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Final report on the Barcelona pilots, evaluations of BarcelonaNow and sustainability plans

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DECODE

DEcentralised Citizens Owned Data Ecosystem

D5.9 Final report on the Barcelona Pilots, evaluations of Barcelona Now and sustainability plans

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CO	Confidential, only for members of the consortium (including the Commission Services)	

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Date: 15/12/2019

This report is currently awaiting approval from the EC and cannot be not considered to be a final version.

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Introduction

The present document is the final deliverable related to a crucial axis of the DECODE project, which aims at achieving practical implementations of the socioeconomic framework around data commons and data sovereignty and technological tools developed in previous work packages (WPs).

Such an ambitious objective can be formulated as the challenge to *satisfy real user needs, to design an easy to implement solution and effectively test it with real world users*. All of this must be fulfilled while fitting in the state-of-the-art technology developed in this research and innovation project, as well as the economic, social, legal and community practices and lessons learned from the use-cases and pilots as they evolve (continuous improvement methodology). In short, what we aim at achieving with the pilots in Barcelona is to build feasible examples of how *data commons* and *data sovereignty* can be implemented in practice. By *data commons*, we understand any system where people can freely contribute information or data while, at the same time, retaining effective collective sovereignty over it. In other words, retaining the (real and effective) ability to decide with whom the data is shared and under which conditions.

Doing so requires the tackling of three distinct axes described in the figure below, which have been researched within the different project work packages. The current pilots in Barcelona deal with the *practical* side of the project. The main challenges consisted in finding most appropriate use cases for the technology developed and social models studied, while matching them with real world communities to empower them with valuable solutions to their already existing needs.

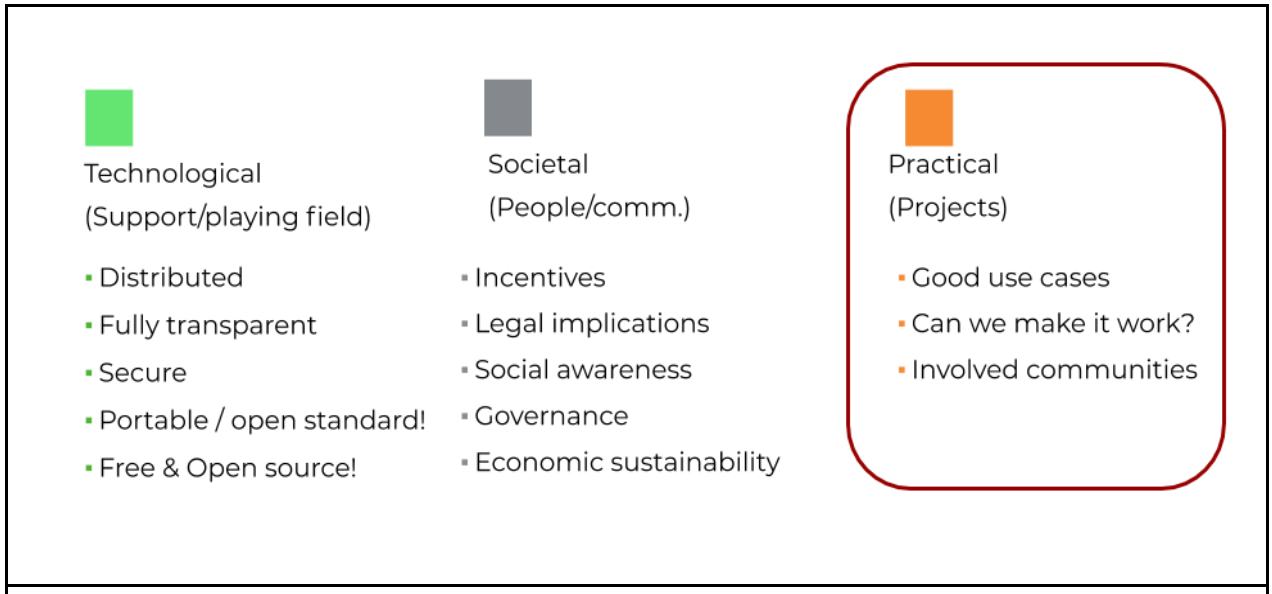


Figure 1: 3 axis of the data commons challenge

To begin, thus, we need to place the work performed in Barcelona in the context of the other work developed in the rest of the work packages, as well as in the other pilot city, that of Amsterdam. That can be seen in the attached figure 2, where actions have been assigned to each Work Package.

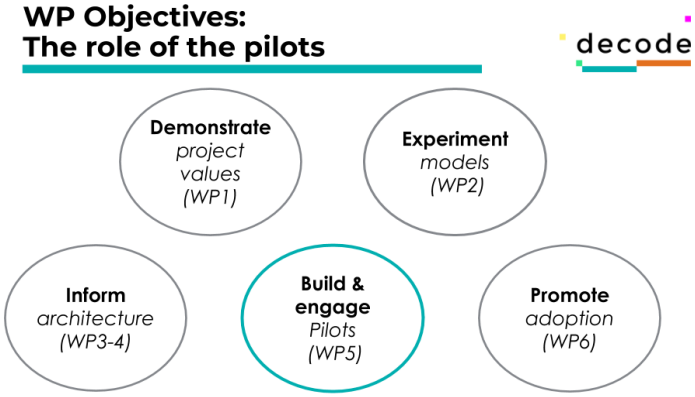


Figure 2: DECODE Work packages conceptual framework

The pilots in Barcelona are the meeting point of the diverse streams of work developed throughout the 3 years. Work Package 1 "*Privacy-aware citizen centric distributed architecture"* has provided methodological tools, frameworks and values to guide the design and development of the pilots. Work Package 2 *"Decentralised Governance and Economic framework: Commons data platforms for digital sovereignty"* has studied and provided legal and social recommendations to make those pilot designs feasible and sustainable. Work Package 3 *"Blockchain for decentralised data and digital identity management"* and Work Package 4 *"DECODE IoT node distributed hardware & software platform"* have built the tools that work on the back-end to provide the solutions envisaged for the communities with whom we work while Work Package 6 *"Standardization, Engagement, Dissemination"* has provided us with tools to enhance visibility, adoption and promotion of DECODE values, technologies and findings.

Due to this intrinsic relation with all work packages, the exact tasks which the Barcelona pilots had to face must be stated in order to analyze its success. Those can be extracted from the project Work Plan and more specifically from Work package 5 *"Pilots and participator innovation description, in the project proposal*, and are presented pictorially in the following diagram (figure 3).

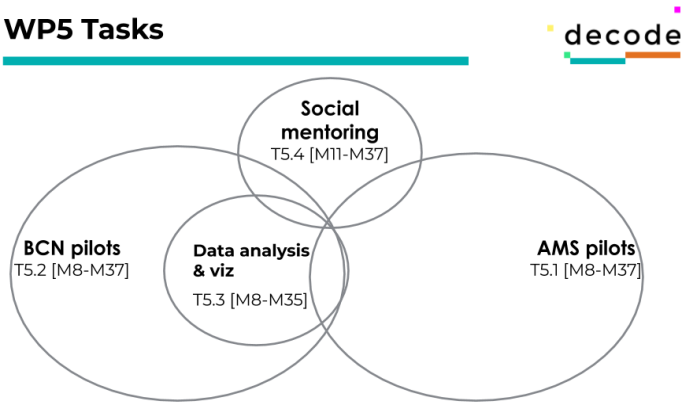


Figure 3: DECODE Work package 5 conceptual fit

Four fronts were covered:

- Technology testing: The pilots in Barcelona have been a perfect ground, where the innovative technologies developed in the project have been tested by users looking for solutions to the problems they face in their day to day life.
- Data Policy application: Data commons and ethical data management policies were developed by the city of Barcelona (Chief Technology and Digital Innovation Office) that put DECODE principles at the core. This included the release of "ethical digital standards" and the setting up of a Municipal Data Office that set the policy foundations and strongly contributed to the success of the DECODE project.
- Social Mentoring: Communities have provided a key support to validating the user interfaces developed, as well as the way they are presented. An important effort has been devoted to Visualization as the embodiment of the important issues at stake regarding data: Not so much *storing* it, but *finding good, actionable use cases* for it.
- Community engagement: We have used the pilots to study whether the proposed models are sustainable and most importantly, whether users understand DECODE's value proposition. Also, all the workshops, meet-ups and activities performed have served a pedagogical as well as raise-awareness purpose, that of discussing DECODEs primary concern about data sovereignty and strengthening arguments and methodologies to make it a reality on an adverse (current) scenario.

Of course, this document cannot be taken alone to understand all the work specifically performed in Barcelona. To place it in its relevant context, we attach in figure 4, a timeline where all the relevant milestones and deliverables of the WP5 workplan are presented.

