e-shape

EuroGEOSS Showcases: Applications Powered by Europe

Deliverable D2.2

Revised model for e-shape co-design

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ABSTRACT

This deliverable presents an updated co-design model adapted to e-shape. The first version of the model detailed in D2.1 deliverable was based on a framework representing the development of services from Earth Observation as a relationship between data, information and usages. The e-shape co-design process was then proposed in two phases: (1) diagnosis process to identify co-design needs based on the analysis of each pilot's framework; (2) implementation of co-design actions to address the identified co-design needs. In the present deliverable, based on the experimentation of a co-design action with one of the pilots, the data-information-usage framework has been complemented by the notion of "design environment", referring to the set of elements provided by the pilot to users in order to support the joint development of the service. This "design environment" is described through its three dimensions – norm, ecosystem's capability and promise. Thanks to these conclusions, the e-shape co-design process has been updated: (1) the diagnosis of co-design needs now includes the analysis of the adequacy between the "design environment" provided by the pilot to users and the characterization of the related users; and (2) first insights on a classification of co-design actions can be outlined.

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Status		Dissemination Level	
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1 INTRODUCTION

Co-design relates to a large variety of situations but can be generally described as a collective design process involving heterogeneous actors. In e-shape, co-design is used as a toolbox to support the development of the 27 pilots. Existing co-design methods focusing on user-centricity tend to consider that it is all about involving users in the process. However, in the Earth Observation (EO) context, developing services based on this type of data is particularly challenging, because of:

- The high level of technical expertise needed, combining both knowledge on data processing and knowledge on the domain of the final usage;
- The heterogeneity of actors that might contribute to the successful development of user-centric services, that are not only users but potentially all other actors of the ecosystem (related to legislation, researchers, platform owners, technical developers etc.).

Because of these specificities, a co-design method specific to EO context is being developed within e-shape, based on recent advances of design theory. In the D.1. deliverable (Barbier et al. 2019), first elements of an e-shape-specific co-design process have been developed, allowing to address the particular challenges of e-shape.

This deliverable aims at **updating and enhancing the co-design model proposed in D2.1, based on a first experimentation of co-design actions with Pilot 2 – Showcase 3 (*High photovoltaic penetration at urban scale*).** The document is organized as follows: a first section synthesizes the co-design process as presented in the deliverable D2.1. A second section details the on-going work for co-design and more specifically the lessons learned from a first co-design action implemented with Pilot 2 – Showcase 3. In the last section, these conclusions are used to update the e-shape co-design model, especially **clarifying the diagnosis process to identify co-design needs and giving first elements on a classification of co-design actions.**

2 INITIAL CO-DESIGN MODEL FOR E-SHAPE

2.1 Synthesis of deliverable D2.1

Because of these specificities, a co-design method specific to Earth Observation context is being developed within e-shape, based on recent advances of design theory.

As mentioned in the introduction, because of the specific challenges of EO context, a co-design method specific to Earth Observation context is being developed within e-shape. More specifically, the D2.1 deliverable highlighted the importance of adding a first phase before implementing co-design actions, that is a thorough initial diagnosis process to identify the actors to be involved and the types of problems to be solved (Barbier et al 2019). Consequently, an initial model of e-shape co-design has been proposed involving the two following phases:

1. **Phase 1: a diagnosis process to identify the co-design needs and the actors to be involved;**
2. **Phase 2: the implementation of co-design actions based on this diagnosis**.

Co-design is a way to support the different design activities involved in the development of e-shape pilots, taking into account the long-term perspective. Therefore, to build the diagnosis process, **these design activities have been further described through the introduction of an analytical framework**. In this framework, the development of EO-based services is described as building relationships between data, information and usages. In the context of e-shape, each pilot builds upon existing services, involving at least one final user (i.e. a specific usage) and aims at expanding these services (the expansion might concern the different elements of the data-information-usage chain, for example it can involve expanding the number of users, but also increasing the geographical coverage, or improving the scientific algorithms, etc.). Therefore, **the proposed analytical framework can be used**

to represent (1) the initial state of each pilot as an existing data-information-usage relationship (see Figure 1), and **(2) the pilot's targeted state** as broader and more robust data-information-usages relationships, thanks to the intertwined expansion of the constitutive elements of the service – data, information, usages, function "f" linking data and information, function "g" linking information and usage (see Figure 2).

More specifically, the following design activities were identified as necessary to build sustainable services in a long-term perspective: **designing and redesigning (1) information which is "use-generative" (i.e. having the power of generating multiple usages), (2) data-information relationships that are able to adapt to future advances and (3) information-usages relationships that are able to cope with multiple usages.**

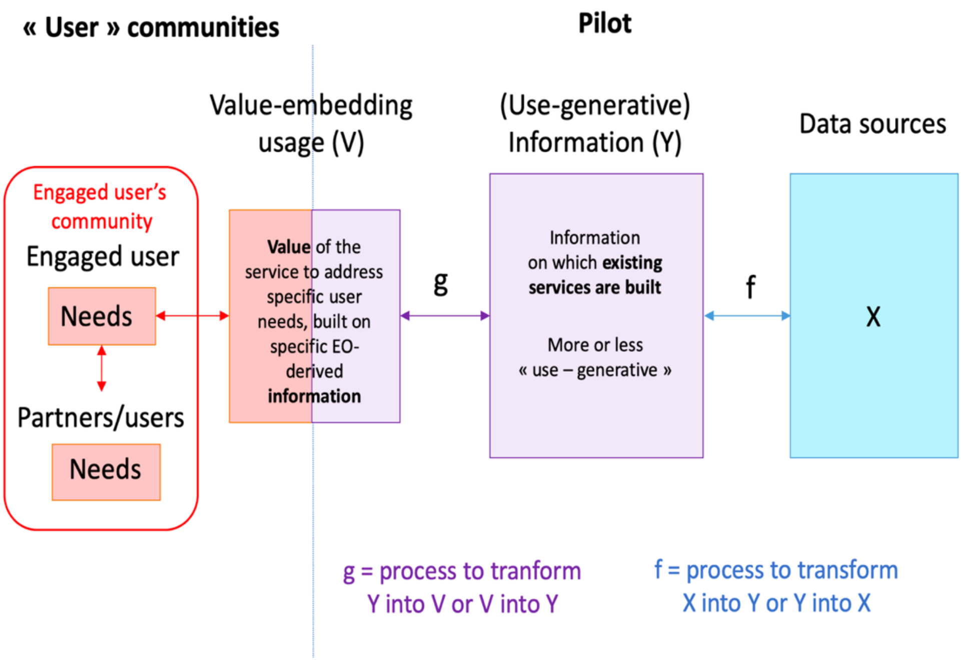

Figure 1: Representation of one e-shape pilot's <u>initial state</u> based on the data-information-usage framework: data (in blue), information (in purple), usage (in purple-red), function "f" linking data and information, function "g" linking information and usage are the different constitutive elements of the service, addressing a certain users' community (in red)

