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SOCIO-BEE

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Wearables and droneS fOr CIty Socio-Environmental Observations and Behavioral ChangE

Deliverable

SOCIO-BEE Methodology for ecosystem & hive creation.R2

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List of definitions & abbreviations

Abbreviation	Description
CA	Collective Action
CoP	Community of Practice
CS	Citizen Science
DB	Drone Bee
DoA	Description of Action
ECS	Extreme Citizen Science
ECSA	European Citizen Science Association
HKU	Stichting Hogeschool Voor De Kunsten Utrecht
IAP2	International Association for Public Participation
IBERCIVIS	Portmanteau of “Iberia” and the Latin word civis, meaning “citizen”
JRC	Joint Research Centre
LGTBIQ+	Lesbian, Gay, Bisexual, Trans, Intersex and Queer
QB	Queen Bee
SCT	Social Cognitive Theory
SLT	Social Learning Theory
T*x.x*	Task *x.x*
VUB	Vrije Universiteit Brussel
WB	Working bee
WP *x*	Work Package *x*

Executive Summary

The H2020 SOCIO-BEE project aims to encourage citizens to take an active role in the fight against climate change through citizen science using disruptive technologies such as drones and wearables articulated by the project engagement toolkit. More specifically, SOCIO-BEE aims to involve different segments of citizens (young people under 16 years of age, older adults over 65 years, and people who commute by car or through public transport in large cities or suburbs) in different scientific endeavours: (i) to identify collectively environmental issues related to air quality; (ii) to raise informed hypotheses or "what-if" scenarios for mitigating or reducing emissions of air pollutants; (iii) to design collective interventions or experiments that help to prove if the hypotheses hold or are wrong; (iv) to collect information and data to support the hypotheses through disruptive technologies involving as many people as possible from the aforementioned segments; (v) to analyse and visualize the information obtained from various data sources; and (vi) to communicate the results to raise public awareness, stimulate behavioural change, environmental stewardship, and create new public policies for environmental protection.

Therefore, challenges faced by the SOCIO-BEE project are two-fold. On the one hand, to involve diverse citizens in the fight against climate change (both people who are already aware of environmental issues and those who for some reason are less aware or passive regarding climate action). On the other hand, to encourage scientific vocations among the target population, as well as to foster the use of data collected to convince policymakers to take actions. This objective is paramount to ensure that new policies or regulations will be put in place in Marousi, Zaragoza or Ancona. Therefore, this second version of the deliverable (D2.6) focuses on describing the methodology to engage Bears (SOCIO-BEE metaphor) in co-creation processes with other honeybees. After characterising the bears, engagement approaches are proposed to involve them in different degrees depending on their interests and their capacity of making an influence on the local communities. Finally, proposals for each pilot are elicited which will inform the creation of new engagement tools for the SOCIO-BEE toolkit (T2.5)

Table of Contents

List of definitions & abbreviations 4
Executive Summary 5
Table of Contents 6
List of Figures 7
List of Tables 7
1 Introduction 8
1.1 Purpose of the document 9
1.2 Relationship with other deliverables 10
2 Previous Experiences involving stakeholders and citizens in participative projects 10
3 Overall Methodology 12
4 SOCIO-BEE proposal to engage Relevant Stakeholders and Policymakers 13
4.1 Bear role through Personas 13
4.2 Stakeholder Maps per Pilot: Who are the bears? 15
5 Stakeholders' involvement focusing on bears 18
5.1 Zaragoza bears' involvement 20
5.2 Ancona bears' involvement 20
5.3 Maroussi bears' involvement 21
6 Stakeholders' barriers focusing on bears 21
6.1 Zaragoza bears' barriers 21
Corrective measurements to be implemented in Zaragoza 22
6.2 Ancona bears' barriers 23
Corrective measurements to be implemented in Ancona 25
6.3 Maroussi bears' barriers 26
Corrective measurements to be implemented in Maroussi 27
7 Analysis of Stakeholders' (bears) interest 29
8 Mapping bears' involvement with the SOCIO-BEE aspirations 30
8.1 Catalogue of activities 30
9 Tips for engaging and communicating with policy makers 35
10 Conclusions and next steps 36
References 38
Annex I 39

List of Figures

Figure 1. SOCIO-BEE Concept map where bears are at the end of the value chain and beekeepers are the artificial initiators. 8
Figure 2. Resulting cascading model to create, develop and replicate hives in SOCIO-BEE 9
Figure 3. WeLive CO-CREATION methodology adopted and adapted in SOCIO-BEE 12
Figure 4. Saragossa updated (M22) stakeholder map 16
Figure 5. Ancona updated (M22) stakeholder map 16
Figure 6. Maroussi updated (M22) stakeholder map 18
Figure 7. The different levels of participation of the bears in SOCIO-BEE hives 19
Figure 8. Involvement phases of public participation to create local services inspired by INTERLINK project. 19
Figure 9. SOCIO-BEE stakeholders' influence vs interest matrix adapted from INTERLINK project 30
Figure 10. The relationship between citizen science and open science 36

List of Tables

Table 1. Archetype of the Bear where their main traits and aims are described along with the barriers they should tackle to empower hives. 14
Table 2. Zaragoza barriers per pilot iteration 22
Table 3. Corrective measures in Zaragoza 23
Table 4. Ancona barriers per pilot iteration 24
Table 5. Corrective measures in Ancona 25
Table 6. Maroussi barriers per pilot iteration 27
Table 7. Corrective measures in Maroussi 28
Table 8. Catalogue of Activities that can be carried out with bears per Participation Goal 32
Table 9. Engagement and feedback mechanisms and methods per engagement category 33

1 Introduction

SOCIO-BEE requires collaborative multi-stakeholder participation. Hence, the project must tackle the challenge of involving groups of citizens, companies, public bodies and institutions in the collaborative definition, execution, dissemination, and exploitation of citizen science experiments addressing climate change led by Queen Bees (QBs) as part of an action group, i.e., SOCIO-BEE Hive. Although QBs have the knowledge and the will, they do not always have the needed resources (manpower, budget or sensory devices) to successfully execute a citizen science campaign or experiments alone. To support them, there are several actors that can help them to achieve their objectives. But one of them is core and are usually left apart in Citizen Science (CS) projects: The **bears,** who usually are at the end of the value chain of the hives see Figure 1. Following the metaphor of the project, those actors are the ones who collect the honey (i.e., not the raw data, but the information, knowledge, and wisdom – following the knowledge pyramid[1] – created on top of them). However, the Figure does not fully represent the involvement of those actors in the Hive. They can also actively participate in the co-creation process of the hive with other different roles beyond being just honey gatherers. For example: supporting the queen bees with infrastructure, budget or creating open science policies, providing ideas for the hive, being consulted about specific issues, sponsoring the campaigns, and finally, to cite some, facilitating the communication of the results to make the outcomes usable in policy-making. The bear role will be of paramount importance to ensure that the co-creation, co-production and co-execution process is performed along the cascading lifecycle of the hives (defined in T2.5 and which is presented in Figure 2). Therefore, this deliverable delves into how those roles can support QBs by promoting the co-creation and co-deployment of citizen science experiments involving other bees (to co-execute the experiment) and bears (who may sponsor, advise regarding the experiment and are recipients of the experiments' results).

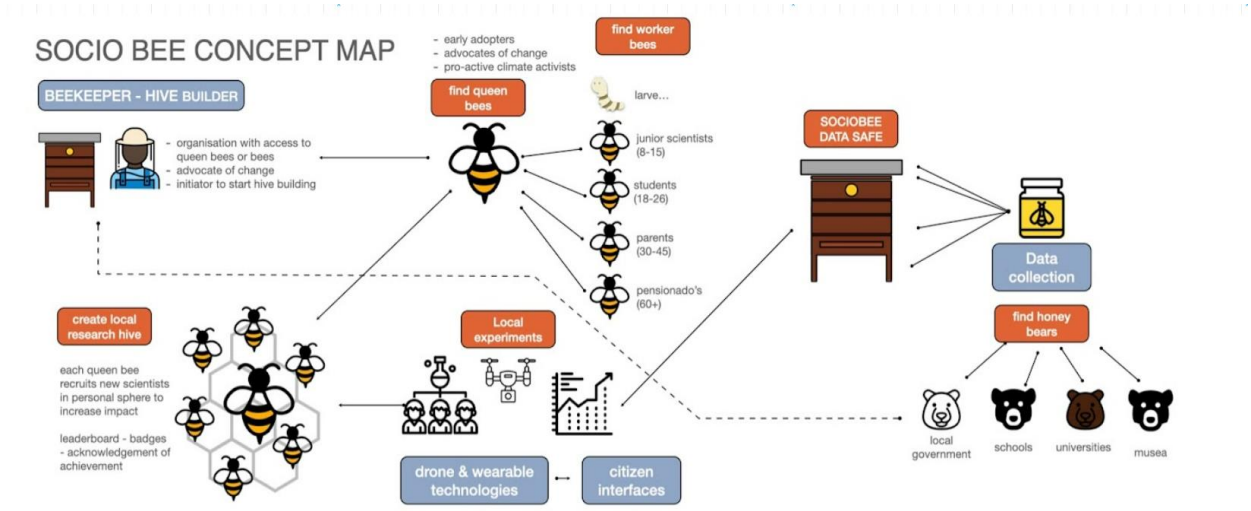

Figure 1. SOCIO-BEE Concept map where bears are at the end of the value chain and beekeepers are the artificial initiators.

[1] https://en.wikipedia.org/wiki/DIKW_pyramid

The initial idea of co-creation of the idea (understood as the combination of a co-design phase followed by a co-exploitation phase) may be led by citizens playing QB role following a *bottom-up approach* or result from a *top-down effort* promoted by public administrations or companies (bears) and their representatives encouraging and helping citizens. As a result, a decision matrix is provided to help choosing WHAT and HOW different stakeholders, overall bears, can be encouraged and motivated to jointly collaborate, in their roles, to avoid climate change effects and aid in their understanding of interventions impact.