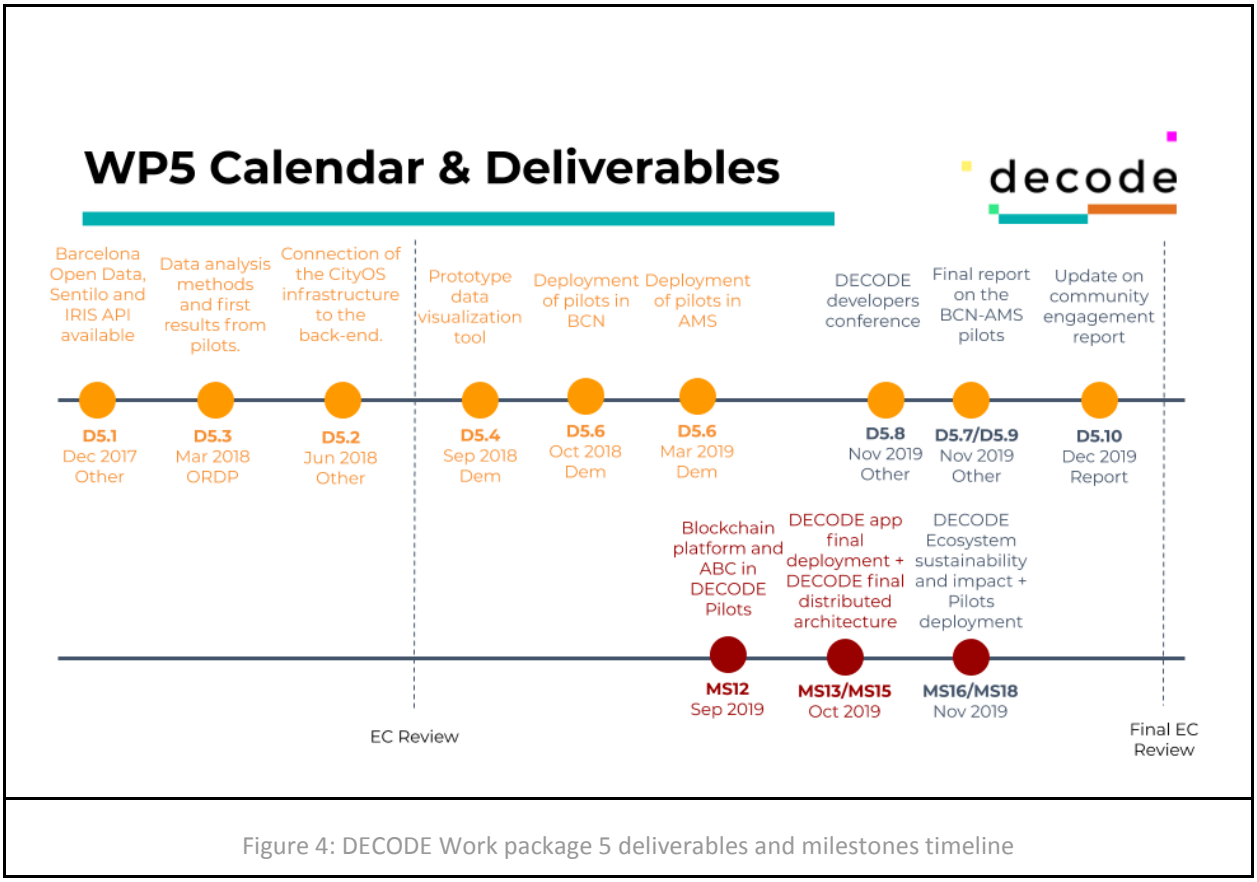


Figure 4: DECODE Work package 5 deliverables and milestones timeline

Moreover, we list below the most relevant deliverables of each contribution matched to the aforementioned fronts covered in the Barcelona pilots.

Technology:

- D1.4 First version of DECODE architecture (Oct '17)
- D5.1 Barcelona Open Data, Sentilo and IRIS API available (Dic '17)
- D5.3 Data analysis methods and first results from pilots (Mar '17)
- D4.8 Hardware prototype and reference platform running the DECODE OS (Apr '18)
- D4.6 Deployment and integration for the DECODE OS and HUB platform (Jun '18)
- D4.9 Design & implementation interface for smart rules (Jun '18)
- D5.2 CityOS connection (Jul '18)
- D5.4 Prototype Data Visualization Tool (Sep '18)
- D5.6 Deployment of Pilots in Barcelona (Oct '18)
- D1.5 Intermediate version of DECODE architecture (Jan '19)
- D3.7 Data submission interface for sensor data owners (Jan '19)
- D3.6 Smart Rules implementation, Evaluation of Prototypes and integration (Feb '19)
- D3.9 IoT privacy-enhancing data sharing: integration with pilot Infrastructures (May '19)
- D3.10 Implementation of Blockchain platform and ABC in DECODE Pilots (Aug '19)
- D1.11 Final version of DECODE architecture, documentation and sustainability (Oct '19)
- D4.14 Final DECODE app release. App published on multiple platforms (Oct '19)
- D4.15 Integration of all DECODE components tested in real world pilots and future sustainability roadmap (Nov '19)

Socioeconomic Mentoring:

- D6.5 Co-creation framework, methodologies and templates (Jun '17)
- D2.1 Multidisciplinary framework on commons oriented sharing economy (Jul '17)
- D2.2 Economic and regulatory analysis of data platforms and value-creation models of the on-demand economy; functionalities to be experimented in pilots (Dec '17)
- D6.6 Report on ecosystem bootstrapping activities (Dec '17)
- D2.5 Technopolitical Democratization and Digital Commoning: the Case of the Digital Democracy and Data Commons (DDDC) pilot (Sep '18)
- D6.3 Progress report on Standardisation activities (Jun '19)
- D4.10 UX/UI for DECODE app development integrated to BarcelonaNow (Jul '19)
- D2.6 Impact and economic sustainability of DECODE Ecosystem and future developments (Oct '19)
- D1.12 Policy impact of architecture and pilots implementation (Nov'19)

Community Engagement:

- D1.1 DECODE scenarios and requirements definition report (Jun '17)
- D6.2 Project Dissemination Strategy and Communication plan - interim (Jun '18)
- D5.8 DECODE Developers Conference: Opening up the DECODE App and tools to third party developers and entrepreneurs (Nov '19)
- D6.7 Project Communication, exploitation plans, events report and overall project impact (Nov '19)

It is also relevant remark the *D7.2 "1st Periodic Report"* (Jul '18) and the Reviewers report (Aug '18), both documents contributed to the pilots in a general perspective and covering the three aforementioned fronts.

With all the due context in place, we now proceed to explain the structure of the present document. This deliverable it is composed of 5 parts, including the current introduction which provides context on the pilots, followed by a general overview of the common methodology followed for all the use cases. Then, specific details for each pilot are given in three respective sections, transforming the general phases mentioned earlier into tangible examples of the general methodology. For each pilot, special emphasis is placed on its impact as well as sustainability and future roadmap as well as social, technological and practical details of the implementation.

Finally, a concluding section is provided that wraps up on the work done and provides insights into lessons learned and future directions that the current work has opened for further exploration.

BCN Pilots: Towards building the Barcelona data commons and DECODE ecosystem

As stated in the introduction, the aim of the pilots in Barcelona was set towards building an *effective data commons* ecosystem. To that end, we tried to follow a methodology that would allow us to fulfil several specific requirements that can be listed as follows:

1) **Usability:** Detect real citizens demands and communities in need where the inclusion of DECODE technology would make a difference (e.g. Decidim and Smart Citizen).
2) **Complementarity:** Reconcile the need for real use cases with the need to fit all pilots into a common framework re-using and integrating compatible technologies, polcies and models.
3) **Interactivity:** Work with communities susceptible to share common values and interests, so they can be made to interact and enhance the DECODE ecosystem via cross-pollination.

The resulting methodology has led us to a scenario where we have developed three complementary pilots with different communities that interact with a variety of common tools. In a nutshell, they are presented in figure 5.

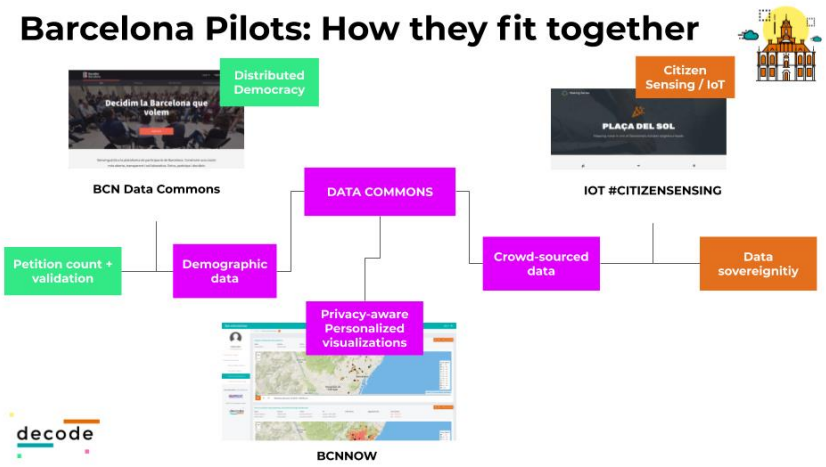


Figure 5: Barcelona Pilots' conceptual framework

The figure above shows the overall schema for the pilot structure in Barcelona. In the following lines, we describe how the Barcelona pilots were discovered and a short introduction of them is provided[1].

At the beginning of the project, we performed a discovery process (documented in deliverable *D1.1 "DECODE scenarios and requirements definition report"*) and as a result of this task, two DECODE pilots were selected to be implemented in Barcelona.

The first was the Digital Democracy and Data Commons (DDDC) pilot, which is a participatory process oriented to test DECODE technology to improve the digital participation platform Decidim by improving the user's control over their data as well as the transparency in citizen petitions. Moreover, the process has the goal of discussing alternative visions, networks and practices on citizens' data.

Second pilot is the Citizen Science Data Governance (IoT), which enables communities to support Iot data gathering and allow them to control what information is shared with whom, and under which conditions.

In order to connect both pilots and to ensure and simplify the task of showing in a simple way DECODE aims and functionalities, the need to design a platform for empowering citizens with interactive dashboards and to facilitate them the exploration of urban data emerged. In this way, we designed and started the implementation of BarcelonaNow. It is a platform that combines crowdsourced data from citizens with open data form the city and data gathered from other DECODE services, in order to empower citizens with interactive dashboards showing the impact of DECODE at the individual, community and city level.

The three pilots fulfill the general objective of DECODE and in particular with main goals described in the task T5.2 "Barcelona Pilots specifications and implementation"and T5.3 "Data analysis, metrics and visualization for citizen awareness."

