Cos4Cloud

Co-design as a service

METHODOLOGICAL GUIDE

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METHODOLOGICAL GUIDE

Cos4Cloud

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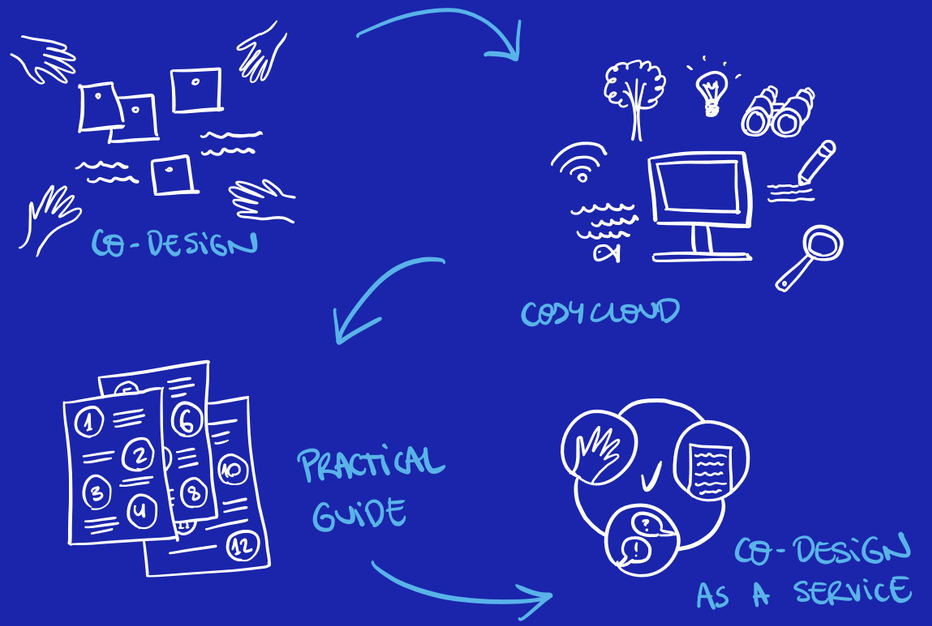
EXECUTIVE SUMMARY

Executive summary

This guide results from the experience and lessons learned in co-designing thirteen technological services within the Cos4Cloud project. The technological services were created from a bottom-up approach, following a co-design process connected to an agile software development methodology. The co-design team implemented the co-design process as a service within the Cos4Cloud consortium, as stated in task 5.2. The result of implementing the co-design framework and methodologies and the corresponding monitoring during the co-design of the services, were evaluated and adapted to be shared with the citizen science community as a methodological guide.

The present methodological guide includes an introduction to the world of co-design, where the main definitions and mindsets of co-design and design thinking are given, as well as some tools to start applying the creative methodologies within them. Secondly, it introduces the co-design methodology followed in Cos4Cloud, together with some important concepts, such as citizen science and citizen observatories. Then, a practical guide of implementation is given, including all the co-design methodologies used in Cos4Cloud. The most standard methods include a description and a work map template, while the customised ones incorporate a step-by-step guide to implement them. Finally, an explanation is given on how the co-design process was implemented in Cos4Cloud as a service for software developers, by using three interactive platforms that allowed us to perform all creative sessions. The document concludes with an invitation to implement co-design processes in other software development projects.



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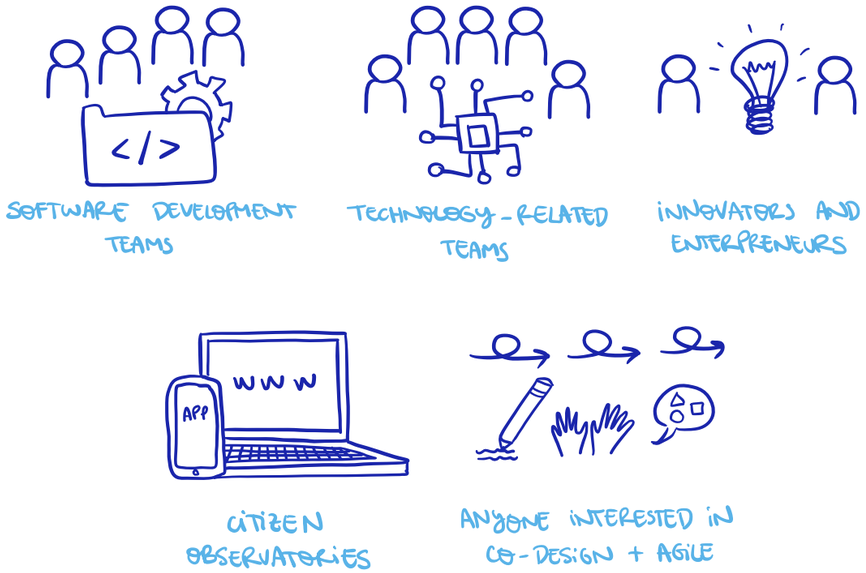
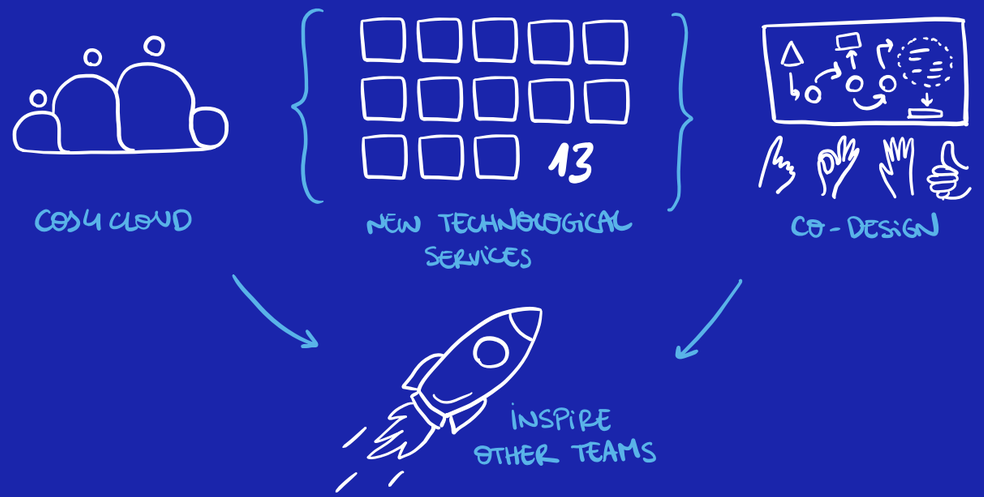
Who is this guide for?

This booklet can serve as a reference guide for:

- Any **software development team** that wants to **include a new human-centred perspective** in the development of their services.
- Any **technology-related team** that wants to **achieve more innovation** in their projects.
- **Innovators and entrepreneurs** of all types playing a part in technological design and development.
- Citizen observatories and other **citizen science institutions** or platforms that want to **carry out the co-design process** used in Cos4Cloud.
- **Anyone interested in co-design being applied together with agile methodologies**.





Why is this guide relevant to the reader?

This guide shares the co-design journey carried out within the Cos4Cloud project, a European Horizon 2020 project that has developed 13 new technological services to help citizen observatories to increase the quantity and quality of their observations.

In it, you will find the processes, tools and methodologies that were used throughout the duration of the project to address different challenges with an interdisciplinary approach. The co-design process contributed to solving complex problems using a simple language and working collaboratively with the potential users of the services and other relevant stakeholders.

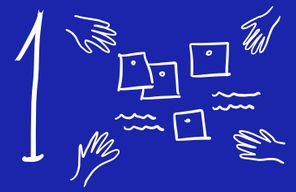
Beyond being a tool for reference, we hope this guide will inspire other software development teams that are interested in involving users in a more direct and complete way, to create a design and development culture that combines a human-centred approach with the agile methodologies they are used to working with.

What learning objectives does this guide offer?

1. **To understand the design thinking approach, the co-design process and co-design methodologies**, their relevance and how to apply them.
2. **To influence traditional ways of thinking in software development** by changing the mindset that users cannot be part of the development process itself. Co-design is not a consultation, it is a direct collaboration where users make decisions together with developers and other stakeholders.
3. **To redefine the value of users' opinions in the development ecosystem**, by challenging the status quo towards innovation.
4. **To empathise with users** throughout the lifecycle of a project.
5. **To be constantly waiting for new improvements proposed by users**, and not be afraid to change in order to progress and advance.
6. **To understand the co-design process followed within Cos4Cloud** and how the co-design team worked as a service for software developers.
7. **To inspire other software development teams** to apply these methodologies in their daily work.

How is the guide structured?

The contents in this booklet are distributed in **four main sections**. These are:



The world of co-design

Here you will find the main definitions and mindsets of co-design, as well as some tools you can use to get started in the world of co-design.

The co-design methodology in Cos4Cloud

In this section, the concepts of citizen science and citizen observatories are presented, and we explain how we used co-design in the Cos4Cloud project.

A practical guide of implementation

This is the most hands-on part of this guide. In it, we introduce all the co-design methodologies that we used in Cos4Cloud, as well as a step by step guide to implement the most complex and relevant ones.

Co-design as a service

This final section is a conclusion of the whole process. We explain how we implemented co-design as a service within the Cos4Cloud project by using three online platforms, and we encourage you to do the same in your own projects.

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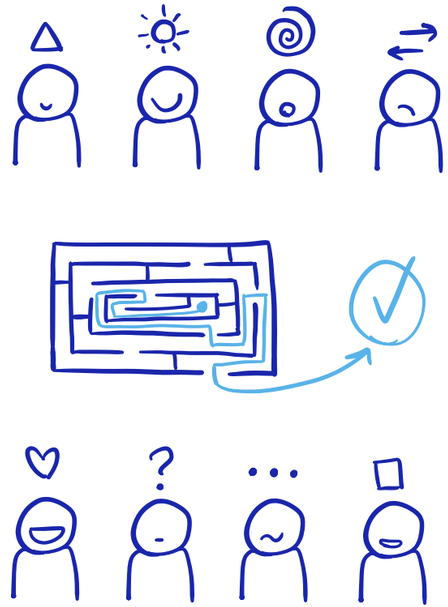
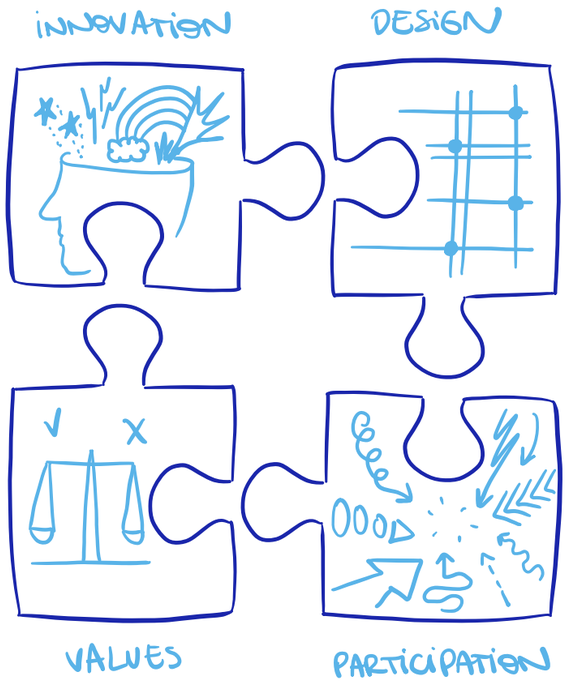
What is co-design?

Co-design is a creative practice that **enables a wide range of people to make meaningful contributions in the formulation and solution of a problem**. The term “co-design” is often used as an umbrella term for other concepts, such as co-creation, open design process, collaborative creative process, participatory design process or design thinking process.