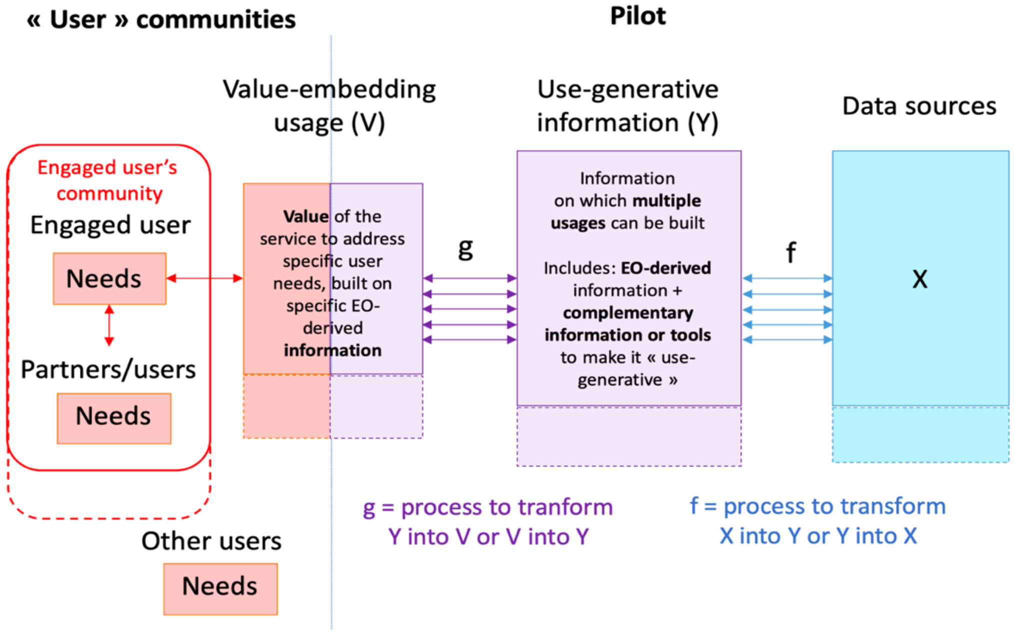

Figure 2: Representation of one e-shape pilot's targeted state based on the data-information-usage framework: data (in blue), information (in purple), usage (in purple-red), function "f" linking data and information, function "g" linking information and usage are the different constitutive elements of the service, addressing a certain users' community (in red)

Based on this analysis, the two distinct phases of e-shape co-design have been detailed as follows:

1. **Phase 1 - diagnosis process to identify (1) co-design needs**, defined as the elements that are crucial to ensure the sustainable development of services as described in the previous paragraph, but currently not addressed or difficult to handle by the actors in charge of developing the services (i.e. pilots' members in e-shape context); and (2) **the actors to be involved** to address these issues.
2. **Phase 2 - implementation of co-design actions:** once co-design needs are identified, co-design actions are implemented to address them, involving the different stakeholders concerned by a given co-design need. As underlined in the D2.1 deliverable, the co-design needs are likely to concern other elements of the data-information-usage relationship than the design of the final usage. Therefore the co-design actions do not necessarily involve the final users, but all kinds of stakeholders involved on the data-information-usage chain (for example technical developers, commercial partners, etc.).

2.1.1 Phase 1: Diagnosis process

Regarding the first phase - diagnosis of co-design needs, a specific process with six steps has been set up and is detailed in the 2.1 deliverable as follows (Barbier et al. 2019):

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1. *[Step 1]* ***The data-information-usage framework is used as a tool to represent the situation of each e-shape pilot****. A first version is drawn, only based on existing documents already filled by the pilots. Initial and targeted states tend to be mixed up in these documents, thus they are not distinguished yet at this phase of the process. Based on the framework, the conditions needed for a sustainable development of services are examined, and blocking or unclear elements are identified.*

2. *[Step 2] Through Confluence[1], this framework is then shared with each pilot. Specific questions are raised based on the identified blocking or unclear elements.*
3. *[Step 3] These questions are expected to be answered by the pilot on Confluence as far as possible.*
4. *[Step 4] A telco discussion is then organized with the pilot leader to clarify the elements remaining unclear and further assess his/her knowledge on the mentioned user communities, through a story-telling exercise where the pilot leader is asked to take the user's point of view and imagine the sequence of actions conducted by the user to implement the service provided by its pilot.*
5. *[Step 5] Thanks to these clarifications, the pilot framework is updated and divided into two distinct frameworks: one for **the initial state and one for the targeted state** (as shown in Figures 1 & 2)*
6. ***[Step 6] Co-design needs** are then identified based on these frameworks. "*

2.1.2 Phase 2: Implementation of co-design actions

Regarding the second phase - implementation of co-design actions, the forms of the actions need to be investigated and experimented and will include the use of specific tools or workshops. Indeed, these forms will be adapted depending on the nature of the co-design need in question. As explained in D2.1 deliverable, existing methods reported in literature (Le Masson et al. 2017, Dubois 2015) could be useful as a starting point but will also need to be adapted to the specific context of e-shape. This aspect has not been thoroughly examined yet as we have mostly focused our efforts on clarifying and setting up the diagnosis process.