Data sovereignty policies at Municipal level

Furthermore, at a policy level, it is important to mention that pilots integrate with the Barcelona City Hall data architecture (CityOS, Sentilo, Barcelona open data portal) and that the DECODE's approach has strongly influenced the ethical digital standards set up by Barcelona CTO: https://www.barcelona.cat/digitalstandards/en/. These standards also include new "data sovereignty" procurement clauses integrated in public procurement contracts, mandating city's providers to give back the data they gather to deliver the service to the city hall in machine readable format.

Data in this way is considered another kind of public infrastructure – like water, roads, the air we breathe. Data is seen as a meta-utility that will enable us to build future smart public services in transportation, healthcare, education. This is a first important policy step towards reconquering the city's digital sovereignty, declaring data as a public good. On top of this privacy-enhancing data ecosystem, DECODE enabled to demonstrate how data can then be governed and managed as a common good, shifting agency and control to citizens themselves that have the right to decide what data they want to share, with whom and on what terms. The terms and conditions for data access and sharing are in this way set by citizens themselves using the DECODE cryptography tools and smart contracts. Citizens will set the anonymity level, so that they can't be identified without explicit consent. And they will keep control over data once they share it for the common good. This common data infrastructure will remain open to local companies, coops, social organizations that can build data-driven services and create long-term public value, by integrating with the city's open data infrastructure and data lake.

DDDC pilot

In this pilot we have worked with the Decidim team and the Metadecidim community to enhance their technology while preserving users' data control and privacy, when they debate and support citizen petitions. The basic objective of the pilot has been to allow the use of blockchain and distributed technologies for safe, privacy-

[1] Most of the content of this section is a summarized version of the extended explanations present in the *D5.6 "Deployment of Pilots in Barcelona"*.

respecting, transparent and trustable petition support. We have allowed them to gather, in an aggregated way, demographic information about the users of the platform which can be used for enhancing its processes (f.i.: defining and improving inclusion strategies). While doing so, we have provided them with a visualization platform (the third pilot, BarcelonaNow) to explore the results of the gathered information with public data sources. All of this has been done while developing a debate over the use of the gathered data sources and data in today's society more broadly.

Citizen Science Data Governance (IoT) pilot:

The focus of this pilot has been around the development of effective rules, combined with cryptographic technology, that might allow users to share the same data at different granularities with different target groups. The results of the pilot have been applied to an IoT context and connected with a CAPS community (Making Sense), but could be extended to other, with more sensible datasets such as health data. Basically, the community with whom we have worked has solved a need related to gathering data in community to attain a certain degree of volume, while at the same time protecting some key privacy vulnerabilities that this crowdsourcing can produce.

BCN Now pilot

This pilot has been built to provide participants with visualization features for the data generated and donated by their communities. A key point around data sovereignty is to have the ability to analyze, explore and take action based on quantitative insights. That is to say, to extract practical value from the data commons. For this, data evidently is needed, but not only that, also appropriate tools must be used. BCN Now has provided these tools, while allowing users to feel a personalized, yet privacy aware experience and the ability to compose and share their own data exploration dashboards.

Through this tool, synergies between grassroots movements, the partners of the consortium as well as the public sector have flourished. The BarcelonaNow tool merges data from the public municipality, directly fetched from their infrastructure, with citizen donated data (from both the other DECODE pilots) and also with other external datasets curated by external developers. Thus, it conforms a live and real example of a data commons resource for the citizenry of Barcelona. Last but not least, its open source nature makes it extendable to any city wishing to follow the same model.

In the upcoming subsection, we specify the general process followed that has enabled us to identify proper use cases and successfully design and implement solutions for them. Then, we detail for each pilot, in particular, the elements involved as well as their specific implementations.

Pilot development general methodology

For each pilot, we have followed a structured methodology phased in 5 parts whose distribution in time is presented in figure 6.

Figure 6: General pilot phases

Below, we provide a detailed description of each of the phases followed, a recapitulation of its main feats and difficulties and we relate them to existing project deliverables. To facilitate the ease of reading, we here only formulate the general framework while describing the detailed actions carried out for each pilot in each of the corresponding devoted sections.

Phases

Exploration & Selection

An extended exploration phase was carried out mostly throughout 2017 to perform a thorough search and evaluation of potential communities to work with in the context of the DECODE pilots. To that end, many interviews were carried out and the potential candidates for pilots were evaluated on the basis of mainly four aspects:

1) Was the need of the candidate aligned with the values, objectives and aims of the DECODE project around data sovereignty?
2) Did the candidate community possess (or had access to) an existing infrastructure and the capability to integrate the DECODE technology to be developed?
3) Did the candidate community have an active and engaged user base?
4) Could we foresee any big blocker that would not allow us to complete the pilots in the timeframe of the project?

The analysis of those aspects was included as an appendix in deliverable *D1.1 "DECODE scenarios and requirements definition report"* It was a vital step to ensure pilot success, focused on trying to fulfill the already three enunciated objectives for this work in the introduction of this document.

The initial selection comprised the *Metadecidim* and *MakingSense* communities (see each pilot corresponding section for details). For each of those, two inception 3 day sprints lead by consortium partner Thoughtworks with support from IMI were held following *agile methodologies.* In those, the main ideas for the pilots (from a technological standpoint) were sketched out. At this point, the need for the third pilot - BarcelonaNow - became apparent. In addition to BarcelonaNow being a part of the original proposal, while working on imagining *personas* it soon became evident that if we were aiming to build a *data commons* for people, we needed to show them that it *did work in reality*. The central idea at work here is not only *where the data is*, or *who controls it*, but also, *what can we do with it?* Thus, the ideas sketching the platform were laid out. More detailed information on this process can be also found on the deliverable *D1.1 "DECODE scenarios and requirements definition report"*

The conclusions from this ongoing study informed the first DECODE tech symposium, held in London by the consortium partners in October 2017.

Design

Once the basic ideas for the pilots had been sketched out, the design phase began. The main goals of this phase were to explore in-depth the infrastructure of the communities with whom we would be working, test their technological development skills (or find suitable providers for them) and establish more clearly the scope of each pilot. Reaching an agreement between the communities and the DECODE Consortium about what is needed and what is feasible within the timeframe of the project and the resources available was also important.

The initial ideas around those objectives informed on the one hand the first version of the DECODE whitepaper (Deliverable *D1.4 "First version of DECODE architecture"*) and took the form of what we called *Pilot Packs*, attached in the appendices of this document.

Planning

Once the scopes for each pilot were defined and the technical requirements sketched out, we proceeded to the planning phase. This phase is important since the chosen pilots involves a large degree of complexity, characterized by:

- Inclusion of State of the Art technologies, in the process of research and thus highly mutable.
- Multiple actors with different skills, locations and areas of interest.
- Multiple requirements on different fronts such as deliverable timelines, community constraints, external local factors (city council *elections*) and others, as well as a large degree of interdependence between tasks (specifically regarding community engagement as well as technology development and implementation).

To face these challenges, a series of roles for the governance of each pilot were defined, calendars agreed and architectural choices were made. All of those were based on the ideas and conclusions from the discovery and Inception sessions, as well as discussions during the consortium General Assembly held on January 2018 in Amsterdam. The defined roles and governance for the pilots are presented in the following subsection.

On the architectural front, a development decision was agreed between the developers of our partner communities, the tech lead at that time, Thoughtworks[2] and the Barcelona pilot coordinators (IMI and Dribia). In a nutshell, self-contained DECODE components would be developed for each pilot, but their integration and *last-mile development* would be carried out by the involved communities. By *last mile integration* we mean the adaptation and integration of DECODE features into the UX/UI of the existing technology. Such a choice has emerged from research on the feasibility of the pilots, and has remained a founding keystone for the development of other software related to the project, such as the DECODE App presented in deliverable *D4.14 "Final DECODE app release. App published on multiple platforms"*.

More details on the planning phase can be found on the deliverable *D5.6 "Deployment of Pilots in Barcelona"*, but essentially throughout this phase a second DECODE Technical Symposium was held in Barcelona (April '18), to discuss and plan technical matters among DECODE partners. Other sessions such as threat modelling session for both pilots, and user design sessions to establish the mock-ups for the DECODE app were carried out and organized by Thoughworks also (see appendix). A final milestone was reached in this phase with the official kick-off of the pilots in Barcelona with a public event on October 18th, 2018.

Delivery

Once the development roadmap was clear, detailed integration and architectural plans were laid out and *Scale Model* software for the pilots was developed. The scale model was intended to be iteratively enhanced via parallel UX research feedback so in the end it could easily be integrated into the community tech infrastructure in a simple way. Many of the involved components were first *mocked* to accomodate for the ongoing development in other branches of the project (mainly work packages 3 and 4).

The key ingredient for the deployment of the pilots was the DECODE App. An initial version of the App was initially developed by Thoughtworks, together with the related user research and wireframes. This app was initially focused only on the DDDC pilot, to be extended to BarcelonaNow and IoT cases in the future.

Once the Consortium shifted responsibilities for App development towards Dribia, a decision was taken to split the work in the app in two parallel branches (to get the State of the Art research transformed into real innovation usable products): One aimed at finishing the first prototype of the DECODE app for the DDDC case and another lead by Thingful to make ready a web-app for usage on the IoT pilot (see more details below).

Despite some delays, thanks to the intense work of consortium partners and pilot communities, the technology for the three pilots was successfully delivered and tested with users, whose feedback was used in a subsequent phase to enhance it. This phase was concluded when all the necessary elements of technology needed to deliver the pilots was in place, including prototypes to use directly with real users. For details, see the related deliverable

[2]Most of the key architectural decisions relating the pilots' implementations to the general DECODE framework were agreed between partners and Dribia, who originally was working as a subcontractor for IMI and had a significant role. This was the main reason why technological implementation resources and leadership was given to Dribia, including the SME as new partner to the Consortium due to their core role in the Barcelona use cases.

D4.14 "Final DECODE app release. App published on multiple platforms" where technical details are given on the entire stack used, as well as *D4.10 "UX/UI for DECODE app development integrated to BCNNow"* for details on design choices for the app.

