e-shape

EuroGEOSS Showcases: Applications Powered by Europe

e-shape-WP2-D2.6 Validated model of co-design process for e-shape

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ABSTRACT

This deliverable presents the validated model of co-design process for e-shape (update of D2.4 deliverable). Previous deliverables already highlighted the importance of including two phases in the co-design process: (1) a critical "diagnosis process" to identify the co-design needs, classified in four main types of co-design, (2) the implementation of co-design actions to address these co-design needs. This deliverable aims at presenting the updated version of the co-design framework, based on latest advances of the work-package. The following results are more specifically stressed: (1) co-design involves the implementation of a dynamic process of specific types of co-design actions, to unlock the different blocking points occurring in the development of EO-based services over time, (2) each co-design action aims at creating a 'resilient fit' between stakeholders.

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1 INTRODUCTION

Earth Observation (EO) refers to the production of information about the planet and its environment, based on different types of instruments (satellites, in-situ sensors etc.). Initially produced mainly for scientific goals, EO data are now made available to every economic actor, through 'open-data' policies. Socio-economic applications of this data seem to be diverse and promising for a large variety of socio-economic stakeholders: research communities, but also public authorities, private companies, academia, citizens. **However, in practice, developing usages from EO data seems to be particularly challenging.**

Indeed, this effort could be schematically described as **connecting various and highly heterogeneous socio-economic ecosystems**: the ecosystem of Earth-observation data and the various ecosystems of potential usages, that do not share the same dynamics, time horizons (e.g. very long cycles to develop new measuring instruments compared to short timeline of actions in the data usage context), performance logics and competencies (e.g. data processing might require very specific technical expertise while data usages might also require specific domain expertise).

Co-design precisely aims at connecting these various and heterogeneous ecosystems of data and usages, through the development of EO-based services, and support their dynamics in a long-term perspective. Generally speaking, co-design can be defined as a collective design process involving heterogeneous actors. Several approaches can be found in literature, either in the Earth-observation field or in the design and innovation management fields. On the one hand, in the Earth-observation field, despite being implemented in several projects through dedicated processes, what is understood by 'co-design' is not systematically discussed and formalized. On the other hand, in the design and management fields, various methods already exist but their relevance in EO context is not guaranteed and needs to be further examined.

In e-shape, a co-design model taking into account EO specificities is progressively designed and tested with e-shape pilots, through a dedicated work-package led by the authors of the present document. This research work is based on recent advances of design theory and aims at proposing an analytical framework for co-design in the EO context, clarifying co-design ambitions and the operational tools that could effectively contribute to the expansion of EO data usages.

A first analytical framework has been built and described in D2.1, D2.2, and D2.3 deliverables, especially highlighting that a co-design model adapted to EO context should involve two distinct phases: (1) a critical "diagnosis process" to identify the co-design needs, classified in four main types of co-design, (2) the implementation of co-design actions to address these co-design needs. This deliverable aims at presenting the updated version of the co-design framework, based on last advances of the work-package. The following results will be more specifically stressed: (1) co-design involves the **implementation of a dynamic process of specific types of co-design actions**, to unlock the different blocking points occurring in the growth of the ecosystem over time, (2) each co-design action aims at **creating a 'resilient fit' between stakeholders**.

The following document is organized as follows: a first section gives a synthetic overview of the literature discussions on co-design. A second section details the methodology and results of the first phase of "diagnosis process" . A third section presents the patterns of co-design actions developed for each type of co-design. A last part concludes on the role of co-design in the long-term development of the EO-based services and next steps to be carried out in e-shape.

2 OVERVIEW OF CO-DESIGN IN LITERATURE

2.1 Co-design in literature on climate services

In order to connect distant data and usages ecosystems, several approaches have been promoted and implemented by the EO community in the last decades. The first one consists in having each ecosystem bridging independently half the distance, through an 'open-data' strategy (Borzacchiello and Craglia, 2012; Zotti and Mantia, 2014): on the one side, data are made available to everyone; on the other side, the different stakeholders take advantage of these resources by integrating them in their own usage context. Despite being necessary to broaden the usages of data, this approach has proved to be insufficient in practice, as the stakeholders tend to have difficulty making use of EO data spontaneously. This accounts for the current efforts of the EO community to operate a second approach that consists in connecting the distant ecosystems of data and usages by encouraging the development of operational services based on EO data, through specific 'co-design' activities. An important stream of literature documents the implementation of such an approach in the case of climate services (based on climate-related data, being a certain type of EO data). Co-design (also referred as 'co-production' or 'co-development' depending on the authors) mostly relates to the involvement of data users in order to adjust user demands and the supply of useful information (McNie, 2012). Without appropriate processes, this might lead to ad hoc small-scale and short-lived data-based services. However, despite being implemented in several projects through dedicated processes, recent research also underlines that what is understood by 'co-design' is not systematically discussed and formalized (Goodess et al., 2019).

2.2 Co-design in design and innovation management literature

Literature in design and in management gives interesting insights on different approaches of co-design and its evolution over time. Co-design reported in the EO field seems to mainly corresponds to a first approach consisting in building specific interactions between users and service designers in order to fit the developed service to user needs. This approach of co-design, as supply and demand adjustment, has largely developed since the years 2000s (Steen, 2013). However, as noticed in (Dubois, 2015; Dubois et al., 2014), co-design had been previously used in completely different situations, aiming at addressing other blocking points of the development of products or services concerning actors other than the user:

- First, in the 70s, for the development of embedded systems (Wolf, 1994): co-design referred to hardware and software integration, as the issue was to make different fields of expertise cooperate, a list of requirements being already defined;
- Later in the 90s, co-design referred to reshaping collaborations between buyers and suppliers, beyond usual price negotiation, to design new required components (e.g. in the automotive industry, new modules to increase comfort and reduce pollutant emission of cars) (Spina et al., 2002).

These elements suggest that co-design objective goes beyond adjusting supply and demand between data users and service designers. This has led us to rather describe co-design ambitions in the EO context as follows: **co-design should be rather seen as a way of growing an ecosystem of efficient service designers by unlocking the different blocking points occurring in the development of EO-based services**. The co-design approach built in e-shape thus includes two phases:

1. **Diagnosis phase: to identify the blocking points faced by each pilot.** Through WP2 work, the different blocking points occurring in the development of EO-based services have been described and classified in four main types.
2. **Implementation of co-design actions to unlock these blocking points.** Through WP2 work, a protocol for each type of co-design action is progressively built and tested with e-shape pilots.

3 DIAGNOSIS PHASE

3.1 Methodology

A specific process has been designed for this first phase. It has been introduced in D2.1 and D2.2 deliverables (Barbier et al., 2019a; Barbier et al., 2019b) and updated in D2.3 deliverable (Barbier et al., 2020), and can be summarized as follows:

- **Stage 1: Pre-diagnosis**: first analysis of co-design needs made by WP2 based on written exchanges with the pilots and WP2 analytical frameworks;
- **Stage 2: Telco with pilot**: discussion of the pre-diagnosis made by WP2 through a dedicated meeting of one hour and a half with each pilot;
- **Stage 3: Diagnosis**: updated analysis of co-design needs based on discussion outcomes.

The diagnosis of each pilot relies on the representation of the pilot on a 'data-information-usage' framework introduced in previous deliverables, that represents the 'data journey' from data to information, up to usages, and the actors involved in the different transformation processes. In this framework, the development of EO-based services can be seen as building relationships between data, information, and usages (see D2.3 deliverable). This framework is analyzed following five main points (see *Figure 1*):

1. *Usage ecosystem:* global vision of the usage ecosystem, involving the overall organization of the ecosystem (links between actors, underlying rules and regulations, etc.), the potential users' communities considered by the pilot, and the entry points of the pilot in these different communities.
2. *Users' competencies:* for each actor identified as entry point in the usage ecosystem, the following elements need to be addressed: the existing tools these actors already use in their day-to-day operations, their ability to transform EO-based information provided by the pilot into actions (on their own, with the help of additional support/tools,…).
3. *Types of services to be developed by the pilot:* given a certain identified use case, different ways of building services based on EO information can be considered. Indeed, EO information is expected to be integrated with a certain set of supporting elements (customization tools mentioned above). To describe the different types of services in a generic way that would be common to the different pilots, a typology of a few recurrent systems has been introduced:
    - **Monitoring system** when the user only needs to monitor a certain variable or phenomenon - information is then complemented with visualization tools and other customized tools depending on user's operations. *Ex: monitoring pollutant concentrations.*
    - **Decision support system:** monitoring system complemented with other customized tools based on specific decision rules, helping the user to choose between a certain set of predetermined alternatives. *Ex: system that integrates some functionalities to help trigger certain actions when threshold is exceeded.* To be noted that building such a system requires to make explicit these decision rules, the level of precision expected and the underlying risks (for ex false alarm).
    - **Scenario design support system:** monitoring system complemented with other customized tools helping the user to design new alternatives or operations, for example by the exploration of specific scenarios. Ex: *system that integrates some functionalities to help explore new mitigation actions, regulations, etc.* To be noted that it differs from the decision support system as the latter only helps to choose between existing alternatives.
    - **Specific service provision:** punctual advisory service, specific preliminary study, punctual information provision. Such service provision might be necessary as a first step before considering building more stabilized systems, in a temporary mode. Ex: *Preliminary scientific study on the possible correlation between air pollution episodes and visits to*

emergency departments. But it can also concern permanent situations, for ex *a targeted scientific partnership such as working on specific measurement and standardization protocols for specific pollutants.*

- In some cases, **information can be used as such directly by the user**, we could then refer to a simple "information provision or data brokering system" (better name could be probably found). It is for example the case when users are research communities. In this case, information could be complemented with access to other resources such as modelling resources.