It is defined as the practice of **collaborative product or service development**. Or it has also been defined as the **joint creation of value**, since it reflects a fundamental change in the traditional designer-client relationship. It goes beyond consultation by building and deepening equal collaboration between all the stakeholders that are attempting to resolve a particular challenge (Trischler et al., 2019).

Therefore, it involves the participation of stakeholders and end-users in the product/service design and development processes to find a solution that suits their context. Actually, in a co-design process, the users are considered “experts” of their own experience and their needs and concerns become central to the design process.





Co-design is a human-centred and creative approach to problem solving. This is why there are four factors always present in any co-design process:

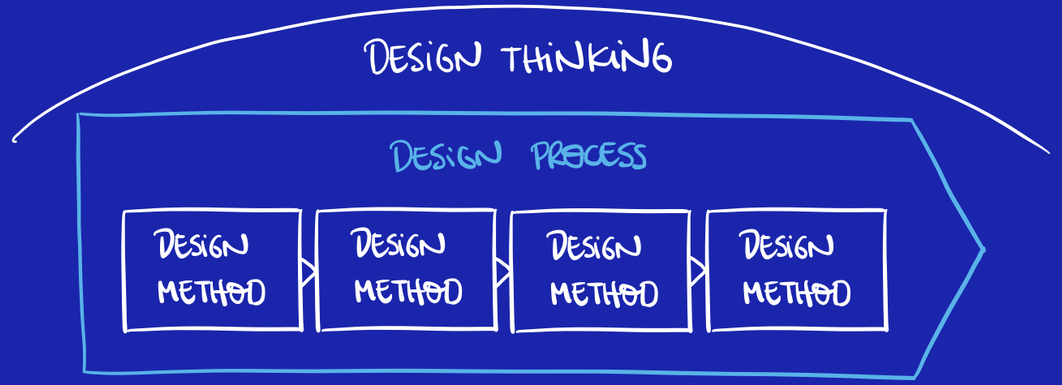
- **Innovation**. Thinking outside the box thanks to the application of creative and lateral thinking methods and techniques entails coming up with new ideas and unexpected solutions.
- **Design**. As the word itself states, co-design is used for designing. That means, creating something smart and useful that did not exist before and that has a relevant meaning – e.g. it solves a problem.
- **Values and social considerations**. This refers to the "co-" in "co-design". Having a participatory and collaborative approach is not always easy, since it implies cultural and demographic differences, as well as different goals, perspectives and attitudes.
- **Participation and democratisation**. The balance of power in a group of individuals that need to make decisions and co-produce new knowledge needs to be taken into account.

The broad picture

There are three terms that help describe a co-design process:

1. **Design thinking**. An approach to designing that supports innovation and intelligent change. It is a human-centred approach which is driven by creative and analytical thinking, customer empathy and iterative learning.
2. **Design process**. A systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve or satisfy human needs or wants and to narrow down the possible solutions to one final choice.
3. **Design methodologies**. Procedures and techniques for designing. There are hundreds of methods that a designer might use within a design process. Since co-creation was created, design methods are the tools that designers use to externalise the design process, to let anyone be a designer.

So design thinking would be the big umbrella under which a design or a co-design process can be defined, using design methods and techniques.



If we add a “co-” at the beginning of each of these areas, we have the same for co-design.

Design thinking

In the field of design, creativity is the operating engine of any process. For this reason, the design thinking approach is based on creative intelligence, which is a type of intelligence born from the combination of various subjective aspects of personality. These are: the temper of an individual, the way they perceive reality, the way they process information, their personal values, their reaction to different situations, the way they do things and achieve goals, and other subjective elements linked to behaviour, attitude, imagination and knowledge (Micheli et al., 2018).

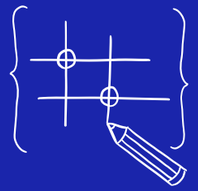
Design thinking allows using creativity as the most ordinary work tool, while benefiting everyone who is involved in it. In its use, it is necessary to take a creative attitude and an open mentality, and follow the following recommendations:

1. Show what you want to explain, instead of describing it.
2. Focus on empathy and human values.
3. Communicate clearly and consistently.
4. Use experimentation to think and learn, not just to validate an idea.
5. Be aware of the process being followed and the goal to be achieved.
6. Focus on action.
7. Work from collaboration and diversity.

(Co-)design process

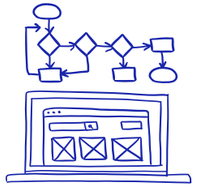
In general, every creative process – that is, any process where you create something that did not exist before (an idea, a product, a concept, a service, etc.) – consists of a challenge or need as starting point, a final implementation of the solution, and the following five phases in between (Kwon et al., 2021):

Empathise: Know the context and the users. Empathy is the foundation of every user-centred design process. In order to understand the needs of a user, you need to feel empathy towards them, and so, observe them and analyse their behaviour in the context in which they move. You also need to interact with them and generate dialogues, as well as to experience what they experience.

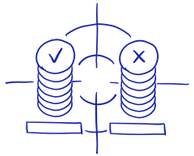


Define: Frame the needs, challenges or goals. The definition phase takes place when the results obtained in the empathy phase are unpacked and synthesised into specific needs, in order to pose a specific challenge to be solved from this point. It is necessary to develop a deep understanding of the user and their environment, as well as to determine the point of view from which they will try to find an answer to their needs.

Ideate: Think of possible solutions and select one. The ideation phase is the phase in which ideas are generated to respond to the defined challenge. It is a phase where you need to open your mind to explore a wide solution space, where there can be a large amount and diversity of ideas. At the end of the ideation process, you need to evaluate the proposed ideas and select the final solution to your challenge, in order to move on to the next phase.

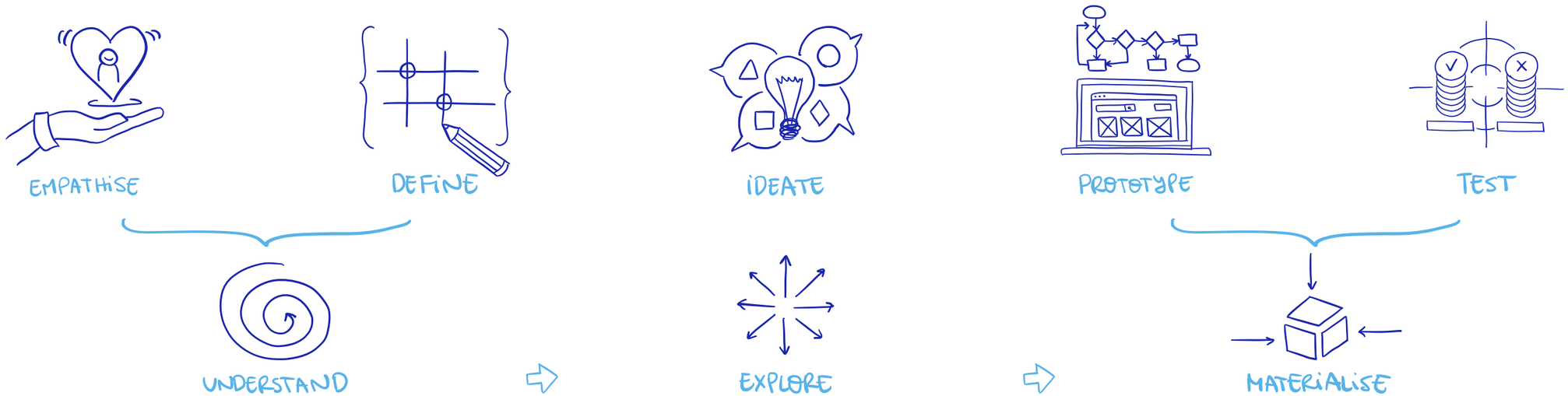


Prototype: Turn your solution into a reality. Prototyping is the phase in which the chosen solution is given shape. A prototype can be anything that has a physical form. Prototypes allow for experimentation and interaction, and can help drive deeper empathy as well as make a solution tangible, visible, and thus, more understandable.



Test: Evaluate your solution, make changes and repeat. This last phase offers the opportunity to test and evaluate the developed prototype with real users, in order to be able to improve and perfect it. It is an iterative phase in which you should try to find out if the solution found is adequate, if it needs to be modified, or if another solution needs to be considered.

The first two stages serve to understand the situation, the third one helps explore possible solutions, and the last two are used to materialise the selected solution.



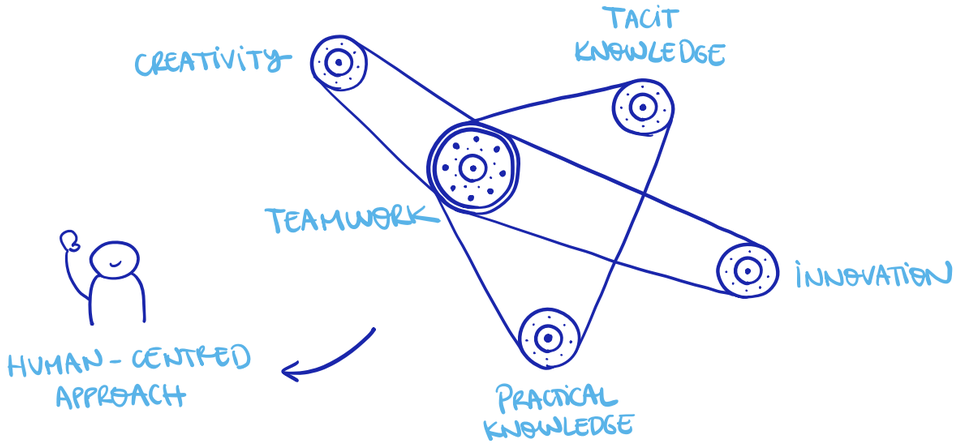
(Co-)design methodologies

We call design methodologies all those methodologies that are used in the field of design to conceptualise and develop new products and services. They all use creativity as their engine and offer the possibility to structure conversations around meaningful information.

The vast majority of these methodologies are applied in teams – this is why we usually talk about co-design methodologies. They are characterised by having a human and society-centred approach and a problem-solving perspective. They also encompass a very broad set of creative methods, techniques and resources that can be applied to address different problems or challenges in a wide variety of fields by interdisciplinary groups (Hanington and Martin, 2019).

The key aspect in the use of these co-design methodologies is the high level of innovation that can be achieved. This is because the techniques applied within them intend to use the two types of knowledge that humans have: the tacit knowledge and the practical knowledge (Wijngaarden et al., 2020). Tacit knowledge includes everything a person knows without knowing how to express it. Practical knowledge refers to the way a person does something based on previous experience, unconsciously.

