Use Case:** Awareness was raised through Air Quality Training for schools, DIY sensor workshops, and presentations of COMPAIR dashboards. The process was interactive, involving educational activities and discussions with students and parents.
2. **Kindergarten Air Quality Use Case:** Efforts included providing training materials and workshops on air quality. The project's suspension led to maintaining sensor operations and keeping stakeholders informed.
3. **CO2 Calculator Use Case:** Awareness was raised through social media, surveys, and ideathons. These activities were hands-on, involving public feedback on tool usage and features to encourage engagement.

4. **Information Campaign Use Case:** The campaign used calls to action and educational content to increase public awareness about individual environmental impacts and promote sustainable behaviors.

Q6: How did you involve the community in defining or taking actions? What actions were taken, and how were they implemented?

Community involvement in defining actions included:

1. **School Bus Service Use Case:** Community input was gathered through direct communication, surveys, and flyers. An ideathon at the end of the trial period involved parents, school staff, and municipal representatives in discussions about expanding and improving the service. Parents and all the other stakeholders shared their recommendations to the local authorities on how the school bus service can be further developed and optimized.
2. **Kindergarten Air Quality Use Case:** The community was informed about project plans through regular updates. Although the project was on hold, efforts were made to keep stakeholders engaged.
3. **CO2 Calculator Use Case:** The general public was encouraged to use the tool through promotional efforts. Every user was able to calculate its Carbon footprint and as the tool provides some recommendations for improvements in the everyday habits, users can implement them into their habits. As a simulation tool users were also able to indicate their preferences for policy measures on a municipal or government level. Feedback from users informed further development and application in municipal programs.
4. **Information Campaign Use Case:** Focus groups and stakeholder meetings ensured campaign messages were aligned with municipal plans and effectively addressed public concerns. Most of the visuals promoting sustainable living has a QR code that was calling to action the citizens to scan and learn more about the initiative, the program or the platform.

Q7: How involved were participants in interpretation? What processes were used for reflection and analysis?

Participant involvement in data interpretation varied:

1. **School Bus Service Use Case:** Participants provided feedback on their experiences with the bus service, including car usage and satisfaction levels. This feedback helped assess the service's effectiveness and identify improvements. It was quite satisfying and positive and also contained some suggestions for improvements. The final analysis was made by the SDA team and was summeried in a report submitted to the Transport Department of Sofia Municipality.
2. **Kindergarten Air Quality Use Case:** With only static sensors, participants were not involved in data interpretation. The focus was on monitoring sensor functionality.
3. **CO2 Calculator Use Case:** Users interpreted their own CO2 results from the calculator, gaining insights into their environmental impact and making personal adjustments based on the data.

4. **Information Campaign Use Case:** Data interpretation was not a focus, as the campaign aimed more at awareness and behavior change rather than data analysis.

Q8: What options do you see to spark additional experiments? How can the use case's legacy be sustained?

Opportunities for further experiments and sustaining the use cases include:

1. **School Bus Service Use Case:** Expanding the service to more schools and integrating it with the free public transport policy for children could further reduce traffic and improve safety. Positive feedback and continued community support could help sustain and grow the initiative. The SDA team is in contact and conversations with the policy makers to prolong the service and to work on a strategic level for scaling up the model.
2. **Kindergarten Air Quality Use Case:** Despite the project's suspension, future opportunities include enhancing educational efforts about air quality and implementing sensor systems in more institutions once funding is secured.
3. **CO2 Calculator Use Case:** The tool could be integrated into municipal programs, such as those for changing heating appliances. Continued promotion and user engagement can help sustain its impact.
4. **Information Campaign Use Case:** Future campaigns can build on existing approaches to raise awareness about new municipal policies and continue promoting sustainable behaviors among the public.

4. Summary of the pilots

In the previous chapter we provide an extensive exploration of the various pilot activities and how in each step they may have induced lasting behavioral change, drawing on extensive input from each initiative. This chapter is dedicated to a cross-sectional evaluation, providing a detailed summary of the successes and challenges encountered across all eight phases of each pilot. Our focus will be on assessing how these phases contributed to fostering behavioral change, offering insights into what strategies were effective and where improvements were needed.