2.2 Aspects to be clarified in the initial co-design model

In the co-design model proposed in D2.1 deliverable (Barbier et al. 2019), the different elements composing the framework (data, information, value, function "f" and function "g") characterize the chain to be built between data and usage. They are the constitutive elements of the service, *i.e.* the different elements on which the service is built. However, **although this framework sheds light on the nature of the service, it does not clearly highlight the role of the actors and the actions to be implemented to develop the service.**

Consequently, to complement this framework, we have focused on the actions of the two main types of actors directly involved in e-shape pilots' development: the pilot's members (that are the different organizations constituting each e-shape pilot, in charge of developing the services) and the users.

Several configurations of the respective involvements of these actors in the service development might exist. The two extreme configurations can be described as follows:

- **Extreme configuration #1 - there is a buyer-seller relationship between the pilot's members and the users**: the pilot's members develop ready-to-use and turn-key services to users that are only in a buyer position. In this situation, for each new user, the pilot's members are expected to make all necessary modifications on the existing services (or even build completely new ones) to address the specificities of this new demand. Thus, in a long-term perspective, this configuration might be overwhelming for the pilot's members if they want to address a growing number of users (that might be in the same field or market segment, or even in new fields or markets requiring even more modifications to adapt to their specificities).

[1] Collaborative platform used in e-shape to provide an efficient and smooth coordination of the scientific and technical activities as well as the administration of the project.

- **Extreme configuration #2 - the user is able to design the service on its own, that is going from its needs to related information and EO data, building “f” and “g” functions**. This situation is unlikely to occur very often. Indeed as highlighted in D2.1 deliverable, there is a significant distance between data and value because of the high level and heterogeneity of expertise related to the usage domain and the data processing chains. Moreover, even if the user decides to focus its investments and efforts on building a first data-information-usage chain, it will keep evolving over time, in order to take into account the external advances on data or usage sides. Therefore, the level of investments and efforts might be too overwhelming for a user in a long-term perspective.

It is interesting to note that **these configurations describe the nature of the interaction between the actors, but do not make any hypothesis on the types of actors.** Therefore, these two extreme configurations should not be restricted to the common notions of “business-to-consumer” or “business-to-business” configurations, which do not specify how the actors interact. Indeed, in both “business-to-consumer” or “business-to-business” situations, the actors - whatever business or customer - could be either in the extreme configuration #1 where the service/product is fully designed by the service provider, or in the extreme configuration #2 where the user is able to design the service on its own.

In between these two extreme configurations, there is a **broad range of configurations of respective involvements of pilot’s members and users in the service design process, where both pilot’s members and users are in a designer position.** These in-between configurations seem to be the most sustainable ones in a long term perspective, both from the pilot’s and from the user’s points of view. The objective is then to **describe what is the nature of the interaction between the pilot’s members and the users to jointly design services, when they are both in a designer position**. More specifically in e-shape context, the interaction is described from the point of view of the pilots’ members, as the latter cannot control - but only influence - how users interact with them. **The way pilots’ members interact with users can be described as providing users with a set of elements to support a shared development of the service.** This set of elements is labelled **“design environment”** to make a parallel with the notion of “development environment” in computer science, that refers to a collection of procedures and tools helping developers to build, test and debug applications or programs.

In the last months, we have thus focused on experimenting and enriching our co-design model, especially by **better describing the nature of such a “design environment”.**

3 ON-GOING WORK ON CO-DESIGN IMPLEMENTATION AND LESSONS LEARNED

3.1 Description of current co-design implementation

Co-design process is being progressively implemented according to the two phases presented above:

- Regarding the diagnosis process, most of the pilots have gone through the process up to step 3 (*c.f.* section 2.1.1)). The status of the process for each pilot is synthesized in *Annex 1* of this document.
- Regarding the implementation of co-design actions, a first experimentation has been carried out with Pilot 2 – Showcase 3 (*High photovoltaic penetration at urban scale)*. The present deliverable mainly focuses on the conclusions drawn from this first experimentation, whereas the conclusions on the diagnosis of all pilots’ co-design needs will be rather examined in the D2.3 deliverable.

In the D2.1 deliverable, the diagnosis of co-design needs for Pilot 2 – Showcase 3, is presented into detail as an illustrative example of the process. As an outcome of this process applied for Pilot 2 –

Showcase 3, it has appeared that five aspects could be supported by co-design, as stated in D2.1 and summarized in the framework below (Figure 3):

1. The pilot seems to be divided into two sub-pilots. Co-design could help to clarify the articulation of these two parts.
2. For the sub-pilot supported by O.I.E. center, one crucial aspect of the pilot's success is the ability to show that assessing variability of solar energy is valuable. Co-design could help to define the good ways of "showing" this value, involving InSunWeTrust (ISWT on the framework).
3. The development and operationalization of the pilot are jointly shared by the O.I.E. center and Transvalor (valorization and commercial entity). Specific efforts are needed to build clear relationships between these two actors to ensure the sustainability of the service and future services in a long-term perspective. Co-design can be used to support these efforts.
4. Still in a long-term perspective, as highlighted in this document, it seems crucial to build information that is "use-generative". In order to foster new usages, co-design could help to find ways of "showing" information in order to generate multiple usages.
5. Finally, on a technical perspective, a "Digital Surface Model" is needed to build the service and currently provided by a French public institute. To further extend the service, co-design could be used to investigate alternatives to this source of data.