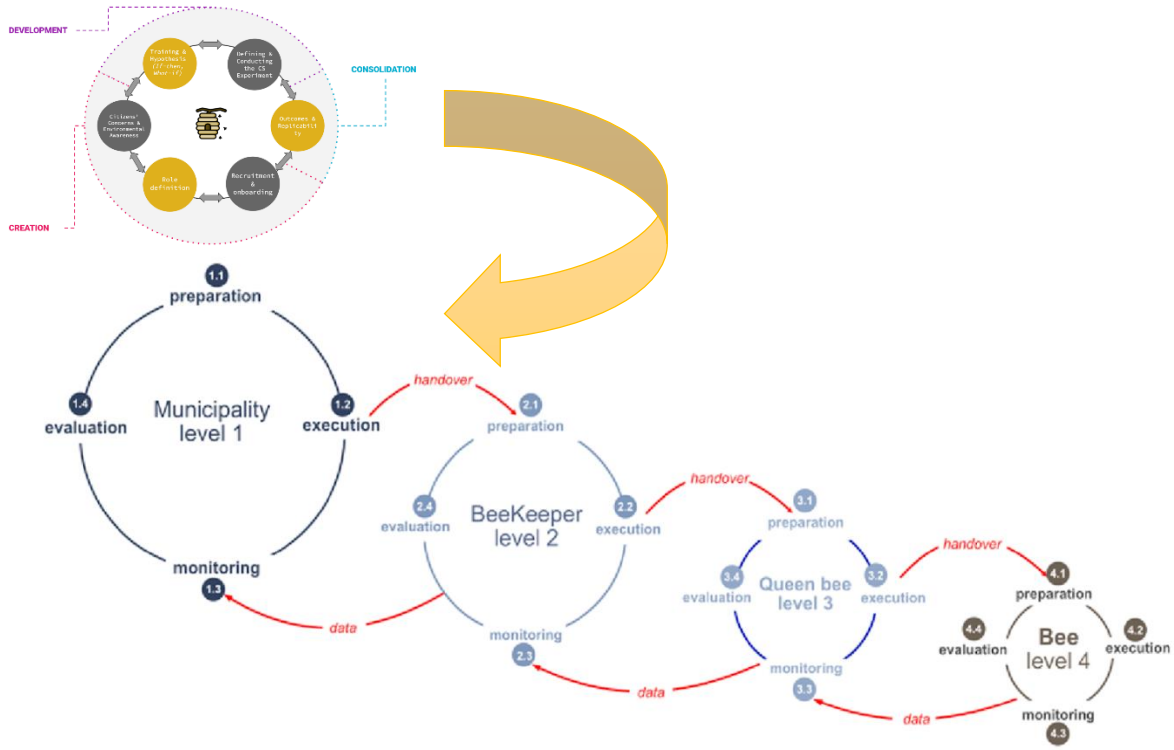

Figure 2. Resulting cascading model to create, develop and replicate hives in SOCIO-BEE

In essence, the main outcome of this deliverable is to describe the *SOCIO-BEE methodology for assembling Citizen Science Hives having the involvement of bears in them and exposing their results to society* to maximize impact. Moreover, this second version of the deliverable, underpin the bears involvement in the three pilot cities: Ancona, Maroussi and Saragossa.

1.1 Purpose of the document

This deliverable has several purposes which are summarized below. On the one side, it presents in detail what SOCIO-BEE understands as co-creative processes. Furthermore, it presents the challenges for involving bears (e.g., organizations, policymakers, city planners, associations or companies) in the co-creative process of the hives. For that, a better description of the bear role is presented, followed by a methodology for engaging them in the different phases of the hives (creation, development and consolidation). Finally, the involvement of the different bears and similar actors per pilot is presented.

With all these information, a series of recommendations are given to create custom made tools to involve bears in the co-creative processes of CS-based experiments.

1.2 Relationship with other deliverables

D2.1 established the understanding of the different roles and responsibilities of the participants in the CS-interventions and experiments that will be conducted in the project's three years lifetime. D2.3 and D2.4 dealt with engagement strategies for the public in general whilst this deliverable, D2.6, focuses on the roles of bears in co-creation. Therefore, it has a lot of connections with other tasks throughout the whole project. First, it is tightly aligned with all the tasks of WP2. Tailored and successful engagement of all actors will only occur if the people with whom we will work are correctly identified and characterized and their aims are understood. Specifically, this deliverable will inform some tools that will be created in T2.5. WP3 has also strong connections as it is the place where the use cases in which bees and bears are the leading actors are identified which is also true for the beekeepers in the first piloting iteration. WP4's deliverables should consider the main responsibilities and roles of the participants in the hives to assign to them appropriate micro-task and/or providing them bespoke recommendations to collect more evidence to back the hypotheses defined in the experiments. Of paramount importance to this deliverable is the co-creation module of this WP. WP5, and especially T5.3 (pilot planning) and T5.4 (pilot preparation) are also tightly coupled to this deliverable as this will serve to understand which segments of the population we will work with in the different pilots and the methodology that we will apply them to engage them. Finally, it is fully related and dependent of WP8 as if dissemination and communication from this WP is done correctly that will allow the adaptability to fit and attract new bees and bears in the project. Also, in WP8, the task 8.2, where the exploitation plan is defined, is of paramount importance as this deliverable is all about the bears involvement who usually have the budget and the resources to help the hives to flourish.

2 Previous Experiences involving stakeholders & citizens in participative projects

Co-creation is a management initiative that brings different parties together (e.g., company, group of customers), to jointly produce a mutually valued outcome [2]. Multi-stakeholder engagement processes and co-creation activities have major advantages: they produce results that are truly adapted to the reality of concerned people and thus allow more sustainable changes [8]. Involving stakeholders to develop innovative climate mitigation and adaptation actions is even more relevant as climate change is obviously global, but also highly contextualized, local, and often requires changes in the society [7].

For SOCIO-BEE co-creation means that "*government, companies and citizens initiate, design, or implement programs, projects, or activities together, associated to climate change and air quality concerns*". In SOCIO-BEE approach, the CO-CREATION process is divided into CO-DESIGN and CO-EXPLOITATION phases as will be further explained in the next sections. CO-DESIGN implies that stakeholders jointly CO-IDEATE and CO-IMPLEMENT, i.e., they collaborate in the specification of an idea which is turned/implemented as an app/experiment or any other type of open/citizen science enabling asset. At any stage, the collaboration process may be stopped, i.e., the CO-EXIT stage is executed. CO-DESIGN is followed by CO-EXPLOITATION where those involved in the ideation and then implementation collaboratively devise a

deployment and exploitation strategy for the derived asset, e.g. citizen science experiment together with its realization approach. Such exploitation consists at least of two stages, namely CO-MAINTENANCE where the produced asset is deployed, maintained (in the case of SOCIO-BEE it would correspond to the actual experiment execution during a timespan), and sustained and CO-BUSINESS where different sustainability approaches might be adopted to ensure the asset keeps providing service (in the case of SOCIO-BEE this could be used to make the EXPERIMENT design and lessons learnt during the execution turn the experiment into a replicable experiment for further use in other pilots and even domains).

The SOCIO-BEE CO-CREATION process will be managed and operated through the CO-CREATION module at the SOCIO-BEE platform layer developed in WP4. As such, the public can be involved to varying degrees and partake in several steps of a CS process, like defining the questions, developing explanations/hypotheses, collecting data, interpreting data, or drawing conclusions. To make an idea of what kind of collaboration we envisage, projects are often classified on a ladder of participation [3] that includes contributory projects (mostly data collection); collaborative projects (data collection and refining project design, analysing data, disseminating results); and co-created projects (designed together by scientists and public where the public shares responsibility for most or all the steps in a scientific project/process). As it was described in D2.3, this is also connected with the type of participation of Bonney [4] which identified involvement into contributory, collaborative, and co-created projects. Similarly, but putting the focus on the users, Haklay [5] defined the level of participation and engagement, and cluster projects as crowdsourcing, distributed intelligence, participatory science, and extreme citizen science. In such article, inquiry activities that citizens are involved in may range from contributing data (contributory or crowdsourcing) to participating in the entire process and taking part in publications (co-created or extreme citizen science). Finally, we found a piece of research [6] that focuses on the level on participation considering the behavioural traits and personal needs finding five types of users in online citizen science: hardworking, persistent, loyal, lurking and visitors. However, this work does not relate to the cooperation among peers in a co-creative process.

With this review of participation in co-creative citizen science endeavours, the co-creation methodology that devised for SOCIO-BEE fosters sustainable continuous in time and feasible in economic terms co-creation. Beyond just defining how the people will collaborate, it consists of the co-design and co-exploitation phases which are further divided into co-ideation and co-implementation and co-maintenance and co-business stages, respectively, ensuring the sustained cooperation in the hive. Indeed, the co-creation process does not end when a new service is delivered, e.g. a citizen science experiment is designed and rolled out, it must also be supported afterwards; a business and sustainability model (results publication, dissemination and communication to bears and main public (citizens), open source publication, license, documentation) should be developed to make the service sustainable and replicable in other CS hives if needed. The WeLive H2020[2], on which the SOCIO-BEE co-creation methodology is mainly based, was previously validated to create new value in form of new public services. In a nutshell, the project WeLive was conceived to transform the current approach towards e-government by providing

[2] https://cordis.europa.eu/project/id/645845

a new open model oriented towards the design, production and deployment of public services based in the collaboration of a quadruple helix, i.e., research organizations, companies, public administrations and citizens. WeLive provided a novel We-Government ecosystem of tools (Live) built on the Open Data, Open Services and Open Innovation paradigms that was easily deployable in different public administrations and which promoted co-innovation and co-creation of personalized public services through public-private partnership and the empowerment of all the stakeholders to actively take part in the value-chain of a municipality or a territory. In SOCIO-BEE, this methodology is extended to the field of citizen science to solve environmental needs as can be seen in Figure 3.

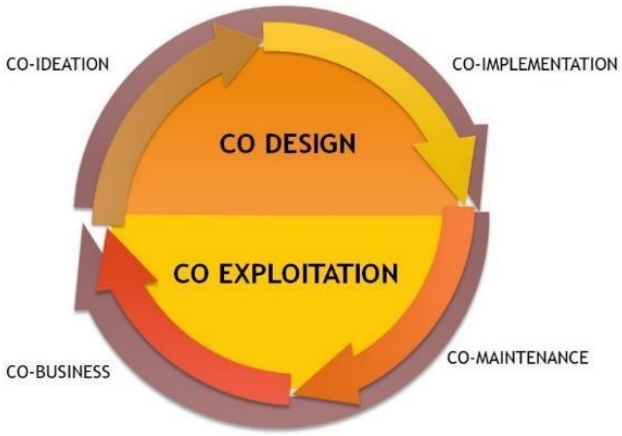

Figure 3. WeLive CO-CREATION methodology adopted and adapted in SOCIO-BEE

3 Overall Methodology

As was established in D2.1 and then in D2.8, SOCIO-BEE hives are divided into 3 main phases which then are specified in a cascading model per actor (see Figure 2). Considering these phases and the co-creation methodology, in T2.3 we sought to understand which actors should be involved in each task, overall, the bear role, and the questions that hive creators, i.e., the beekeepers or QBs, should address to ensure that the hives will be created with the SOCIO-BEE soul. Thus, cooperation, egalitarian participation, mutual exchange of ideas and knowledge and sustainable development should be kept in mind.