4. *Pilot-user relationship:* clarification of the history of the relationship between the pilot and a given user, the existing interaction loops (frequency, adequacy to the learning needs), and the strength of this relationship (interest of the user, potential competitors of the pilot from the user's point of view, formalization of the relationship through dedicated agreements).
5. *Ability of the pilot to provide the required service (prototype/operational)*: given a certain identified use case, capacity of the pilot to build and sustain services in practice (either for a first prototype, or for an operational service). Specific efforts might be needed to ensure the engineering and operationalization of the services might be needed, possibly involving new partners, or strengthening the relationship between existing partners.

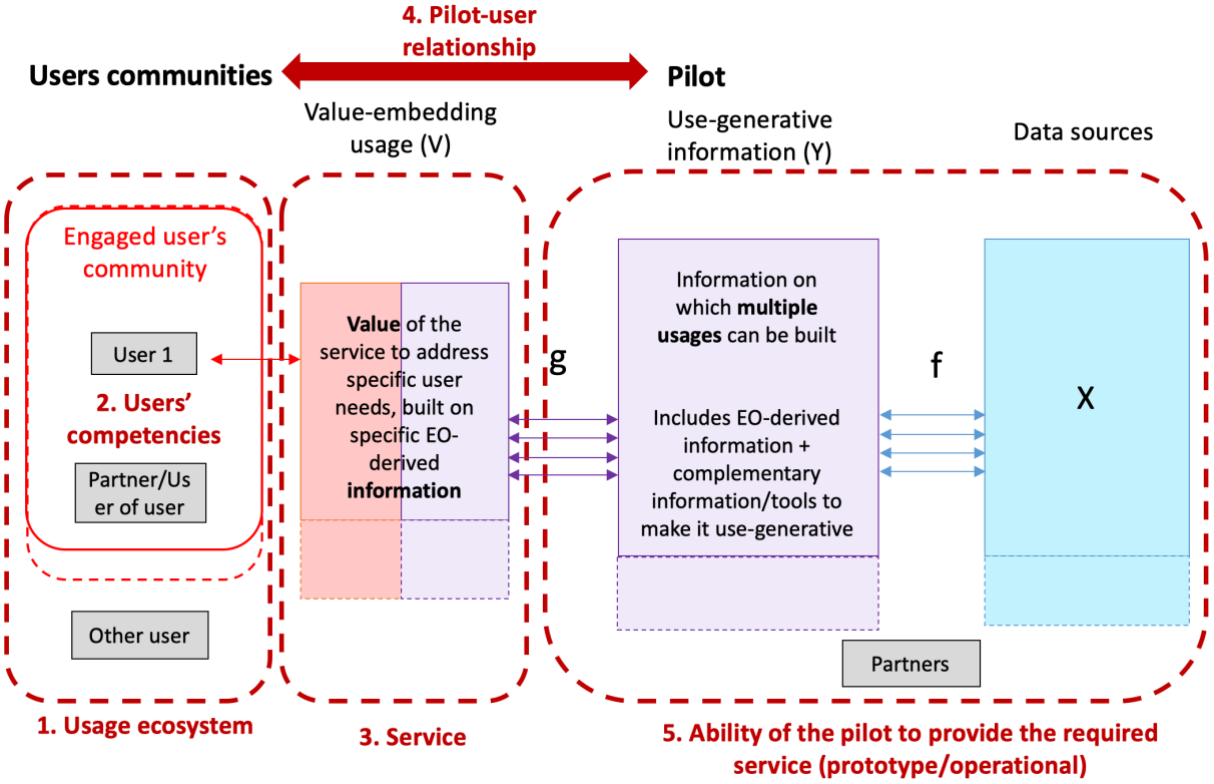

Figure 1: Representation of the "data journey" for the targeted state based on the data-information-usage framework: *data (in blue), information (in purple), usage (in purple-red), function "f" linking data and information, function "g" linking information and usage are the different constitutive elements of the service, addressing a certain users' community (in red)*

3.2 Classification of the blocking points faced by the different pilots

A classification of the blocking points that can occur in the development of EO-based services has been built following two dimensions drawn from literature:

1. **A dimension related to the design of the service**, described with two terms **usefulness and usability**, as commonly used in literature on climate services (Lemos et al., 2012). *Usefulness* refers to the general potential seen by users, whereas *usability* refers to the effective integration in users' operations. Literature on climate services highlights that both aspects need to be addressed to successfully develop services, and that specific efforts are especially needed to move from useful to usable information, i.e. narrowing the so-called "usability gap".
2. **A dimension related to the design of a specific relationship**. (Dubois et al., 2014) indeed show that reinforcing the collective of the participants could be an output of co-design. In the EO context, this second dimension is crucial as the development of a service cannot be done only through collective work phases but also requires separate work phases. Agreeing on cooperation modalities is therefore crucial to guarantee the continuation of alternate collective and separate work phases over time. In a way, 'co-design' must put a strong emphasis on **designing the 'co'**, and not only the service itself.

Four main types of blocking points, i.e. co-design needs can be deduced depending on the status of each of these dimensions, as illustrated in *Figure 2*. Each co-design need calls for a specific co-design action, requiring the design of the relationship with a specific actor. These four types of co-design are more thoroughly described in *Table* 1, indicating the initial state, the blocking point to be addressed and the expected outcomes. *Figure 3* gives a schematic representation of these four types.

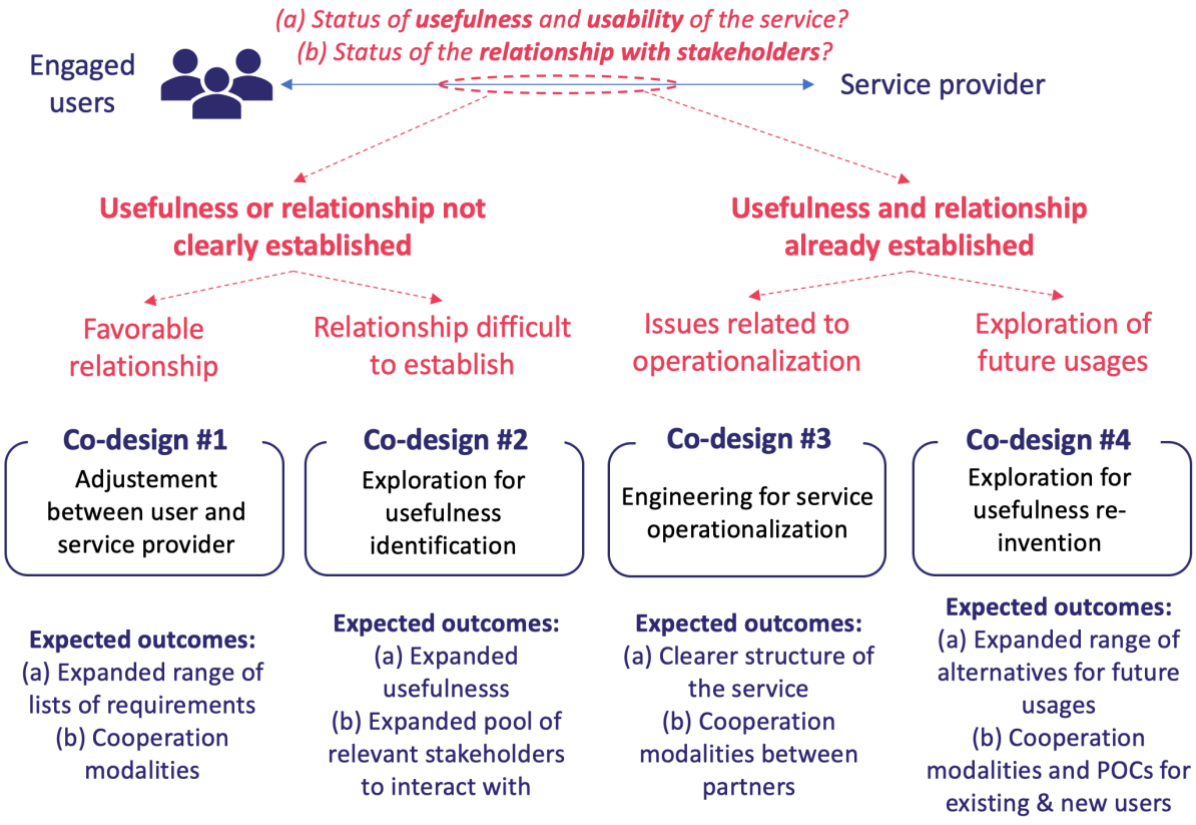

Figure 2: Classification of co-design needs following two dimensions: (a) status of usefulness & usability of the service, (b) status of the relationships between stakeholders

	Overall context	Initial state	Blocking point to be addressed	Expected outcomes
Type 1	**Adjustment between user and service designer**	**(a)** Usefulness already identified on a first basis but to be enhanced. Usability to be enhanced. **(b)** Relationship with the user to be precisely defined but at least user willing to devote time settling it.	Establishing **adapted relationships with specific users** for *usefulness & usability assessment and enhancing*	**(a)** Expanded range of lists of requirements ensuring usefulness and usability **(b)** Cooperation modalities with these specific users clearly formalized
Type 2	**Exploration for usage initiation**	**(a)** Usefulness not well-known *and/or* **(b)** Relationship with the user appearing to be difficult to establish (uncommitted users)	Establishing **adapted interactions with user communities** for *usefulness identification*	**(a)** Expanded usefulness of the service **(b)** Expanded list of relevant stakeholders to interact with
Type 3	**Engineering for service operationalization**	**(a)** Requirements for usefulness and usability established. **(b)** Relationships with some users established.	**Establishing adapted relationships with relevant partners** for *extensive usefulness & usability realization* and operationalization of the service	**(a)** Clarification of the service structure (parts ready to be operationalized, parts needing further exploration) **(b)** Cooperation modalities between R&D and operationalization entities clearly formalized
Type 4	**Exploration for usage expansion**	**(a)** Existing service (usefulness & usability established for at least one use case) **(b)** Relationships already established with existing users.	Establishing **adapted relationships with existing & potential new users** for *usefulness reinvention*	**(a)** Expanded range of potential alternatives for future usages (which usefulness for which actors) **(b)** Cooperation modalities and supports for interactions (proofs-of-concept) defined for existing and new users