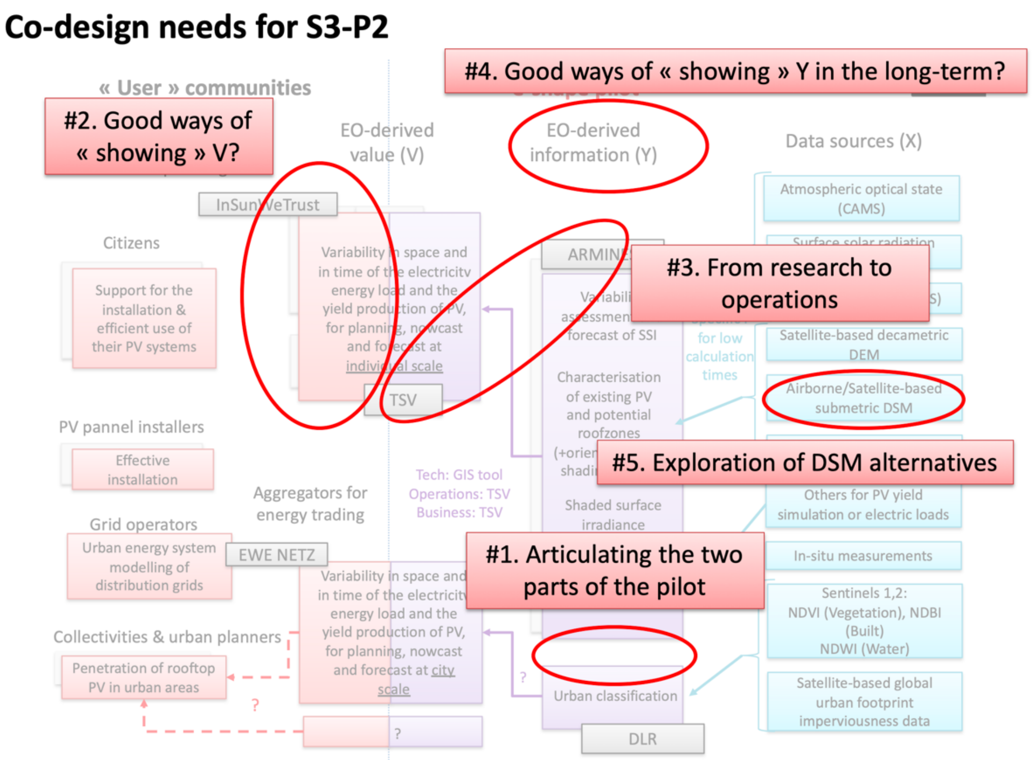

Figure 3: Identification of co-design needs of the pilot 2 – showcase 3 (based on the framework of the targeted state of the pilot as presented in Figure 2)

To experiment a first co-design action, we have focused on the co-design need #3, that is building clear relationships between these two actors to ensure the sustainability of the service and future services in a long-term perspective. This example has been selected as a first experimentation for practical reasons: the stakeholders involved have been working in close relationships for a long time and are located in the same city.

The co-design action consisted in a one-day workshop, involving two researchers from O.I.E. and three doctor-engineers from Transvalor. The organization team was composed of the three members of the co-design team (WP2). The participants were asked to (1) provide a retrospective of the relationships between O.I.E. and Transvalor, that have been working together to develop and operate SoDa services since 2009[2]; and (2) share their vision on the potential alternatives for the development of "the future surface solar irradiance nowcast/forecast product" and how they plan to interact. Each entity (O.I.E. and Transvalor) shared its point of view one after the other and was asked to comment the other entity's vision.

3.2 Lessons learned

This first workshop has been mainly used to draw insights on the co-design model and not really on the form of the co-design action in itself. As explained above, in addition to the framework detailing the constitutive elements of the service (data, information, usage, function "f", function "g"), our co-design model should also include a more detailed description of the "design environment" provided by the pilot to the users. This workshop has enabled us to better describe **how to build such a "design environment". More specifically the three following dimensions are introduced based on the workshop conclusions: (1) norm (2) ecosystem's capability, and (3) promise.** These three dimensions are defined below and illustrated with the Pilot 2 – Showcase 3 workshop, either on the case of the development of future nowcast/forecast products by Pilot 2 – Showcase 3, or on the historical case of SoDa services. Although these dimensions are introduced based on one single pilot analysis, they appeared to be quite generic as they also describe well what happened in a historical perspective. However, they might still evolve to take into account future lessons learned from further pilots' analyses and experimentations.

3.2.1.1 "Norm" dimension

If we take the users' point of view, in order to make them participate to the development of the service, they must be able to see the potential advantages the service generates. Therefore, it is crucial to have **a shared reference system – that we label "norm" dimension - in which the service, its properties and advantages are understandable and apparent for potential users.** This shared reference system might refer to different aspects of the service:

- A first important aspect is to express information on which the service is built in **a shareable and understandable language for a large community**. It includes different kinds of norms. To give a few non-exhaustive examples, it might concern: the type of information - variables to be used or its units (for example the International System of Units), the way it has to be described (for example *ISO 19115: Geographic information - Metadata* that "provides a model for describing information or resources that can have geographic extents"[3]), and also more specific standards related to exchange protocols (for example GEO Data Management principles or OGC standards);
- A second aspect is to have **a reference system in which potential users are able to see the advantages brought by the proposed service**. It might involve developing new indicators showing the quality of a certain type of information, or disseminating best practices involving processing and use of this type of information to make them largely recognized by the community.

[2] Services and webservices related to Solar Radiation (see D2.1 deliverable for a detailed history of SoDa services)

[3] https://www.iso.org/obp/ui/#iso:std:iso:19115:-1:ed-1:v1:en

It is worth noticing that some parts of this reference system might already exist (for example existing ISO standards), but some others might be still to be built (for example the development of new performance indicators or recognized best practices).

Illustration on Pilot 2-Showcase 3 workshop

This notion of "norm" came into the discussion when the workshop participants exposed a recurrent problem when trying to convince new clients for the interest of their nowcast/forecast product. It was indeed reported that the customers often had a very limited understanding of how to assess the quality of such a product. Most of the time, they seem to rely on simple indicators such as Root Mean Square Error (RMSE), choosing the service offering the lowest value. However, this indicator may not be a relevant measure of the forecast quality as in some cases RMSE can be low and forecast not relevant (Vallance et al. 2017). This shows the importance of working on the "norm" dimension, that is in this case mostly related to the second aspect mentioned above by building a common understanding of how to define the quality of a nowcast/forecast product. In this case, this work could be done through the involvement of O.I.E. in international organizations. For solar energy, the activities of the International Energy Agency's implementing agreements such as PVPS (task 16)[4] and SolarPACES (task V)[5] were mentioned as most relevant.

This "norm" dimension was also mentioned as being an important success factor in the development of SoDa services from the 80s up to now. Indeed, O.I.E. and Transvalor have progressively transformed SoDa services to be compliant with OGC and GEO standards allowing them to be recognized in GEO community (first aspect mentioned above). Moreover, many efforts have been made to transform their initial approach into a shared approach, that is recognized by the community (second aspect mentioned above). First they started to animate a community of practice aiming at sharing best practices among players in EO and energy. This community of practice then became the "GEOVENER" initiative within GEO community, with the same objective.