Therefore, drawing from existing literature on examples where citizen science and co-creation has been successfully accomplished, the researchers from SOCIO-BEE project started by interacting with the pilot cities to create a stakeholder map. Stakeholder mapping is the visual process of laying out all the stakeholders of a product, project, or idea on one map. The main benefit of a stakeholder map is to get a visual representation of all the people who can influence your project and how they are connected.

The produced stakeholder maps which were created and the beginning of the project and then revisited before the first pilot iteration on mid-May 2023, have been very important for better understanding the name of existing associations, entities, or institutions behind the bear roles, across the three different pilots in SOCIO-BEE. This exercise also helped to connect the beekeeper's role with the Artificial Hive creation as sometimes the difference between one role (bear) or the other (beekeeper) becomes blurry,

but it should not**. Bears are actors involved in the "research valorisation" part, so they benefit from the results of the project, while beekeepers actively participate in the project piloting and research itself**. Nevertheless, it is true that if bears can be consulted they will be directly involved in the production of the honey they can become beekeepers. To recap, using the updated maps that were presented in D2.4 and considering that the first phase of the piloting will be artificial, i.e., hives will not emerge spontaneously, they will be driven by the project, though. In other words, researchers identified potential beekeepers and bears in the three cities as brokers/initiators of hives.

With those actors identified, we design the way the collaboration and the co-creation might occur. For that, we are inspired by two H2020 projects (WeLive and INTERLINK[3], this latter one still ongoing which offers an innovative solution – a collaborative governance model, merging the enthusiasm and flexibility of grassroot initiatives with the legitimacy and accountability of top-down e-government frameworks) in which some of the partners were or are involved to inherit and adapt their co-creation methodology.

4 SOCIO-BEE proposal to engage Relevant Stakeholders and Policymakers

This section starts with the characterization of the bears as well as their will to be involved in the hives. Furthermore, the updated stakeholders' map per pilot is presented along with some custom-made recommendations per pilot site. More information about the updated inputs provided by pilot cities can be found in Annex 1.

4.1 Bear role through Personas

In the DoA, it was established that the bears are actors that sponsor, launch, set the common strategy (in a neighborhood, city, etc.), understand the domain/problems, and are willing to support societal and pro-environmental behavior change through Citizen Science in the geographical scope they live, or they manage. They are essential facilitators supporting Queen Bees, engaging citizens in their campaigns, and disseminating the results of such campaigns. As such, the bears are difficult to characterize in a static role using the persona methodology. Nevertheless, we tried to create a persona based on the inputs of the pilots provided by the stakeholder map, using the environmental department of one city in Europe as an example and taking into account the rationale applied in D2.1 (consult this document to better understand the fields used in this Persona (e.g., values, attitudes, etc.)).

[3] https://cordis.europa.eu/project/id/959201

Table 1. Archetype of the Bear where their main traits and aims are described along with the barriers they should tackle to empower hives.

WAN		
	**Environmental knowledge**	High per convincement or per societal mandate
	Values	Rational Empirical Change Agents
	Emotional involvement	High locus of control, and high scoring in meaningful experience
	Attitudes	Responsibility and priorities
	Skills	Communication and management
	Practices and Habits	Structuring
	Self/Collective-Efficacy	Trust in collective efficacy
	Social and cultural drivers	Openness
	Institutional factors	High
	Economic factors	High, with resources.
Description		
WAN is always looking for greater good for everyone, but she understands that her role does not always allow her to make it happen through getting a common good. She is always seeking to exploit information and wisdom, but not data. Ensuring that hives will develop such knowledge and helping to remove barriers under her control is what drives her to invest time and resources to fight climate change.		

Personal Quote (Goals)	Main Barriers	Main motivations
"We have the mandate to decarbonise the economy by 2050"	Fluctuation of powers, elections, and geopolitical issues out of their control or deviations on the budget allocated	Make her city and her citizens part of the list of cleaner cities in Europe in the next years.

4.2 Stakeholder Maps per Pilot: Who are the bears?

A stakeholder analysis exercise was conducted in collaboration with T2.2 led by VUB with the three pilot cities participating in the project to better understand who can be involved and in what capacity at each location. The following figures show the three updated stakeholder maps that were the outcome of the exercise based on the input of the pilot cities. Annex 1, drawing from the results presented in D2.4 belonging to T2.2, provides details / ideas on how the different stakeholders might be involved in the pilot cities. However, this document puts the focus on the bear role on each pilot city. In essence, we will use this material to create the matrix of WHAT, WHO and WHEN they should collaborate to create custom-made recommendations and tools for bears involvement in T2.5.

As was commented previously, the maps clearly indicate that the initiation of each pilot case starts from the participating municipalities resulting in a new key role of the Beekeeper. The stakeholder analysis also revealed the analogy of the *artificial and organic hive*s, which corresponds to a first (*exploration*), small-scale and more controlled piloting phase and a second (*consolidation*), large-scale piloting phase.

Starting from Zaragoza, in the Figure 4 we can observe that around the queen bees appear some institutions which will be of paramount importance to make the hives a reality. These are the teachers and tutors of ETOPIA[4] the managers of the centre and finally, the municipality of Zaragoza with special focus on the partners involved in SOCIO-BEE. The bears on top of the Figure are local institutions, corporations, local bodies, and foundations.

The list of institutions identified as Bear in the stakeholder map of the Zaragoza pilot is as follows:

For the pre-piloting and first iteration phases, carried out "in house" with staff from the organisations coordinating the pilot are:

- One representative from each of the organisations responsible for the Zaragoza pilot: Ibercivis Foundation, Zaragoza City of Knowledge Foundation and Zaragoza City Council.

For the second iteration of the pilot the identified bears are:

- Representatives of Zaragoza City Council
- Representatives of the Zaragoza City of Knowledge Foundation
- Representatives of the Ibercivis Foundation
- Representatives of the Water and Environment Documentation Centre

[4] https://etopia.es/

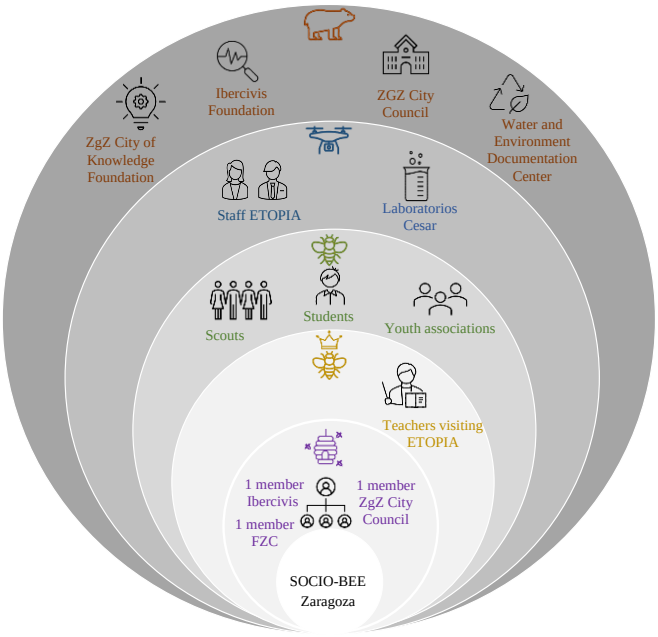

Figure 4. Saragossa updated (M22) stakeholder map

In Ancona the identification of the bears, on top of the figure also map with local institutions, corporations, universities, local bodies, and foundations as can be seen in Figure 5.

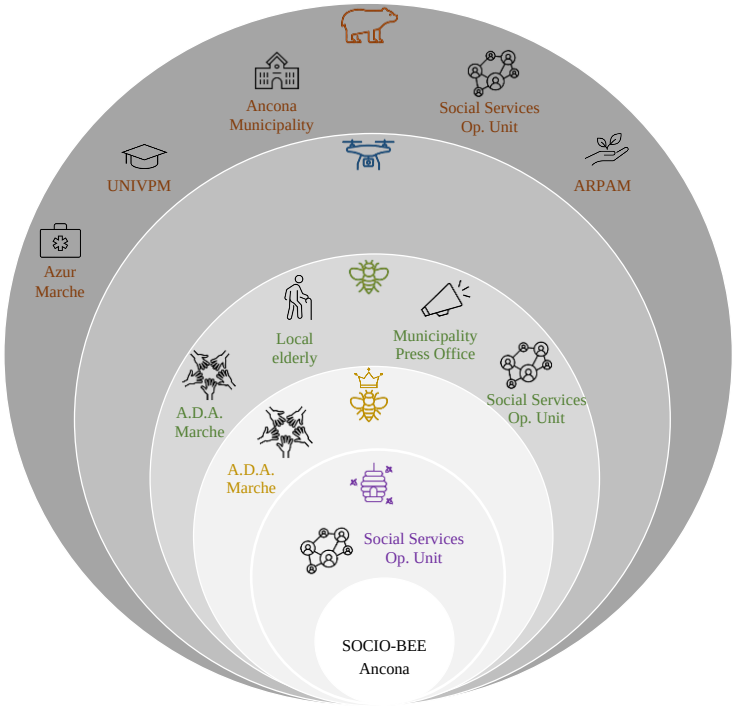

Figure 5. Ancona updated (M22) stakeholder map

The list of institutions identified as Bear in the stakeholder map of the Ancona pilot is as follows:

For the pre-piloting and first iteration phases, carried out "in house" with staff from the organizations coordinating the pilot are:

- One, or more, representative from each of the organizations responsible for the Ancona pilot: Municipality of Ancona, UNIVPM.

For the second iteration of the pilot the identified bears are:

- Representatives of Municipality of Ancona
- Representatives of UNIVPM
- Representatives of ADA (Association for Elders' Rights)

Finally, Maroussi identified Municipality employees, over all those working in the environmental departments, the ones that can initially take the role of the beekeepers. The bears on top of the **Figure 6** are related to the municipality as institution or force for creating polices and the public transport service which have the power to create new regulations around mobility programs working hand in hand with the municipality. Moreover, the university or some associations are also a salient role in the bears. Recall, that bears are not only policy-makers bur people or groups with decision power.