Table 1: Classification of co-design needs: thorough description of each type

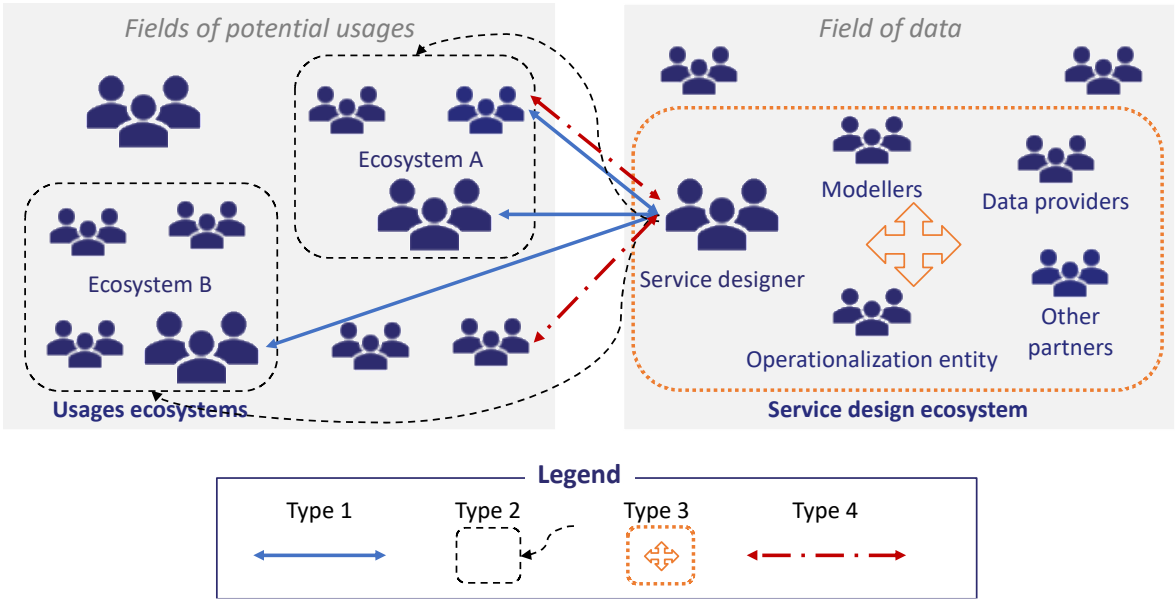

Figure 3: Schematic representation of the four types of co-design needs

3.3 Results of the diagnosis phase: co-design needs identified for each pilot

The diagnosis process has been completed the 27 initial pilots and for the 5 additional pilots of the first on-boarding. The results are summarized in *Table 2* below.

Pilot	Status of diagnosis	Diagnosis short term	Diagnosis longer-term
S1 – P1: GEOGLAM	DONE	Type 1	Type 3
S1 – P2: CAP support	DONE	Type 1 Type 2/4	Type 1 with Users 1 & 2 Type 3 with partner
S1 – P3: VICI Insurance	DONE	Type 3	Type 4
S1 – P4: Agroindustry	DONE	Type 1 & 2	-
S1 – P5: EO and Farm IoT	DONE	Elmibit and its users: type 1 Riscognition and Elmibit: type 1 (by the pilot)	Types 2, 3 & 4
S1 – P6: SDG indicators	DONE	Types 1 or 2 depending on the status of the relationships SRI has with its current users.	Types 3 & 4
S2 – P1: Mercury	DONE	Type 1	Type 4
S2 – P2: POPs	DONE	Type 1	Type 3 & 4
S2 – P3: Air quality	DONE	Type 1	Type 2 for global scale
S3 – P1: NextSENSE	DONE	Type 1/3/4	Type 4
S3 – P2: PV urban scale	DONE	Sub-pilot 1 : Type 3 & 4 Sub-pilot 2 : Type 1	Type 4 between sub-pilots Sub-pilot 2 : Type 3 if relevant
S3 – P3: Wind offshore	DONE	Type 2	Type 3
S3 – P4: WindSight	DONE	Type 1	Type 4
S4 – P1: mySPACE	DONE	Type 1	Type 4 (at SC level)
S4 – P2: mySITE	DONE	Type 1 or 3	Type 4
S4 – P3: myVARIABLE	DONE	Type 1 or 2	Type 4
S5 – P1: Historical water	DONE	Type 1 & 4	-
S5 – P2: Floodwater	DONE	Type 1 Type 3	Type 4
S5 – P3: Diving visbility	DONE	Type 2	Type 1
S5 – P4: Sargassum	DONE	Type 1 Type 4	-
S5 – P5: Fisheries	DONE	Type 1	Type 2
S5 – P6: Phytoplankton biomass	DONE	Type 1, 2 & 4	Type 3
S5 – P7: Aquaculture	DONE	Type 1 with the Spanish and Greek farms Type 2 with the Irish and French farms	Type 4
S6 – P1: Volcanic ash	DONE	Type 1 / Type 2	Type 3/4
S6 – P2: Disasters urban	DONE	Type 1 & 3 (by the pilot)	Type 4
S6 – P3: Vulnerable cities	DONE	Sub-pilot 1 : Type 1 & 4	Sub-pilot 1 : Type 4
S6 – P4: Resilient agri	DONE	Type 1	Type 3 & 4
S7 – P1: GHG emissions	DONE	Type 3	Type 4
S7 – P2: Urban extreme weather	DONE	Type 1	Type 4
S7 – P3: Forestry harvesting	DONE	Type 1	Type 4 / Type 3
S7 – P4: Hydropower	DONE	Type 1	Type 4
S7 – P5: Seasonal preparedness	DONE	Type 1	Type 4

Table 2: Results of the diagnosis process for e-shape pilots

Several noticeable results can be highlighted. First, it appears that e-shape pilots frequently face co-design type 1, **confirming the need of complementing simple open-data approaches by specific co-**

design activities. Second, the table also shows that, for e-shape pilots, **co-design goes far beyond adjusting supply and demand between data users and service designers**. Indeed, this perspective only corresponds to type 1, whereas the pilots are also concerned by the three other types of co-design actions. Therefore, co-design could be rather described as consisting in a **dynamic interplay of these four types of actions:**

- It is first an **interplay** of actions because at every moment, each service designer might deal with several co-design needs. This can be explained by the variety of stakeholders each pilot is interacting with (either in the usage ecosystem, or in the service design ecosystem). For example, the service designer might at the same time need a co-design type 1 to strengthen the relationship with a certain identified user, but also consider a type 2 to explore a new type of user community, and prepare for the operationalization of the service with partners through a type 3.
- This interplay is also **dynamic** because each service designer goes through different co-design types at different moments in time, depending on its evolution and the issues faced all along. This appears in *Table 1* through the integration of both short-term and long-term time horizons.

Third, it is interesting to investigate the **trajectory logic between these different types of actions**. According to the definition of these actions, the following trajectory should be expected:

- Type 2 to learn on a given little-known ecosystem and find relevant entry points in this ecosystem;
- Type 1 to build the adapted relationships with the relevant actors identified in type 2;
- Type 3 to build the engineering of the service, in order to meet the lists of requirements identified in type 1;
- Type 4 to explore future usages based on the first usages built trough previous co-design types.

However, in practice, **this trajectory logic cannot be systematically followed by the pilot**. Indeed, the pilot might face **unexpected evolutions of the data or usage ecosystems**, thus leading to a switch between different types of co-design. Two examples based on e-shape pilots can illustrate this point:

- Some pilots have had to deal with an initial user that has changed its priorities (due to Covid situation in one case, due to the restructuration of the company in another case), thus requiring the pilot to transform a co-design type 1 (resp. type 4) initially planned into a type 2.
- In some cases, a type 3 can be launched without being preceded by a thorough type 1. Indeed, the dimensions of usefulness (required as a starting point of type 3) are not necessarily derived from specific user requirements, but might also result from a need of adapting to identified competitors.

4 CO-DESIGN ACTION(S) PHASE

The second phase of the co-design approach built in e-shape consists in the implementation of co-design actions, aiming at unlocking the different blocking points faced by the pilot. **One protocol for each type of co-design action has been designed by WP2.** These protocols have been experimented with e-shape pilots for all co-design types and their results are detailed in a separate deliverable D2.7 deliverable (Barbier et al., 2022).

4.1 Key insights common to all co-design actions

Before detailing the protocols for each type of co-design action, it is worth highlighting the following two key insights, common to all types:

- *Key insight 1:* the co-design actions should not only focus on the design of the service, but also on the design of the relationships, i.e. **'co-design' has to design the 'co'**. The protocols of the workshops integrate this aspect by always organizing a final phase dedicated to building agreements for future cooperation between participants.
- *Key insight 2:* the co-design actions developed by WP2 aim at **establishing a 'resilient fit' between participants, rather than a 'quick fit'**:
    - *'Quick-fit'* actions would focus on finding one type of interaction between data and usages ecosystems (single list of requirements with one user, in a punctual relationship).
    - Whereas, *'resilient-fit'*[1] actions aim at generating a range of alternatives (regarding the lists of requirements, the stakeholders involved, the types of partnerships), allowing a better adaptation to future surprises or unexpected constraints.