3.2.1.2 "Ecosystem's capability" dimension

As described in the D2.1 deliverable, developing services from EO data involves a very high level of expertise, both on data processing and on the domain of the final usage (including specific requirements, needs, norms related to this domain). Thus, providing a shared reference system might not be sufficient to encourage the development of services: enhancing the ecosystem's capability seems to be another crucial dimension. The idea is **to build an ecosystem of skilled users that are able to handle EO-based services and take part in their development.** To build this ecosystem, many different approaches might be considered by a pilot aiming at developing EO-based services. The following approaches have been especially identified:

(a) **Building supporting tools/toolkits** to bridge the gap between the users' skills and the expertise needed to use/build services;
(b) **Improving the skills of the users by training them**, so that they are able to use the service developed by the pilot, and take part in the development of the service;
(c) **Working on the structure of the ecosystem**, possibly by identifying intermediary users with higher skills, and in a longer term perspective by building interactions with these actors to ensure a **continuous evolution of both users' and pilot's skills.**

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[4] "The main goals of Task 16 are to lower barriers and costs of grid integration of PV and lowering planning and investment costs for PV by enhancing the quality of the forecasts and the resources assessments" (http://www.iea-pvps.org/index.php?id=389)

[5] The objectives of this Task are: "Evaluate solar resource variability that impacts large penetrations of solar technologies; Develop standardized and integrating procedures for data bankability; Improve procedures for short-term solar resource forecasting; Advance solar resource modeling procedures based on physical principles." (https://www.solarpaces.org/csp-research-tasks/task-annexes-iea/task-v-solar-resource-assessment-and-forecasting/)

It is important to note that having an ecosystem of **"skilled users" is different from "aware users"** as raising awareness of users is necessary but might not be sufficient. Indeed, our approach tries to put users in a designer position that is more skill-demanding than being only in a buyer position. Moreover, **depending on the context of the pilot, the three approaches (a), (b), and (c) might not be equally implemented all at once**. Indeed, the strategy to increase the ecosystem's capability also depends on the type and number of users to be addressed. For example if the pilot plans to address a large number of users, the approach (b) might not be as relevant as the approaches (a) and (c) at first as training a large number of users is highly time-demanding. In this case, training could be implemented at a later stage, focusing on intermediary users or high value users that might have been identified.

Illustration on Pilot 2-Showcase 3 workshop

The three approaches mentioned above are well illustrated when considering the development of SoDa services since 2009. Indeed, O.I.E. and Transvalor have progressively built a skilled ecosystem, resorting to these approaches:

(a) *Building supporting tools/toolkits*: to handle EO data coming from Meteosat, routines have been developed in order to make it easier to implement the algorithm. The help desk can also be considered as such a tool, as it allows users to directly contact the technical team to get support.
(b) *Improving the skills of the users by training them*: every year since 2013, a one-week training session is organized with a dual objective: improving future or existing users' skills and identifying potential orientations for future research and service development.
(c) *Working on the structure of the ecosystem*: progressively, the users' ecosystem has been structured in a specific way allowing the continuous evolution of its members' skills and O.I.E. – Transvalor's skills at the same time. Indeed, privileged relationships now exist with long-standing clients. First, these clients often play the role of intermediary users as they have significantly improved their skills related to EO and solar energy and are often able to build their own services by themselves. Therefore, Transvalor and O.I.E. have built a way of coping with a large number of users in different domains, without overwhelming efforts to adapt to the different situations. Second, these clients often bring new research questions to O.I.E. and also new clients to Transvalor. Indeed, significant technical issues might occur when these long-standing clients design a new service for their customers. They often ask O.I.E. to join the development of the service focusing on the research part to deal with these issues, allowing O.I.E. to continuously take into account the evolution of the users' ecosystem in their research work.

Regarding the development of future nowcast/forecast products, the "ecosystem's capability" dimension appeared in the discussions as crucial. The pilot's team seems to be willing to make efforts on building supporting toolkits - approach (a) - and training users - approach (b) – taking advantage of the means already developed for SoDa service. The structure of the ecosystem - approach (c) - appears to be also considered by the pilot: the user engaged in e-shape – (InSunWeTrust) plays the role of a skilled intermediary user.

Indeed, the current business model of InSunWeTrust is structured as follows: O.I.E. and Transvalor provides InSunWeTrust with solar cadasters; InSunWeTrust provides private individuals with a free support service for the installation of PV on their roof (simulation of economic feasibility, connection with PV installers); and margins are made on the relationships with PV installers when the individuals resort to PV installers thanks to InSunWeTrust service. In this situation, O.I.E. and Transvalor are not in charge of developing services for private individuals or PV installers as they are directly addressed by InSunWeTrust. For the development of future nowcast/forecast products at urban scale, the configuration is expected to be similar: O.I.E. and Transvalor will be involved in the development of nowcast/forecast products at urban scale, still requiring research efforts. Based on this product, InSunWeTrust plans to design its own service to address other user communities such as energy aggregators, PV installers, etc. Finally, the pilot can also take advantage of the existing ecosystem's structure that has been put in place thanks to the development of SoDa services, for example taking advantage of the interaction with its long-standing clients to launch new collaborations on nowcast/forecast products.

3.2.1.3 "Promise" dimension

Finally, providing a shared reference system and enhancing ecosystem's capability might still not be sufficient to encourage the development of services. Indeed, some stakeholders might not be spontaneously interested: **to turn them into potential users, their interests have to be stimulated.** Therefore, the "design environment" also needs to include **a third dimension – that we label "promise" dimension – stimulating and driving joint development efforts.**

This "promise" dimensions might take a large variety of forms. The following elements are proposed to describe it:

(a) **Target**, i.e. the stakeholders to which the promise is addressed. This element needs to be explicitly questioned as different stakeholders might be stimulated by different aspects of the service.
(b) **Content**, i.e. the elements stimulating and driving joint development efforts. Depending on the target, it might concern all aspects on which the service is built (both technical and market-related aspects), either for current services or future services.
(c) **Distance between promise and current state**, i.e. the extent to which the promise is achievable given the existing state of the service, and the means and resources that are available. It gives an idea of the level of residual effort that would be needed to achieve the promise. A broad range of distances might exist. For example, a very short distance could correspond to cases where the users already have explicit interests, that can be met by existing on-the-shelf services. In the cases of longer distances, the promise could require designing and building new means (for example building new tools, structuring the ecosystem etc.).
(d) **Embodiment**, i.e. the way this promise can be expressed, depending on the previous elements – target, content, distance. Several forms can be considered, potentially resorting to demonstrators or proof-of-concepts to better showcase this promise.
(e) **Combination and dynamics**: several promises can be combined at the same time in order to take into account the different kinds of targets, contents and distances that might be relevant. Moreover, because we are considering the development of services in a long-term perspective, the way of combining different types of promises might evolve over time depending on the stakeholders' and pilot's evolution. Thus, this promise has to be seen as dynamic and not static. It is interesting to note that playing on this "combination and dynamics" aspect can help find a balance between users' and pilot's interests that are both needed to maintain a joint development of the services. For example, it is possible to combine short-term and long-term aspects, to ensure the involvement of the users but also to start paving the way towards future research questions and advances.

It is important to note that we have chosen to introduce the notion of **"promise" rather than "value"**. First, because we do not want it to be confused with the monetary meaning of value (in e-shape other types of advantages might exist, for example related to regulation compliance). Second, as described above, the notion of "promise" is **larger than only making a certain value proposition (monetary or not) to given users**. This dimension can also be seen as **a way to drive future expansion of the service while maintaining users' and pilot's interests** (for example involving new stakeholders, going beyond only reacting to users' demands towards the exploration of new potential advances). In this perspective, the promises do not aim at being necessarily reached, as unexpected elements might progressively emerge during the process and result in the expression of new promises.

Illustration on Pilot 2-Showcase 3 workshop

This notion of "promise" emerged during the workshop when we addressed the question of the current interactions of O.I.E. and Transvalor with users regarding nowcast/forecast services. Two targets were more specifically mentioned: InSunWeTrust and InSunWeTrust's own clients. For these two types of actors, different promises were considered:

- Regarding InSunWeTrust, Transvalor underlined the importance of showing to InSunWeTrust what they were already able to propose (an existing nowcast-forecast product already on SoDa website), enhancing their existing expertise and involvement in the field. However, to engage InSunWeTrust in a longer term perspective, it was also important to show that the existing products could still be improved, highlighting the potential evolutions of the service and further research efforts. This promise on long-term concepts was more particularly interesting for O.I.E. because it contributes to build and develop its research strategy.
- Regarding InSunWeTrust's own clients, O.I.E. mentioned the importance of initiating interactions with them, to demonstrate the potential advantages of future InSunWeTrust's own service. Using a proof-of-concept of this service was mentioned as an interesting way to showcase the promise of a future service.

This example illustrates well the different elements of the "promise" dimension stated above:

(a) **Targets**: here several actors might be addressed with different objectives - InSunWeTrust to engage them in a long-term relationship for the development of nowcast-forecast products; and InSunWeTrust's own clients to start raising the latter's interests regarding future services.
(b) **Content**: related both to existing and future services;
(c) Distance between promise and current state: explicitly mentioned with InSunWeTrust showing both existing state, research resources that O.I.E is ready to provide, and their vision of the future regarding nowcasting-forecasting;
(d) **Embodiment**: as for the content of the promise, its embodiment highly depends on the considered target. In the discussions, we have especially discussed the proof-of-concept related to variability at urban scale. This point was mentioned as needing further development to better adapt showcasing to the different types of targets.
(e) **Combination and dynamics**: different types of promises were combined in the interaction with InSunWeTrust with short-term to longer-term perspectives. As for the dynamics, it cannot be underlined yet as the project has just started. However, considering the history of SoDa services, its successful development seems to be well explained by this ability of combining and making evolve several types of promises: promises about current services (making sure that their services were of interest for their users) and also future services, continuously regenerated thanks to the different research axes of O.I.E.

To summarize this section introducing the "design environment", its characterization by three dimensions - norm, ecosystem's capability and promise - seems to be a convenient tool to characterize the interaction between pilots and users. These dimensions are introduced based on one single pilot analysis. Their definitions might still evolve to take into account lessons learned from future analyses and experimentations. However, they already appear to be quite generic as they also describe well what happened in a historical perspective. An updated co-design model is proposed based on these new insights.

4 Updated model of e-shape co-design

To summarize our approach, in e-shape, co-design is used as a toolbox to support the development of twenty-seven pilots in a user-centered perspective. Existing co-design methods focusing on user-centricity tend to consider that it is all about involving users in the process. However, in the Earth

Observation context, developing services based on this type of data has to cope with some specific challenges, that are:

- The high level of technical expertise needed - combining both knowledge on data processing and knowledge on the domain of the final usage;
- The heterogeneity of actors that might contribute to the successful development of user-centric services - not only users and researcher but potentially all other actors of the ecosystem - related to legislation, platform owners, technical developers etc.

Because of these specificities, a co-design method specific to Earth Observation context is being developed within e-shape, based on recent advances of design theory. The D2.1 deliverable highlighted the importance of adding a first phase before implementing co-design actions, that is a thorough initial diagnosis process to identify the actors to be involved and the types of problems to be solved. The e-shape co-design is thus proposed in the two following phases:

1. **Phase 1: a diagnosis process to identify the co-design needs and the actors to be involved;**
2. **Phase 2: the implementation of co-design actions based on this diagnosis**.

To further specify the diagnosis process, the deliverable D2.1 enhanced how the constitutive elements should be designed to guarantee the sustainability of the developed services: (1) information which is "use-generative" (that is having the power of generating multiple usages), (2) data-information relationships that are able to adapt to future advances and (3) information-usages relationships that are able to cope with multiple usages.

In this D2.2 deliverable, these considerations can be completed with **a better understanding of the actions that the pilots' members should carry out in practice in the service design process**.

Based on these conclusions, our co-design model can be updated and now relies both on:

1. The **representation of the different elements constituting an EO-based service** (based on the frameworks represented in Figure 1 & 2), that are data, information, usage, function "f" linking data and information and function "g" linking information and usage.
2. The **description of the interaction of the actors to jointly develop services**, and more specifically how the pilots' members interact with users as **providing a certain "design environment"** based on three dimensions **– norm, ecosystem's capability and promise**.