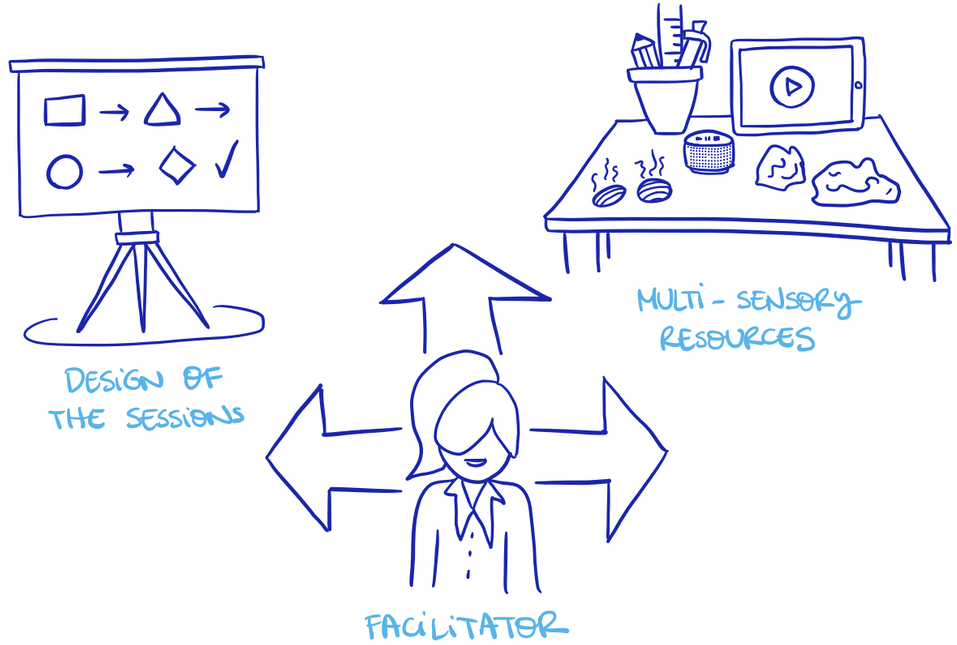
The combination of these two types of knowledge in a shared experience makes it possible to visualise aspects that are impossible to detect through the use of other methodologies.



There are three indispensable aspects in the application of co-design methodologies:

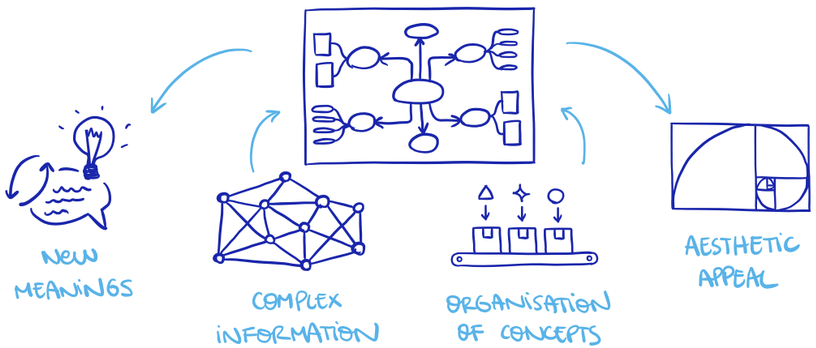
1. **The design of the sessions.** Since these methodologies are used in teams, it is necessary to design the work sessions well. This means creating a structure of the methods that will be carried out, with a specific time dedicated to each part of the session, and the selection or creation of the work materials.
2. **The consideration and use of multi-sensory resources.** In the field of design, visual information is very relevant, but also olfactory, tactile, gustatory and auditory. The use of images, sounds, and other materials that can be touched and manipulated is always a help to offer a more complete session and attend to the different receptive and interpretive capacities of the participants.
3. **The role of facilitator.** The facilitator is the person in charge of organising the sessions and moderating them. This person is the one who encourages the participants to express their thoughts and ideas, and to generate a creative and cooperative atmosphere.

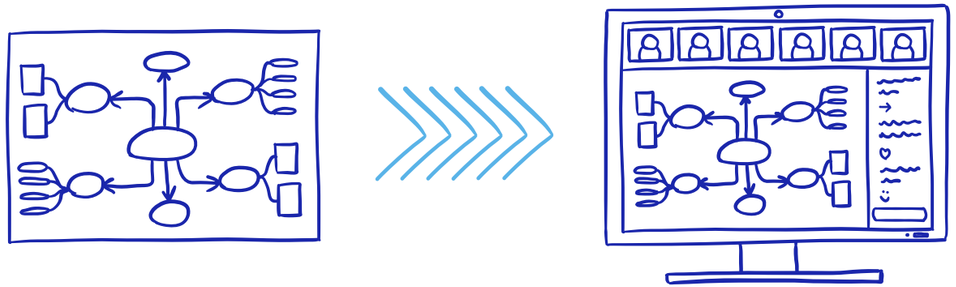
As stated by Wehrmann and van der Sanden (2017), design is a means of finding solutions to all kinds of problems in a systematic way. This is why co-design methodologies have the capacity and the potential to infiltrate other areas of knowledge, research and development.



The use of concept maps and collaborative boards

Concept maps are a graphic technique that shows information organised in a hierarchical way, as well as other relationships between concepts (Romero et al., 2017). These types of maps are beneficial because they (a) make it possible to establish new relationships between concepts and thus new meanings; (b) help understand complex information; (c) promote agility and skill in the organisation of concepts in a specific subject; and (d) have high visual impact, simplicity and aesthetic appeal.





In the last years, and mainly due to the COVID-19 pandemic, many online collaboration tools that facilitate remote co-creation have emerged. Collaborative boards, in particular, are a very useful tool for having co-design workshops remotely. They allow you to create your own templates or use predesigned ones and, with an easy click, give access to anyone. They also allow asynchronous work and different options for downloading the information within them.

A user-centered approach

In all the phases of the co-design process, we will consider the users' requirements as the basis and starting point, as well as a source of possible improvements for the service. Why?

1. To design for the users and their tasks.
2. To maintain consistency and simplicity by using a natural dialogue with the users.
3. To receive adequate feedback and therefore implement adequate solutions.
4. To provide adequate navigation mechanisms and consequently maximise usability.

On the other hand, when involving users in any design process, we need to bear in mind that there will be very specialised users, and very nontechnical ones. Therefore, we have some responsibilities:

1. Reduce unnecessary mental effort by the users.
2. Motivate the users so that they feel valuable.
3. Acknowledge any idea as a good idea for co-creation. When brainstorming, quantity is better than quality.
4. Keep the users tuned with future developments of the project/product/service, to enhance the community.

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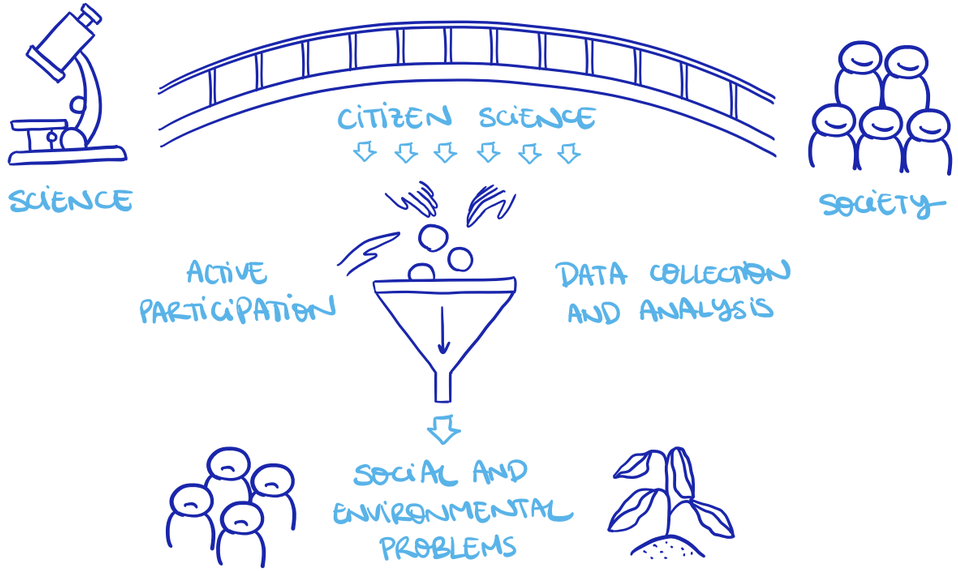
Citizen science and co-design

Citizen science is seen as a growing practice in which scientists and citizens collaborate to produce new knowledge for science and society (Vohland et al., 2021).One of the most expanded forms or approaches of doing citizen science today is the collection of data resulting from the observation of biodiversity and environmental monitoring. In this kind of process the scientific method is implemented by non-experts, typically as part of a collaborative project with experts and other stakeholders involved.

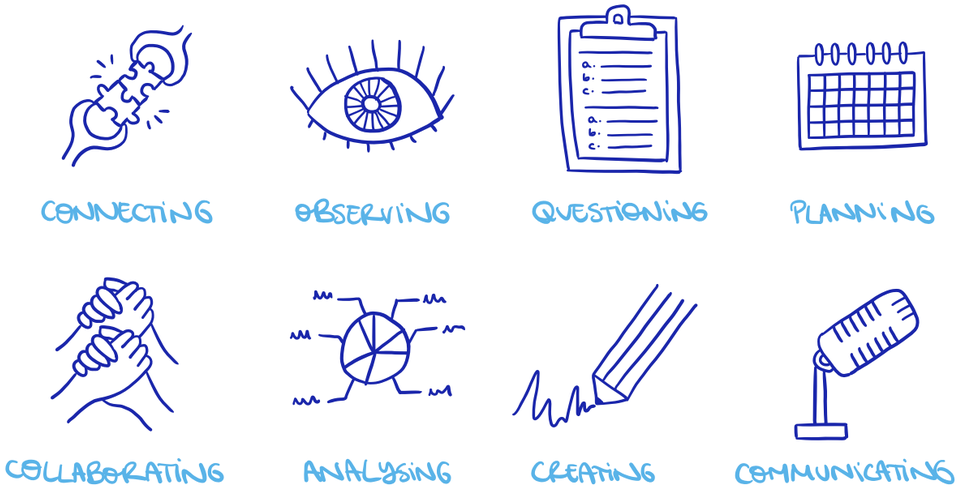
Citizen science represents a bridge between science and society, since there is active participation of citizens in scientific research, which in turn contributes to solving social and environmental problems and challenges.

Citizen science processes empower citizens to be able to reach new perspectives and data that would be unknown to science if these types of processes were not used. This is due to the fact that citizens live together with social and environmental problems every day, which makes it possible to carry out a much deeper investigation if it is done hand in hand with them.



The following steps are crucial in any citizen science project:

1. **Connecting**. Putting together, either digitally or in person, all the people needed to carry out the project.
2. **Observing**. Empathising with the problem or need and analysing what is happening.
3. **Questioning**. Nothing is one hundred percent true or false; we should have all perspectives taken into consideration and have a research question in mind.
4. **Planning**. Just as any other research method, planning is one of the most important steps; even more when the project includes multiple and non-expert collaborators.
5. **Collaborating**. Co-investigating, co-analysing, co-creating, co-deciding.
6. **Analysing**. Data analysis is what can help us make decisions and move forward.
7. **Creating**. Coming up with solutions to the initial problem or research question.
8. **Communicating**. All research needs to be communicated to the scientific community, the media and the general public.



There are many methodologies that can be used in citizen science processes. **Citizen observatories and co-design methodologies are great allies**.

Citizen observatories and co-design

Citizen observatories

They are spaces for **citizen collaboration**. They support the collection, analysis and sharing data of citizen science initiatives.