Measurement and dissemination

This is the closing phase of all the DECODE pilots, in which the impact assessment is carried out and measurements are gathered and future directions for the byproducts of DECODE are opened and explored. In this phase, on the community side, we have worked into uniting the two streams of work of the pilots via a series of workshops to discuss subjects of interest to them. See details of each impact assessment per pilot.

On the technological front, besides validating the scalability and general working of all the architectures deployed, we also devoted efforts into making the developed tools as simple as possible to be adopted by external developers. In this sense, the work in the pilots must be linked to the Decode Milestone *MS14 "DECODE app website - Website development to market and promote DECODE app and tools and to guarantee future sustainability."* and deliverable *D4.15 "Integration of all DECODE components tested in real world pilots and future sustainability roadmap"*, where the entire ecosystem has been opened to external developers in a wide event held in Torino (November '19) which has generated a significant amount of attention within both open-source and commercial tech communities.

Roles

The roles involved in each pilot have been standardized, and have performed the duties detailed below. First a description is given, then the specific details for each pilot are also provided and identified.

Coordinator

They are partners whom are part of the consortium that are focused in the coordination, planning and management of the pilot in its different areas, planning, technical, social, resources, etc. For all Barcelona pilots, this role has been covered by IMI (Barcelona City hall) and DRIBIA jointly.

Consortium partner

They are partners whom are part of the consortium and involved in developing technical components in general, not only devoted to a specific pilot. They are mainly focused on building the DECODE technology and infrastructure and their corresponding connectors. They also have the task to guide and help the pilot partners in the integration and test stage once those components are ready

Pilot partner

They are partners whom are not part of the consortium but have a central role in the pilot because they are in charge of the technology used by the existing communities to whom it is directed at. They participate in the pilot as liaison in different areas, such as integration of the DECODE technology with pilot infrastructure, as well as facilitating the community engagement with the DECODE use case

Communities

They are the already existent users or newcomers to the pilot communities, with different profiles and backgrounds. They provide the required feedback during the pilot life cycle in order to ensure that we were meeting the agreed results, as well as providing recommendations for continuous improvement.

DDDC pilot

DRIBIA (Coordinator)

Dribia is the consortium partner responsible for leading the technical aspects of the pilot. They supported TW in leading the design of the pilot architecture and collaborated intensely with IMI to deliver a first version of the DECODE app. After that, they have developed the second version of the DECODE app, with a new design, structure and functionalities. They have also worked with IMI in the design, planning, coordination and management of the pilot, from end to end. Last but not least, they have designed, supported and overseen the entire technical architecture and correct integration of the various pilot components.

IMI (Coordinator)

IMI is the consortium partner responsible for coordinating and managing the pilot in order to guarantee its success. Through the Chief technology and Digital Innovation Office and the role of DECODE's coordinator Francesca Bria, they have kept the engagement of DECODE with the public institutions in order to establish innovative data policies, ethical digital standards, and a sustainable environment that fosters the use of data in a privacy-preserving and rights respecting way, experimenting new avenues for data sovereignty at municipal level. Because of this novel approach, they managed the connection of BarcelonaNow with the Data Lake of the city council of Barcelona (CityOS) and with Open Data BCN, with the technical support of Eurecat. Moreover, they have worked with UOC and DRIBIA in the pilot planning and also in the organisation and management of the community sessions. Finally, thanks to the engagement of the project coordinator and the municipal data office, they contributed to spread this policy and infrastructural approach amongst cities and policy makers at European and global level.

UOC *(Consortium Partner)*

UOC is the consortium partner responsible for leading the pilot socially, facilitating the engagement with the Metadecidim community. From UOC, two research groups, rooted at the Internet Interdisciplinary Institute (IN3), where involved in the pilot: CN&SC-Tecnopolítica (Communication, Networks, and Social Change), specialized on democratic participation and leader of the Decidim project, and Dimmons, specialized on commons production.

They have led and created the participatory process known as DDDC. They have also supervised with the help of Dribia the work of Alabs, a technological subcontractor who has developed a new instance of DECIDIM known as DDDC. Moreover, they have collaborated in the integration of the DDDC instance with the DECODE connector and with BarcelonaNow.

Eurecat *(Consortium Partner)*

Eurecat is the consortium partner that developed the BarcelonaNow platform, which is an interactive tool for exploring and visualizing urban data. They have worked in the integration of the DECODE component, the META-DECIDIM instance and the above mentioned data coming from Barcelona City Council infrastructure with BarcelonaNow. Their work has also been tested and evaluated by the user's community.

Dyne *(Consortium Partner)*

Dyne became the technical coordinators of the project after the responsibility switch from Thoughtworks. They have developed all the cryptographic tools and their integration in the DECODE components. Their technology known as Zenroom has guaranteed the data encryption and it has been used in the implementation of the Coconut protocol, which allows participants share their attributes in a cryptographically secure way. They have collaborated closely with Dribia, Eurecat and Alabs in the last stage of development and integration.

Thoughtworks *(Consortium partner)*

Thoughtworks is the consortium partner responsible for pilot requirements definition and for organizing and performing the inceptions sessions. They have participated in the design of the pilot with the guidance of Dribia and the support of the technical partners. They also started the development of the first version of the DECODE app.

Metadecidim (Community)

Metadecidim is a community that collaborates in the design of the digital platform for citizen participation (deliberation, collaboration and decision) Decidim. The Decidim digital infrastructure was created by the Barcelona City Council for democratic processes, the aim being for it to become a common asset. Because of this, it was made available in 2017 to any public or private entity. Since then, it has been used by 110 institutions and organisations, including 70 municipal councils, two provincial councils and the Government of Catalonia, in Spain. At an international level, the Decidim software is being used in various cities in ten countries, as well as different social organisations.

Citizen Science Data Governance (IoT) pilot

DRIBIA (Coordinator)

Dribia is the consortium partner responsible for leading the technical aspects of the pilot. They have guided the design of the architecture and its functionalities. Moreover, they have also worked with IMI in the planning, coordination and management of the pilot, being a fundamental piece for the pilot success.

***IMI** (Coordinator)*

IMI is the consortium partner responsible for coordinating and managing the pilot in order to ensure that all the players work efficiently and deliver a functional system for the pilot, achieving goals previously established in the work plan. They also work with the pilot partners to organise and manage the sessions and the interaction with the community.

***Thingful** (Consortium partner)*

Thingful is the consortium partner responsible for designing and developing the core infrastructure of the pilot, such as stream encoder, datastore, policystore, etc; they have also developed the software component called Web-app and have led testing phase with the support of Smartcitizen and Eurecat.

***Eurecat** (Consortium partner)*

Eurecat is the consortium partner that have developed the BarcelonaNow tool, which is an interactive tool for exploring urban data. They have also built tools to integrate the platform with the components developed in the pilot, achieving a complete and effective integration between both architecture. At the end, BarcelonaNow is able to decrypt and display the sensor data following the terms (policies) described by the pilot community.

***Dyne** (Consortium partner)*

Dyne is the technical lead of the project. They have provided the core cryptographic engine known as Zenroom, that encrypts the Iot data generated in the pilot. They have also developed the Credential issuer service that also use Zenroom to generate credentials to guarantee the security in the data.

***Thoughtworks** (Consortium partner)*

Thoughtworks is the consortium partner responsible for pilot requirements definition and for organizing and performing the inceptions sessions. They have also support the rest of the technical partners in the design of the pilot architecture.

IAAC & Ideas for change (Pilot partner)

IAAC is a pilot partner that had an existing infrastructure of IoT devices and data infrastructure known as Smartcitizen. They have provided their technical knowledge in order to help in the design and development of the pilot, and they also led the integration of the Smartcitizen infrastructure with the DECODE components.

Ideas for change is a pilot partner with expertise in community engagement projects. They have mobilized the community and they also planned and executed the community engagement sessions under the leadership of IMI and DRIBIA.

Smart Citizen (Community)

This active worldwide community seeks to engage citizens, cities, developers and researchers in collectively addressing environmental problems in cities such as light, noise and air pollution. They based their action in two main strands: the Smart Citizen Kit, a low-cost set of tools which uses Arduino technology to allow citizens to collect environmental data. This data is then transmitted by wifi to a server where aggregated data can be researched and analysed. The second one is the Smart Citizen Platform, lets researchers, schools, communities, citizens, cities and developers connect with each other and with data to generate participatory processes and tools to address environmental problems in cities.

Pilot 1: Digital Democracy and Data Commons

The Digital Democracy and Data Commons (DDDC) pilot[3] has focused on experimentally implementing the DECODE mission by the convergence of two technological systems: DECODE and Decidim. As it was mentioned in the deliverable *D2.5 "Technopolitical Democratization and Digital Commoning: the Case of the Digital Democracy and Data Commons (DDDC) pilot"*, the DDDC pilot has two threads, the Digital Democracy thread and the Data Commons thread. The Digital Democracy thread, the primary one, has a central aim: testing the DEcidim system. Ultimately, this thread speaks to the potential of DECODE technology to push forward Decidim's technology and vision of participatory democracy. The Data Commons thread, which is a complementary thread, is oriented to cover the other two general aims of the pilot, namely, to collectively deliberate upon data policies and experiment with data commons. Ultimately, this thread speaks to the potential of Decidim to advance DECODE's vision of a citizen-centric form of data governance and the democratization of the digital economy.

Pilot Objectives

DDDC pilot, like the rest of the DECODE pilots, has served to engage citizens and local communities to demonstrate the use of the different privacy-enhancing, decentralized and rights-preserving digital tools developed. It has also integrated the legal, economic and social aspects of the data commons development. In this sense, DDDC pilot has served several complementary goals:

1) The first was to integrate DECODE technology with the Decidim digital platform for participatory democracy, with the goal of improving it for processes involving citizen e-petitions, providing more safety, privacy, transparency and data enrichment.
2) The second objective was to enable a deliberative space around data regulation, governance and economics, in the context of the new digital economy and public policy. The goal was to provide a vision oriented to promote a greater citizen control over data and their exploitation in commons-oriented models (that is, models where people share data and allow open use while remaining in control over it, individually and collectively).
3) The third objective was to experiment with the construction and use of a data commons generated in the process, for improving the inclusion of the participatory process itself.