In this chapter, we will systematically address each phase of the pilot activities, highlighting key achievements and areas for improvement. By collating and analyzing the feedback and data from the project members involved, we aim to present a clear picture of the impact and effectiveness of each pilot. This detailed overview will lay the groundwork for the subsequent chapter, where we will undertake a longitudinal evaluation to extract overarching conclusions and recommendations based on the collective experiences across all pilots.

PHASE	HITS	MISSES
Scoping	**Detection and Scope Determination in Various Locations:** Several successful projects demonstrated effective methods for detecting opportunities and determining the project scope. For example, in the case of Herzele, the initiative was successfully identified through SOLVA's need for data-driven traffic safety solutions, leading to a targeted pilot involving three schools. Similarly, in Athens, the project capitalized on the gap in localized air quality data, beginning with a pilot in one neighborhood and expanding based on initial findings. The approach included leveraging citizen science to enhance data collection and refine the project's scope, leading to broader implementation. **Effective Use of Localized Data and Citizen Engagement:** The Berlin project effectively addressed gaps in air quality monitoring by using mobile measurements and static campaigns to cover underserved areas. This approach not only filled data gaps but also engaged citizens directly, raising awareness about air quality issues.	**Challenges in Scope Expansion and Feasibility Testing:** Despite initial successes, some projects faced challenges in expanding their scope and testing feasibility. For instance, the Athens pilot projects, while initially successful, had to carefully manage the expansion to ensure the citizen science model could be effectively scaled and integrated into broader applications. Additionally, the CO2 Calculator project, though ambitious, had to contend with the complexity of measuring public willingness to adopt sustainable practices, which required ongoing refinement and engagement strategies. **Issues with Localized Air Quality Measurement and Data Integration:** In Berlin, while the mobile measurements aimed to fill gaps between fixed sensors, the challenge of integrating this localized data with existing high-end station data proved complex. Moreover, the projects around Primary Schools in Sofia faced difficulties in measuring the direct impact

	In Sofia, several use cases, such as the School Bus Service and Kindergarten Air Quality projects, demonstrated successful identification of needs and scope determination by addressing specific local issues, such as traffic congestion and indoor air quality, while promoting sustainability through CO2 calculators and public information campaigns.	of interventions due to variability in sensor accuracy and the challenges of correlating traffic management measures with air quality improvements. These issues highlighted the need for more robust data collection and integration methods to ensure comprehensive and actionable insights.
Community building	**Effective Engagement through Targeted Outreach:** Several projects demonstrated successful community engagement by tailoring their strategies to specific demographics. For instance, the "Friendship Clubs" approach in Use Case 1 in Athens effectively reached elderly citizens through community centers, combining introductory meetings, workshops, and follow-ups to build a supportive network. In Berlin, the mobile measurement campaign successfully attracted participants through established initiatives and online platforms, maintaining regular communication to keep participants engaged. This approach ensured a consistent connection and high participation levels. **Diverse and Innovative Strategies for Broad Engagement:** The use of diverse engagement strategies across different use cases showed notable successes. The Berlin static measurement campaign effectively used traditional methods like flyers and local newspaper articles to build personal connections with residents, while the Sofia projects utilized direct outreach, surveys, and stakeholder meetings to engage with schools, kindergartens, and the general public. The CO2 Calculator project in Sofia, with its focus on social media and events, successfully demonstrated the tool's features and gathered valuable feedback. These varied strategies helped build and sustain community involvement effectively across different contexts.	**Challenges in Sustaining Engagement:** Despite successful initial engagement, some activities faced difficulties in maintaining sustained community involvement. For instance, the Sofia Kindergarten Air Quality project was delayed due to budget constraints and election-related issues, which hindered ongoing engagement and project progress. Similarly, while the Berlin mobile campaign initially succeeded, the challenge of integrating feedback and maintaining participant motivation over time could impact long-term success. These issues highlight the need for ongoing support and contingency planning to address potential disruptions. **Ineffectiveness of Top-Down Approaches and Limited Outreach:** In some cases, top-down engagement strategies and limited outreach methods proved less effective. The engagement at Primary School Dimitar Talev, while involving municipal authorities, relied heavily on administrative decisions rather than grassroots involvement. This approach, while ensuring official support, might have limited broader community engagement. Additionally, the volunteer recruitment strategy at Primary School Vasil Levski, targeting low-income households and the elderly, faced challenges in effectively reaching and involving these groups. These issues emphasize the importance of balancing top-down and bottom-up strategies to ensure comprehensive and inclusive community engagement.