Their objective is to **collect information**, in order to carry out analysis and generate recommendations

The information provided can be **quantitative and/or qualitative**, and is generally referred to as **data**

Citizen observatories **bring to science observations and measurements** that would not otherwise be contemplated

Citizen observatories need technology to be **able to store and compare data**

Co-design methodologies

They are **collaborative methodologies** that arise from the field of design

Their objective is to allow a diverse group of people to **work collaboratively to create something new**

Its greatest contribution is the **high degree of innovation** that can be achieved when applying them, as opposed to other more traditional methods

Thanks to their multi-sensory techniques, they **facilitate complex conversations** in an apparently simple way

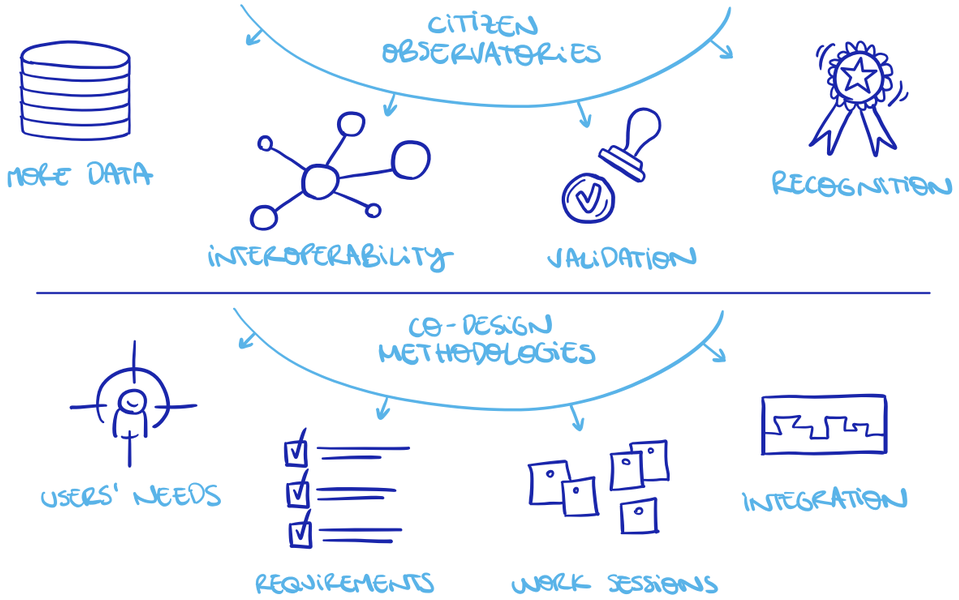
They allow the generation of a **common language between different stakeholders** around a need, challenge or problem

Why would we put these two concepts – citizen observatories and co-design methodologies – together? Well, because there are some **challenges that citizen observatories face every day**, such as:

1. The need for more data, everywhere and at all times
2. The need to improve interoperability and standardisation
3. The need to validate observations and data
4. The lack of recognition towards citizens who provide observations

In Cos4Cloud, we applied a co-design process and co-design methodologies to address these issues, by **co-creating 13 new open technological services** that citizen observatories can incorporate or use. And how did we do this?

1. By experiencing and documenting users' needs
2. By collecting requirements and common challenges faced by citizen observatories.
3. By conducting work sessions with our co-design community
4. By integrating the co-design process with the agile methodologies used by software developers



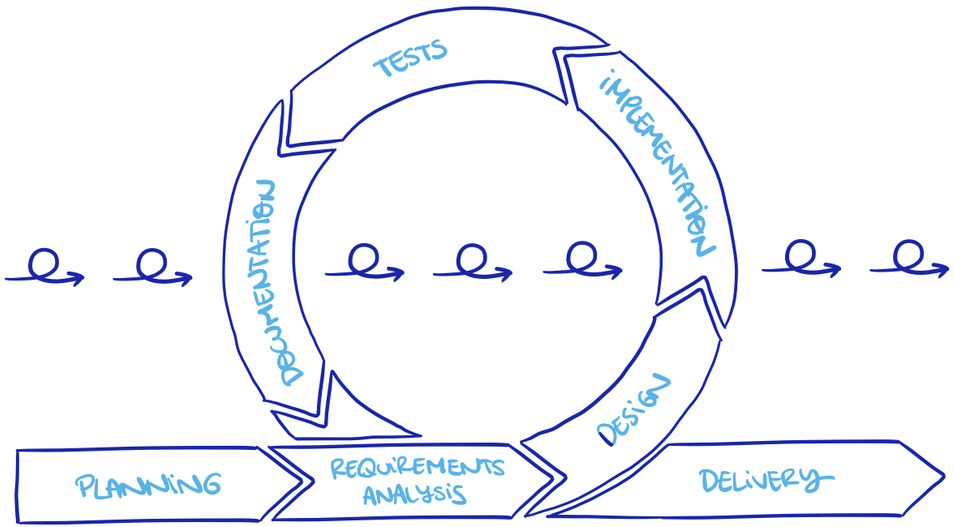
Agile software development and co-design

Agile software development comprises diverse methodologies characterised by applying a collaborative effort to make requirements and solutions evolve continuously. These methodologies are used in self-organised and cross-functional teams, and they include their users' opinions within the process.

Agile methodologies are increasingly applied in software development, as they offer numerous benefits: they advocate adaptive planning, evolutionary development, and continuous improvement. Thanks to an early delivery of small changes and advances, a rapid and flexible response to change is achieved.

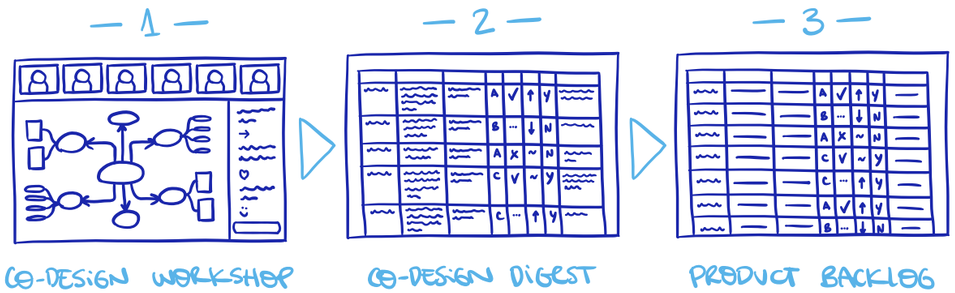
These methods can support the creation of complex products and services by minimising up-front planning and helping developers to learn continuously from different feedbacks.

Agile software development is iterative, and each iteration has a full development life-cycle: planning, requirements analysis, design, implementation, tests, documentation and delivery.



Now, how do we make agile development and co-design coexist?

What we did in Cos4Cloud was integrate the outcomes of co-design workshops with different stakeholders to the backlogs of software developers.



We performed various workshops, each of them with a specific objective and methodology. Once a workshop was done, we created what we called a co-design digest, which consisted of a table with the fields on the following page.

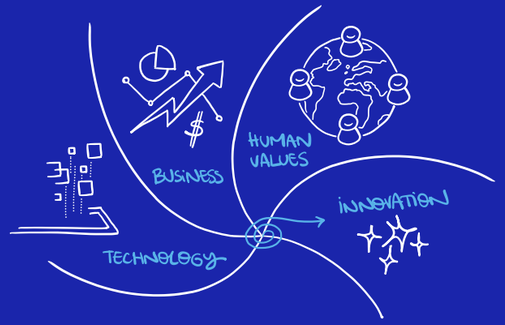
1. **Users' input**. What was collected in the workshop.
2. **Description/doubts**. A comment on what the person wanted to say with that, and/or if there were any doubts regarding the input.
3. **User story**. A transformation of the users' input into a valid user story.
4. **Category.** General category to which the input referred (engagement, interoperability, AI, documentation, quality, sustainability, search, statistics, GDPR, UX/UI, etc.)
5. **Status**. Not done, in process, done.
6. **Relevance**. High, medium, low.
7. **Decision**. The decision that the software developer made about integrating that comment or not in their service. This field was a yes/no question.
8. **Why?** The reason why the developer had agreed or not in integrating each of the users' inputs. This also served to give feedback to the workshops' participants on which of their comments and opinions had been taken into consideration or not, and why.

Thanks to these co-design digests, software developers could easily integrate the co-design outputs in their daily work.

Multiple perspectives in co-design

By using co-design methodologies, we seek to achieve innovation while aiming to fulfil the technological, business-related and human-related interests:

1. **Technological interests**: feasibility and sustainability.
2. **Business-related interests**: viability and effectiveness.
3. **Human-related interests**: usability and desirability.

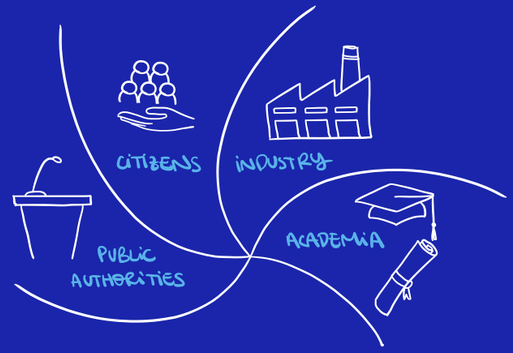


Through the use of technology and considering human values, we achieve creativity. With technology and business in mind, we can perform a detailed analysis. Finally, considering viability and effectiveness together with human values, we achieve empathy. These are the three pillars of innovation.

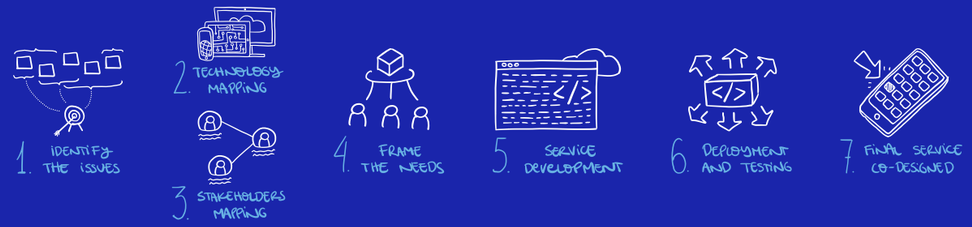
If we want to address all these interests, we find it crucial to follow the quadruple helix model for stakeholder engagement in the co-design process, which includes the involvement of:

- Governments and public authorities
- Citizens, civil society associations, citizen science observatories and NGOs
- Industries, SMEs, local businesses and clusters
- Academia, experts and scientists

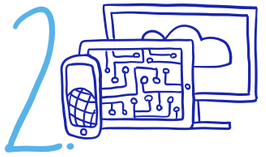
The objective of this engagement scheme is to find a common agenda to walk towards specific objectives to advance in the process. With this model, the main protagonists of innovation-generating processes interact to accelerate the transfer of research and innovation results and increase growth in society.



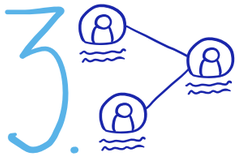
The 7 phases of the co-design process in Cos4Cloud



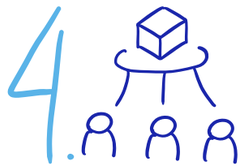
Identify the issues. In this first phase we try to understand the context, challenges and issues related to the specific context being studied. We also focus on detecting aspects of improvement and growth perspectives, to better understand the needs that should be addressed with the service being co-designed. Besides, we observe and analyse some aspects that we believe are key, such as interoperability, end users' perspective, open data, participation strategies and access mechanisms.



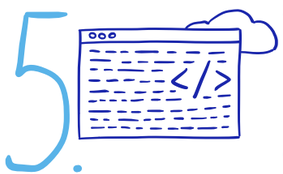
Technology mapping. In this phase, we analyse other existent technological services available. We analyse our possible competitors while we also look for references of platforms, user interfaces, architectures, functionalities and other aspects that could be interesting for us in the future. Here we should also identify technical, human, political, cultural, scientific and other possible constraints we might face, in order to search for new opportunities. an answer to their needs.



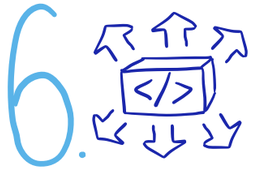
Stakeholders mapping. At this stage, we analyse who are the key stakeholders to consider and involve in the co-design process, following the quadruple helix model. We establish how to address them (their motivations, risks, barriers, mitigation strategies, and recruitment) and what incentives/ recognition for participating we should use. Some questions we should ask in this phase are: Are all the quadruple helix stakeholders represented? Is this needed in the specific case? How are they going to be involved and engaged? Are they all participating in all the phases? Why?