To achieve these objectives a participatory process was conducted, oriented to test a new technology to improve the digital participation platform Decidim and to collectively imagine the data politics of the future. As it was described in the report 5.6 *"Deployment of Pilots in Barcelona"*, this pilot has been developed in collaboration with the team behind Decidim, the participatory democracy platform first developed and deployed in Barcelona[4]. The DDDC pilot has worked with communities and citizenry, public sector, private sector and academic actors following a well known open innovation model. Based on these social actors, and in order to achieve the participatory process goals detailed, a user engagement calendar was developed .

Phases

[3] Pilot website https://dddc.decodeproject.eu/
[4] Decidim Barcelona https://www.decidim.com/

Exploration & Selection

In the exploration phase, the precise scope was chosen so as to satisfy several clearly established needs of the users of DECIDIM: 1-user control over data shared with the platform in order to increase rights such as privacy while exerting political rights; 2-user possibility of sharing information about demographics to reduce bias, increase inclusion, and to strengthen a given political cause; 3-immutability, transparency, auditability and balance of power in the signing of citizen petitions.

For making a decision on the selection of the candidates DECIDIM community for the technical track of the pilot, focused on the development of the DECODE app, an Inception session was held in Barcelona (May 2-5th 2017) under the leadership of Thoughtworks. In the event representatives from IMI, Dribia, Eurecat, TW, UOC and Decidim sketched the technical requirements and definitions for the pilot.

Design

In this phase, the metadecidim community (which includes the Office for Innovation in Democracy of the Barcelona city council) was targeted as the key community for the pilot. With the user needs clearly identified in the exploration stage, two design tasks were undertaken: the conceptualization of the participatory process for community engagement and debate and the definition of its interlink with the technological solution to be put in place (see sections below). A set of expectations and responsibilities were set up for the pilot.

The final agreement of the precise scope of the pilot was achieved with the community, using a technique based on DOs and DON'Ts as seen in figure 7.

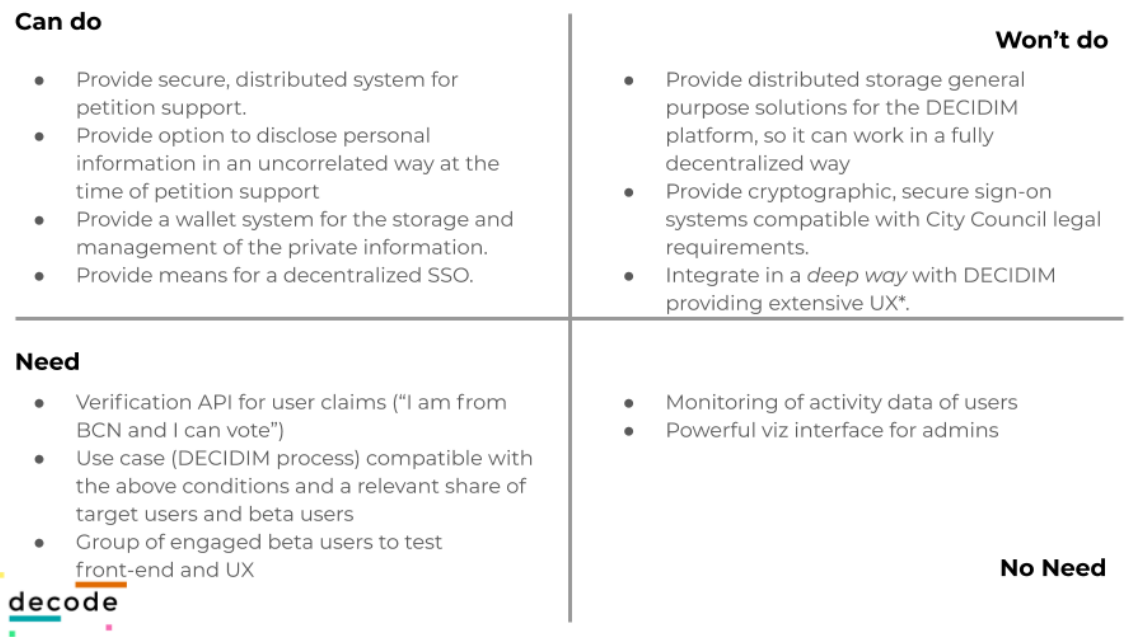


Figure 7: DDDC Pilot scope (DO's and DONT's)

The early generated requirements for the pilots served as a basis for discussion throughout the 1st and 2nd DECODE Tech Symposiums held by the consortium in London (September 20th-21th 2017) and Barcelona (May 3rd 2018), that helped in the definition of the technologies to use as well as their implementation.

Planning

From a project management point of view, this phase was initiated once all the necessary ingredients were in place: A user target group (metadecidim) with defined needs (results of the inception) and technological capacities and infrastructure (decidim.org), together with researched and understood innovative technologies (distributed ledger, coconut and zenroom) and a set of achievable goals.

At this point, a governance model following the general framework presented for all pilots was agreed and calendars set into place to prepare the delivery and measurement phases.

Delivery

The delivery phase was kickstarted with a workshop held at Fabra i Coats and organized by Thoughtworks, with participation of Dribia, IMI and UOC (June 5th 2018). Also, a threat modelling session was held at the Thoughtworks Barcelona offices on June 25th 2018 to ensure the validity of the designed and proposed architecture. In it basic user journeys were refined from the early work on scale modelling that was showcased on the mid-term project review (Brussels, July 2018).

In a parallel stream, the UX process around the DECODE App scale model was started: user research inputs on the DECODE app under construction were gathered by visiting regular metadecidim community meet-ups or by setting up UX sessions to speed up the development. Three UX sessions with users of the metadecidim community took place, in the following dates:

- May 8th 2018
- June 5th 2018
- September 20th 2018

The sessions were mainly divided in two sections, first of all consortium partners evaluated the technology background of the user related to the DECODE context. After that they provided feedback on the different functionalities of the App scale model. More than 20 people were interviewed in this process, with persons from very diverse sociodemographics, trying to prevent design bias. The sessions usually took place at the Laboratory for Innovation in Democracy, the headquarters of the Decidm project. This phase concluded with a first prototype of a DECODE app ready to be tested by the pilot on April 1st, 2019, at the DDDC Finale event.

Measurement and promotion

Once the prototype was ready, its inner workings were put on test in a real world scenario and feedback was gathered both on the user journeys as well as on its performance. At this stage, quantitative and qualitative research was conducted to evaluate the impact of the pilots (see below).

Also, a second round of enhancement of the technical parts of the pilot was carried out, with improvements on all the back-end systems and a new iteration of the app. This iteration used the learned lessons from the previous prototype and experimented with users (see relevant deliverable *D4.10 "UX/UI for DECODE app development integrated to BCNNOW"*) by conducting additional user research throughout June 2019.

The phase was concluded on the social front with a social event closure and, on the technological one, with the official presentation of the app at the developers conference track of the final DECODE symposium held in Turin (November 2019).

In order to get detailed information about the activities results and participant feedback, see the deliverable D6.7 "Project communication, exploitation plan, events report and overall project impact". .

Social Deliberation

Following the process referred in deliverable *"D2.5: Technopolitical Democratization and Digital Commoning: the Case of the Digital Democracy and Data Commons (DDDC) pilot"*, the implantation of DECODE app has had these phases:

- A first phase (May-September 2018) was dedicated to test and integrate DECODE app with Decidim through a series of User Experience sessions. More than 20 users participated in the DECODE app User Experience sessions. This task was led by Thoughtworks and UOC.
- A second phase was focused (September-October 2018) on defining the final design of the process and strategy and communication of the implantation.
- The third phase (October 2018-April 2019), the participatory process, inspired in other processes run in Decidim.barcelona, was divided into different sub-phases.

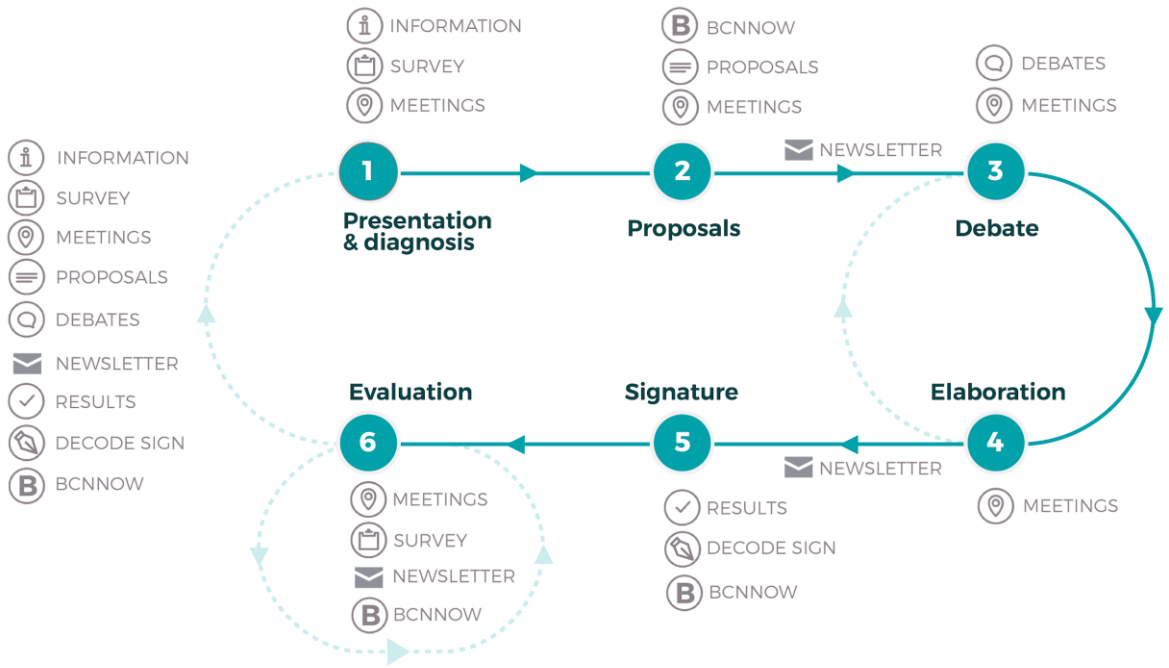


Figure 8: Process of implementation and evaluation of DDDC pilot.