Planning	**Active Community Participation in Planning:** Community members engaged in informative sessions and hands-on demonstrations, with volunteers aiding in device installation and monitoring. This involvement ensured participants were well-informed and engaged throughout the project. In other examples, community feedback during workshops helped shape the CO2 calculator and tools, aligning the project with municipal goals while involving city officials. **Involvement in Technical Refinement and Feedback:** For Berlin's mobile and static measurement campaigns, community feedback was crucial. Participants helped refine the DEVA app and other tools, enhancing their functionality. In the static campaign, input on technical devices improved the research process. This involvement ensured that the tools met user needs and increased participant investment in the project.	**Challenges in Maintaining Engagement and Feedback:** In some cases, maintaining continuous community engagement was challenging. The Kindergarten Air Quality project faced delays due to budget issues, which affected ongoing stakeholder communication. Although the School Bus Service Use Case successfully involved parents and school administrators, it highlighted the need for continuous engagement to address potential disruptions. **Limited Impact of Top-Down Approaches:** The planning strategies at Primary School Dimitar Talev, while involving students and teachers, relied heavily on structured workshops and top-down communication. This approach, though effective, may have limited broader community involvement. Similarly, the involvement at Primary School Vasil Levski, focused on volunteers and stakeholders, faced challenges in ensuring comprehensive input and adapting to feedback effectively.
Sensing	**High Engagement in Sensor Installation and Maintenance:** Volunteers were actively involved in installing and maintaining sensors outside their homes, with Telraam, Sodaq or BCmeters, across all pilots. This is a definite success of COMPAIR as a whole. The hands-on role fostered strong community engagement, with minimal drop-offs, demonstrating commitment to the project. Similarly, in Berlin's mobile measurement campaign, participants played a crucial role in collecting data during their commutes, with a high level of engagement from those involved. **Active Participation in Data Collection and Analysis:** For Primary School Dimitar Talev, students were actively involved in monitoring data from sensors and	**Challenges with Technical Issues and Complexity:** In the static measurement campaign, technical issues with the soot measuring device led to frustration and reduced participation. In some pilot activities, seniors found it challenging to engage with complex atmospheric data, limiting their involvement to simple interactions with signal indicators. Similarly, the lack of connectivity of the LTE-M / NB-IoT network technology in Sofia affected the use of mobile sensors in the School Bus Service Use Case, impacting overall participation. **Limited Direct Measurement Involvement:** While the CO2 calculator was used by many individuals, direct involvement in measurements was limited. Participants mainly reported their

	participating in related workshops, which provided practical experience in data collection. In the static measurement campaign, despite some technical issues, participants contributed valuable data on air quality in their neighborhoods, showing resilience and commitment to the project's goals.	carbon footprints rather than engaging in physical measurement activities. In the Kindergarten Air Quality Use Case, staff managed air quality alerts but children were not involved in the technical aspects, limiting their role to a more passive engagement.
Awareness	**Effective Hands-On Demonstrations:** For seniors, educational sessions with live demonstrations of sensors near pollution sources like kitchens and cigarette smoke effectively raised awareness. This hands-on approach made air quality issues more tangible. Similarly, the mobile measurements campaign employed workshops and panel discussions, offering practical insights and tools that actively engaged participants in understanding air quality and mobility issues. **Interactive Engagement and Educational Activities:** In the School Bus Service Use Case, awareness was raised through interactive Air Quality Training, DIY sensor workshops, and presentations of dashboards. This hands-on process involved students, parents, and stakeholders directly. The approach at Primary School Dimitar Talev, including workshops and media dissemination, also effectively engaged the community and promoted understanding of air quality issues.	**Challenges in Sustaining Hands-On Engagement:** The Kindergarten Air Quality Use Case faced challenges as the project's suspension limited further hands-on activities, though training materials and workshops were initially provided. Despite targeted online campaigns and outreach to a tech-savvy audience, the engagement remained limited to digital interactions rather than hands-on involvement with the CO2 calculator. **Limited Hands-On Interaction in Some Campaigns:** The static measurement campaign in Berlin, while involving workshops, had limitations in hands-on engagement compared to the mobile campaign. Similarly, in Primary School Vasil Levski, while workshops and tool introductions were part of the approach, the interaction was more focused on data analysis and feedback collection rather than direct, hands-on engagement with the measurement process.
Action	**Empowering Community Actions:** Across several pilot activities, senior citizens were engaged by informing them about their air quality measurements and discussing potential actions with municipal authorities. This approach aimed to empower seniors to contribute to local air quality improvements. The policy simulation tool in the CO2 calculator, allowing users to express their preferences for climate policies, thereby informing policy development and aligning actions with community support.	**Limited Impact from On-Hold Projects:** For the Kindergarten Air Quality Use Case, although the community was informed about the project, it faced delays and was eventually put on hold. This reduced the scope for community-defined actions and their implementation. The information campaign also faced limitations in translating feedback into actionable changes due to the broad focus on awareness rather than specific action plans.