Frame the needs. This stage is dedicated to identifying and clarifying the needs from the users' points of view, as well as from a technological perspective, considering all the information gathered in previous stages. We should specify what has to be done within the software development and why, in which context (where and when), by who and for whom, and how.



Service development. In order to give continuous inputs to the software developers, two parallel and complementary strategies need to be implemented: agile and co-design. By combining these two, we create an evolving mechanism that rapidly adapts to new changes and allows for software developers to have a wide view of the context, and for users to participate in the process. So this part is where the co-design workshops take place. In this phase, we should also have in mind that service design should be open, interoperable, integrable and accessible.

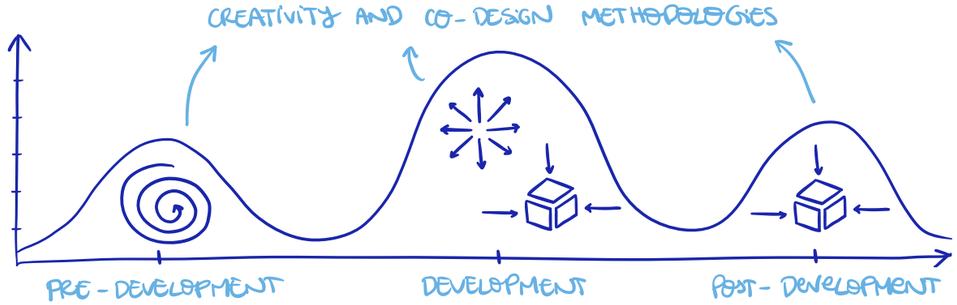


Deployment and testing. In this phase, the co-designed service is in place, offered to users and open to feedback. This feedback is collected so that the software developers can make improvements if necessary and detect errors. Both the functionality and the desirability should be tested, considering aspects such as quality, usability, appearance, ease of use, motivation and speed.

Final service co-designed. Once the final service is designed and launched, we discuss the outcomes, gather the lessons learnt and list the conclusions of the experience of co-designing.

The different phases can relate to the 5 stages of the design process, encompassed between the detection of a challenge and the implementation of a solution.

As we see in the description of the phases, it is in the service development phase where the visible part of co-design happens, since it is when we involve external participants. However, co-design methodologies can also be used in internal meetings before and after the development, just as we did in Cos4Cloud. The following section includes the methodologies that can be used before, during and after the service development phase.



Cos4Cloud co-design phase	Standard design process phase	Action
Identify the issues	Challenge	
Technology mapping	Empathise	Understand
Stakeholders mapping		
Frame the needs	Define	
Service development	Ideate	Explore
	Prototype	Materialise
Deployment and testing	Test	
Final service co-designed	Implementation	

A PRACTICAL GUIDE OF IMPLEMENTATION

Pre-development co-design methodologies 70
Service development co-design methodologies 80
Post development co-design methodologies 94
Other complementary formats 100

There is a huge variety of methodologies that can be used at any phase of the co-design process, and there are others that are more appropriate for a specific phase. You can find plenty of online databases with methodologies that can inspire you in your service development process (e.g. Service Design Tools, Hyper Island Toolbox, Design Kit, Session Lab, etc.).

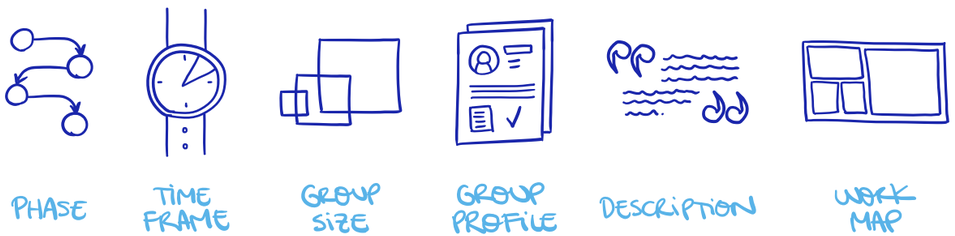
You can either use one methodology alone, or mix different methodologies in one and create your own.

In Cos4Cloud we used some standard methodologies for the pre-development and post-development phases, while we created our own mixed methodologies for the service development phase. We did it this way because it allowed us to customise the co-design workshops in a way in which we could gather a lot of information in a single session.

All the methodologies we used at some point in the process are listed in the following table:

Pre-development co-design methodologies	Service development co-design methodologies	Post-development co-design methodologies
Identify the issues Technology mapping Stakeholders mapping Frame the needs	Service development	Deployment and testing Final service co-designed
1. Brainstorming graphic organisers 2. Mind mapping 3. Concept mapping 4. Stakeholders mapping 5. 5W1H	Customised methodologies: 1. Wheels 2. User stories 3. Parallel boards	1. Usability testing 2. Usability reporting 3. Value opportunity analysis

In the following sections, all these methodologies are explained. For each of them, we summarise in a table the phases in which they should be used, an approximate time frame to carry them out, an ideal group size, and the profile of the participants we would do the activity with. We also include a definition and a work map structure. For the customised methodologies, more information is displayed, such as the standard methods on which they are based, the discussion scope (broad or narrow, abstract or concrete), the stage of development in which the service should be (initial, intermediate, advanced), and a step by step list.



All these methods can be applied both in online and face-to-face sessions. The only difference is preparing the work maps in a collaborative online board, or in a printable format.

Brainstorming graphic organisers

Pre-development

Phase	Time frame	Group size	Group profile
Identify the issues, Technology mapping, Stakeholders mapping, Frame the needs	20-40min	6-12 people	Technological service staff

Description

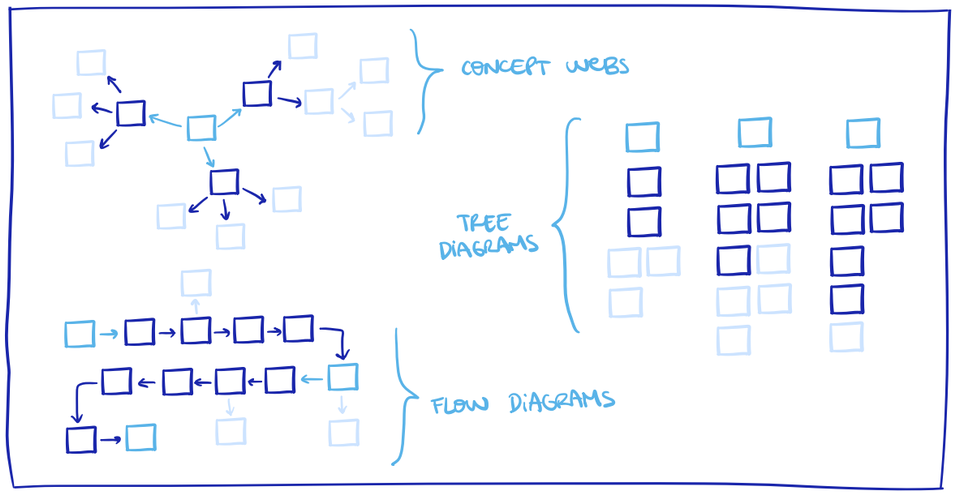
Brainstorming is a widely used method to generate new concepts in relation to a specific challenge or topic. It is about generating the largest number of ideas, accepting everything that comes out, without judgement or criticism.

Brainstorming creates a safe forum of free expression and association of ideas, which promotes creativity. This is why this technique is very useful whenever we need to have quantity over quality of ideas – and usually, when there is quantity, quality arises.

Brainstorming graphic organisers are structures that help generate new knowledge with the freedom of brainstorming, while following a specific visualisation framework, such as:

1. Concept webs, to develop a central question or topic.
2. Tree diagrams, to define hierarchy or a classification system
3. Flow diagrams, to show a process or cause and effect of interrelated elements within a system

Work map



Mind mapping

Pre-development

Phase	Time frame	Group size	Group profile
Identify the issues, Technology mapping, Stakeholders mapping	20-40min	6-12 people	Technological service staff

Description

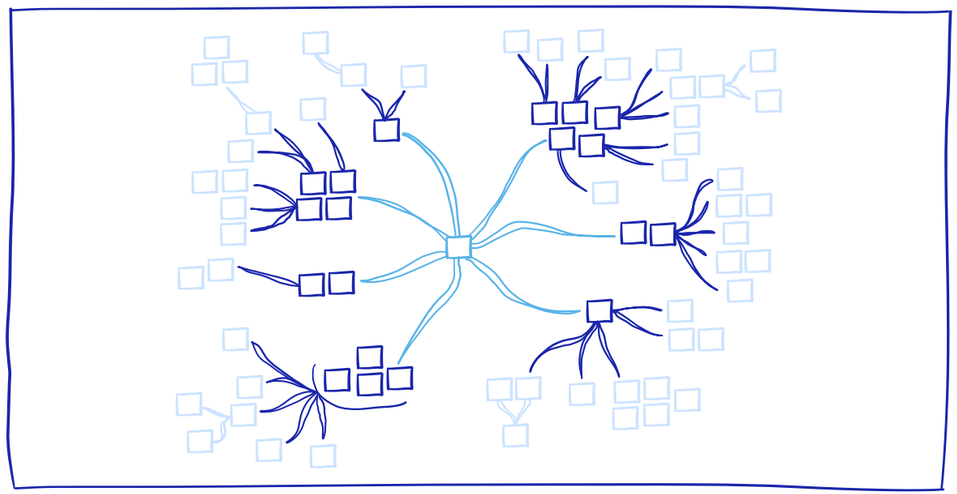
Mind maps are a very useful tool to capture in a simple scheme the ramification of concepts from a central concept.

The way people think is rarely linear. Our brains make neural connections in the form of networks, and the problems and challenges we face in our daily lives are interconnected with all parts of our reality in the same way.

Mind maps help capture these networks. It is a tool for visualising thought in a diagrammatic way, and is characterised by being a powerful mnemonic resource that promotes the understanding of a problem space.

To create a mind map, we just need to identify a core issue to work on, start drawing outward extensions and label them with simple verb-noun pairs or noun clusters. Once the primary connections are identified, we should continue making secondary connections and free associations, to expand the map more and more.

Work map



Concept mapping

Pre-development

Phase	Time frame	Group size	Group profile
Identify the issues, Technology mapping, Stakeholders mapping	20-40min	6-12 people	Technological service staff

Description

Concept maps are a tool that helps make sense of a set of ideas, objects, elements and/or events related to a specific topic.

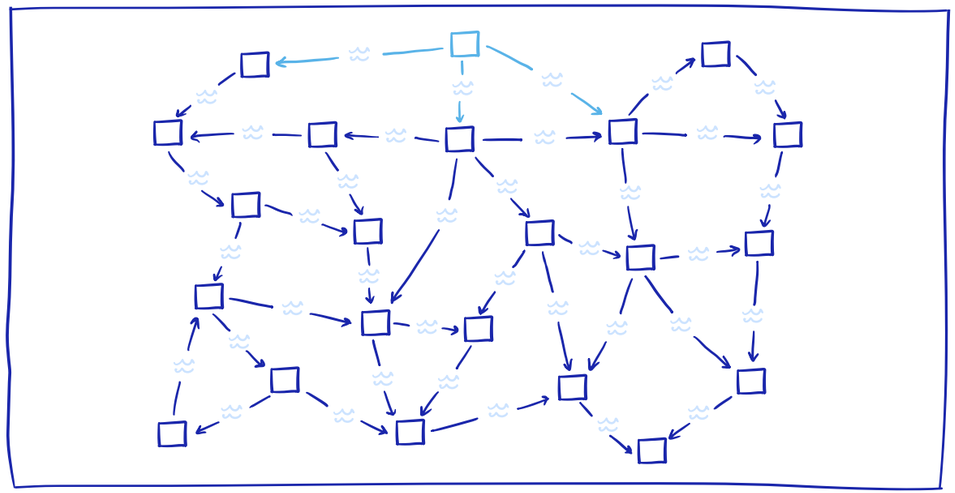
The starting point of any concept map is a set of individual and previously unrelated concepts, to which arrows and connecting words are added to give them meaning within the system.