Presentation & diagnosis

The first sub-phase of the process was dedicated to the elaboration of a brief diagnosis of the state of regulations, governance models and data economy, supported on the analyses previously developed in the context of the DECODE project. This phase has also included the launch of a sociodemographic survey which also included various questions of perceptions on the digital economy. The data from this survey has allowed, in the later stages of the process, to design communicative actions aimed at improving the inclusiveness of the process.

Figure 9: Presentation and diagnosis during the BCN pilots kick off (October 18th) at Fabra&Coats (Barcelona)

Proposals

During the second sub-phase of the process, proposals were collected to address the issues mapped during the diagnosis phase, including proposals derived from the previous work in DECODE. This process started at Sharing Cities Stand Lab during Smart City Expo World Congress[5] on November 14th, 2018. Proposals were framed in three different areas intertwined: Legal, Governance and Economical.

Figure 10: Presentation and working session during the SCEWC (November 14th 2018) at Sharing Cities Stand Cities (Barcelona)

[5] DDDC session at Sharing Cities Stand Lab (SCEWC)
https://dddc.decodeproject.eu/processes/main/f/4/meetings/4

Debate

In the third sub-phase, proposals from the previous phase were discussed. This part of the process has had two ways of participation: on the one hand, through face meetings; on the other, through the participation online on the DDDC pilot platform.

One of the main points of the debate was focused on the new forms of capitalism rely on data, platforms and surveillance and debating and imagining alternatives to it. Both debate-oriented and performance and imagination-oriented events took place. For this purpose, a role-play methodology called Data Control Wars was developed.

Figure 11: Conversation during The Influencers festival in Barcelona (October 27th 2018).

In this context, CNSC-Tecnopolítica led the Automated Control Wars action that took place at The Influencers[6] festival on October 27th 2018. This Data Control Wars session involved a roleplay performance with citizens oriented to reveal and explore the struggles of the present and the near future through a battle between four possible actors and scenarios (corporations guided by the desire to accumulate power and capital, an alt-right state trying to control its population, digital nomads seeking to build a state that protects their way of life, and an empowered citizenry trying to take power) using automated connected technologies to shape the future of the world.

A more debate-oriented event was celebrated in the context of the production, experimentation and artistic research center Hangar. The meeting[7] was held on March 1st 2019; starting from the analyses and proposals of the DECODE project and the DDDC pilot, it moved between diagnosis and prognosis, between dissection and speculation, between hegemony and its alternatives, when looking at the current state of the digital economy.

[6] The influencers https://theinfluencers.org/en
[7] DDDC Hangar conversation face meeting https://dddc.decodeproject.eu/processes/main/f/4/meetings/15

Figure 12:Conversation at center Hangar in Barcelona (March 1st 2019).

The third session, another Data Control Wars, was focused on the multiple possible futures in the context of surveillance capitalism and the growing algorithmic governance of society.

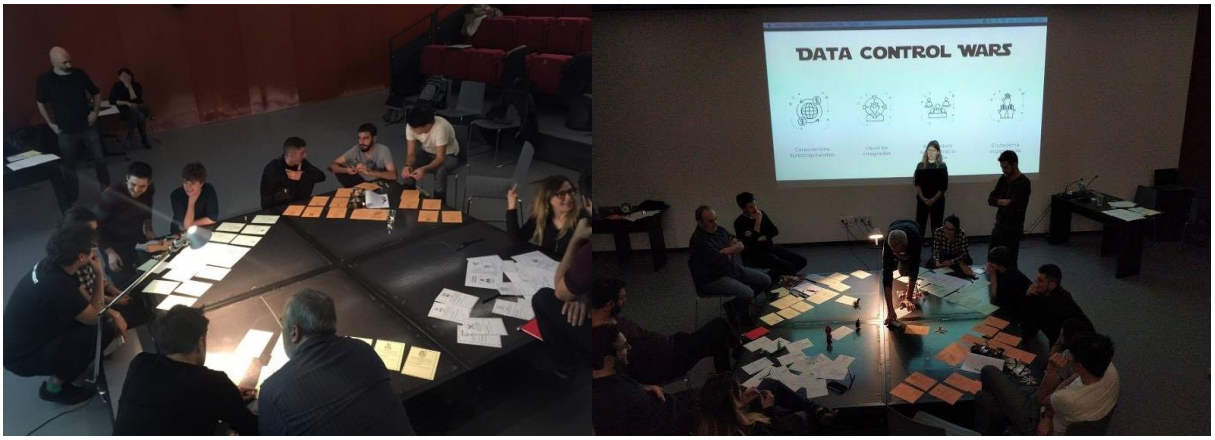


Figure 13: Conversation at Massana School of Art in Barcelona (March 5th 2019).

A third event was held at Massana School on March 5th 2019 during the Smart City Week trough Data Control Wars workshop[8].

[8] DDDC Data Control Wars workshop https://dddc.decodeproject.eu/processes/main/f/4/meetings/21

Elaboration

At DDDC Sprint, celebrated on March 18th, 2019, the experts involved in the conversations of the pilot met to close the elaboration of a Manifesto for data sovereignty and data commons. This meeting had the format of an intensive collaborative writing workshop, starting from the materials collected in the previous stages of the DDDC pilot and was oriented to generate a programmatic text. The meeting was held at Fabra&Coats, site of the Laboratory for Innovation in Democracy.

Figure 14: DDDC Manifesto Co-working meeting (March 18th 2019)

This participatory Manifesto established the resulting vision of the DDDC pilot. The manifesto was presented at the DDDC Finale meeting, on April 1st 2019. The event included the presentation of the manifesto and its digital signing, as the first testing of an alfa version of the DECODE-Decidim technology, followed by an open debate with experts in the field of technology policies and the digital economy, including the Barcelona CTIO and DECODE coordinator Francesca Bria, hacker and public speaker Jaromil Rojo, research group Dimmons leader Mayo Fuster and Decidim coordinator Arnau Monterde, among others.

Figure 15: DDDC Finale meeting (April 1st 2019)

Signing

After the presentation, the document was opened for collection of supporting signatures and comments. This was a central moment in the pilot: the first test of the DECODE technology for secure and transparent signature[9].

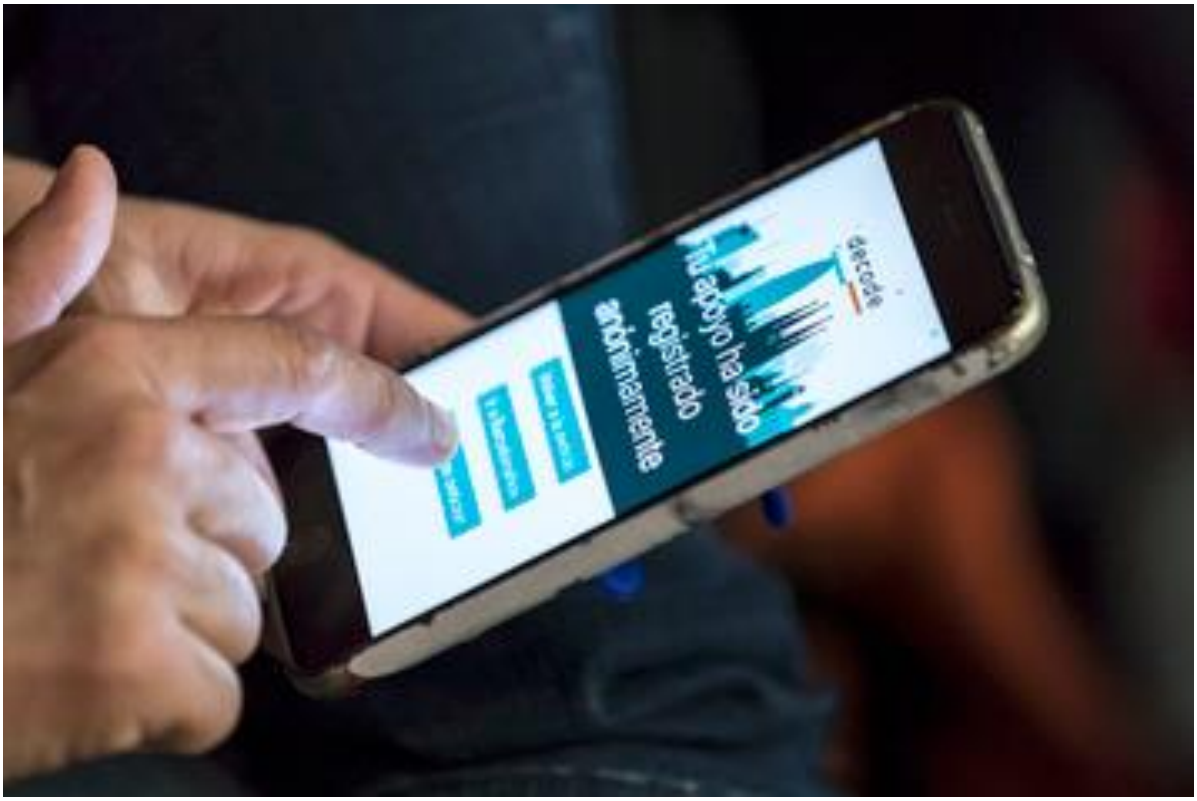


Figure 16: Signature process in the DDDC Finale (April 1st 2019)

[9] DDDC FAQs https://dddc.decodeproject.eu/pages/faq?locale=en

Evaluation

Most of the evaluation of the DDDC process was carried on while the implementation of the pilot. The feedback of events and workshops participants matched with the insights of the experts of different areas generated a permanently evaluation of the process. In spite of that, the pilot managers launched an online survey during the closing meeting to give another possibility to assess the satisfaction of participants with the process and with the DECODE technology. Probably because most of the attendants were already involved in the whole process, only seven people answered it. Out of this small number of participants two positions are manifested in parallel. People who highlights the coherence of the process and the value of the results (manifesto and DECODE app), and others that in spite of valuing this, show their fear for the complexity for understanding the whole proposal.