  The difference between these two types of actions can be illustrated by the metaphor of a plant that is more resilient as its roots' network is expanded, allowing the plant to adapt to various types of water conditions (see *Table 3*). This point appears to be **crucial to foster the use of EO in a long-term perspective,** as pilots will have to deal with **constant evolutions of both the EO field and the different usage fields.**

In this perspective, each workshop is designed to **progressively shape and consolidate 'building blocks' of the long-term development of the pilot's strategy, intertwined with the evolution of both EO and usage fields.**

	"Quick-fit" actions	"Resilient-fit" actions
General description	 Focus on finding ONE type of interaction with the ecosystem (single list of requirements with one user, in a punctual relationship) *If roots only at surface level: plant only grows if water is easily accessible*	 Generating a range of alternatives (regarding the lists of requirements, the stakeholders involved, the types of partnerships) for a better adaptation to future surprises *Expanded root network: plant more resistant to various water conditions*
Type 1	Finding ONE satisfying list of requirements with one specific user	In order to end up with a robust list of requirements, exploring a range of potential services at different time horizons and related cooperation modalities
Type 2	Finding ONE relevant user to interact with	Progressively building a better understanding of the usage ecosystem and cooperation agreements with a portfolio of relevant actors
Type 3	Building the engineering for the operationalization of one service	Building relationships with relevant partners to ensure a continuous investigation on modules to be operationalized/to be explored
Type 4	Merely asking existing users what they would dream of	Setting-up a joint program for long-term exploration of new usages with existing and new actors (identification of obstacles, research efforts to be made, 'stimulating' proofs-of-concept, etc.)

[1] The choice of the term 'resilience' could be discussed. Indeed, in design literature, other approaches also deal with the issue of designing an object that could have multiple evolutions given its different usage contexts, e.g. so-called 'affordance-based design' (Maier and Fadel, 2009). This approach could be seen as a form of 'resilience' as it ensures the robustness of an object in multiple usage contexts, however it only corresponds to a certain type of situations where the object is already largely known and its different evolutions require only slight redesign of the object. Therefore, we prefer using the term 'resilience', that has recently been used in a number of disciplines beyond ecology (Bourcart, 2015), more specifically in situations that seem more similar to the EO context, i.e. situations where the object is not given and its evolution requires significant design efforts, for example for the design of social-ecological systems (Berthet et al., 2021, 2019).

Table 3: Distinction between 'quick-fit' and 'resilient-fit' perspectives for the 4 types of co-design

To be noted **that the 'resilient-fit' approach does not exclude that the pilots might also want to resort to quick-fit' actions at some point of the process**, for example to further specify one list of requirements for a certain user that would explicitly ask for it. However, complementing these 'quick-fit' actions with a specific 'resilient-fit' action is also important to guarantee the robustness of the approach in a long-term perspective. Indeed, the 'resilient-fit' action sets up a frame of cooperation that will ensure sustainable developments of the service in a long-term perspective, by managing the risks associated with the evolutions of data and usage ecosystems. It is thus clear that **the specific 'quick-fit' actions are more successful and efficient as these risks have been taken into account by the pilot through a dedicated 'resilient-fit' action.**

4.2 Preliminary remark on the methodology

Each protocol has been built based on design theory (Le Masson et al., 2017) as a background theoretical framework. Research in design theory has particularly highlighted the **recurrent issue of "fixation effect" occurring in the design process** (i.e. tendency to only use already existing or easily accessible knowledge, resulting in limited and less innovative solutions). Therefore, each protocol is organized in a sequence of phases to control these fixation effects. The sequence of phases depends on the specificities of each co-design type and is further detailed in next paragraphs.

4.3 Co-design type 1

4.3.1 Co-design type 1 specificities and overall process

A co-design type 1 is carried out in cases where the usefulness of the service is not fully defined (but at least identified on a first basis) or the relationship with the user is not clearly established but the user is interested and willing to take part in the development of the service. Its purpose consists in establishing **adapted relationships with these specific users** to progressively build a range of useful and usable services.

In addition to the **recurrent issue of "fixation effect" occurring in the design process**, this co-design action must deal with the following issue: organizing one workshop is not sufficient to end up with a fully comprehensive development plan of the services: co-design type 1 has thus to set the frame for future developments that will involve repeated interactions between the pilot and the users. A specific attention needs to be paid on establishing the cooperation modalities that will **ensure that interactions will last over time.**

The overall organization of co-design type 1 actions can be summarized in two main actions:

- **A preliminary session** restricted to WP2 and the pilot;
- **A cycle of workshops with the users**. The form of the workshops is adapted depending on the pilot & users' constraints and expectations, including the number of workshops (there can be as many workshops as the project situation requires) and timing (from 2h to several days), in person or virtual meeting, on-line tools to complement workshop sessions, etc.

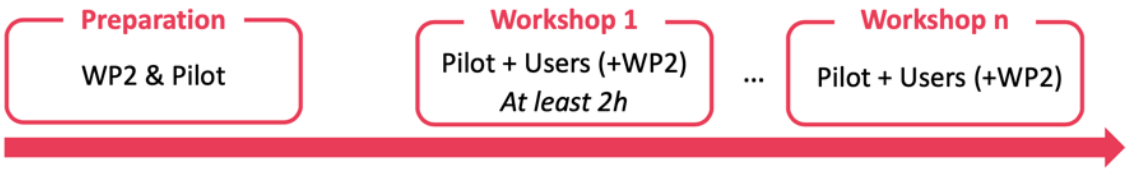

Figure 4: Overall organization of co-design type 1

4.3.2 Preliminary session

The purpose of this meeting is to discuss the organization of the workshop with the pilot:

- Presentation by WP2 of the **co-design type 1 specificities**
- **Identification of participants and resources**: it is important to clarify what are the pilot's expectations related to the different users considered. The following questions particularly need to be discussed:
    - *Who are the primary users for the pilot?*
    - *What are the pilot's objectives related to these users (including both directions: service expected to be provided by the pilot to the user, and elements expected to be provided by the user to the pilot)?*
    - *What are the expectations related to the other users?*
    - *What is the status of relationship for each user?*
    - *Who will join the workshop?*
- **Refining objectives, process, agenda** (agreement on the number of workshops, their form – in person, virtual - timing, etc.)
- **Preparation of the demonstration phase done by the pilot** and the different materials to be sent to the participants prior to the meeting.

4.3.3 Workshops

Co-design type 1 workshop organizes the dialogue between the pilot and the users in a specific way in order to take into account the two specificities mentioned above. More specifically, two main elements contribute to overcome fixation effects.

4.3.3.1 Organization of the workshop in distinct phases

The first important element is to **follow a rigorous process, organizing the workshop in distinct phases**. The following phases are proposed (timing is given for a 3h workshop on an indicative basis, following the situation in which this protocol was experimented, it will need to be adapted depending on the available time given the constraints of each pilot):

- **Introduction:** e-shape & co-design (15')
- **Phase 1**: Demonstration by the pilot (prototype of the service, and overall pilot's expertise and competencies) while other participants are in an active listening role. (15')
- **Phase 2**: Knowledge shared by each user (1h15):
    - Participants react on the pilot's demonstration following guiding questions, prepared with the pilot prior to the workshop.
    - Pilot is in an active listening role, considering the following questions: are new features to be added? What would be adapted relationships with these users? Are there new relevant actors to be involved?
- Break (5')
- **Phase 3**: Enrichment of the lists of requirements and agreements on future relationships where the pilot makes propositions to the participants, that then react to them. (1h)
- **Wrap-up** and next steps (10')

Regarding the issue of overcoming the fixation effects, starting with the demonstration made by the pilot might seem surprising. Indeed, users could be fixated by what was presented by the pilot instead of rooting their thoughts in their usage contexts. However, the relevance of starting the workshop with the demonstration of the pilot lies in the specificities of the context. First, **the participants might have little expertise on EO data.** Therefore, **this first phase of demonstration is necessary to build a common minimal knowledge base on EO data for all participants**. This minimal knowledge base then prevents users from talking about their day-to-day operations in too general ways. Second, for the

users, the interest of interacting with the pilot might not be completely clear. Thus, this demonstration is also expected to have a **convincing effect to trigger the interest of the participants**, necessary for the following interactions.

Several means are then used to control the fixation effects. First, the demonstration of the pilot goes beyond showing a list of certain functionalities and asking for yes/no answers of the users, but it rather aims at showing the overall pilot's competencies and development possibilities. Moreover, the subsequent knowledge sharing phase is guided through specific questions, as detailed in next paragraph.

4.3.3.2 Use of specific guiding questions

The second important element is **to guide the users when they share knowledge** (*Phase 2*) to avoid quick fixation on a certain feature of the service and rather explore all potential alternatives. The following questions were proposed to **make the users consider different use cases** (monitoring/decision support/scenario design support system/ specific service provision) **at different time scales:**

- ***Overall usefulness of the service:*** *What are your current operations that would potentially benefit from the pilot's service?*
- ***Detailed use case of the service (1/2):*** *According to what was presented by the pilot, what would you do with this service? Which division would be concerned? To what extent would you be able to use the provided service on your own?*
    - *If you use the service for monitoring purposes, what information would you like to monitor? Ex: pollutant concentrations*
    - *What types of actions in your operations would it potentially support? Ex: triggering certain actions when threshold exceeded*
    - *Beyond using the service for your current workflows, how could the service help you to develop new operations or services on a longer-term perspective? Ex: exploring new mitigation actions, regulations*
- ***Detailed use case of the service (2/2):*** *What would be the constraints, drawbacks and risks of using the pilot's service?*
- ***Dream of future EO services:*** *If you forget the current technological/resource constraints, what EO applications would you dream of?*

4.3.4 Outcomes

4.3.4.1 Designing a resilient fit between the pilot and the different users

As explained above, the co-design process is expected to build a 'resilient fit' between stakeholders rather than a simple 'quick fit'. For co-design type 1, the difference can be illustrated as follows:

- A *quick-fit action* would on consist in only selecting one list of requirements for each user;
- A *resilient-fit action* explores a range of potential services at different time horizons and related cooperation modalities, giving thus more chance to finally result to robust lists of requirements for these different users in a long-term perspective.

In a resilient-fit perspective, the outcomes of each workshop are thus expected to be at least twofold:

1. **Expanded range of potential lists of requirements** ensuring usefulness and usability (related to different types of services from short-term to long-term)
2. **Formalization of cooperation modalities** between the pilot and the users for future development of the service: expression of a common interest, the nature of exchanges, the interaction loop with series of meetings and specific milestones. This agreement does not necessarily need to be legally binding and can be formalized through different forms

(memorandum of understanding, or even a simple written document precising the cooperation modalities).