Participants can add new concepts at any time, as well as remove those that do not make sense, modify those that are convenient, or group some into clusters.

In order to build a concept map, it is necessary to have a good understanding of the subject to be treated, since it is difficult to create a network of concrete concepts without such understanding.

The purpose of all the connections created in a concept map is to identify relationships between subdomains in the map and give meaning to all the parts that make up a system or reality.

Work map



Stakeholders mapping

Pre-development

Phase	Time frame	Group size	Group profile
Stakeholders mapping	20-40min	6-12 people	Technological service staff

Description

Stakeholder maps are a useful resource to identify and consolidate in a visual way all the people/ institutions involved in a project.

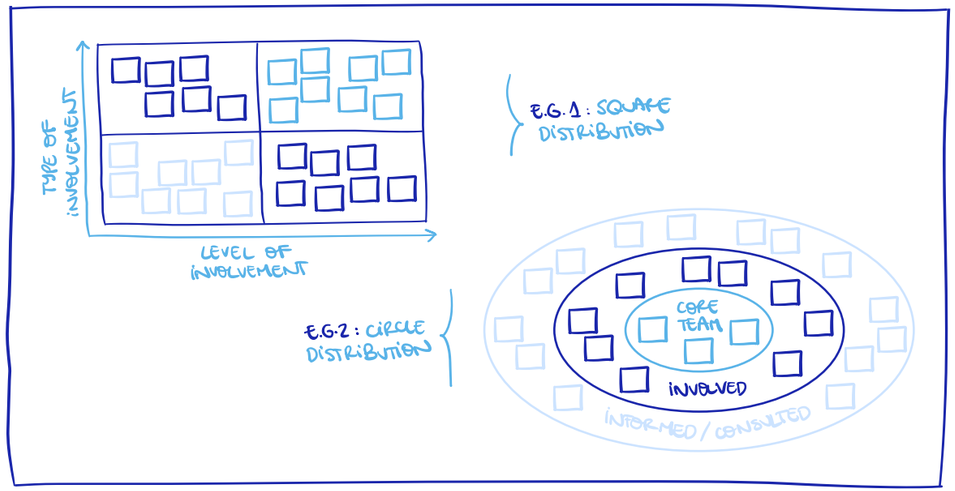
These maps are built at the start of a project to determine who is going to be engaged in the different phases, and in what way: who will be responsible, accountable, consulted, informed, etc.

Stakeholder maps are usually created in a speculative way, as a brainstorming, and it is important that it be done exhaustively, including all the people who are or can be of interest for the project.

In more advanced stages of the project, this map can and should be updated, generating a real map of who has been involved in the project at the end.

There are different ways of structuring the stakeholders: by sector, field, interest, expertise, level of involvement, etc. All of them are valid, and we will apply the one that is most useful for us each time.

Work map



5W1H

Pre-development

Phase	Time frame	Group size	Group profile
Frame the needs	20-40min	6-12 people	Technological service staff

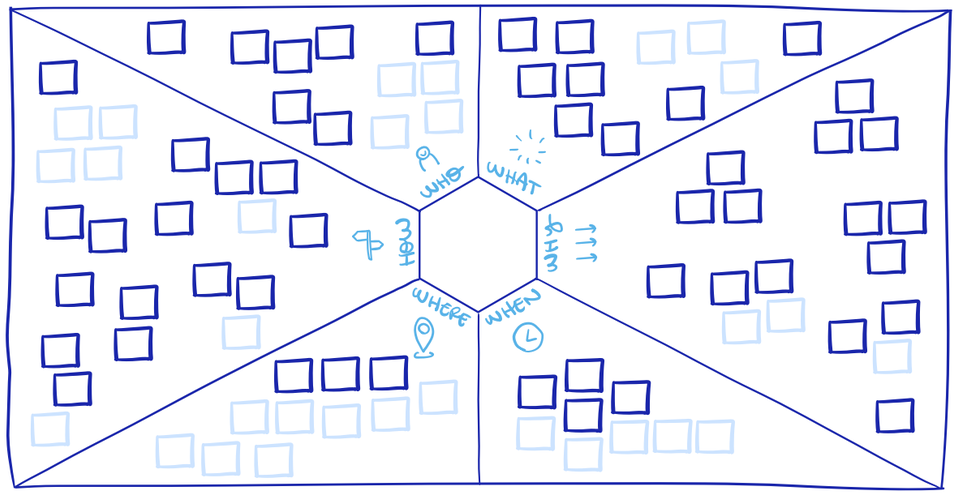
Description

5W1H is an acronym that refers to five words that begin with W and one that begins with H. These are: What, Who, When, Where, Why and How. These interrogative pronouns allow us to define the main terms of any problem, challenge, need or situation.

When starting any project, we need to ask ourselves the most basic questions to know where we are and determine the scope and purpose of what we are going to do: What problem are we going to address? Who is going to do it? When will it be done? Where will it take place? Why is it relevant? How are we going to do it?

These basic questions give us all the information we need to start moving in a direction. Without their answers, we would be lost. That is why this method is extremely suitable for phases in which we have to make decisions, set a scope, and be specific so that the whole team moves forward with the same vision in mind.

Work map



Parallel boards

Service development

Phase	Time frame	Group size	Group profile
Service development	120-240min	6-12 people	Technological service staff, experts, users

Description

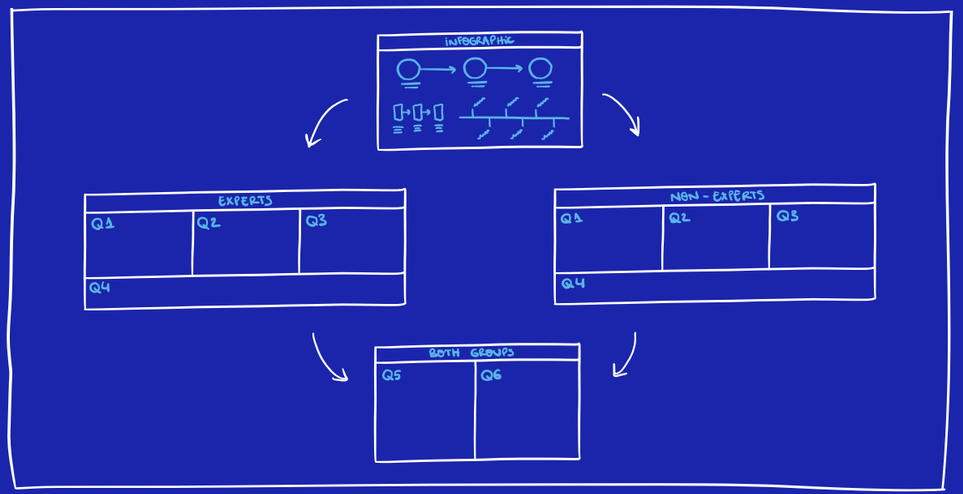
The “parallel boards” methodology arises from two very simple methodologies, from outside the realm of co-design. These are the interviews (from journalism) and the Q&A (Questions and Answers) format that is often used in conferences and forums. Both are based on a question and answer system, and this is how this collaborative methodology has been designed.

The fact that it is called “parallel boards” is because in the work map there are two boards that look identical but are not. One of them is intended for an expert audience, while the other is addressed to an inexperienced audience, and the questions asked in each one are different.

At the end of the dynamic, two general questions are asked to both groups of participants to conclude the session.

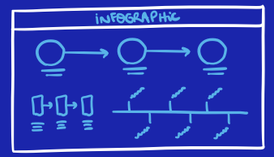
Based on	Discussion scope	Stage of development
Interview, Q&A	Users: broad, both abstract and concrete comments Experts: narrow, concrete comments	Initial

Work map



Parallel boards: step by step

1. Place yourselves on the upper part of the work map. Here you can find an infographic describing the service being developed. The software developer should explain how it works and at what stage of development it is.
2. Divide the participants into two groups. Experts (other software developers or technical profiles) should be in one of them, while non-experts (end users) should be in the other one.



3. One by one, go asking and answering the questions that are displayed on the map. These questions will be specific for each service and the software developer should be the one who writes them. Here is an example of questions for a specific service for environmental citizen observatories:
    a. Users: *How and for what do you use this service? What functionalities should it have? How should the service relate to the observatories that you use? How do you picture the user interface of the service or how would you like it to be? What environmental data might be relevant to include in the service and how could we classify them?*
    b. Experts: *What is your platform about and how does it work? What data does your observatory manage and how do you collect it? How do you process and validate those data afterwards? What environmental data might be relevant to include in the service and how could we classify them?*
4. Once both groups have answered all the questions, you can move into a common group to answer the concluding questions. If the two groups go at different paces and one of them needs more time than the other, you can also address these questions separately and then mix the answers afterwards. Here is an example of questions for the same service:

    a. Concluding questions: *What interesting interactions or added value can the service contribute to the observatories? What interesting interactions or added value can the observatories contribute to the service?*
    b. These concluding questions should spark some debate among participants. Set aside some time to let people discuss this point.
    c. Once the debate is over, you can conclude the session.
5. And... congratulations! You have finished the session and now you have new inputs for the service. Hooray!

Wheels

Service development

Phase	Time frame	Group size	Group profile
Service development	120-240min	6-12 people	Technological service staff, experts, users

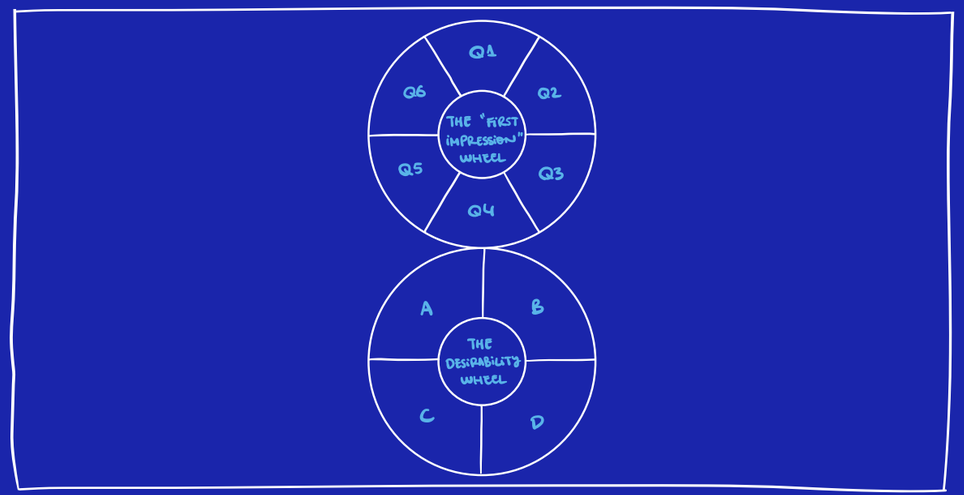
Description

The “wheels” methodology is based, on the one hand, on the SWOT analysis (Strengths, Weaknesses, Opportunities and Threats), which seeks to reveal the strong and weak points of a service, both internal and external.

On the other hand, this methodology is also based on desirability testing, which analyses whether a service – or a part of it – is liked or disliked by users, and how they would change or adapt it.