During the 1st pilot iteration, three SOCIO-BEE bears were identified and established within the municipality of Amaroussion. Initially, the municipality was considered as one bear during the pre-pilot phase. Nevertheless, in the beta testing phase, it was treated as three distinct bears, each representing a different department with specific responsibilities and involvement in diverse decision-making areas. These bears were the Department of Environmental Planning, the Department of Civil Protection and Public Health and the Office of Planning and Resource Allocation.

Despite belonging to the same institution, each department was treated as an individual bear due to its unique areas of authority accompanied by different needs, interests, and result exploitation pathways. Consequently, the acquired results from CS activities are foreseen to be utilized for different purposes. The Department of Environmental Planning will emphasize potentially in leveraging the acquired data for environmental protection, for tackling air pollution problem and for the creation of green spaces, the Department of Civil Protection and Public Health will explore the possibility of exploiting the air quality data for urgent and long-term issues related to protection of public health and safety and the Office of Planning and Resource Allocation may focus on urban development and resource management.

The division of the municipality into three distinct bears will allow for targeted and efficient engagement of the bears in the design of measurement campaigns and the post-experimentation evaluation and exploitation of the results. By recognizing the varying needs and interests of each department, the SOCIO-BEE beekeepers will ensure that the outcomes of the CS activities are aligned with the most relevant policy-making areas. This approach fostered collaboration and cooperation between the bears and the different types of bees, enabling them to identify areas of interest, collect the required information, and provide the opportunity for utilizing the results in their respective domains for future implementation of appropriate actions and measures based on the acquired insights.

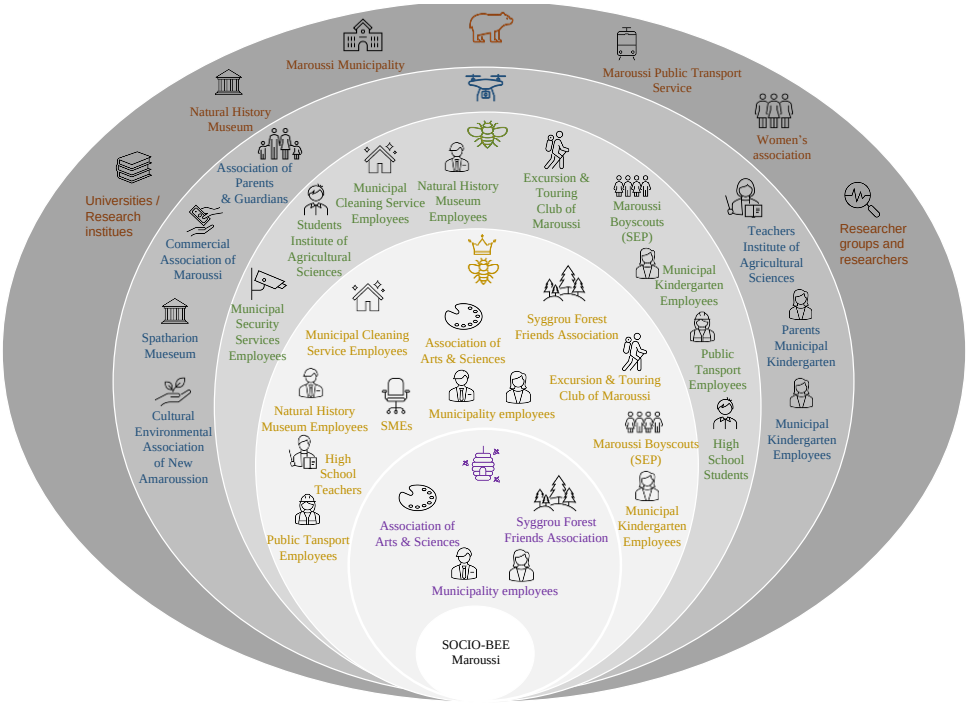

Figure 6. Maroussi updated (M22) stakeholder map

5 Stakeholders' involvement focusing on bears

Motivated by principles of the IAP2 Public Participation Spectrum5 and based on the partners' previous experience in the WeLive and INTERLINK H2020 projects where the co-creation methodology adopted by SOCIO-BEE was created, we have come up with the following categorization of community building activities suitable for the SOCIO-BEE objectives: To inform, to guide, to consult or to work with (see Figure 7). Nevertheless, we argue that this categorization of participation can be also extended to other roles in the colony. The reason why we put the focus on the bears and not on other roles, is because this deliverable recognises the difficulties to reach other relevant authorities beyond the citizens. They usually are interested in pro-environmental issues, but they usually do not have the time to be fully involved in the experimentation process.

To better explain the different involvement categories, these are explained hereafter:

INFORM: creates awareness using traditional communication methods and channels. In this special category of project, bears are only informed about results or development situation from the hives.

[5] The IAP2 Public Participation Spectrum is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program. The Spectrum show that differing levels of participation are legitimate depending on the goals, time frames, resources, and levels of concern in the decision to be made. However, and most importantly, the Spectrum sets out the promise being made to the public at each participation level. The Spectrum is widely used and is quoted in most community engagement manuals.

GUIDE: assistance to Bears is requested to help bees on one hive about how to, for example, address a climate issue in the local surroundings. The bears in this case can help with their knowledge or resources in the organization and realization of citizen science experiments.

CONSULT: it obtains bears' feedback on the SOCIO-BEE CS-based experiment associated to a co-production process (e.g., obtain feedback about the methodology to be followed before to act). As such, before a co-created experiment in launched those potentially taking part in its realization should also be contacted, their feedback gathered and processed.

WORK WITH: it considers bees' concerns and aspirations on the SOCIO-BEE endeavours and its associated co-production process. Therefore, hives request the involvement of bears on the co-production process enabled by SOCIO-BEE. The aim of this final participatory aspect is about to ensure the collaboration among all the different types of actors in a hive is coordinated to make progress towards the goals of the CS-based experiments.

Figure 7. The different levels of participation of the bears in SOCIO-BEE hives

These four aspects of participation of bears are linked to the participatory processes that can occur when it comes to create public services. In this case, the public society can belong to five enchained categories that can be revised in Figure 8 (Inform, Consult, Involve, Collaborate, and Empower).

	INFORM	CONSULT	CO-PRODUCE: INVOLVE	CO-PRODUCE: COLLABORATE	CO-PRODUCE: EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Figure 8. Involvement phases of public participation to create local services inspired by INTERLINK project.

As can be seen in the Figure, only the last three phases are considered real participation in a co-creation process. Therefore, for the four phases listed above for the involvement of bears, only the final aspect called "Work with" can be considered a real horizontal collaboration in a co-creation process of all actors in the hive. As a result, for now on, "Work with" means actions and CS-based experiments in which all actors are equally involved, they collaborate together for the same aim, and finally the citizens (but also the bears) are empowered due to the action of the co-creation process.

In SOCIO-BEE, we aim at finding the ways in which those categories or phases of Figure 7 and Figure 8 will be equally present when creating the hives. That is, for the first phase of the piloting where more artificial hives are created, beekeepers and bears should expect the level of participation that only occurs in the co-production processes. However, as the project advance and will be the citizens the creators of the hives, they have to consider that the level of involvement of bears cannot just come at the end of the experimentation phase, but starting together from the ideation (i.e., Work-with).

In the following, the different levels of bears' participation envisaged from the different pilot cities is presented according to the phases and categories explained above. It can be seen that most of the potential bears will be involved in the higher category of participation for the co-creative process.

5.1 Zaragoza bears' involvement

Identified Potential Bears	***Type of involvement***
One representative from each of the organisations: Ibercivis, FKC, Zgz	*WORK-WITH*
Zaragoza City Council	*WORK-WITH*
Zaragoza City of Knowledge Foundation	*WORK-WITH*
Ibercivis Foundation	*WORK-WITH*
Representatives of the Water and Environment documentation center	*GUIDE*
LIA Cesar Labs	*WORK-WITH*

5.2 Ancona bears' involvement

Identified Potential Bears	***Type of involvement***
Municipality	*INFORM/GUIDE/WORK WITH/CONSULT*
ARPAM	*WORK-WITH*
Researchers @UNIVPM	*WORK-WITH*
ASUR Marche	*INFORM*

5.3 Maroussi bears' involvement

Identified Potential Bears	***Type of involvement***
Department of Environmental Planning, Municipality of Amaroussion	*INFORM, GUIDE, CONSULT*
Department of Civil Protection and Public Health, Municipality of Amaroussion	*INFORM, GUIDE, CONSULT*
Office of Planning and Resource Allocation, Municipality of Amaroussion	*GUIDE, WORK WITH*
Maroussi Public Transport Service	*INFORM, GUIDE, CONSULT, WORK WITH*
Women's association	*INFORM*
Universities /Research institutes	*INFORM, GUIDE*
Researchers' groups and researchers	*INFORM, GUIDE, WORK WITH*

6 Stakeholders' barriers focusing on bears

During the first pilot iteration some of the pilots reported over the barriers and drivers (mitigation actions) for participation of the different bears that they tried to involve in the different pilot phases.

In the following, we report those barriers per each pilot city.

6.1 Zaragoza bears' barriers

Once the first iteration of the pilot has been completed, no notable barriers have been encountered on the part of the bears in the activities carried out. The representatives of each of the institutions involved in the project have shown interest and availability in the activities. Moreover, they have actively participated in the citizen science campaigns. The main expected barrier - defined in the initial stakeholder mapping: "inflexible employees, lack of financial resources" (see table below) - has not arisen and the institutions have facilitated the participation of their staff in the programmed campaigns.

One barrier that did arise - and that needs to be addressed for the second iteration - was the impossibility of showing the bears the results of the campaigns in a simple, useful way that would help them to work together on communication, dissemination and awareness-raising actions on the air quality problem. The online platform has not been used to access the data obtained by the citizen science campaigns, so it has not been possible to carry out data visualization activities and although Ancona tried to provide a visualization tool for the campaigns, **the possibility of easily extracting data from the AcadeMe online platform should be a priority for the project.**

Other barriers encountered in **the relationship between the pilot and its bears have been the lack of communication and dissemination materials prepared for them**, containing quality information for

planning awareness-raising and behavioural change activities among participants, as well as for showing the public the results of the campaigns and the state of air quality in the areas analysed.