Moreover, each workshop can also be the opportunity to identify missing knowledge, competencies, or relevant actors to further interact with. Such learnings can lead the pilot either to integrate new participants in subsequent workshops, or to resort to another type of co-design action. Therefore, each workshop might also result in a third outcome, highlighting again the importance of considering co-design as a dynamic and continuously evolving process:

3. **Suggestion of follows-up for future co-design actions** based on learnings made during workshop.

4.3.4.2 Synthetic representation of the outcomes adapted to the 'resilient-fit' perspective

A specific graph has been elaborated by WP2 in order to synthetically represent the outcomes of each workshop, and especially capture the specificities of a 'resilient-fit' approach. In this perspective, the potential development perspectives for the pilot are represented at different time horizons. **Each box contains rich information as it indicates a certain type of service to work on, at a certain time horizon and the stakeholders concerned** (examples are given in *Figure 5*, see D2.5 deliverable for a complete example). The different time horizons are defined as follows:

- *Short-term:* when the expectations related to a specific type of service are already clear enough to initiate the cooperation and move towards the development phase;
- *Mid-term:* when there is an expressed interest and some expectations have been mentioned, but a certain part of the expectations remains to be clarified before being able to move towards the development phase;
- *Long-term:* when there is a general interest or need expressed, but expectations remain to be clearly specified.

To be noted that these different time scales do not account for the technical feasibility and the level of technical development that might be required. Indeed, even expectations referred as *short-term* could require large development efforts: this *short-term* time scale only indicates that these expectations are clear enough to start these development efforts.

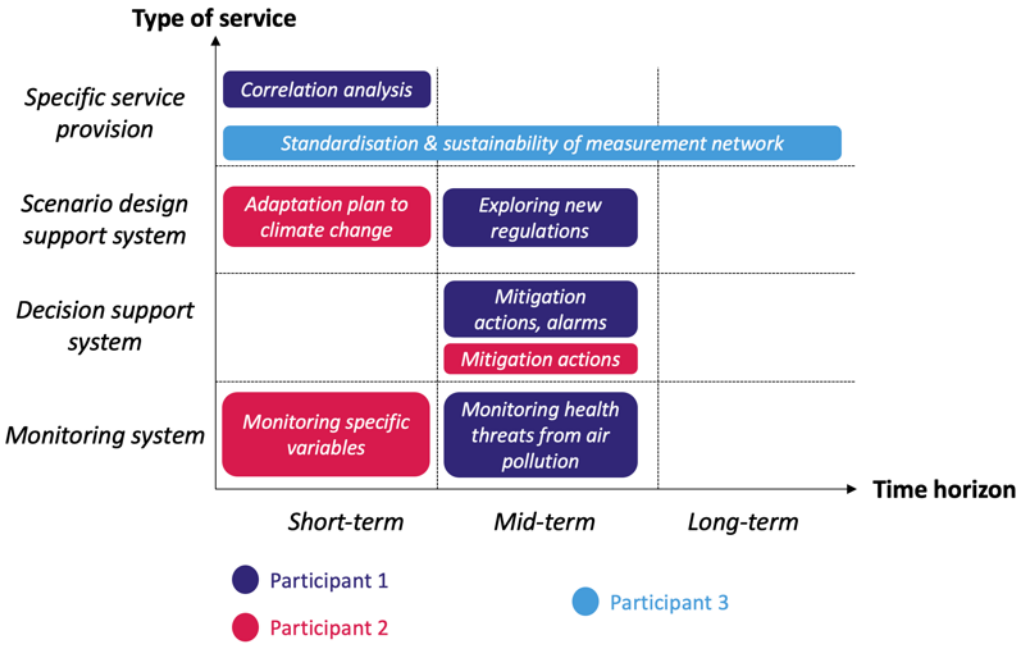

Figure 5: Graph synthesizing co-design type 1 outcomes in a 'resilient-fit' perspective

4.4 Co-design type 2

4.4.1 Co-design type 2 specificities and overall process

A co-design type 2 is carried out in cases where the usefulness is not well-known and/or the relationship with the user is difficult to establish (impact of EO data on his actions not clear, difficulties in the interactions, etc.). It aims at establishing **adapted interactions with user communities** in order to explore the potential usefulness dimensions of EO-based services.

Co-design type 2 can be compared to a **technology-push situation** as the pilot looks for potential applications to a certain technology (here corresponding to the service developed by the pilot from EO data). The major issue in technology-push situations is the fixation on a **"presumed identity" of the technology**, drawing from an initial set of usages assessed as promising. It implies a risk of overlooking other promising applications (Gillier and Piat, 2011), as illustrated in *Figure 6*.

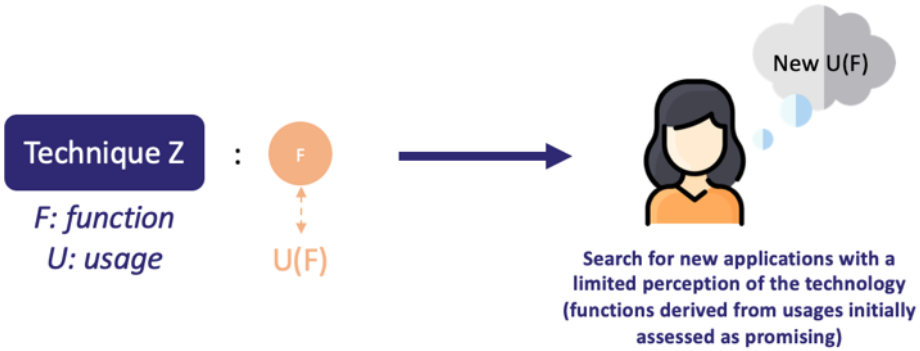

Figure 6: Illustration of the fixation on a 'presumed identity' in a technology-push situation

To overcome this "presumed identity", there is a need to **maximize functional discovery on the technology by organizing the confrontation of the technology to several different contexts** (as a thought exercise or as a prototype), as illustrated in *Figure 7*. To be noted that confronting the technology to a certain context **does not aim at finally using it for this context, but at learning new critical functions revealed by this context.** Previous research works have suggested that the technology could be confronted to the three following broad contexts (Barbier et al., 2019):

- Known contexts, imagining the technology as a substitute of an existing technology already used in these contexts;
- Known contexts with unmet needs, i.e. where the technology could have the potential to address unsolved identified problems;
- Unknown contexts by thinking of specific forms of 'stimulating' demonstrations.

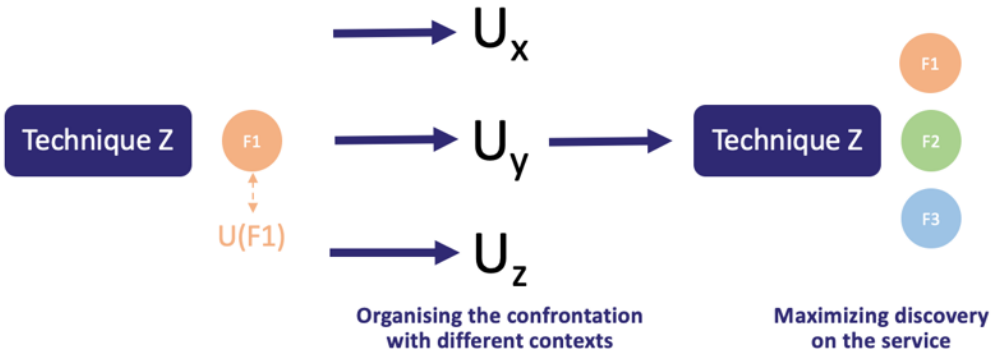

Figure 7 : Maximizing discovery on the service in a technology-push approach

Given these considerations about technology-push situations, **the co-design type 2 relies on a combination of the following methods**:

- **M1**: confronting the service to **known contexts** as a substitute of existing tools + analyzing the related stakeholders;
- **M2**: confronting the service to **contexts with unmet needs** + analyzing the related stakeholders;
- **M3**: confronting the service **to unknown contexts** + analyzing the related stakeholders.

Depending on the pilot's objectives, all three methods are not systematically used: **the bundle of relevant methods is identified with the pilot** in the preliminary phase. If the pilot wants to focus on a specific user community that it has already in mind, methods M1 & M2 are sufficient. Whereas if the pilot wants to explore user communities beyond the ones initially identified as potentially interesting, method M3 should be of interest.

These methods are experimented in **a sequence of several cycles involving different actors**:

- **Internal workshop** with the pilot alone going through all three methods as a thought exercise, and then discussing which methods would be most relevant for the pilot for further experimentation with stakeholders of the user community.
- **Stakeholder workshops**: cycle of workshops with relevant stakeholders to further explore the usefulness dimension of the service, relying on a bundle of M1/M2/M3 according to what was decided by the pilot.

Figure 8: Overall organization of co-design type 2

4.4.2 Preliminary session

Compared to co-design type 1, **co-design type 2 requires a more significant preliminary phase:**

- In co-design type 1, it only consists in a preparatory meeting to discuss the details and formats of workshops with already well-identified users;
- In co-design type 2, the user ecosystem is not well-known and the relationship with potential participants might be difficult to establish. Therefore, there is a need to make an **in-depth exploratory exercise on the service and the ecosystem with the pilot, before running the stakeholder workshops**.

The objectives of the preliminary session are:

- **Define the scope of pilot's objectives and define the relevant methods** to be used accordingly;
- First cycle of **in-depth analysis of the service and the ecosystem** (only involving pilot & WP2)
  - Experimentation of the chosen methods M1/M2/M3 with WP2
  - Identification of relevant actors to run next cycles of workshops.

- **Discuss the form of the workshops to be set up with stakeholders** (number, timing, presential/virtual modes, group sessions possibly complemented with separate exercises, tools to support the process)

4.4.3 Workshops

Each workshop consists in the experimentation of M1/M2/M3, depending of what was decided by the pilot in the preliminary phase. The topic of each workshop can be formulated as follows: *exploring the range of usefulness of the pilot's service and related actors of the ecosystem by leveraging the knowledge & experience* of *the participants to the workshop.*

Three major elements are to be taken into account to overcome fixation effects on a 'presumed identity' of the service:

- The position taken by the pilot in these workshops;
- The organization of the workshop in distinct phases;
- The preparation of specific questions guiding the knowledge sharing phase, in order to unveil the potential of the service.