	Interactive Workshops and Feedback Integration: The mobile measurement campaign involved participants in interim and final workshops, where they explored actionable steps for air pollution control and sustainable mobility. These sessions fostered community involvement and encouraged the implementation of strategies. In the School Bus Service Use Case, community input was actively sought through surveys and an ideathon, leading to discussions about expanding and improving the service.	**Challenges in Implementation and Feedback Integration:** In the static measurement campaign, while workshops helped residents understand data and consider actions, technical issues and a lack of direct follow-up may have limited the effectiveness of these actions. For Primary School Vasil Levski, the reliance on a Google form for suggestions, coupled with the indirect nature of feedback collection, might have constrained the depth of community engagement in shaping and implementing improvements.
Reflection	**Accessible Data Interpretation:** Despite the complex nature of air quality data, elderly participants were able to interpret basic information through simple color-coded signals from the sensors. This approach made the data more accessible and understandable for them. Also with Telraam, in the Herzele case, there was heavy involvement of citizens post intervention. **Engaging Workshops and Feedback Integration:** The mobile measurement campaign effectively involved participants in data interpretation through their feedback on contextual factors influencing air quality. Color-coded LED lights on the sensors helped participants understand real-time air quality data. Workshops at Primary School Dimitar Talev and Primary School Vasil Levski also facilitated student and stakeholder involvement in interpreting data and suggesting improvements, enhancing their engagement and learning experience.	**Limited Direct Involvement:** In the static measurement campaign, while participants provided useful anecdotal insights, their direct involvement in interpreting data was less pronounced due to the static setup. This limited engagement might have reduced the depth of understanding and contextual analysis of the data. **Challenges in Complex Data Understanding:** For elderly participants, understanding detailed dashboards was challenging. This limitation may have hindered their ability to fully engage with the data, despite having access to simpler signal indicators.
Legacy	**Expansion of Experimentation:** The project's innovative approach in Athens provides opportunities for future experiments by exploring alternative methodologies and involving different community groups. For instance, the CO2 calculator can be extended to various building types, broadening its impact and contributing to ongoing CO2 reduction efforts. Similarly, expanding the mobile and	**Challenges in Continuation:** The Kindergarten Air Quality Use Case faced a suspension due to budget and timing issues, which limited further development. Securing future funding and enhancing educational efforts are necessary to overcome these challenges and implement sensor systems in more institutions.

	static measurement campaigns can enhance data collection and influence environmental policies. In Herzele, the school street, which was setup as a trial, has been made permanent as a direct consequence of COMPAIR. **Sustained Engagement and Legacy:** For the School Bus Service Use Case, integrating the service with free public transport policies and expanding it to more schools can sustain and grow the initiative. Training teachers to use DIY sensors at Primary School Dimitar Talev and involving volunteers in other citizen science projects at Primary School Vasil Levski ensures continued engagement and educational impact.	**Limited Direct Integration:** The static measurement campaign's impact may be constrained by its reliance on existing local initiatives and administrative collaboration. Ensuring sustained interest and mobilizing diverse social groups will be crucial for maintaining the project's effectiveness and relevance.

As can seen from the summary above, we can find some common themes of "hits & misses" in all pilot activities across the project, spanning the different phases.

What clearly stands out as a positive, in all cases, is where citizens were directly involved in data collection with sensors, there is strong involvement paving the way for behavioral change as a consequence. Whether it was students measuring air quality with mobile sensors, citizens measuring traffic with Telraam in Herzele or Plovdiv, when they're involved, there is a true sense of involvement of being part of a change process, in every phase of the project.