These two aspects are complementary as the service-constitutive elements represented in the framework (1) correspond to the different parameters that the pilots' members can modify to build the three dimensions of the "design environment"(2). Based on these insights, we propose hereafter an updated co-design process with a refined description of its two phases.

4.1 Phase 1: Diagnosis process

Co-design needs have been defined as the elements that are crucial to ensure the sustainable development of services, but currently not addressed or difficult to handle by the pilot. Their identification used to only rely on the representation of the pilot based on the frameworks. With the enrichment of our co-design model, the analysis is now completed with the **examination of the "design environment" provided by pilots' members to users, and its adequacy with the targeted users**.

As for the overall process, the succession of steps remains the same, but steps 5 and steps 6 are enriched based on the description of the "design environment". The diagnosis process is therefore updated as follows:

1. <u>Step1:</u> **The data-information-usage framework is used as a tool to represent the situation of each e-shape pilot**. A first version is drawn, only based on existing documents already filled by the pilots. Initial and targeted states tend to be mixed up in these documents, thus they are not distinguished yet at this phase of the process. Based on the framework, the conditions

needed for a sustainable development of services are examined, and blocking or unclear elements are identified.

2. Step 2: Through Confluence, this **framework is then shared with each pilot.** Specific questions are raised based on the identified blocking or unclear elements. As an illustrative example questions addressed to Showcase 3 – Pilot 2 are presented in Annex 2.
3. Step 3: These **questions are expected to be answered by the pilot** on Confluence as far as possible.
4. Step 4: A **telco discussion is then organized with the pilot leader** to clarify the elements remaining unclear and further expand on the characterization of the future users' ecosystem, through a story-telling exercise where the pilot leader is asked to take the user's point of view and imagine the sequence of actions conducted by the user to implement the service provided by its pilot.
5. Step 5: Thanks to these clarifications, the pilot framework is updated and divided into two distinct frameworks - one for the initial state and one for the targeted state (as shown in Figures 1 & 2) and each framework is accompanied with a **comparison of the users' characterization and the "design environment" provided by the pilot's members.**
6. Step 6: **Co-design needs** are then identified based on these considerations. For this last step, the **method used to identify co-design needs can be better described** thanks to the enrichment of our co-design model. In the D2.1 deliverable, co-design needs are defined as follows: *"elements that are (1) crucial to ensure the sustainable development of services […], (2) but currently not addressed or difficult to handle by the pilot."* (Barbier et al. 2019). The introduction of the notion of "design environment" allows to better specify how to identify these co-design needs. In the previous co-design model, these were identified based only on the framework and corresponded to elements that were ill-defined or not robust to the expansion dynamics of the pilot. With the introduction of the notion of "design environment", co-design needs can now be described as referring to a **situation where there is a misfit between the users' ecosystem characterization and the "design environment"**, either for the initial state or the targeted state of the pilot. It is based on the examination of the following aspects:
    - Analysis of the pilot's initial state based on:
        - The representation of the constitutive elements of the pilot based on the framework, and making sure that these elements seem to be clearly defined in a long-term perspective ("use-generative" information, ability of "f" and "g" to address multiple usages and adapt to future evolutions);
        - The characterization of the existing users' ecosystem:
            - For each existing user category: interest of the user and advantages brought by the service (from both the users' and pilot's perspectives), reference system in which the service has value, skills, robustness taking into account potential competition;
            - Structure of the users' ecosystem: interactions between stakeholders, skills;
        - The characterization of the "design environment" provided by the pilot's members according to the three dimensions - norm, ecosystem's capability and promise.
    - Analysis of the pilot's targeted state based on:
        - The representation of the constitutive elements of the pilot based on the framework, and making sure that these elements seem to be clearly defined in a long-term perspective:

        - "Use-generative" information, ability of "f" and "g" to address multiple usages and adapt to future evolutions;
        - Characterization of the expansion dynamics wanted by the pilot: expansion objectives, robustness of the constitutive elements to adapt to this expansion;
    - The characterization of the future users' ecosystem :
        - For each expected user or users' community: interest of the user and advantages brought by the service (from both the users' and pilot's perspectives), reference system in which the service has value, skills, foreseen robustness taking into account potential competition;
        - Structure of the expected users' ecosystem: interactions between stakeholders, skills;
    - The characterization of the "design environment" planned to be provided by the pilot's members according to the three dimensions - norm, ecosystem's capability and promise.

It is worth noticing that this identification mode is consistent with the previous one (only based on the framework), as the elements of the framework are still used to characterize the users' ecosystem and the "design environment". Furthermore, this identification mode appears to us as easier to handle and routinize, and also helpful to further characterize the types of co-design actions to be implemented accordingly.

4.2 Phase 2: Implementation of co-design actions

To address the identified co-design needs, co-design actions are then implemented. The forms of these actions are still under investigation, however **some categories of co-design actions can already be foreseen**. As the co-design need corresponds to a misfit between the users' ecosystem characterization and the "design environment", the co-design action has to re-adjust the couple {users' ecosystem characterization, "design environment}; either by acting on the users' ecosystem to fit a given "design environment", or by acting on the "design environment" (that is its three dimensions – norm, ecosystem's capability, promise) to fit a given users' ecosystem. Therefore, we can foresee a **first kind of co-design actions adapted to work on the users' ecosystem** (for example by identifying other users that would be more adapted to the existing design environment, or looking for intermediary users), and a **second type of co-design actions adapted to work on the "design environment"** (and possibly different kinds of tools depending on the dimension to be modified).

5 Next steps for e-shape co-design

In the next few months, the diagnosis of co-design needs will be completed for all pilots. Based on this analysis, we plan to:

- Classify the recurrent problems faced by pilots;
- Experiment co-design actions for these different types of problems;
- Start building a co-design toolkit providing insights on the form of co-design actions most adapted to each type of problems;
- Keep updating our e-shape co-design model, based on the lessons learned from the future experimentations.