4.4.3.1 Position taken by the pilot in the workshops

It is crucial that **the pilot does not put itself in a seller position**, considering directly the user as a future client. Indeed, as the objective is rather to explore broadly the range of potential usefulness of the service and the user ecosystem, **the pilot should rather consider the user as partner for this exploration and knowledge expansion.**

4.4.3.2 Organization of the workshop in distinct phases

Second, the workshop is organized in three distinct phases aiming at structuring the dialogue between the pilot and the stakeholders participating to the workshop (timing is given for a 1h30 workshop on an indicative basis, following the situation in which this protocol was experimented, it will need to be adapted depending on the available time given the constraints of each pilot).

- **Introduction:** presenting e-shape and co-design (5')
- **Phase 1**: demonstration by the pilot (10')
- **Phase 2**: exploration of the range of usefulness of the pilot's service with participants' support, see next paragraph for guiding questions (1h)
- **Phase 3:** building-up relationships with the usage ecosystem (10'), considering both:
    - The different forms of the future cooperation with the stakeholders participating to the workshop;
    - The other stakeholders of the ecosystem that the participants might know and that would be relevant to interact with.
- **Wrap-up** and next steps (5')

As for co-design type 1, an important comment can be made on the order of the phases. Indeed, **starting with the demonstration made by the pilot might seem surprising considering the fixation effects, but is actually relevant** for several reasons. First, it ensures building a minimal knowledge base on EO data for participants that might not be expert. Second, this demonstration is a way of triggering the interest of the participants, necessary for the following interactions. This second aspect is all the more important as in co-design type 2 the common interest of the pilot and participants is likely to be more unclear than for co-design type 1.

4.4.3.3 Use of specific guiding questions

For the *Phase 2 - exploration of the usefulness of the service phase*, it is important that the questions aim at **exploring the potential of the service at different time scales, rather than only asking for yes/no answers on specific features.** The following questions are proposed:

- **Opening question following the pilot demonstration:** *What potential do you see in what was presented by the pilot?*
- **Guided exploration** by breaking down the pilot's service in several types of information that could be potentially derived from EO data and asking 3 questions for each type of information:
  - *Could you detail a **potential use case** for this information: for which use? **Added-value** of this information? What would be the **constraints** of using it?*
  - *Same questions for **other actors** of the ecosystem you are interacting with.*
  - *If you forget the current technological/resource constraints, what EO services would you/other actors **dream of?***

4.4.4 Outcomes

4.4.4.1 Designing a resilient fit between the pilot and the potential users' communities

The co-design process is expected to build a 'resilient fit' between stakeholders, rather than a simple 'quick fit'. For co-design type 2, the difference can be illustrated as follows:

- A *quick-fit action* would only consist in finding one relevant stakeholder that seems to find potential to the pilot's service;
- A *resilient-fit action* consists in progressively building a better understanding of the usage ecosystem (which usefulness dimensions for which actors) and cooperation agreements with a portfolio of relevant actors.

Thus, the outcomes of each workshop are expected to be at least twofold:

1. **Expanded usefulness of the developed service**, by enriching in parallel the pilot's representation of the users' ecosystem and the different usefulness dimensions of the service;
2. **Expanded pool of relevant stakeholders to interact with,** progressively building different forms of agreements with these stakeholders.

As for co-design type 1, learnings resulting from these workshops can also lead the pilot either to run additional workshops with new stakeholders identified as relevant (thus continuing type 2 on a regular basis), or also to resort to another type of co-design action (especially co-design type 1 for stakeholders that appear as interested users). Thus, a third outcome might also result from each workshop:

3. **Suggestion of follows-up for future co-design actions** based on learnings made during workshop.

4.4.4.2 Synthetic representation of the outcomes adapted to the 'resilient-fit' perspective

A specific graph has been elaborated by WP2 in order to **synthetically represent the outcomes of each workshop, and especially capture the specificities of a 'resilient-fit' approach**. In this perspective, the potential development perspectives for the pilot are represented at different time horizons. **Each box indicates a certain development perspective to work on, at a certain time horizon and the stakeholders concerned** (examples are given in *Figure 9,* see D2.5 deliverable for a complete example).

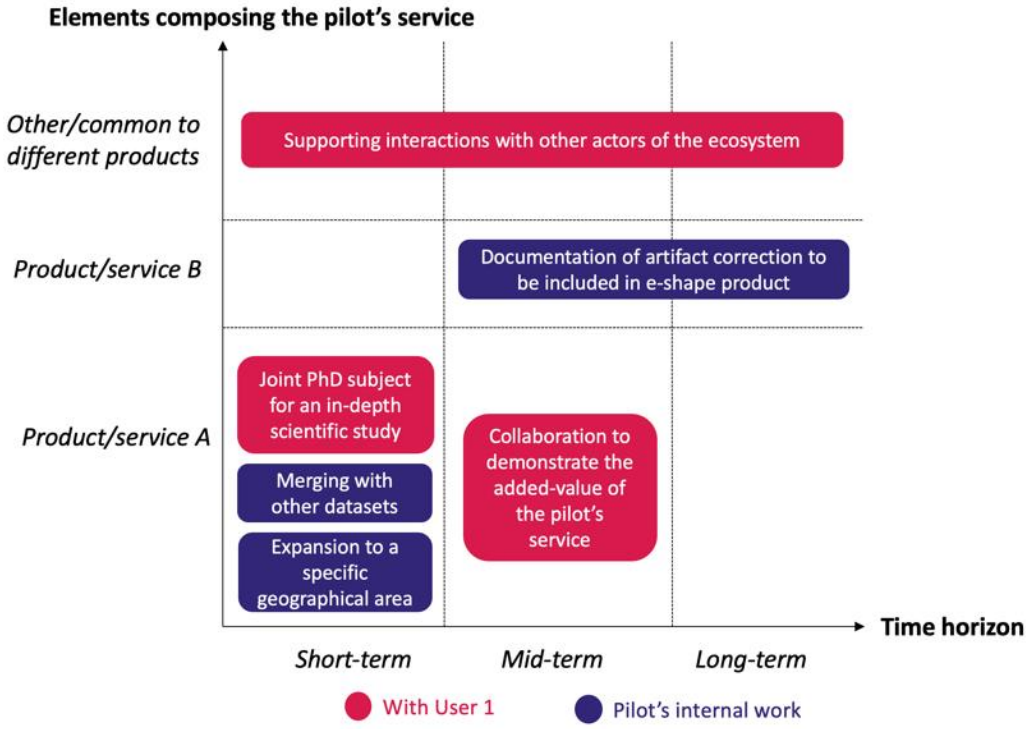

Figure 9: Graph synthesizing co-design type 2 outcomes in a 'resilient-fit' perspective

4.5 Co-design type 3

4.5.1 Co-design type 3 specificities and overall process

Co-design type 3 is relevant in cases where there is already a certain usefulness identified, but there is a need to **establish adapted relationships with relevant partners within the service design ecosystem** to further operationalize the services. It thus consists in building **the engineering needed to further operationalize existing and future services.**

Specific issues need to be addressed in type 3. Indeed, when considering operationalization of the service, it might seem at first sight that it is only a question of **transferring modules** to the entity in charge of operationalization. However, **some modules of the service might still need further exploration**. Neglecting this distinction between the two types of modules might result in **difficulties establishing the relevant relationships** with entities in charge of operationalizing the service. Type 3 thus acts as a **revealing chamber, eliciting each category of modules**. This clarification also allows to better specify the type of cooperation modalities needed to deal with each type of modules.

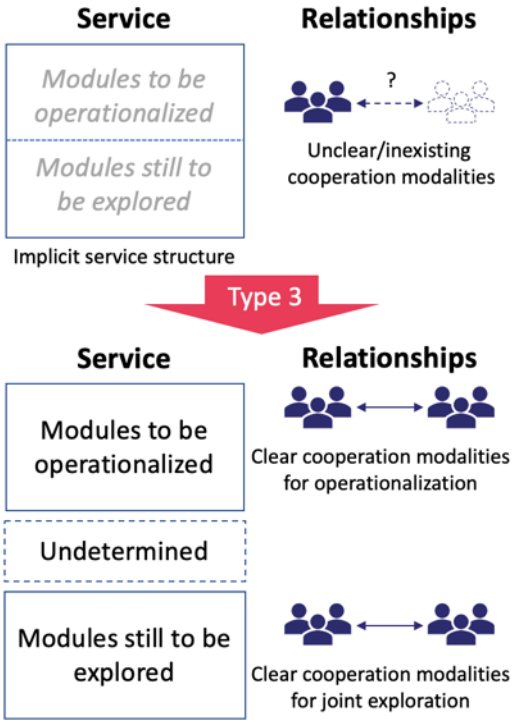

Figure 10: Co-design type 3 expected effects

Co-design type 3 process again consists in a preliminary session, followed by a cycle of workshops depending on pilot's objectives and constraints.

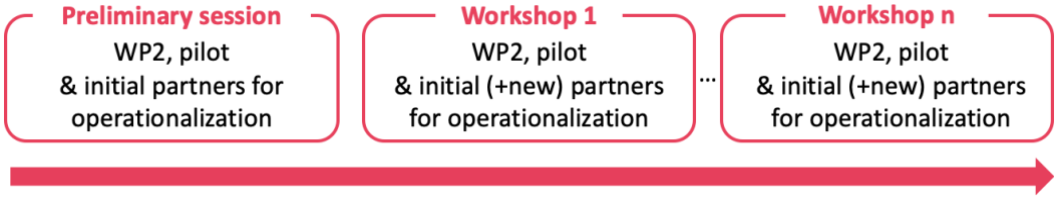

Figure 11: Overall organization of co-design type 3

4.5.2 Preliminary session

The preliminary session consists in:

- WP2 presenting the **specificities of type 3**
- **Defining the scope and expectations of the co-design action**: identification of several concrete cases (at least one or two) where the relationship between the service developer and the operationalization entity has proved difficult to be defined
- **Defining the cycle of future workshops** (number, timing, etc.), depending on the pilot's objectives and constraints

4.5.3 Workshops

A sequence of workshop sessions is organized to progressively refine and update a common understanding of the service structure (modules to be operationalized/to be further explored), and the related cooperation modalities on each type of modules.