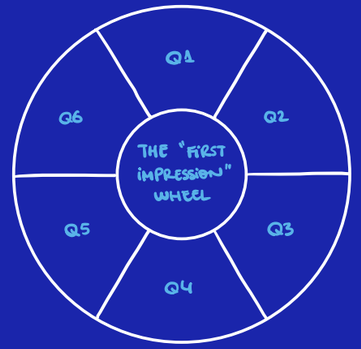
Based on	Discussion scope	Stage of development
SWOT Analysis, Desirability Testing	Very broad, both abstract and concrete comments	Initial, Intermediate

Work map

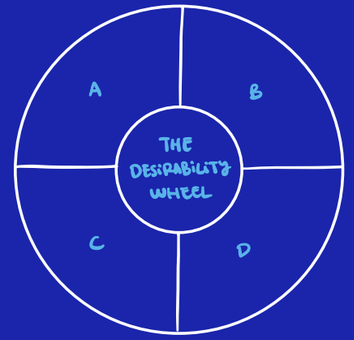


Wheels: step by step

1. Place yourselves on the upper wheel.
2. Starting at the top and going clockwise, go answering all the questions that are written on the wheel. These are:
   a. How would you use this service?
   b. What are the most interesting features? (strengths)
   c. Would you change anything? (weaknesses and opportunities)
   d. Is there anything missing? (weaknesses and opportunities)
   e. How can this service contribute to [*the main goal of the service; e.g. the quantity and quality of data in Citizen Science Observatories*]?
   f. What could go wrong? (threats)
3. At any moment during the dynamic, you can group similar ideas, categorise them, or organise them in any way in which they make more sense to you.



4. Once you are done, situate yourself on the lower wheel.
5. In the order you prefer, go filling in ideas about how you would like the service to be in relation to the four aspects shown. These are:
   a. Functionality
   b. Interface
   c. Architecture
   d. [*The specific topic your service is addressing; e.g. Citizen Science*]
6. Once you have filled all the areas with your thoughts, you can group the comments that are similar, categorise ideas or organise them as you prefer.
7. And... congratulations! You have finished the session and now you have new inputs for the service. Hooray!



User stories

Service development

Phase	Time frame	Group size	Group profile
Service development	120-240min	6-12 people	Technological service staff, experts, users

Description

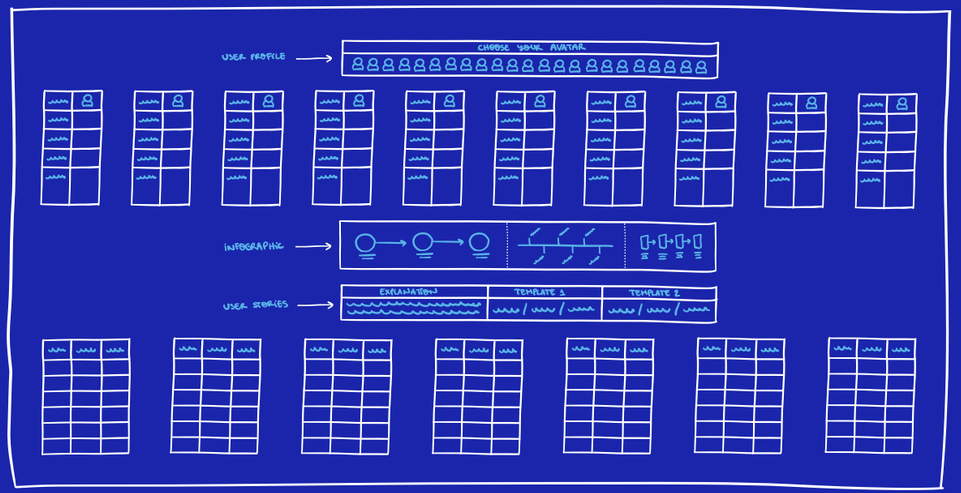
The “user stories” methodology is based on the affinity diagram, with which individual ideas are organised based on a specific structure.

Likewise, it is also based on the user journey maps, which capture in a storyline the different actions that a person does to accomplish a purpose.

Finally, and as its name indicates, it is also based on user stories, which are a resource used in software development to express a final goal of a service from the user’s perspective.

Based on	Discussion scope	Stage of development
Affinity Diagram, User Journey Maps, User Stories	Narrow, concrete comments	Intermediate, Advanced

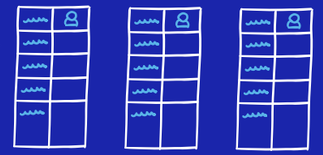
Work map



User stories: step by step

1. Situate yourselves in the upper part of the map.

2. Each participant needs to choose an avatar that represents them in some way and place it in one of the tables below.
3. Once you are situated on the individual tables, write down the information that is asked (this part is done individually and in silence):
    a. Your name, or a nickname.
    b. Your user profile [*some profiles should be given as options; e.g. citizen scientist, general public, private sector, public sector, researcher, student, journalist, developer, etc.*].
    c. Your professional field, background or expertise.
    d. Your most relevant hobby/ies.
    e. The main challenges you face when [facing the main challenge that your service faces; e.g. using using Citizen Science apps in your daily life].



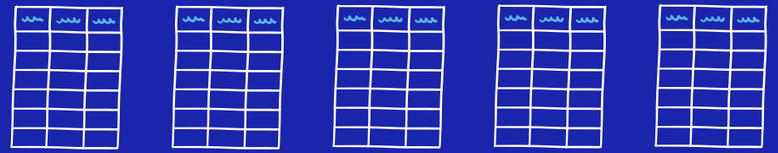
4. Once everyone is done filling in their profiles, move on to the next section.
5. Here, the software developer should explain the service, how it is supposed to work and to look like, and at which stage of the development it is.

6. Give some minutes for participants to ask questions and for developers to answer them. Once everything is clear, move on to the next section.

7. In this part, you will create user stories. This explanation should be given:
    a. *A user story is an informal, natural language description of features of a software system. They are written from the perspective of an end user and they help software teams document their understanding of the system and its context.*
    b. *Stories do not need to be perfect but they need to be clear. Take a moment to read the two templates and examples given:*
    c. *Template 1: As a [user/role] I want [to do something] so that [I can benefit from something]. Example: As a scientist, I want to access verified citizen science data, so that I can trust the data.*

   d. *Template 2: As a [person] I have the need to [do something] in purpose of [a particular scope]. Example: As an expert, I have the need to find all suspicious species guesses in a dedicated location area, in purpose of verifying all observations with pending review.*

8. Once you have read the explanation and the examples, you are ready to create user stories according to the profile you filled in above. Since every character will have different needs, expertise, and challenges to face, different user stories will emerge. You can do this part collaboratively or individually. If you do it individually, set aside some time at the end to share your stories to the group and discuss them.



9. And... congratulations! You have finished the session and now you have new inputs for the service. Hooray!

Usability testing

Post-development

Phase	Time frame	Group size	Group profile
Deployment and testing, Final service co-designed	60-240min	2-4 people	Experts, users

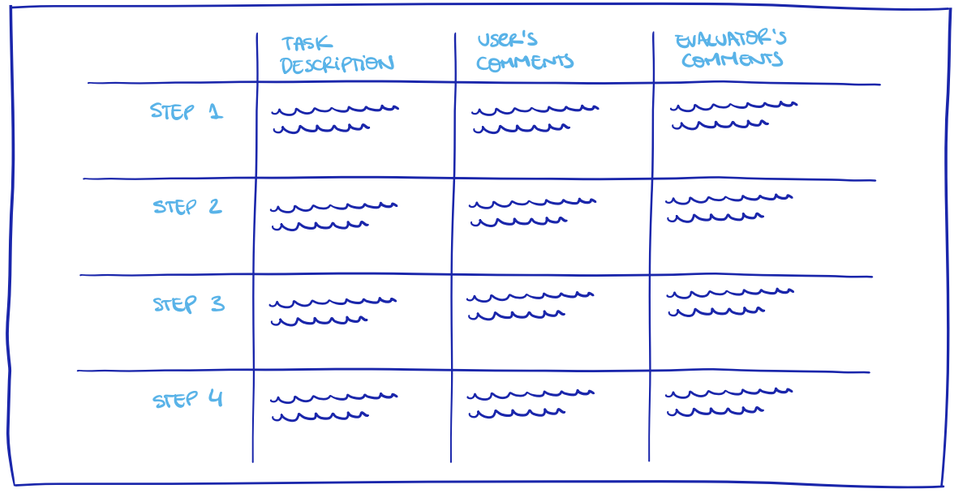
Description

Usability testing is an evaluation method that focuses on people and their tasks, and allows software developers to observe the individual experiences of different people, and how they execute certain processes in their services.

The tests are organised and designed around specific user stories or scenarios, which represent real cases encountered by the end users of the services.

This methodology usually follows the format of the think-aloud technique, in which the users have to say everything they are doing out loud while executing it. This allows us to see if the user is understanding the task, if they are taking the appropriate steps to complete it, if they express surprise or some other emotion, if they make a mistake, if they have to go back a step in the process, etc., as well as reveal problems or unclear steps.

Work map



Usability reporting

Post-development

Phase	Time frame	Group size	Group profile
Deployment and testing, Final service co-designed	60-240min	2-4 people	Experts, users

Description

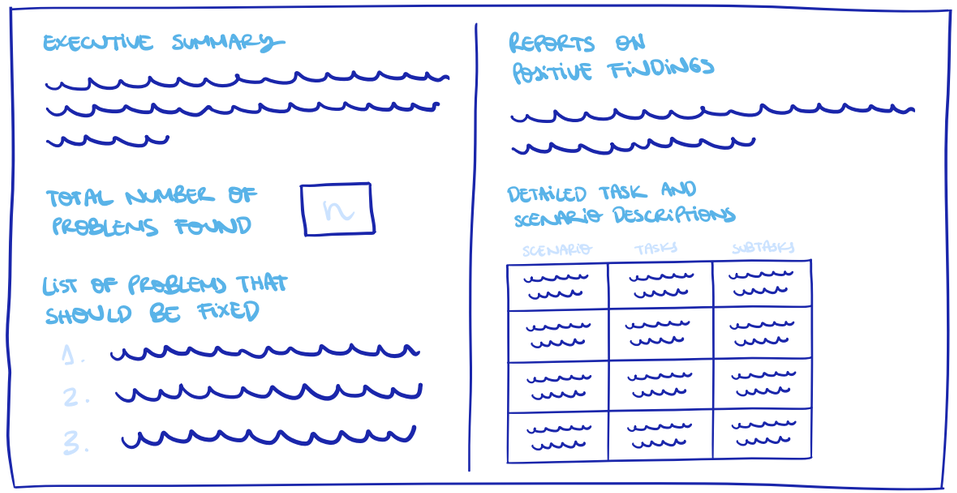
Usability reports are a resource or technique that allows to clearly highlight which parts of the user interface should be improved, modified or fixed.

A few years ago, all usability reports were done in the format of long documents. Today, these reports can take different formats, including video and audio. The relevance of the report is not so much its final format, but rather the user input found in it.

In a collaborative activity where you want participants to build a usability report, the work groups should be small and have very clear objectives, as well as a structure to follow with the following sections: executive summary, total number of issues found, list of problems that should be fixed, reports on positive things, detailed task and scenario descriptions.

The time required for this methodology is highly variable depending on the complexity of the service to be evaluated.