As possible corrective measures to improve the role of the bears in the second iteration, as well as to reinforce their role in the project, the possibility of developing communication materials adapted to their role, i.e., to allow them to learn first-hand about their results and progress and to help them plan policies to mitigate the effects of air pollution in the city - especially for city council representatives, who need scientific evidence to implement corrective measures - is proposed. We insist on the need to have access to the data obtained in the campaigns to be able to work with them, both with the members of the hives and with the public. **Free access to these data is needed in the next iteration of the project.**

Table 2. Zaragoza barriers per pilot iteration

	PHASE	Barriers
Already executed	Pre-pilot	● INFORM: Lack of communication materials to inform the bears about the project status and its development. ● GUIDE: ● CONSULT ● WORK WITH
	1st Iteration – alpha testing	● INFORM: No training materials adapted to bears expectations. ● GUIDE ● CONSULT ● WORK WITH: Technology is not ready to be shared to the bears at this stage.
	1st Iteration - beta testing	● INFORM: Lack of visualization tools for sharing the campaigns results in a more comprehensive way to the bears. ● GUIDE ● CONSULT ● WORK WITH:
Execution from January 2024	2nd Iteration	● INFORM: ● GUIDE ● CONSULT ● WORK WITH:

Corrective measurements to be implemented in Zaragoza

According to the phases described in the second iteration (mostly the WORK WITH and the INFORM phases, regarding the pilot and its bears relationship), we want to point two more corrective measures:

- For the INFORM phase: Develop communication materials to inform the project's stakeholders about the project, what the campaign will consist of and what is expected to be achieved.

- For the WORK WITH phase: Explore the possibility of creating a board of experts between the bears to assist and give their opinion in the co-creation process of the next citizen science campaigns.

Table 3. Corrective measures in Zaragoza

	PHASE	Corrective measures
Already executed	Pre-pilot	● INFORM: More communication material, especially aimed at bears. ● GUIDE ● CONSULT: ● WORK WITH:
	1st Iteration – alpha testing	● INFORM: ● GUIDE ● CONSULT ● WORK WITH: Technology is not ready to be shared to the bears at this stage.
	1st Iteration - beta testing	● INFORM: ● GUIDE ● CONSULT ● WORK WITH:
Execution from January 2024	2nd Iteration	● INFORM: Develop communication materials to inform the project's stakeholders about the project, what the campaign will consist of and what is expected to be achieved ● GUIDE ● CONSULT ● WORK WITH: Board of experts (bears) to assist and give their opinion in the co-creation process.

6.2 Ancona bears' barriers

No significant obstacles have been encountered by the bears during the activities conducted as of the first iteration of the pilot. The project's representatives from each institution have expressed interest in and availability for the activities undertaken, as well as active participation in the citizen science initiatives. The primary anticipated barrier - described in the original stakeholder mapping - has not materialized, and institutions have made it easier for staff to take part in the campaigns that have been planned. However, **we have found a lack of communication material dedicated to Bears and subsequently, the inability to see and interpret the results.**

The aforementioned obstacle also occurred in the second iteration generating the **inability to present the campaign results to the Bears in a straightforward manner** that would enable them to collaborate on information-sharing, dissemination, and awareness-raising activities regarding the air quality issue. Although UNIVPM has made an effort to provide a visualization tool for the campaigns by a web platform

to visualize devices data, we want to underline the suggestion from Zaragoza **to easily visualize extract data from the AcadeMe online platform as a priority for the project.**

The lack of prepared communication and dissemination materials for them, containing quality information for planning activities for participants to increase awareness and change the way they act, as well **as for showing the public the results of the campaigns and the state of the air quality in the areas analysed**, represents an additional obstacle in the relationship between the pilot and its bears.

The possibility of creating communication materials tailored to their role, i.e. to let them learn first-hand about their results and progress and to support them in planning policies to mitigate the effects of air pollution in the city - especially for city council representatives, who need scientific evidence to implement corrective measures - are possible steps to improve the role of the bears in the second iteration as well as to reinforce their role in the project. We highlight that **to collaborate with the participants of the hives as well as the general public, it is necessary to have access to the data collected during the campaigns**. In the next iteration, free access to these data is required.

Table 4. Ancona barriers per pilot iteration

	PHASE	**Barriers**
Already executed	Pre-pilot	● INFORM: ● GUIDE: ● CONSULT: ● WORK WITH:
	1st Iteration – alpha testing	● INFORM: No training materials adapted to bears expectations; lack of a standard template to insert easily the information about the campaign. ● GUIDE: ● CONSULT: ● WORK WITH: Technology is not ready to be shared to the bears at this stage.
	1st Iteration - beta testing	● INFORM: Lack of visualization tools for sharing the campaigns results in a more comprehensive way to the bears. ● GUIDE ● CONSULT ● WORK WITH:
Execution from January 2024	2nd Iteration	● INFORM:lack of a standard template to insert easily the information about the campaign ● GUIDE ● CONSULT ● WORK WITH:

Corrective measurements to be implemented in Ancona

According to the phases described in the second iteration, (mostly the WORK WITH, GUIDE and the INFORM phases, regarding the pilot and its bears relationship), we want to point the following corrective measures:

- For the INFORM phase: Develop communication materials to inform the project's stakeholders about the project, what the campaign will consist of and what is expected to be achieved; also it is advisable to develop a standard template for pilot owners, in order to precisely insert the required information that could be relevant for the stakeholders.
- For the GUIDE phase: it would be advisable to develop a user manual that instruct users to play with the overall platform.
- For the WORK WITH phase: Explore the possibility of creating a board of experts between the bears to assist and give their opinion in the co-creation process of the next citizen science campaigns.

Table 5. Corrective measures in Ancona

	PHASE	Corrective measures
Already executed	Pre-pilot	• INFORM: More communication material, especially aimed at bears. • GUIDE • CONSULT: • WORK WITH:
	1st Iteration – alpha testing	• INFORM: • GUIDE: more tailored training material for using the app (user manual) • CONSULT • WORK WITH: Technology is not ready to be shared to the bears at this stage.
	1st Iteration - beta testing	• INFORM: • GUIDE: more tailored training material for using the app (user manual) • CONSULT • WORK WITH:
Execution from January 2024	2nd Iteration	• INFORM: Develop communication materials to inform the project's stakeholders about the project, what the campaign will consist of and what is expected to be achieved • GUIDE: more tailored training material for using the app (user manual) • CONSULT • WORK WITH: Board of experts (bears) to assist and give their

		opinion in the co-creation process.

6.3 Maroussi bears' barriers

Upon completing the first iteration of the pilot, MRSI team found that some of the already identified barriers were not encountered completely as expected. In the case of certain foreseen barriers, they did not materialize during the pilot's execution. Such barriers were the "lack of time", the foreseen "limited engagement between volunteers and organisers" and the "lack of financial resources" indicating that the bears were motivated and eager to participate in SOCIO-BEE project and its CS activities at least for this particular pilot iteration.

However, in some situations where barriers did arise, the SOCIO-BEE team managed to effectively tackle some of them, including those related to the "lack of awareness and of communication material" and the "lack of technical knowledge". Thus, during the pre-pilot and the alpha testing phase, targeted communication, informative and training material were prepared and translated in the local languages.

Nevertheless, even if most barriers were successfully addressed during the pilot, a few but critical challenges still remain and require further attention and mitigation actions. Notably, the barriers related to: **i) the "lack of visualization and processing tools and the lack of direct access to results", ii) the issue related to the "contribution not translating into tangible impact" and iii) the barrier arising from the "very specific technological requirements"** are issues that they were observed, addressed to some extent however further attention and corrective measures must be foreseen and applied prior to the 2nd pilot iteration. In more detail**, the absence of visualization and processing tools, along with the no direct access to results, can be a significant barrier for engaging a bear because it doesn't allow them to analyse and interpret the data collected during the campaigns**. Without proper tools and access to the results, the bears may face challenges in understanding the outcomes of the campaigns and thus making it difficult for the bear to actively participate in the project and utilize the data for policy-making or other relevant purposes. On the other hand, **the barrier of "contribution not translating into tangible impact" can be discouraging for engaging not only a bear** but actually all types of participants in the SOCIO-BEE project. This barrier will diminish the perceived value and significance of their participation in the CS activities. So, in the scenario where a bear and/or a volunteer invests time, effort, and resources into **contributing to the project but does not see tangible outcomes or concrete results from their efforts, it can lead to disappointment and lack willingness for further involvement and make them question the relevance and importance of their contributions.** Finally, the last critical barrier faced during the bear engagement is **the "complex or very specific technological requirements", which can diminish the participation and the engagement level.**

Table 6. Maroussi barriers per pilot iteration

Pilot Iteration	Status	PHASE	Barriers
1	Already executed	Pre-pilot	• INFORM: Lack of communication materials to inform the bears about the project status and its development. • GUIDE: • CONSULT: • WORK WITH:
		Alpha testing	• INFORM: • GUIDE: Lack of technical knowledge and/or very specific technical requirements. • CONSULT: • WORK WITH:
		Beta testing	• INFORM: 1. Lack of visualization and processing tools for sharing the campaigns results in a more comprehensive way to the bears together with lack of direct access to results 2. Contribution may not lead to tangible impacts or outcomes. • GUIDE: • CONSULT: • WORK WITH: Limited technical knowledge and very specific technical requirements may have hindered some bears to participate.
2	Execution from January 2024	Beta testing	• INFORM: 1. Lack of awareness of the SOCIO-BEE project, its objectives, roles and Bear's expected contribution. 2. Lack of processing tools of results and easy access to them • GUIDE: Lack of time and human resources • CONSULT: • WORK WITH: 1. Contribution not translated into tangible impacts or outcomes. 2. Very specific technological requirements

Corrective measurements to be implemented in Maroussi

In order to improve and strengthen the position of bears and support their active engagement during the 2nd iteration, corrective measures must be put in place. These require enhanced communication and engagement with the bears, new set of goals and actions for leveraging the CS results and translating them into valuable insights for policy making and finally modifications in terms of technology and/or

participation mechanisms. According to the four phases, MRSI would like to suggest the following corrective measures to be implemented during the 2nd pilot iteration:

- INFORM: 1. Communication material designed tailored to bears. 2. Explore the use of multiple communication channels. 3. Designate specific team member responsible for keeping the bears informed. Improve visualization and processing tools and provide easy access to CS results.
- GUIDE: 1. Consider fostering a collaborative and supportive team, 2. Communicate and emphasize on the flexibility and adaptability of the CS campaigns and required effort and time allocation 3. Continue discussions on how to address technical issues related to specific requirements.
- CONSULT.
- WORK WITH: 1. i) (co)-Design clear objectives and strategy for CS result exploitation. This is critical point to be addressed as it may appear as a barrier during the engagement of all bee types. ii) Establish recognition/acknowledgement mechanism iii) provide easy access to the results and to visualization and processing tools. 2) Identify alternatives to tackle these issues and/or explore new types of involvement in the project (especially for iphone users).