Technology

The technology used in the pilot is described in detail in the following deliverables

- D5.6 Deployment of Pilots in Barcelona (Oct '18)
- D1.5 Intermediate version of DECODE architecture (Jan '19)
- D3.6 Smart Rules implementation, Evaluation of Prototypes and integration (Feb '19)
- D3.10 Implementation of Blockchain platform and ABC in DECODE Pilots (Aug '19)
- D1.11 Final version of DECODE architecture, documentation and sustainability (Oct '19)
- D4.14 Final DECODE app release. App published on multiple platforms (Oct '19)
- D4.15 Integration of all DECODE components tested in real world pilots and future sustainability roadmap (Nov '19)

For reference, a brief overview of the components developed is provided below.

App

The DECODE smartphone app was used in this pilot, which was fully published to the general public to fulfill milestone *MS13 "DECODE app final deployment"* and whose documentation is available both on its repository, website and related to the deliverable *D4.14 "Final DECODE app release. App published on multiple platforms"*.

Two versions of the app were used with different code bases. Throughout mid 2019 a complete rebasing of the app was performed to simplify its development and ease adoption by external developers.

Coconut

The process of petition support needs the use of cryptographic credentials with a *Zero Knowledge Proof* schema. It uses a current implementation of a newly developed and innovative cryptographic breakthrough generated in the context of the project and named *Coconut* (see also deliverable *D3.8 "Decentralised models for data and identity management: Blockchain and ABC MVPs preliminary version").*

Distributed ledger

The current pilot constitutes a prime example of usage of a distributed ledger for non-monetary purposes. In particular, we have experimented with two different implementations of distributed ledgers: A preliminary version based on the highly experimental and innovative chainspace platform (also a project research result) and a final implementation using Sawtooth (see details in related deliverable *D3.10 "Implementation of Blockchain platform and ABC in DECODE pilots")*.

We have built a simple API that allows access and abstraction to manage petitions in a distributed way, with an open source back-end service (available online) written in python, highly portable (*dockerized*) and easy to deploy.

This simple API makes it also simple to replace the ledger system by any type of conventional database (distributed or centralized) without the user or external services noticing any change. This approach was taken so as to be able

to experiment with a variety of forms (Chainspace, Sawtooth and conventional DB), and the latter was used on the signature of the DDDC manifesto with the first version of the app.

Per the current implementation, we use the distributed ledger to record petition support processes and allow any citizen interested in verifying its usage to audit any process stored within.

Credential issuer

The DECODE app uses a credential service to issue and generate cryptographic certificates. The consortium has built an easy to deploy and extendable credential issuer API (available online) that abstracts cryptographic operations and in particular the coconut flow and is easy to manage.

We use the credential issuer to aggregate demographic data from users and to issue credentials that enable them to prove they can participate in petition processes and log-in to the BCNNow platform.

Zenroom

All the cryptographic operations in the entire technological stack are handled using the DECODE created language Zencode and its implementation Zenroom, which makes handling cryptographic operations a simple task for non-expert programmers.

DDDC in numbers

Since the launch of the participation process (October 2018), the DDDC pilot has generated a growing interest that we summarize in the following table (as of October 2019):

Table 1: DDDC Results summary

DDDC results summary	
Participants	223
Proposals	77
Governance	32
Legal	9
Economic	26
Transversal	10
Votes	118
Comments	86
Meetings	8
Petitions	2

DDDC results summary	
Manifesto signatures	36

The entire stack of proposals generated in the process can be browsed at the DDDC website.
Also, the DECODE app has impacted large numbers of people, as can be seen from reported metrics both on the IOS and Google Play platform. It reached circa 5000 screen impressions on IOS, and an average number of over 50 distinct active users per day since its private release.

DECODE is also now integrated with the Decidim participatory democracy platform with 40.000 users in Barcelona, and now adopted by more than 80 cities globally: https://decidim.org. The platform was recently launched in Italian by the Italian government, that will be using it as national participatory democracy platform: https://partecipa.gov.it .

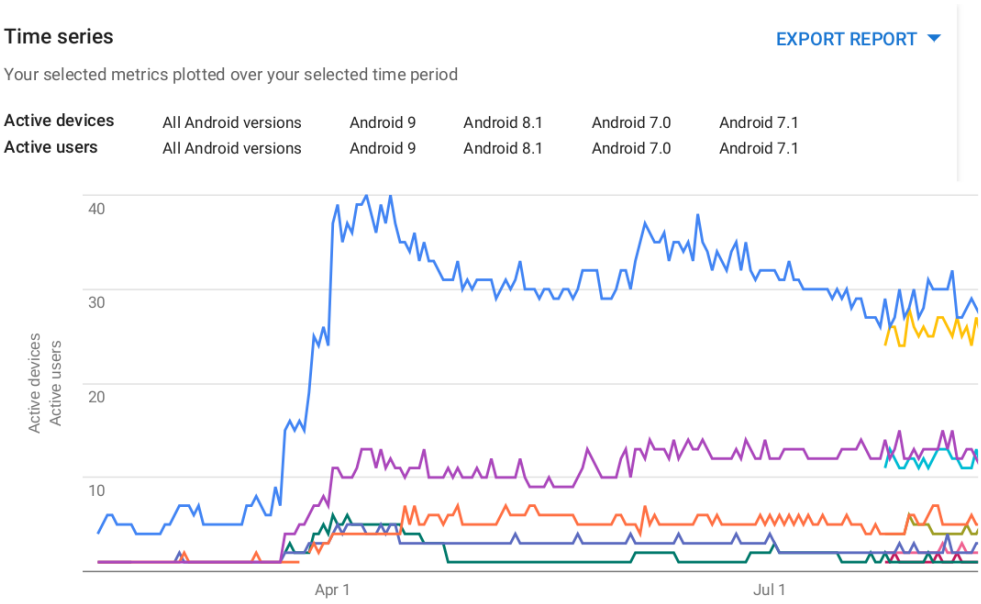


Figure 17: Active unique users for the app throughout the pilot.

Lessons learned, impact, sustainability and future steps

The design of the process, based on multi-stakeholders meetings (following the quadruple helix model), organized around three working areas (regulation, governance and economic sustainability), and the close relation with Decidim community, have facilitated a considerable engagement for the project that it is summarized below.

When thinking about the pilot's limitations we fell important to mention at least two: One related to technological development and the other to the targeted audience. The technological research carried throughout the project involved work on all pilots and communities, and hence the Consortium decided for pilots to be consecutively

implemented. Due to this decision some technological features which were developed at a late stage were not yet in place to be tested during this pilot. Also, due to the electoral calendar at the City Council, some actions needed to be postponed or cancelled due to publicity restrictions during that period according to the local legislation.

Social

Starting from the workshops carried out in the DDDC pilot's implementation process, we can identify three essential elements (two reactive positions and one proactive) linked with the debate on data, its use and its property.

Focusing on the reactive positions of data usage and the control of the big tech companies (so called GAFAM[10]) that dominate cyberspace appear two reactions to stop data-based surveillance and data-based mass persuasion. The workshops allow us to deep in the value of data from different perspectives: citizens' rights and their connection with the GDPR to protect them, economic value and the new tentacles of capitalism to lead our lives as consumers and the data control and its concentrated (undemocratic) governance , even if we refer to open data. Some contextual situations during the process, such as the obligation for the organizations to apply GDPR law to detail and request for the data usage or the announcement of Facebook to pay for the data that get from their users, reinforced the value of these workshops.

The proactive reaction has allowed to deep in the configuration of data commons. This means, to take into account a holistic vision about data and going beyond about some permanent debates, like the need to open data, and propose a data sovereignty. The Data Control wars, a role-play dynamic, has helped to engage participants in this goal. On one side, the data confessionary helps to aware about personal habits, think and change them. On the other side, the different roles that participants take during the workshop, put them in each role of the quadruple helix point of view. This means, to think as GAFAM platform, as a researcher, as public administration and, as a part of organized citizens (ONGs, unions, etc.). The request to build strategies during the different game-rounds deeps in the strengthens and weakness of each actor.

In the presentation of DDDC pilot, the decode app has been presented as a tool to provide users more control of their data and also possibilities for sharing it with various platforms. That may contribute to increase data sovereignty, privacy and security, and to reduce surveillance and data-based mass persuasion. The DECODE ledger contributes to transparency and non-tamperability of democratic processes in Decidim.

Regarding social approach, DDDC pilot has resulted in the constitution of a local network that addresses these issues from civil society, the Barcelona Data Commons Network[11]. Also, the pilot served to design a tool for awareness rising, the Data Control Wars toolkit. Finally, it contributed to a manifesto[12] that projects an alternative narrative.

The creation of the Barcelona Data Commons Network links to the sustainability of the pilot because it constitutes a task force to promote the proliferation of data commons. Currently, the network is establishing its goals and governance. In spite of that, the organization will be a spot of intercooperation to aware citizenship about the relevance and value of the digital data and the necessity to promote a common space of governance of the data commons. This is especially appropriate because Decidim is currently increasing its use into organizations linked to Social and Solidarity Economy (i.e, Som Energia, the largest renewable energy cooperative in Catalonia). Another goal for the coming months is to promote a dialogue with the Barcelona Data Office in order to explore the constitution of a democratic governance framework for city and citizen data in Barcelona.