Thus, a generic formulation of each workshop objective could be the following: *based on the concrete cases identified in the preliminary phase, clarifying the parts of the service to be operationalized/to be explored & the associated cooperation modalities between the service development team and the operationalization team.*

A generic template for the workshop could be the following (timing is given for a 2h workshop on an indicative basis, following the situation in which the protocol was experimented, it will need to be adapted depending on the available time given the constraints of each pilot):

- **Introduction** on e-shape and co-design (15')
- **Investigation on a 1st case study** chosen by the service development team (45')
    - **Phase 1:** presentation of the case study by the service developer, explaining the context, difficulties encountered, and importantly **making explicit the assumptions on the usefulness of the service in this case study** (15')
    - **Phase 2:** reaction of the operationalization entity (15')
    - **Phase 3:** clarification with WP2 support of the two types of modules (to be operationalized/to be explored) and the associated cooperation modalities to be put in place (15')
- **Same exercise on a 2nd case study** chosen by the operationalization entity with the same three phases (45')
- **Wrap-up** and next steps (15')

As for the other co-design types, **the phases of knowledge sharing (here *phase 1* and *phase 2*) are guided in a specific way**. In co-design type 3, each entity is asked not only to focus on the ideal version of the service and to explicitly express **a range of alternatives for the service** (ideal / quick & smart / in-between versions). Moreover, each entity is asked to share specific knowledge bases identified as important in the preliminary session.

4.5.4 Outcomes

4.5.4.1 Designing a resilient fit between partners of the service design ecosystem

The co-design process is expected to build a 'resilient fit' between stakeholders, rather than a simple 'quick fit'. For co-design type 3, the difference can be illustrated as follows:

- A *quick-fit action* would only consist in building the engineering for the operationalization of one service;
- A *resilient-fit action* consists in building relationships with relevant partners to ensure a continuous investigation on modules to be operationalized/to be explored.

Thus, the expected outcomes are at least twofold:

1. **Clarification of the service structure**: distinction between two categories of modules - the modules that can be operationalized, and the modules that need further exploration.
2. **Establishing relationships with the relevant actors to deal with each category of modules:**
    i. If the pilot is already linked with an entity in charge of the operationalization, this will involve clarifying the cooperation modalities between existing partners for each category of modules
    ii. If not, this can involve identifying potential new partners to be involved to handle each category of modules

As for the other co-design types, learnings resulting from these workshops can also lead the pilot either to run additional workshops with other partners identified as relevant or with the same partners on new topics that might have emerged (continuing co-design type 3), or also to resort to another type of co-design action. Thus, a third outcome might also result from each workshop:

3. **Suggestion of follows-up for future co-design actions** based on learnings made during workshop.

4.5.4.2 Synthetic representation of the outcomes adapted to the 'resilient-fit' perspective

A specific table has been elaborated by WP2 to **synthetically represent the outcomes of each workshop, and especially capture the specificities of a 'resilient-fit' approach**. In this perspective, the service structure with modules to be operationalized / too be explored / undetermined is clarified. The different development perspectives corresponding to each type of module are assigned to a certain time horizon, and cooperation modalities are set up relatedly to each type of modules (examples are given in *Table 4*, see D2.5 deliverable for a complete example).

	Short-term	Mid-term	Long-term	Cooperation modalities
Modules to be operationalized	Product based on *method a,* limited to a a certain geographical area	Product based on *method a*, with additional functionality		March 2021: kick-off and working sessions to define inputs & outputs and development planning.
Modules to be explored	Product based on *method b*, limited to a certain geographical area	Processing transferred to operationalization entity	Product based on *method b,* with additional functionality	March 2021: technical working session with on python code developed by research entity
Undetermined	Collaboration for exploration of new deep learning methods		Commercial service for forecasting at different time horizons	R&D collaboration (joint PhD & internships, specific interest group)

Table 4: Table synthesizing co-design type 3 outcomes in a 'resilient-fit' perspective

4.6 Co-design type 4

4.6.1 Co-design type 4 specificities and overall process

Co-design type 4 is relevant in situations where usefulness and usability are established for at least one use-case, and relationships are already established with some existing users. It thus aims at exploring future usages by **establishing adapted relationships with existing & potential new users** for usefulness reinvention.

The specificities of type 4 can be summarized as follows:

- It is based on a **good knowledge of the usage ecosystem** with no urgency to adapt to an unexpected evolution of the usage ecosystem (distinguishing it from a type 2);
- Thus, compared to type 2, it should include **a deeper investigation on how to build 'stimulating' proof-of-concepts**, that would help trigger a certain evolution of the usage ecosystem (generating future usages for existing users and/or stimulating the emergence of new users);
- Compared to other co-design types, type 4 thus also requires **more intensive exploratory efforts.** This has especially led WP2 team to conduct a thorough analysis of the ecosystem prior to the different workshops, also serving as support materials for the workshops.

As for the other types, co-design type 4 should be organized through a cycle of different meetings and workshops:

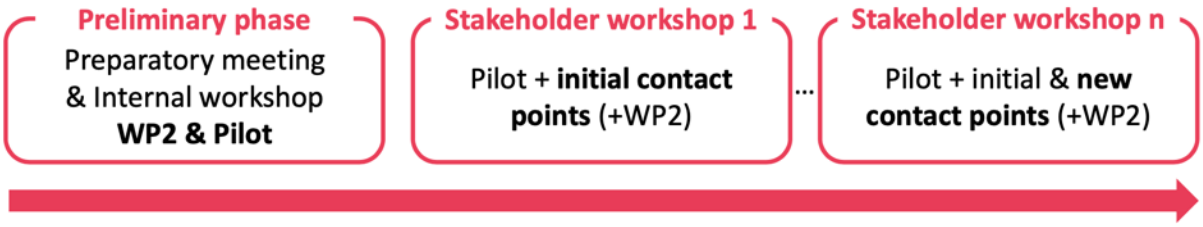

Figure 12: Overall organization of co-design type 4

4.6.2 Preliminary phase

This preliminary phase should consist in:

- WP2 presenting co-design type 4 specificities;
- Defining the scope and expectations of the co-design action;
- Defining the cycle of future workshops: number, timing, resources, participants, etc. (depending on the pilot's objectives and constraints).

In the context of co-design type 4 experiment, we set up 3 preliminary sessions to organize the different phases of the co-design activities and to discuss the forthcoming co-design workshops.

4.6.3 Workshops

The cycle of workshops consists in a joint exploration with the help of existing users to explore a range of perspectives for the development of future usages - either new usages for existing users or for others (supporting the evolution of the usage ecosystem in certain directions).

A generic template for the workshop could be the following (timing is given for a 1h30 workshop on an indicative basis, following the situation in which the protocol was experimented, it will need to be adapted depending on the available time given the constraints of each pilot):

- **Introduction** e-shape & co-design (15')
- **Presentation of exploratory analysis work carried out by WP2** (10')
    - Introduction to the topic
    - Hot spots presentation *with guiding questions. These allow us to recontextualize the presented elements to pilot's context*
- **Exploratory phase** (30')
- **Agreement on actions to be conducted** (20') – to be placed and organized in a synthetic outcome graph
    - Joint actions
    - Individual actions
- **Wrap-up** and next steps (5')

4.6.4 Outcomes

Co-design type 4's outcomes are expected to be at least twofold:

- Expanded range of potential alternatives for future usages;
- Cooperation modalities and supports of interactions (proofs-of-concept) built for existing and new users.

To identify the expanded range of potential alternatives we have set-up a map using design theory principles, and especially C-K design theory (Le Masson et al., 2017), allowing us to represent:

- Existing knowledge and missing knowledge (Knowledge Space)
- Concepts to be explored based on the content of the Knowledge Space (Concept space)

This tool has allowed us to capture the richness of workshop's overall reflection and outcomes. It is important to keep track of these elements as they contain essential information from the in-depth analysis work carried out prior to the workshops and the exchanges during the workshops. Thus, we can represent and link the paths to be followed by the pilot and its partner(s) to operational actions. Here is a synthetic graph summarizing this work:

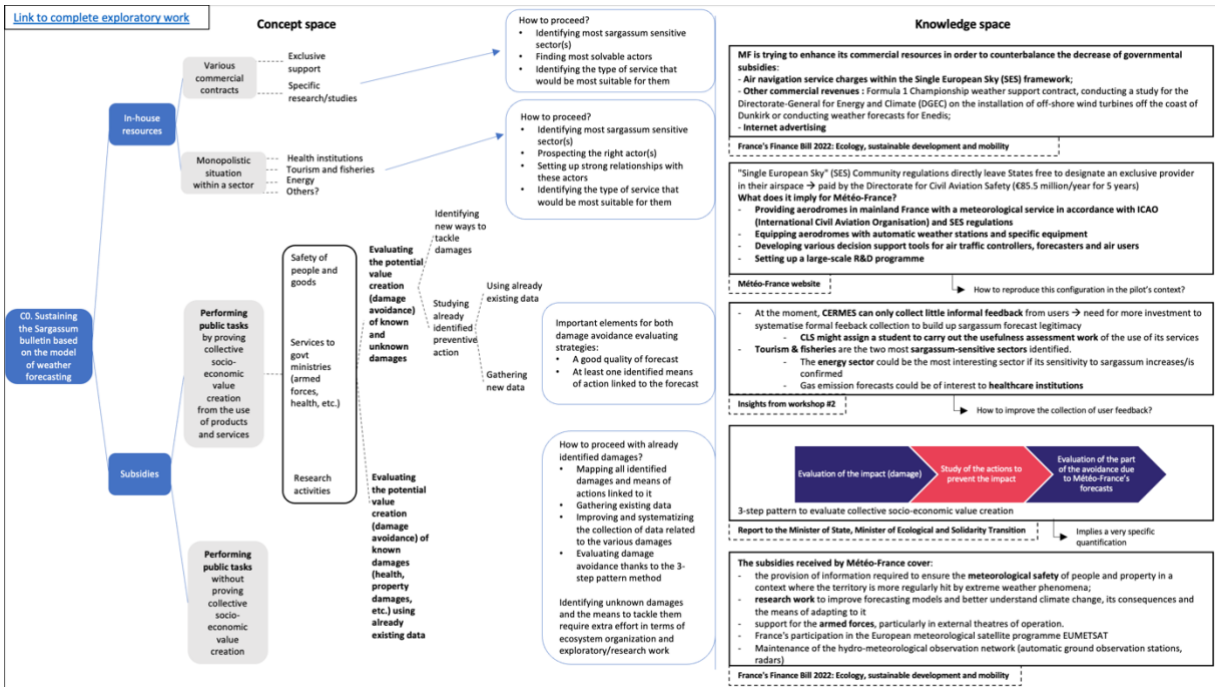

Figure 13 Graph representing co-design type 4 workshops' overall reflection

A specific graph has also been elaborated by WP2 to **synthetically represent the outcomes of each workshop, and especially capture the specificities of a 'resilient-fit' approach**. In this perspective, the actions to be taken by the pilot and its partner(s) are represented at different time horizons. **Each box indicates a certain development perspective to work on, at a certain time horizon and the stakeholder(s) concerned**. The graph also summarizes the cooperation modalities agreed by both organizations.

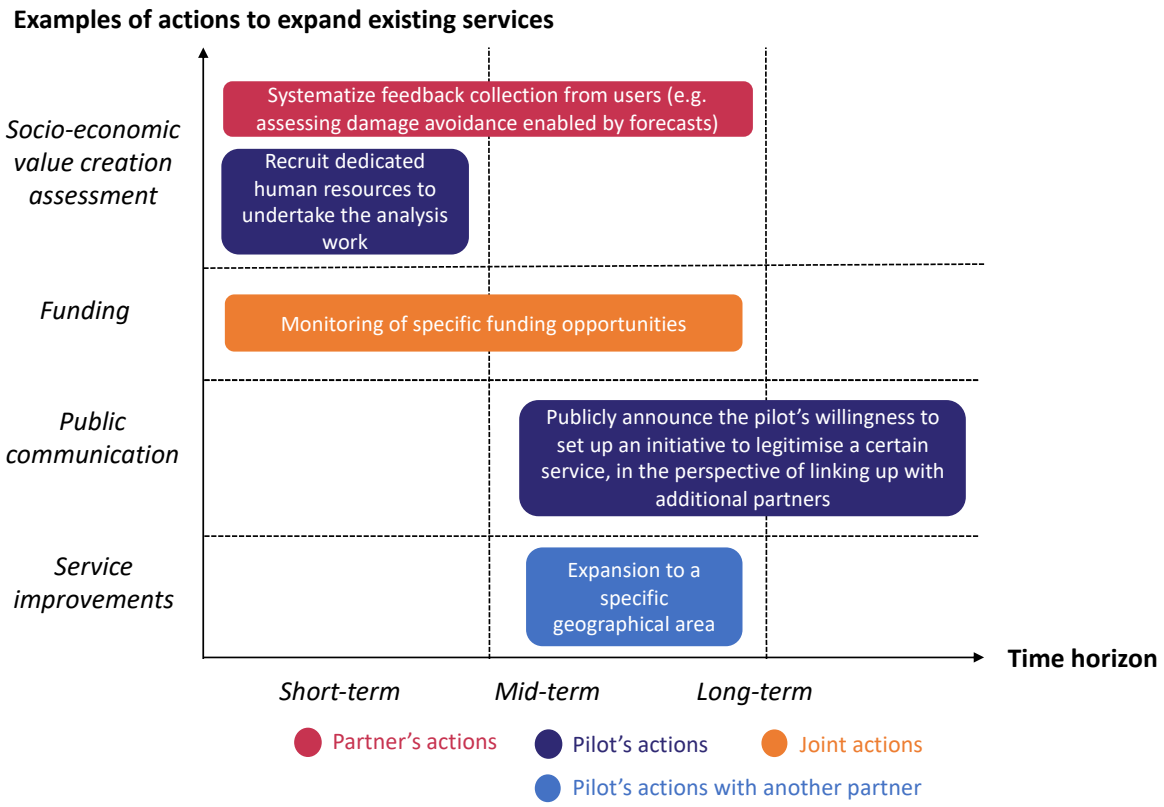

Figure 14 Graph synthesizing co-design type 4 outcomes in a 'resilient-fit' perspective

4.6.5 Debriefing meetings

As co-design type 4 requires a consistent exploratory effort, having consequent debriefing meetings is also essential to adjust what to focus on during the next workshop. Thus, each workshop must be followed by at least a debriefing meeting with the pilot, with a twofold objective: (1) agreeing on the focus of analysis for next workshops, (2) sharing feedbacks on the co-design protocol itself.

5 CONCLUSION AND NEXT STEPS

This deliverable has presented an updated version of the co-design model developed in e-shape, especially highlighting the overall ambition of such a co-design approach as a long-term and continuous effort of connecting heterogeneous and evolving fields: the field of EO data and the various fields of potential usages. In this perspective, we have highlighted that co-design should not be restricted to the adjustment between users and service designers but should be considered as a way of **growing an ecosystem of efficient EO-based service designers**. It is based on a **continuous process involving four types of actions** aiming at unlocking blocking points occurring in the development of the services. Each type should include **the design of a certain committed form of relationship (designing the 'co')** and should aim at establishing **a 'resilient fit' between relevant stakeholders, in order to make sure that these efforts are sustainable over time**. A specific protocol has been designed for each type of co-design action, and has already been experimented for co-design type 1, 2, 3 and 4.

5.1 Impacts

It is important to notice here that the impacts of co-design do not only concern the co-design action phases, but the overall process including the diagnosis phase. Different forms of impacts are illustrated in the next paragraphs.

First, considering the diagnosis phase, one of the main outcomes consisted in allowing the pilots to better understand their own organization and the organization of their ecosystem. Thus, they were able to take actions with a richer understanding of their own objectives and constraints. The diagnosis phase has also enabled pilots to enhance their resiliency. It allowed pilots to better assess the robustness of their relationships with stakeholders and thus to identify the weak nodes of their network. This has for example been acknowledged by the pilots during last e-shape General Assembly in 2022:

"Once you showed the graph of the pilot and its complexity it was very interesting. I think no one in our team had this overall vision so we were missing that… it helped us to formalize what we wanted to do." (S3-P2 pilot)

Considering co-design actions, they have also contributed to avoid fixations of both the pilot and the participants of the workshops. This has impacted the way pilots wanted to develop their service but has also brought them to consider further service alternatives.

"In the beginning we only focused on the Seas of Europe but one of our users reminded that the Asian seas and the US offshore areas are really the hotspots for wind energy development at the moment." (S3-P3 pilot)

"For me it was really eye opening that we could use it in such a broad way to look at all sort of possibilities rather than trying narrow down what we wanted to do." (S3-P3 pilot)

Co-design workshops were also effective at overcoming the users' fixation effects related to the integration of the considered solution in their own operations. Indeed, the guiding questions used during workshops forced the users to evaluate the solution from different angles, and especially to imagine an ideal or dreamt case of data integration without considering any obstacle. This was recognised by the pilots as an efficient way of enriching the exchanges:

"I would like to comment that I really enjoyed the last bullet that you mentioned, the one about this free mode free Dreamers […] it worked like a slider so we know where we stand and they gave us the other hand so we have a slider and this is where we can go with e-shape. How did that help us? Now, we can organise the first part and it gives us the vision for the next steps and engage further discussion with stakeholders on organising the next steps and next operations." (S2-P3 pilot)

Moreover, the pilots have recognized the positive impacts of the organized workshops to better define their relationships with the participants. Furthermore, in a longer term perspective, the pilots who have integrated the process have seen their capacity to maintain the co-design dynamics improved and are now able to reproduce these actions with other actors.

"We have enquired the possibility to replicate some of the aspects we did in e-shape in other projects for similar thematic (health and air quality) […]. It was a big benefit for us and now from onward it is easier for us to look for new stakeholders and to approach them." (AIR QUALITY)

"We will continue to organize user workshops, so we maintain a co-design cycle and continue to improve our insights in the ecosystem in the future." (WIND)

Co-design actions have thus generated impacts that can be classified into two categories:

- Direct short-term/mid-term impacts on the relationships with participating actors
- Longer-term impacts on pilots' capacity to reproduce co-design actions

5.2 Next steps

This approach of co-design and the related tools will be further experimented in the coming year within e-shape. More specifically, this should involve the following actions:

- Finalize the diagnosis of remaining pilots (newly onboarded pilots);
- Support e-shape pilots in implementing these different types of actions. Several modalities could be considered:
    - The pilot could autonomously use the materials proposed by WP2, with regular interactions with WP2 (for punctual advice and feedbacks);
    - Or the pilot might also run these actions with a stronger support from WP2.
- Update our e-shape co-design model, based on the lessons learned from these experimentations;
- Routinize co-design methods, so that they could be more broadly used beyond e-shape:
    - Routinization of the diagnosis process is currently under experimentation: a specific 'self-diagnosis' table has been prepared and shared to new on-boarded pilots and other H2020 projects. The relevance of such tools is still to be assessed and discussed.
    - Routinization options for co-design actions are still to be explored (third-party actors, self-supporting materials etc.)

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