The same goes for the challenges encountered, in particular maintaining the momentum of engagement. In each phase, there is a risk of citizens dropping out and losing connection. This can be due to technical issues with the sensors used, to planning issues or even political push-back frustrating citizens in their ambitions to enable change.

From these findings, we distill the following pathways to enable behavior change, as a key lesson from COMPAIR regarding this particular project objective.

4.1 Pathway 1: Choosing healthier commutes

A first pathway we identified in COMPAIR is the example of using mobile air quality sensors to nudge citizens to choose “healthier” routes. This has been executed in multiple pilot activities (Flanders, Berlin) and while differing in execution, there are commonalities.

Start by capturing attention with the prompt, "**Discover how healthy your commute truly is**." This approach appeals directly to personal interests, encouraging individuals to explore their daily habits from a health perspective.

Encourage group participation to foster a sense of community and shared goals. By creating a group of peers with similar concerns, you can generate critical mass, allowing participants to compare their findings and experiences, thus enhancing the collective impact of the initiative.

Ensure that the planning process is flexible yet structured. While it's important to avoid chaos, **allowing participants autonomy** and the ability to take initiative is key. Clear planning should include details on who uses which sensor, when data will be collected, and ensuring that conditions for data collection, such as weather, are suitable.

Empower participants to **take ownership of the data collection process** using mobile air quality sensors. By allowing them to self-install and maintain these simple, user-friendly sensors, participants become actively engaged. This hands-on involvement is essential for fostering a mindset shift and encouraging behavioral change.

Provide a straightforward, comprehensible analysis process that participants can engage in themselves. When **citizens lead the interpretation** of their data, using tools like a map-based dashboard, they gain intuitive insights. External experts should serve as resources, available on demand to assist in interpreting the data, but not dictating conclusions.

Allow the data itself to **guide participants toward healthier alternatives**. At this stage, the insights gained from the collected data will naturally encourage participants to make healthier choices, with minimal additional prompting needed to influence behavior change.

Encourage participants to reflect on the experiment, deepening their understanding of air quality as an environmental concern. This **reflection can dispel misconceptions**, such as the belief that poor air quality is solely caused by cars, highlighting other contributors like local construction or wood stoves.
Finally, emphasize the **lasting impact of the experiment**. Route choices for commutes are often deeply ingrained habits, but once participants change their routes based on the data, these new, healthier choices are likely to become lasting behaviors.

4.2 Pathway 2: Evaluation of local traffic interventions

A second example involves making citizens the owners of the evaluation of a local traffic intervention. The Herzele example, and later on the one in Sint-Niklaas as a replication, reveal the potential of a repeatable flow to enable durable behavior change.

Begin by **jointly defining** the problem that the traffic intervention seeks to address, ensuring that all potential impacts, both positive and adverse, are considered. It is vital to recognize and respect the expertise of local residents, who have an intimate understanding of the traffic situation in their area. This approach not only validates their knowledge but also increases the likelihood of gaining their support. When experts approach the situation with this mindset, it fosters collaboration and ensures that the intervention is grounded in the real-world experiences of those most affected.
Involve all voices and build a broader community, including those who support and oppose the intervention. It is essential to acknowledge skepticism and embrace diverse perspectives to build a well-rounded community of stakeholders. This is particularly important in contentious situations, such as implementing a school street in Herzele, where differing opinions on traffic issues must be addressed. By bringing together stakeholders with various viewpoints, you create a more robust and inclusive process that is more likely to achieve a consensus on the intervention's desirability.
Carefully craft the timeline for the intervention, ensuring that both pre- and post-measurements are conducted and are representative of the true impact of the changes. Accurate data collection at these stages is crucial to objectively evaluate the

intervention's effectiveness and to provide clear evidence of its outcomes. A well-planned timeline ensures that the data gathered is reliable, which is essential for convincing all stakeholders of the intervention's success or addressing any unintended consequences.

As with air quality sensors, **entrust citizens with the ownership** of the data collection process. By allowing them to handle the sensors and collect their own data, the information becomes more personal and trustworthy. This sense of ownership is crucial for building trust in the data, particularly among skeptics. If possible, enable citizens to verify the quality of the data, as demonstrated by the Telraam system, where traffic counts are transparently displayed. This verification process further strengthens trust and increases the credibility of the data, making it more likely that skeptical citizens will be won over.