Table 7. Corrective measures in Maroussi

	PHASE	**Corrective measures applied at 1st iteration and proposed corrective measures for the 2nd iteration**
Already executed	Pre-pilot	• INFORM: More communication material designed including banners, leaflets, presentations, etc. • GUIDE • CONSULT: • WORK WITH:
	Alpha testing	• INFORM: • GUIDE: Training material was created and translated to local language. Preliminary discussions to address issues related to specific technical requirements were initiated. • CONSULT • WORK WITH:
	Beta testing	• INFORM: 1. UNIPMV created a visualization tool for sharing the campaigns results. 2. This issue is still pending • GUIDE • CONSULT • WORK WITH: Training material was created and translated to local language. Preliminary discussions to address issues related to specific technical requirements were initiated.
Execution from January 2024	2nd Iteration	• INFORM: 1. Communication material designed tailored to bears. 2. Explore the use of multiple communication channels. 3. Designate specific team member responsible for keeping the bears informed. • GUIDE: 1. Foster a collaborative and supportive team, 2. Communicate

	PHASE	Corrective measures applied at 1st iteration and proposed corrective measures for the 2nd iteration
		and emphasize on the flexibility and adaptability of the CS campaigns and required effort and time allocation ● CONSULT ● WORK WITH: 1. i) (co)-Design clear objectives and strategy for CS result exploitation. This is critical point to be addressed as it may appear as a barrier during the engagement of all bee types. ii) Establish recognition/acknowledgement mechanism iii) provide easy access to the results and to visualization and processing tools 2) Identify alternatives to tackle these issues and/or explore new types of involvement in the project.

7 Analysis of Stakeholders' (bears) interest

The above identified stakeholder maps are paramount to make the SOCIO-BEE hives a reality. For that, in this section we aim at identifying the stakeholders' influence vs interest matrix (see Figure 9) in which we can better understand when to expect contributions from bears depending on their level of interest of the campaign.

Influence is very subjective factor. One might think that a certain stakeholder has a high level of influence in an engagement objective, but they may actually not. Hence, identifying and gauging the interest and influence levels of stakeholders is critical for stakeholder prioritisation and this is paramount to involve bears. For example, as SOCIO-BEE tackles pro-environmental stewardship, many municipalities should take the project into consideration due to the climate crisis and the 2050 decarbonisation agendas. Constructing the stakeholder map exposed in the previous section ensures that we have considered the full range of people and organisations that need to be included in this matrix. Analysing stakeholders, grouping them based on their posture, and understanding their concerns will also help to better target our communications and engagement strategies [9] devised on T2.2.

The diagram presented in Figure 9 helps to understand the need for communication and potential resistance to change for some stakeholders (in our case bears). Interest (or power of stakeholders) indicates stakeholders' likely concerns and willing to take decisions, whilst Influence indicates their ability to resist to some hives' recommendations, proposals, or policy-changes. In the context of SOCIO-BEE, drawing from the knowledge acquired in the project INTERLINK, we follow this map and we have accommodated it to our objectives. Therefore, for the engagement tools to be devised in T2.5 and adopted in WP5 we should envisage the upper quadrants of the Figure where the level influence will be top having more or less engagement on the activities carried out in the context of the project. Therefore, we can foresee that if the public bodies, organizations, or municipalities are less concerned or interested, we can only aim at informing or consulting them. However, if SOCIO-BEE can attract their interest, we will witness scenarios of real cooperation and coproduction of experiments and air quality campaigns. The level of influence has been already identified here while the strategies to boost the engagement were reviewed in D2.3.

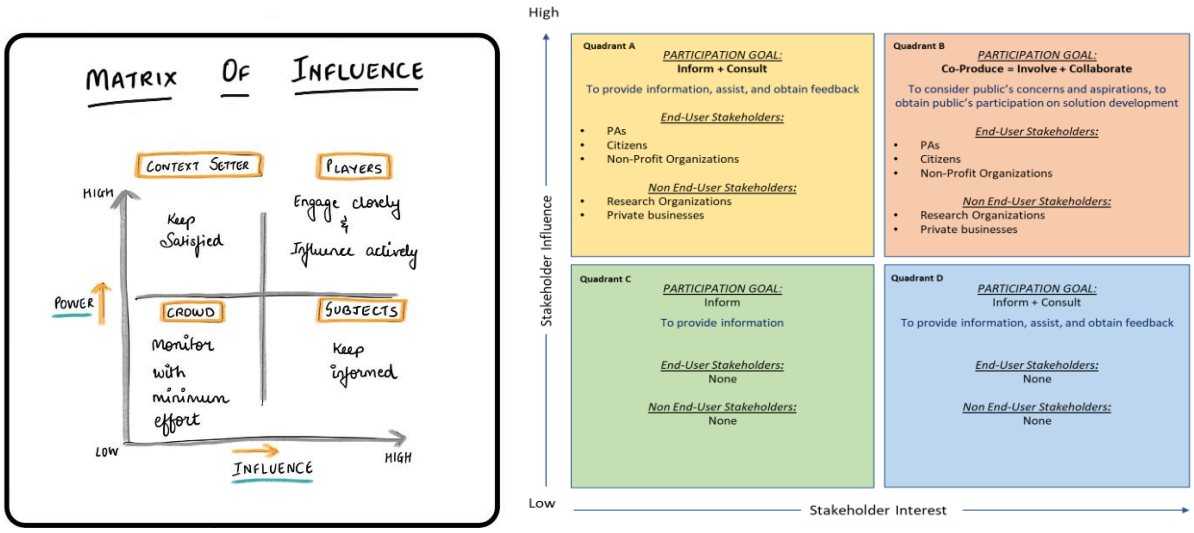

Figure 9. SOCIO-BEE stakeholders' influence vs interest matrix adapted from INTERLINK project

8 Mapping bears' involvement with the SOCIO-BEE aspirations

We deem that there are different types of activities that can be carried out to attain the participation objective associated in SOCIO-BEE with the influence and interest of stakeholders analysed earlier and taking into consideration the barriers and needs detected on each pilot site. Therefore, hereafter, we list some of the activities we envisage in SOCIO-BEE for the collaboration of public sector, enterprises or organizations and the citizens through the different levels of participation.

8.1 Catalogue of activities

Here can be found a summary of some possible activities that could be organised for each engagement phase. This list of activities should serve as a guideline for pilot owners' planning activities when it comes to involve bears. The list of potential activities will be transformed on actionable tools in T2.5 after the agreement of all WP2 and WP5 partners. Some of the proposed activities are interwoven with engagement actions proposed in D2.4 and communication activities of WP8.

INFORM + GUIDE candidate activities (Here the role of drone bees is paramount):

- Training Sessions (e.g., how to outreach scientific results). For that, final air quality data (already curated and validated) per pilot is needed.
- Seminars with public bodies. For that, it is important to have clear measurable objectives and actions carried out.
- Promotional activities in the local area where the hive will be created.
- Briefings (to reach out to established groups of bears).
- Public Meetings with local authorities.
- Articles in local press.
- Appearance in local social media channels.
- Bilateral meetings.

- Policy briefs

CONSULT candidate activities:

- Community building through communication. It is important to understand which channels are effective to reach decision makers.
- Focus groups (to explore attitudes and opinions in depth) or World Cafes. Specialized researchers are needed for this activity.
- Public Meetings & Hearings with open discussion at the end. Invitations to decision makers is of hight importance.
- Public Workshops with open discussion at the end.
- Evaluation processes inviting relevant stakeholders (for example, just before to launch an experiment)
- Pre-Evaluation Sessions (e.g., think aloud evaluation and heuristic evaluation)
- Mid-Evaluation Sessions (e.g., interviews, open-ended questions in questionnaires, contextual inquire sessions)
- Post-Evaluation Sessions (e.g., interviews, open-ended questions in questionnaires, surveys and open calls for guidance for future endeavours)

WORK WITH candidate activities:

- Community building through collaboration. It is important to understand which channels are effective to reach decision makers.
- Focus groups (to explore attitudes and opinions in depth) or World Cafes. Specialized researchers are needed for this activity.
- Evaluation process inviting relevant stakeholders to participate in the election of themes to explore.
- Administration of questionnaires during the pilots while SOCIO-BEE is in use for the co-creation of citizen science experiments
- Consensus Workshops (to identify shared objectives, values, and agreement).
- Hackathons where public bodies and citizens will be present and teaming up together.
- Challenges or contests where the outcomes can be transformed into policies recommendations.

Consequently, Table 8 provides a catalogue of such activities drawn from the Public Participation Guide[6], the scientific literature [10] , and previous projects of public participation through digital means (e.g., WeLive) organised by Activity Type. It is important to note that “Inform and Consult” activities are carried out for end-user stakeholders with a priori low interest (see Quadrant A in Figure 9) with the goal of raising awareness towards the SOCIO-BEE solution so that such stakeholders can become more interested and move to Quadrant B in such a Figure.

[6] https://www.epa.gov/international-cooperation/public-participation-guide

Table 8. Catalogue of Activities that can be carried out with bears per Participation Goal

	Inform	**Consult**		**Co-create / Co-Produce / Co-exploit**	
				Involve	**Collaborate**
PARTICIPATION GOAL	To provide to bears with balanced and objective information.	To obtain bears' feedback.		To consider bears' concerns and aspirations (e.g., climate change actions) for CS-based experimentation on air quality.	To achieve bears' participation on solution development and delivery of public interest citizen science experiments.
BEARS' ROLE	They are informed.	They are informed, listened to, and their concerns acknowledged in the project if they participate.		Bears' concerns and aspirations are taken into consideration, and they are provided with feedback about outcomes.	Bears are also prosumers that participate in the co-production of citizen science experiments addressing air quality enhancement in cities or districts.
ACTIVITY TYPE	**INFORM + GUIDE**	**CONSULT**		**WORK WITH**	
Potential Activities	*Recruitment and onboarding.*	*Bears' pro-environmental awareness.*	*Experiment definition and roll out.*	*Results evaluation and outreaching.*	*Hives' Replication.*
	- Public Meetings - Training Sessions - Seminars - Policy Briefings (to reach out to established groups)	- Focus groups (to explore attitudes and opinions in depth) - Public Meetings & Hearings	- Pre-Evaluation Sessions (e.g., think aloud evaluation and heuristic evaluation) - Mid-Evaluation Sessions (e.g., interviews, open-	- Focus groups -Consensus workshops (to identify shared values and agreement).	- Ensure that everything is open source and well documented. - Facilitate the reachability of the results through FAIR principles.