6 REFERENCES

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7 Annex 1: Status of co-design process for e-shape pilots

Pilot	Phase 1: Diagnosis process						Phase 2: Co-design actions
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	
S1 – P1	DONE	DONE	DONE	ONGOING	-	-	-
S1 – P2	DONE	DONE	DONE	ONGOING	-	-	-
S1 – P3	DONE	DONE	DONE	ONGOING	-	-	-
S1 – P4	DONE	DONE	DONE	ONGOING	-	-	-
S2 – P1	DONE	DONE	DONE	ONGOING	-	-	-
S2 – P2	DONE	DONE	DONE	ONGOING	-	-	-
S2 – P3	DONE	DONE	DONE	ONGOING	-	-	-
S3 – P1	DONE	DONE	DONE	ONGOING	-	-	-
S3 – P2	DONE	DONE	DONE	ONGOING	-	-	-
S3 – P3	DONE	DONE	DONE	ONGOING	-	-	-
S4 – P1	ONGOING	ONGOING	-	-	-	-	-
S4 – P2	ONGOING	ONGOING	-	-	-	-	-
S4 – P3	ONGOING	ONGOING	-	-	-	-	-
S5 – P1	DONE	DONE	DONE	ONGOING	-	-	-
S5 – P2	DONE	DONE	ONGOING	ONGOING	-	-	-
S5 – P3	DONE	DONE	DONE	ONGOING	-	-	-
S5 – P4	DONE	DONE	DONE	ONGOING	-	-	-
S5 – P5	DONE	DONE	DONE	ONGOING	-	-	-
S6 – p1	DONE	DONE	DONE	ONGOING	-	-	-
S6 – P2	DONE	DONE	DONE	ONGOING	-	-	-
S6 – P3	DONE	DONE	ONGOING	ONGOING	-	-	-
S6 – P4	DONE	DONE	DONE	ONGOING	-	-	-
S7 – P1	DONE	DONE	DONE	ONGOING	-	-	-

S7 – P2	DONE	DONE	DONE	ONGOING	-	-	-
S7 – P3	DONE	DONE	DONE	ONGOING	-	-	-
S7 – P4	DONE	DONE	DONE	ONGOING	-	-	-
S7 – P5	DONE	DONE	DONE	ONGOING	-	-	-

8 ANNEX 2: QUESTIONS ADDRESSED TO SHOWCASE 3 – PILOT 3 (DIAGNOSIS PROCESS – STEP 2)

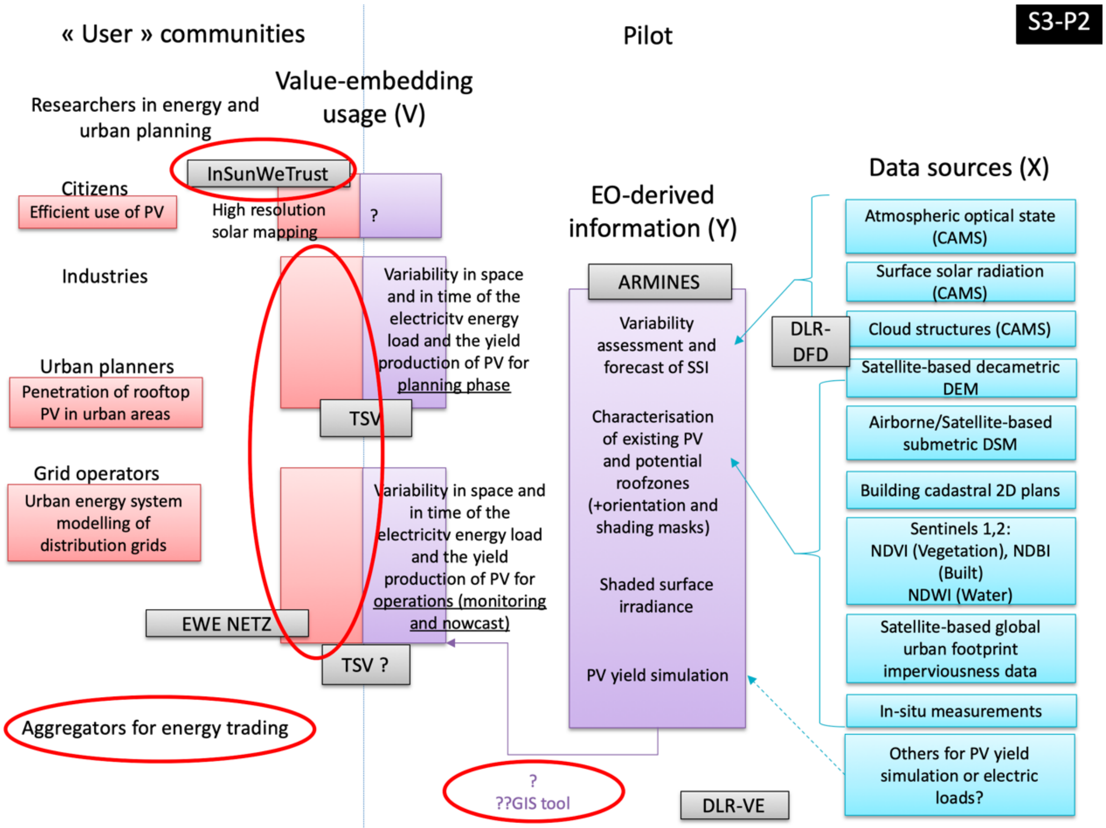

Figure 4: Framework shared with Showcase 3 – Pilot 2 at step 2 of the diagnosis process

On this framework, it appears that the following elements particularly need to be clarified. These elements will be further discussed during the telco, but please try to write some first elements to answer the questions:

- Why does "assessing variability of SSI" bring value?
- It appears that ISWT is an actor that will organise the link with several end-user communities: to what extent is ISWT a robust actor?
- What is the robustness of the GIS tool if there is an expansion of usages?
- It seems that the pilot is divided into two different branches: one with EWE NETZ and one with ISWT: what are the connections with these two branches?
- Do you have existing interactions with the mentioned users?
- Do you expect some use cases to be particularly challenging? Which difficulties have you already identified? - cf. Pilot's description in the challenge section.
- Are there user communities that you would like to address but you don't know how?
- Have you already identified factors that will be vital for the sustainability or future expansion of the service?