Use the data to raise awareness about the volume of traffic in the area. Simple indicators, such as the average number of cars per hour, can help local residents understand how much of the traffic they contribute themselves, prompting them to reflect on their own travel habits. By comparing traffic intensity between different streets, residents gain a more objective understanding of problematic areas. Most importantly, straightforward comparisons of average traffic volumes before and after the intervention can clearly illustrate the benefits of the changes, and for skeptics, these comparisons can reveal whether any unintended negative effects have occurred.

The cases of Herzele and Sint-Niklaas demonstrate the engagement process itself serves as a **catalyst for cementing those changes**. Although the pathway to lasting behavioral change is more indirect in this approach, it is primarily driven by countering skepticism with objective data that has been collected and analyzed by the citizens themselves. This process fosters a deeper understanding and acceptance of the intervention, and should ultimately lead to more durable changes in traffic behavior.

4.3 Pathway 3: Modal shift

A third example is how citizens can be nudged in mode choice (i.e. car => bus), involving citizens in each step of the way, including collecting the evidence to demonstrate the positive health impacts on themselves.

Identify air pollution and traffic congestion around schools as key issues, focusing on younger students most likely to be driven by car. Clearly define project goals to reduce car usage by introducing school bus routes.
Engage parents, schools, and stakeholders early through meetings and workshops to build support for the bus initiative. Form partnerships with local organizations to ensure broad backing and sustainability.
Plan routes and schedules carefully, and install citizen-owned air quality sensors to monitor impact. Develop a robust communication strategy to keep the community informed about the data and engaged throughout the process.
Install air quality sensors and distribute surveys to gather data and feedback on the bus service's effectiveness. Use this data to assess and refine the initiative as needed.
Conduct workshops and campaigns to educate the community on the benefits of the bus service and share sensor data to encourage wider adoption. Highlight the positive environmental and safety impacts.
Implement the bus routes with regular monitoring, and be prepared to make adjustments based on feedback. Expand communication efforts to include all potential users, such as parents of older students.

Regularly evaluate outcomes by analyzing sensor data and gathering feedback from stakeholders. Use these insights to identify areas for improvement and plan for future iterations of the project.

Secure ongoing support and funding to ensure the bus service's long-term sustainability and consider expanding the initiative. Document the project as a model for other municipalities to follow.

5. Conclusion

In conclusion, the COMPAIR project aims to demonstrate the significant potential of citizen science (CS) in driving behavioral change towards sustainable practices. In the pilots, COMPAIR has found traces of evidence for this in some of the activities. By actively involving citizens in the collection and analysis of data related to air quality and climate change, the project has empowered communities to understand the direct impact of their actions on the environment.

The various pilot activities across different regions have shown that when individuals are equipped with the right tools and knowledge, they are more likely to adopt behaviors that contribute to better environmental outcomes, such as reduced energy consumption and increased support for policy measures. However, most of the evidence is coming from a qualitative assessment by researchers (COMPAIR project members) and it remains to be seen if the activities will indeed lead to sustained behavioral change, beyond the project timeline. Also, it is clear some project activities were definitely more successful than others in enabling behavior change as well as monitoring.

The project's eight-phase framework provided a structured approach to assess the effectiveness of these activities, revealing key insights into the processes that foster or better should foster, behavioral change. The findings underscore the importance of community engagement, hands-on involvement, and continuous reflection in sustaining long-term impact. Moving forward, the legacy of COMPAIR lies in its ability to inspire additional experiments and initiatives that build on these successes, ensuring that the momentum for positive environmental change continues. As communities remain engaged and empowered, the pathways to sustainable behavior that COMPAIR has pioneered will likely yield lasting benefits, both for the participants and for broader societal efforts to combat climate change.

To conclude, while we did find evidence, the assessment if COMPAIR's activities have indeed generated lasting behavioral change was hindered by lack of hard evaluation data. In retrospect, insufficient attention was given specifically to evaluating behavior changes in the project inception phase. As a recommendation for future projects, in particular those which are implementation-oriented, such as COMPAIR, sufficient resources should be attributed to evaluating outcomes.