	-Printed information (Factsheets, Newsletters, Leaflets, Posters, and Bulletins) - Websites - Information Repositories - Information Hotlines and Kiosks - Press and Media - Social Media - Exhibitions & Stands	- Public Workshops -World Cafes (fostering open discussion of a topic/aspect)	ended questions in questionnaires) - Post-Evaluation Sessions (e.g., interviews, open-ended questions in questionnaires)		

Very linked with the deliverable D2.4 of T2.2 in which different engagement strategies were offered for attracting citizens, in the following Table 9 we provide a list of potential actions to attract bears to the hives for each of the Activity types identified in Figure 7.

Table 9. Engagement and feedback mechanisms and methods per engagement category

ENGAGEMENT PHASES AND AIM		ENGAGEMENT MEANS AND METHODS	ENGAGEMENT MEASUREMENT AND FEEDBACK FROM STAKEHOLDERS (KPIs)
INFORM	Raise awareness for SOCIO-BEE project and the co-creation tools and toolkit for engagement and policymakers' awareness.	● Different communication methods and channels ● Marketing communication mix ● Multichannel marketing strategy ● Ear to mouth ● Word of mouth	● How many organizations are aware of the results or the hive creations. ● Number of externals informed about SOCIO-BEE experiments' results. ● SOCIO-BEE platform usage from external users.

GUIDE	To give guidance on how to use the SOCIO-BEE citizen engagement and co-creation services and tools (associated to campaign blueprints driven from SOCIO-BEE toolkit).	● (Online) workshops and tutorials ● Hackathons ● Contests	● How much public interest from organizations and public bodies back the science experiments and how often have been accessed to better understand their development. ● Usability and user experience evaluation.
CONSULT	To obtain bears' feedback on the SOCIO-BEE tools and associated co-creation methodology and resulting citizen science experiments and associated resources.	● Interviews, questionnaires, surveys ● Reports	● Satisfaction level. ● Perceived quality of co-created public interest citizen science experiments and supporting SOCIO-BEE tools by policymakers and public bodies. ● Acceptance ● Provide funding
WORK WITH	To achieve more profound and active engagement, collaboration and use (empowerment) of the SOCIO-BEE framework by different stakeholder groups where bees and bears are involved	● Service design tools for collaboration ● Elements that support all actors' engagement and collaboration	● How many new SOCIO-BEE citizen science experiments have been co-created involving bears. ● In-app questionnaire, Online survey, in-depth interviews (acceptability).

9 Tips for engaging and communicating with policy makers

In the existing literature there are many documents and pieces of research related to how researchers and the public can involve policymakers. In the following, we provide a list of potential ideas to guide the involvement of those actors on each of the phases or categories described above based on existing evidence [11][12][13][14][15].

1. **Get involved:** Be reliable and willing to engage and, in time, you will beginto be recommended by others.
2. **Understand the policy environment and stay up to date:** Take the time to research the people you'll be interacting with.
3. **Be timely:** Get involved with policy and decision-making processes early on.
4. **Connect to current priorities:** Understanding of the policy agenda and its pipeline of initiatives should be coupled, when possible, with demonstrations of the potential citizen science impact on constituencies, and this could increase such commitment. A clear policy strategy for citizen science initiatives would help ensure they are perceived as useful for policy.
5. **Plan your approach:** Different policy makers work atdifferent levels so you will need to tailor your language and message appropriately to connect with them.
6. **Tell a relevant and engaging story:** Create a narrative to bring your research to life. Create human interest with stories, case studies and graphics that are relevant to them.
7. **Be a generalist as well as a specialist:** Policy makers won't necessarily always expect,need or want to know about the minute details of a particular study, but instead the wider areas of your subject.
8. **Rid yourself of imposter syndrome:** Policy makers don't expect you to know everything.
9. **Be certain about uncertainty:** Beclear and open, use language that is easy to understand and try not to make it into the big issue you may think it is.
10. **Be objective:** Make it obvious when giving your own personal opinion or when using a scientifically informed one. Referring back to what the evidence says can add clarity to your answer and highlight that you are acting as a knowledge broker.
11. **Build trust:** Making a difference to science or the (local) environment and its acknowledgement by policymakers are key motivations of participants in environmental citizen science projects. It can therefore be expected that the uptake of policy-relevant citizen science projects will depend on the public's confidence in whether the outcomes will lead to actual change.
12. **Ensure Data quality and management:** Data quality, comparability and interoperability are considered essential for both evidence-based policy-making and scientific evidence. At the same time, the capacity of citizen scientists to deliver high-quality and reliable data is one of the most debated issues in citizen science. Try to ensure data accuracy that complies to standards.
13. **Remember, science is not everything, but must be open (see** Figure 10**) :** As long as you can convey the message as best you can and give them evidence that can be used to inform their decision, that is all that can really be expected of you. Be open and apply FAIR principles. Although a majority of CS projects claim to provide access to raw or aggregated data, they not always apply appropriate use conditions or well-defined licences.
14. **Don't give up!** One important aspect to take from our recommendations is that they will not always yield immediate, tangible rewards, but this should not be the sole aim of practicing good engagement. Rather, ongoing, long-term engagement can lead to a change in the overall policy framing of problems and solutions, something which can occur diffusely over long timescales.

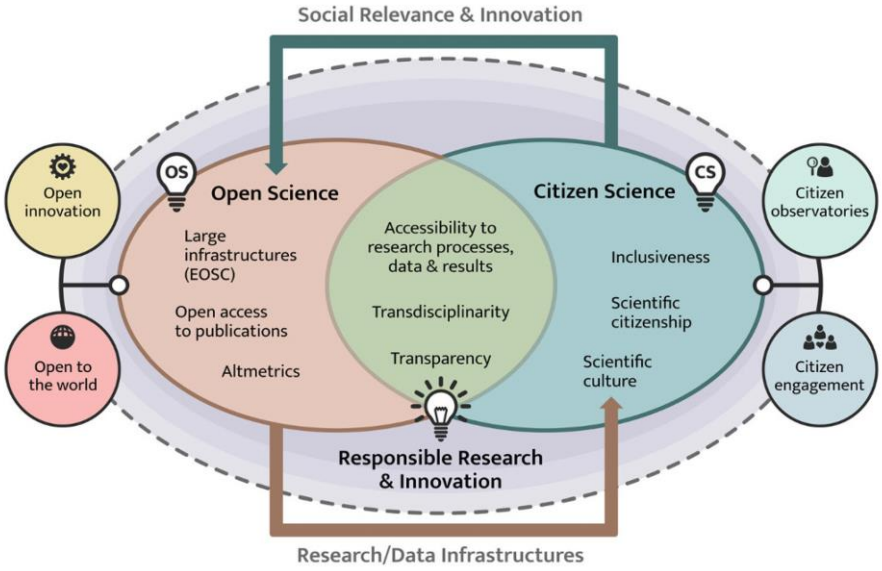

Figure 10. The relationship between citizen science and open science

10 Conclusions & next steps

In this deliverable, which is the second version of two (D2.5 and D2.6), we have addressed the rationale behind the co-creation in SOCIO-BEE hives. Furthermore, we have explained the important bear role in detail. For them, we have introduced a methodology to involve such actors in the different phases of the hive with different levels of involvement as well as we have introduced some examples of the methodologies that can be used to make them be informed, consulted, guided or jointly collaborated in the hive endeavours. Finally, we provided barriers to involve bears obtained from the first pilot iteration and we have provided an initial list of activities that should be put in practise to overcome the identified barriers. Finally, some tips to involve policymakers are given. The list of actions and tips should be used by drone bees, QBs and beekeepers to ensure that the hive outcomes will inform future policy recommendations.

Putting the focus on the first pilot iteration, it demonstrated positive progress in addressing identified barriers, but further investigation and refinement of strategies are essential to maximize the effectiveness and impact of SOCIO-BEE activities and in actively engaging Bears. The experience gained from this initial pilot will serve as valuable insight for pilots to continually enhance stakeholder engagement and overcome potential challenges in future implementations. It is worth noting some of the materials provided in this deliverable will be used differently on pilots with higher or lower experience in citizen-based projects. By participating in citizen science activities, the different pilots are fostering a deeper connection with their local communities and creating a pathway for citizens to actively contribute to important environmental and public health issues (hopefully to be transformed in evidence-based policy recommendations). The report is clear on some recommendations that must be put in practice:

1. Make data available to ensure that bears can be informed and with the data available, they can guide, be consulted, or even involve them on the overall CS process.
2. Provide a useful and actionable list of tools to ensure effective communication with bears.
3. Find ways to easily interpret the results obtained on the campaigns so policymakers can better understand the impact of the measurements on some areas.
4. Make sure to explain that available data is reliable and that use common standards.

5. Try to engage all actors at all means making the citizens contributions to be translated into a tangible impact. For that, the main recommendation is to visualize the role of the bears in the campaigns and the way they are involved to transform data into policy recommendations.

Next steps

Whereas the task is completed, the work to involve decision makers has not finished yet. The next steps are:

1. to create custom made materials to involve bears in each pilot city;
2. to inform WP54 and WP5 about the necessity to have data available (not only raw data, but contextualised information which enable people take informed decisions based on data); and
3. find a digital tool that helps to foster ideation,co-creation and co-execution on each new hive created.