Work map



Value opportunity analysis

Post-development

Phase	Time frame	Group size	Group profile
Deployment and testing, Final service co-designed	60-240min	6-12 people	Experts, users

Description

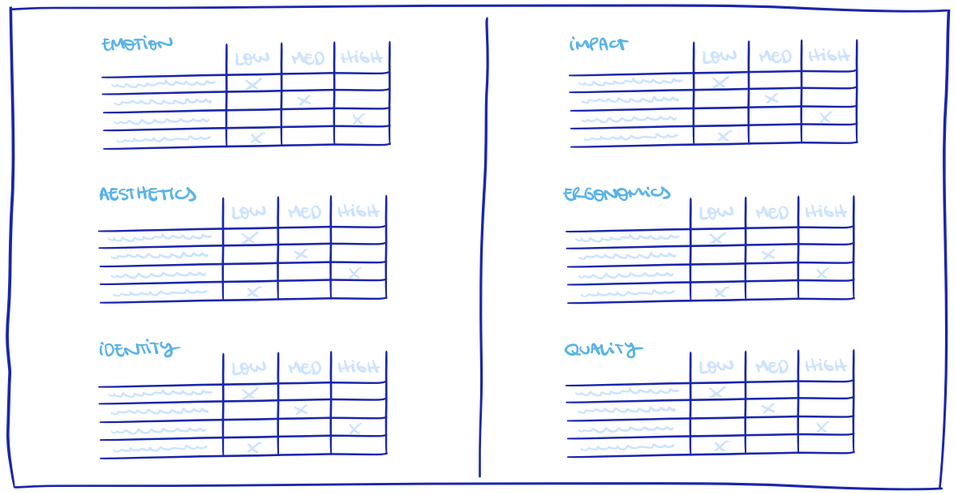
Value opportunity analysis are an assessment of a service's aspirational attributes. They collect the intangible qualities that the user perceives out of it.

Thus, this analysis goes beyond the execution of tasks and the user interface, to focus on the emotions and sensations that a service transmits. Some of the fields to evaluate are: emotion, aesthetics, identity, impact, ergonomics, quality, etc.

It is, therefore, a very subjective analysis, and the evaluations of each individual will be biassed by their culture and identity. This is why a value opportunity analysis usually results in different ratings of each of the fields, and often generates discussions among the development team members.

However, it is critical to understand this more subjective part of the users, since it will determine why they choose your service over others, or vice versa.

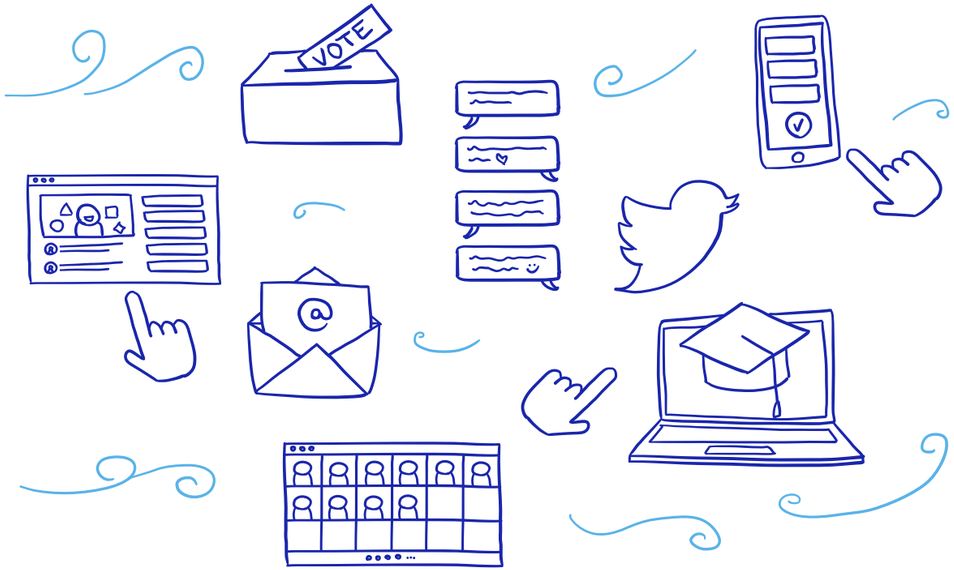
Work map



Other complementary formats

Besides all the co-design activities performed during the Cos4Cloud project, we also gathered information from the users through other channels and formats. It is crucial to have a full understanding of your audience and their needs at all stages of development. This is why we find it important to list here the other activities that can be carried out in parallel to co-design to increase the users' input in your project:

1. Discussion forums
2. Open meetings
3. Courses and training
4. Webinars
5. Hackathons
6. Tweetathons
7. Exchanges via email with users
8. Exchanges via app with users
9. Voting platforms
10. Etc.



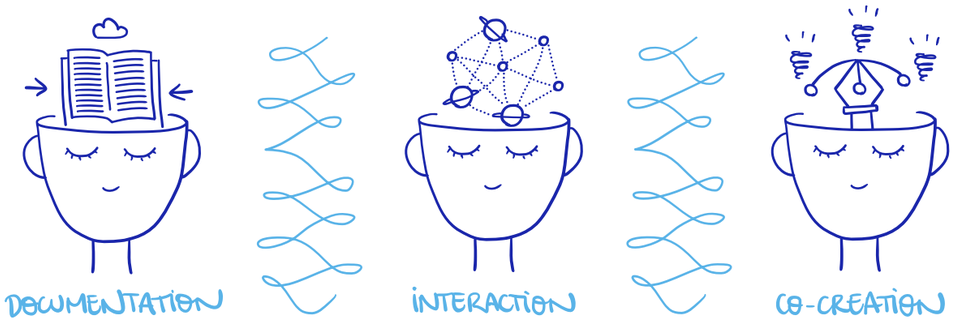
Co-design team 108
Co-design community 110

CO-DESIGN AS A SERVICE

Co-design as a service

Throughout the course of the Cos4Cloud project, we established a way of working based on three pillars that facilitated the planning, documentation, and monitoring of the co-design process for all de services. It worked as a service, offered by the co-design team to all the software developers. The three pillars were the following:

1. **Documentation**. A place where the partners of the project can share and store all the documents and the different versions of the services being developed.
2. **Interaction**. A place where the partners can easily give and receive feedback, as well as establish dialogues on the design of the services.
3. **Co-creation**. A place where the co-design community can perform online workshops, so that we can gather their opinions on usability, desirability, and general improvement of the services.



The digital tools that we used for these pillars were:

1. **Confluence** for documentation.
2. **Slack** for interaction.
3. **Miro** for co-creation.

Thanks to them, we were able to create what we called the co-design platform.

Confluence allowed us to have a specific co-design space, where we uploaded all the co-design related content: information on co-design principles, the methodologies for the service development workshops with users, the testing methodology, the reports of the sessions, the co-design digests, etc.

Slack allowed us to have different channels of direct communication among partners, and we used it to have all kinds of conversations: about the organisation and content of the workshops, the engagement strategies, the information we put in the project website and social networks, etc. It is a friendly and easy-to-use tool that allows easy and fast dialogue and discussions.

Miro was the platform we used for all collaborative activities. The co-design team designed the methodology and the work maps, and all participants could easily enter the collaborative board and add their comments and opinions. It allowed us to have synchronous meetings and also asynchronous interactions, all in the same place.

We believe that this way of working – proposing co-design as a service – can be implemented by other interdisciplinary groups that need to integrate co-design with software development methodologies.

This is why we developed this practical guide, to open our process to whoever may find it interesting and wants to use it, adapt it and implement it.

Co-design team

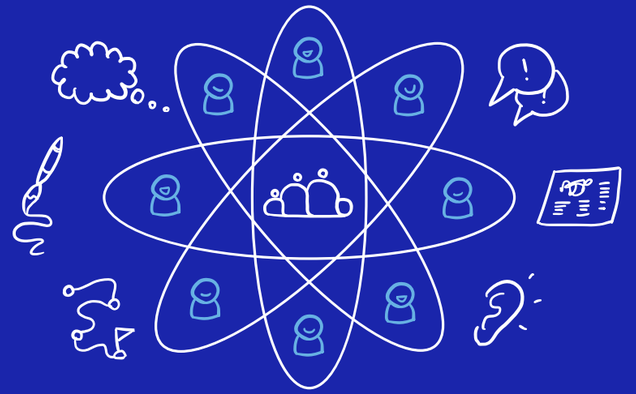
One of the key aspects of implementing co-design as a service was creating the co-design team. An interdisciplinary group that combined multiple backgrounds and expertise to make co-design a reality. The co-design team made it possible to co-create the methodologies, recruit participants, facilitate the workshops, accompany the service leaders in the co-design implementation, create and maintain the co-design community, and support the seven steps of the co-design process.

The **team that supported the co-design process** was conformed by:

- **Blanca Guasch**, design manager and co-design specialist, **Science for Change**
- **Álex Amo**, IT & data officer, **Science for Change**
- **Miguel Hernández**, circular economy and odour specialist, **Science for Change**
- **Ángela Justamante**, communication and engagement specialist, **CREAF**
- **Claudia Fabo**, engagement and communication, **ECSA**
- **Sonia Liñán**, communication and engagement specialist, **ICM-CSIC**
- **Karen Soacha**, co-design coordination, **ICM-CSIC**

Collaborators:

- **Henning Bredel**, agile methodologies, **52ºN**
- **Isadora Jimenez**, PMO manager, **Science for Change**
- **Silvina Frucella**, project manager, **Science for Change**

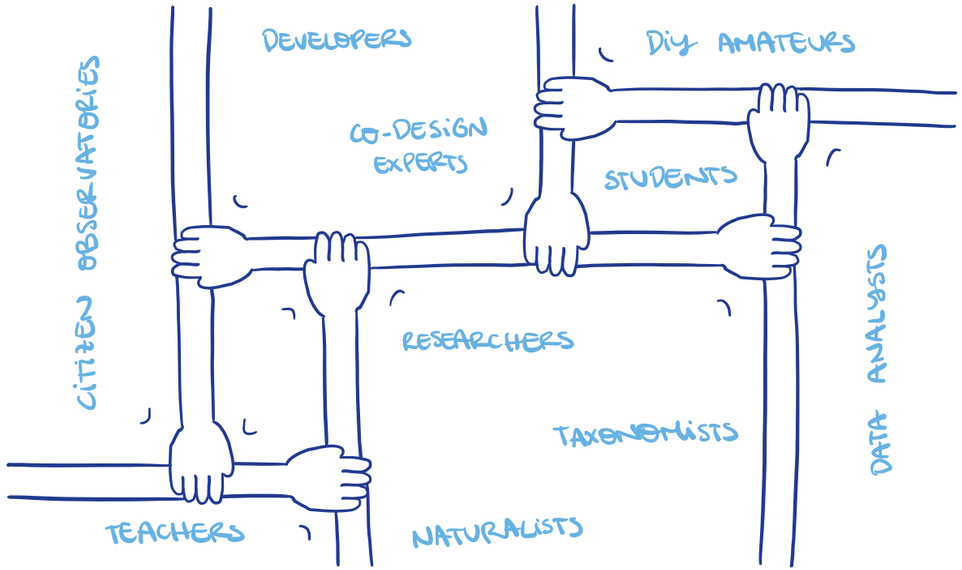


Co-design community

The co-creation of the services was a reality thanks to the active participation of multiple stakeholders that formed the co-design community.

Researchers, students, teachers, developers, taxonomists, naturalists, DIY amateurs, citizen observatories managers, data analysts, from multiple sectors, academia, industry, civil society and government were part of the community. Eleven citizen observatories for environmental and biodiversity monitoring and their user communities were also an active part of Cos4Cloud. Pl@ntNet, iSpot, CanAir.io, Artportalen, Natusfera, Kduino, OdourCollect, iSpex and FreshWaterWatch, MINKA and Aire Ciudadano.

Networks such as the Greek Network for education and citizen science and the FELIS project for camera trap monitoring in Catalonia actively contributed to the process. There were more than 800 participants, 20 spaces and multiple allies that allowed Cos4Cloud services to be co-created.



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Cos4Cloud