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Annex I

Maroussi stakeholder map

Iteration	*Bear*	*Activities*	*Barriers of engagement*	*Motivations to participate*	*Recruitment strategies and channels*	*Support*	*What do you need from the SOCIO-BEE Consortium?*	*How do you plan to involve Bears? (i.e., inform, guide, consult, work with)*
0	*Municipality of Amaroussion*	*Act as recruiter, social Media streaming, advertise SOCIO-BEE project and promote its objectives through all available communication channels (newsleters, social media, events, etc.), knowledge sharing, provide technical and finacial support for the CS campaigns, writing and disseminating conclusions, discussing the results, policy making also based on CS findings*	*Lack of awareness, lack of time, contribution not translated to impact, limited engagement between volunteers and organisers, lack of financial resources*	*View real time (air quality) information, make evidence-based decision making, build trust between municipality and citizens, contribute to scientific knowledge, seeing change in local neighborhood, have information on other projects, have access to high quality data, share concerns with citizens, improve local neighborhood, develop new technologies, health conditions, think about future generations*	*In-person social and learning events, traditional media channels (TV, radio, newspapers), conferences or events related to smart cities, pro-environmental applications/ solutions for local authorities, etc.*	*Technical support, network creation, provide physical/online space for communication and collaboration, minimize preparation time*	*Brochures, presentation, guidelines*	*INFORM, GUIDE, CONSULT*

1	*Department of Environmental Planning, Municipality of Amaroussion*	*Social Media streaming, advertise SOCIO-BEE project and promote its objectives through all available communication channels (newsleters, social media, events, etc.), knowledge sharing, discussing the results, policy making also based on CS findings*	*Lack of awareness, lack of time, contribution not translated to impact, lack of financial resources*	*View real time (air quality) information, make evidence-based decision making about urban planning and green planting, build trust between municipality and citizens, co-create change in local neighborhood, have access to high quality data, share concerns with citizens, health conditions, think about future generations*	*In-person conferences or events related to smart cities, pro-environmental applications/ solutions for local authorities, etc*	*Technical support, network creation, provide physical/online space for communication and collaboration, minimize preparation time*	Access to results	INFORM, GUIDE, CONSULT
1	*Department of Civil Protection and Public Health, Municipality of Amaroussion*	*Social Media streaming, advertise SOCIO-BEE project and promote its objectives through all available communication channels (newsleters, social media, events, etc.), knowledge sharing, discussing the results, policy making also*	*Lack of awareness, lack of time, contribution not translated to impact, lack of financial resources*	*View real time (air quality) information, make evidence-based decision making for urgent events and/or long-term planning on public health, build trust between municipality and citizens, have access to high quality data, share*	*In-person conferences or events related to smart cities, pro-environmental applications/ solutions for local authorities, etc*	*Technical support, network creation, provide physical/online space for communication and collaboration, minimize preparation time*	Access to results	INFORM, GUIDE, CONSULT

		based on CS findings		*concerns with citizens, improve health conditions, think about future generations*				
1	*Office of Planning and Resource Allocation, Municipality of Amaroussion*	*Act as recruiter, social Media streaming, advertise SOCIO-BEE project and promote its objectives through all available communication channels (newsleters, social media, events, etc.), knowledge sharing, provide technical and finacial support for the CS campaigns, writing and disseminating conclusions, discussing the results*	*Lack of time, lack of financial resources*	*Raise awareness and enhance citizen engagement, view and share real time (air quality) information, build trust between municipality and citizens, contribute to scientific knowledge, share concerns with citizens, develop new technologies*	*In-person conferences or events related to smart cities, pro-environmental applications/ solutions for local authorities, etc*	*Technical support, network creation*	*Brochures, presentation, guidelines*	*GUIDE, WORK WITH*
2	*Maroussi Public Transport Service*	*Act as recruiter, provide technical and finacial support for the CS campaigns, potential policy making based on CS findings*	*Lack of awareness, lack of technical knowledge, lack of time, technical*	*View real time (air quality) information, share concerns with policymakers and other stakeholders, proceed to informed decision*	*Through internal channels of the municipality websites with extensive information (e.g., publications,*	*Technical support, training, feedback, design lesson/training packages, minimize preparation time, establish*	*Brochures, presentation, guidelines, WSNs, email/phone support from technical partners for ad-hoc questions*	*INFORM, GUIDE, CONSULT, WORK WITH*

			limitations of sensors or apps, lack of financial resources	*making,learn new skills, receive information on how to reduce environmental footprint, have access to high quality data, improve local neighborhood, health conditions, think about future generations*	*tools, resources, news, events, data etc.), in-person social and learning events, provide resources / incentives to employers*	*communication channel with hive, network creation, provide access to collected data for processing and visualisation*		
2	*Women's association*	*Act as recruiter, social Media streaming, advertise SOCIO-BEE project and promote its objectives through all available communication channels (newsleters, social media, events, etc.), knowledge sharing, investigate inclusivity aspects and be consulted for gender equality issues, writing and disseminating conclusions, discussing the results, policy making also*	*Lack of awareness, lack of technical knowledge*	*Receive information on how to reduce environmental footprint, think about future generations, enhance gender equality in CS activities, seeing change in local neighborhood, have information on other projects, share concerns with policymakers and other stakeholders, be involved in a community initiative, health conditions*	*Through internal channels of the municipality, workshops, e-WOM, in-person social and learning events, brochures, email*	*Technical support, network creation, training, feedback, establish communication channel with hive, provide access to collected data for processing and visualisation, design training packages*	*Guidelines, templates, leaflets*	*INFORM*

		based on CS findings						
2	*Universities / Research institutes*	*Raise environmental awareness among the local population, act as recruiter, social media streaming, knowledge sharing, advertise SOCIO-BEE project and promote its objectives through personal socail accounts, communicate and support hives and hives' creation, provide technical support for the CS campaigns, recommendations for policy making also based on CS findings*	*Lack of awareness, lack of technical knowledge, lack of time, lack of financial resources*	*Contribute to scientific knowledge, lreceive information on how to reduce environmental footprint, have information on other projects, have access to high quality data, share concerns with policymakers and other stakeholders, interest in new technologies, develop new technologies, health conditions*	*Word of mouth, in-person social and learning events, provide resources / incentives to employers, brochures, email websites with extensive information (e.g., publications, tools, resources, news, events, data etc.), email, existing channels of specific groups, conferences or events related to climate change, air pollution, citizen science, etc.*	*Establish communication channel with hive, technical support, network creation, provide access to collected data for processing and visualisation, training, feedback, provide space for communication and collaboration, design training packages*	*Guidelines, Templates, Leaflets*	*INFORM, GUIDE*
2	*Researcher groups and researchers*	*Searching for information, raise environmental awareness among the network*	*Lack of awareness, lack of technical*	*Contribute to scientific knowledge, learn new skills, have fun, view real*	*Word of mouth, in-person social and learning events, provide*	*Establish communication channel with hive, technical support,*	*Guidelines, templates, leaflets, training material, WSNs*	*INFORM, GUIDE, WORK WITH*

		(scientific community, students, etc.), act as recruiter, social media streaming, knowledge sharing, advertise SOCIO-BEE project and promote its objectives through social accounts, organize, design and run CS campaigns, hypothesis testing, what if scenarios, communicate and support hives and hives' creation, participate in CS campaigns for data collection, hypothesis testing, drawing and disseminating conclusions, discussing the results and potentially make recommendations	*knowledge, lack of time, technical limitations of sensors or apps, inflexible employer, lack of financial resources*	*time (air quality) information, receive information on how to reduce environmental footprint, have information on other projects, have access to high quality data, share concerns with policymakers and other stakeholders, career development, interest in new technologies, develop new technologies, develop STEM capacities*	*resources / incentives to employers, training videos, brochures, email, websites with extensive information (e.g., publications, tools, resources, news, events, data etc.), workshops, conferences or events related to climate change, air pollution, citizen science, air quality sensors, etc.*	*network creation, provide space for communication and collaboration, provide access to collected data, financial support, feedback, design training packages*		

Zaragoza stakeholder map

Iteration	*Bear*	*Activities*	*Barriers of engagement*	*Motivations to participate*	*Recruitment strategies and channels*	*Support*	*What do you need from the SOCIO-BEE Consortium?*	*How do you plan to involve Bears? (i.e., inform, guide, consult, work with)*
1	*One representative from each of the organisations: Ibercivis, FKC, Zgz*	*Support amd foster activities participantion in their facilities. Promote the results.*	*inflexible employees, lack of financial resources.*	*Have access to high quality data.Seeing change and improve in both local organzations and citizens*	*Social media, newsletters, press, word-of-mouth marketing*	*Feedback, provide physical/online space for communication and collaboration*		Work With
2	*Zaragoza City Council*	*Support amd foster activities participantion in their facilities. Promote the results.*	*inflexible employees, lack of financial resources.*	*Have access to high quality data.Seeing change and improve in both local organzations and citizens*	*Social media, newsletters, press, word-of-mouth marketing*	*Feedback, provide physical/online space for communication and collaboration*		Work With
2	*Zaragoza City of Knowledge Foundation*	*Support amd foster activities participantion in their facilities. Promote the results.Adequate their green behaviour according to the defined activities.*	*technology not user-friendly*	*Have access to high quality data.Being involved in a community initiative*	*Social media, newsletters, press, word-of-mouth marketing*	*Feedback, provide physical/online space for communication and collaboration*		Work With
2	*Ibercivis Foundation*	*Support amd foster activities participantion in their facilities. Promote the*	*Time constraints, success in content adaptation and*	*Have access to high quality data.Being involved in a community initiative*	*Social media, newsletters, press, word-of-mouth marketing, workshops*	*Having a positive feedback about their behavior changes*		Work With

		results.Adequate their green behaviour according to the defined activities.	*engagement strategy*					
2	*Representatives of the Water and Environment documentation center*	*Adequate their green behaviour according to the defined activities.*	*lack of awareness, lack of technical knowledge, contribution not translated to impact, lack of financial resources*	*learn new skills, seeing change and improve in local organization/facilities, share concerns with policymakers,*	*Social media, newsletters, press, word-of-mouth marketing*	*Having a positive feedback about their behavior changes*	*Access to the data captured in the campaigns (honey), in order to elaborate the hypotheses.*	Guide

Ancona stakeholder map

Iteration	*Bear*	*Activities*	*Barriers of engagement*	*Motivations to participate*	*Recruitment strategies and channels*	*Support*	*What do you need from the SOCIO-BEE Consortium?*	*How do you plan to involve Bears? (i.e., inform, guide, consult, work with)*
1	Municipality of Ancona	Recruiter, searching for information, journalist, dissemination	Lack of time	Influnce policy makers	This stakeholder is a partner of the project	It should be consulted for people recruiting; for disseminating activities and for pilot coordination	Access to the sociobee data in order to draw some conclusion about air pollution's sources and their impact on the health	INFORM/GUIDE/WORK WITH/CONSULT
2	ARPAM	Data collector	Barriers in getting data from them	Influence policy makers, contribute to scientific knoledge,	There is a direct contact between the municipality and this stakeholder, plus use of social media and press	Technical suppport, feedback, and provide space for communication online	They could need the data collected from the campaigns to use it and analyze them	INFORM

2	Researchers of UNIVPM	Searching for infromation, data analyst, writing and disseminating on conferences, research journals, sensors installation and data collection	limited access to data, sensors malfunctioning	Contribute to scientific knowledge	People that already working on the project as researchers plus use of the social media of university, municipality channles (Telegram, Whatsapp)	Have support in collecting data from sensors	Template and guidelines to present the project and to lead the participants of the campaign execution and also easy access to data to analyze them	INFORM/GUIDE/WORK WITH/CONSULT
2	ASUR Marche	recruiter, searching for information, dissemination	Complex communication	Contribute to rise up the quality life of elder people	Direct contact with eledrly people and general practitioner, social media and newspaper articles, municipality channles (Telegram, Whatsapp)	cClear communication with project responsibles and bears	They could need the data collected from the campaigns to use it and analyze them	INFORM