The Data Control Wars toolkit may be a tool to improve the awareness about data. At the same time, it can be a way to imagine future stages to counteract data-based surveillance and data-based mass persuasion and, propose strategies around data sovereignty.

[10] Google, Amazon, Facebook, Apple and Microsoft.
[11] A civil society network, that emerged during the process of the pilot development, with the aim to engage the organizations of Barcelona, with principles close to those of DECODE. Their web (under construction) can be accessed at https://datacommons.barcelona/.
[12] Data Commons Manifesto https://dddc.decodeproject.eu/processes/main/f/13/

The promotion of the Data Commons Manifesto will increase the interest of more citizens in this field and, in consequence, to spread the use of the new DECODE app.

Finally, the BCNNOW dashboard will help people to more easily visualize and use their data in democratic processes in Decidim platform. This fact contributes to data empowerment and data-enriched collective intelligence and action. The combination of Decidim with the DECODE system should help to promote alternatives to surveillance and data-based mass persuasion in democratic processes as well as to increase citizen data empowerment.

Legal

As we have described in the phases of implementation of the pilot, throughout the participation process each of the areas of the project has been articulated. Regarding the legal framework, the experts and the rest of the participants have considered a series of proposals that we summarize below:

Regarding civil society we proposed to participate in the design of smart rules to protect their data rights. Indeed, citizenship, as a collective, could press to foster further regulation related to data ownership and privacy such portability rights. What is more, own citizenship could organize (maybe taking advantage of current organizations, like NGOs or unions), creating agreements and other legal tools that eases being aware and track personal preferences related to data in real time

From governments, the need to promote a clear aggregation of standards to ensure anonymization was clearly identified, with the goal of aggregating all data of citizenship under fair agreements (or other legal tools) to ensure anonymization. At the same time, a stable and clear legal framework to improve data regulation to improve business confidence on regulation around data issues was demanded. Finally, the Public Sector should recognize the value of data protection issues and the primacy of consent to data exploitation & rights of subject data.

To the perspective of research, a more understandable privacy agreements is needed. Thus, researchers and scholars should create a more friendly and understandable privacy agreements. In addition, academia could lead projects (especially action research) focused on creating commons-promoting taxation rules.

Eventually, during the process, the participants claim to generate a common business. This means, business should be able to work in regards to what we could call "commonright" related to data privacy and ownership as it happens (as a way of example) with free licenses for software.

To sum up, in general, on the one hand, the experts and participants bet for a better intercooperation among the quadruple helix. On the other hand, spaces for the co-creation of public policies are needed to incorporate the vision of the whole society actors.

Technological

- The DDDC pilots has been a perfect playground to put to test the various technological and scientific solutions developed throughout the project. In particular, we have fulfilled the following objectives:
- We have validated and shown how distributed ledgers can be used for petitions processes in an auditable, fast and secure way.
- We have designed a system that allows users to protect their private data while deciding to freely donate some attributes to allow platform managers to understand their user base, without having direct access to personal data.

- We have put in place a real world implementation of the Coconut flow (an example of Attribute Based Credential, ABC) designed in the context of the project, and gotten users to effectively use it. Thanks to the abstraction of many technical steps, users have been able to use and roughly understand the petition support process, despite not having technical expertise.
- We have also implemented a use case for ABC to selective log-in using anonymous credentials to the BCNNow platform.
- The first testing of the entire process performed in the DDDC Finale meeting13 has been validated to be GDPR compatible by the relevant data protection authority at the city council of Barcelona. An evaluation and need of performing a PIA was performed, taking into account three levels of analysis.
    - Verification of the list of types of data processing that do not require a data protection impact assessment (Art. 35.5 GDPR).
  - Second level
    - Verification whether the pilot is accomplished some the circuntance specified in the article 35.3
  - Third level
    - Evaluation of conditions described in Art 35.1 GDPR following list of verification about nature, scope, context and purposes of the processing.
  - In the appendices of this document it is attached a DPIA evaluation report
- An app was published for the general public that allows users to perform all the actions required by the pilot with ease and simplicity from their mobile phones, covering the two major platforms (iOS and Android) and devices.
- The app was integrated into the DECIDIM ecosystem in the form of a pluggable module, and all the technological stack has been packaged and is ready to be deployed.

The process has been very interesting due to the fact that from a technological perspective, many different actors (researchers, cryptographers, developers, UX designers…) were involved. Interesting lessons have been learned from the interaction with users (see deliverable *D4.14 "Final DECODE app release. App published on multiple platforms"*) that can inform future projects and initiatives around the issue of data sovereignty. In particular, the most important aspect to bear in mind is the difficulty in reconciling high degrees of privacy and control over data, with transparency and ease of use by users. The third vertex of this triangle is easy adoption by non technical developers. The DECODE project has combined and balanced both three aspects, yet it has become evident that compromises must be made in order to achieve real world usable solutions.

Future steps

Many exciting venues lie ahead of this project. DECIDIM is a well-established social and technological project around the world, with more than 100 active instances worldwide. Given the fact that (a) its main promoter and largest user base is within the consortium (Barcelona City Council), (b) it solves a pressing user needs around decentralization and tampering and (c) it provides solutions for easier user adoption; its continuation is very likely.

In this pilot due to its direct link with the City Council, as a key partner of the DECIDIM platform, it is relevant to mention the D1.12 "Policy impact of architecture and pilots implementation" where a fuller policy impact analysis can be found.

The app is easy to adapt and the petitions module for DECIDIM simple to deploy, hence once the results of the pilot are published, the DECIDIM community will integrate the work done on the official repository and each instance will decide on the convenience of adopting it for further use. Evidently, minor changes will be required,

[13] In the first testing of the Decidim-DECODE technology, it was used a DB in order to manage petitions through an API to replace in first instance the ledger system, under development at that time and therefore according to DPO guidelines it was not included in the DPIA. In the following tests the distributed ledger was integrated.

but this opens also interesting venues for economic sustainability of the project, shaping a business model of open source support and service management for those communities.

Concretely in Barcelona, the appearance of the Data Commons network, federating citizens, social collectives, research groups, public bodies, cooperatives and SMEs, foundations and other related actors will help in the spread of adoption and promotion of DECODE values and solutions.

Furthermore, a big project of citizen e-consultation was delayed through the last city council mandate but will be put in place in the following 4 years. Such a project needs a credential management service and the city council is studying DECIDIM as a base infrastructure for it, hence DECODE, with its powerful visual capabilities (dashboard), secure infrastructure and integration (see *D5.1 "Barcelona Open Data, Sentilo and IRIS API available"* and *D5.2 "CityOS connection"*) into the municipal systems, is a well suited candidate for a task that is targeted at the entire Barcelona population (>1M people).

Finally, and most importantly, DECODE has been strongly impacting the policies related to data governance and digitalization of the city of Barcelona, contributing to define the city's "ethical digital standards" (https://www.barcelona.cat/digitalstandards/en) and its "data sovereignty" procurement clauses that became the reference implementation for the Cities Coalition for Digital Rights, a global Alliance supported by the United Nations, UCLG and Eurocities. This is very promising, since we expect a strong contribution towards a European effort to reconquer data sovereignty. DECODE in this respect is having strong recognition also by media and policy makers that broadly refer to the project as one of Europe's most innovative actions in this direction. (e.g. see the Financial Times article recently published: https://www.ft.com/content/9ca5b0b2-0f64-11ea-a7e6-62bf4f9e548a.

Pilot 2: Citizen Science Data Governance - IoT

The IoT pilot was conceived and designed as a complement to the DDDC pilot in the DECODE universe. Thus, it was focused on testing a different set of technologies (while re-using the maximum number of common components as possible). In particular, while DDDC is targeted at a large community and quite focused on scalability, the IoT one was focused on obtaining user feedback to effectively test granular data permissions.

In particular, the pilot is meant for testing the concept of *end-to-end* granular data sharing permissions - data entitlements- at different levels (individual, community and public) with privacy enhancing technologies (PETs) and IoT devices. An entire framework for crowdsourcing data was thus tested in this pilot, integrating into existing hardware and software aligned with the CAPS EC funded project "MakingSense".

Pilot Objectives

The layout of the pilot is described both in *D1.1 "DECODE scenarios and requirements definition report"* and *D5.6 "Deployment of Pilots in Barcelona"*, and the pilot objectives can be succinctly described below:

1) The first is a privacy risk that has been expressed by user communities when publicly sharing data from IoT devices streaming from within their private environments such as houses. Examples of those risks are security concerns derived from knowing when someone is at home, monitoring concerns on within home habits or profiling concerns from external agents such as insurances companies for example.

   The users would thus like to experiment with advanced forms of data sharing beyond an "all or nothing" publishing scheme. They would like to decide at different macro levels how to share their data, in such a way that they can effectively donate data for objectives they agree with while restricting the use of data to a specific set of aims.

2) Secondly these groups of users would like to use devices to gather even riskier personal data sources such as health data, for which they need a platform flexible enough to allow for sharing usable data while allowing users to keep control.

To achieve both objectives a process was conducted to raise data awareness, coupled with open discussions to define policies for the usage and sharing of crowd-sourced aggregated data. A secondary objective but relevant enough to be mentioned is to test privacy-enhancing (PETs) technology with low- risk personal data in order to consider its later expansion to more sensitive domains such as health and others.

Phases

Exploration & Selection

In the exploration phase, the *SmartCitizen (SC)* community gathered around the CAPS project *Making Sense* was selected. This community was based on neighbors that came together to map a specific problem of noise in their neighborhood in Barcelona. They used data gathered from their sensors to spur authorities into action by analyzing and denouncing the noise patterns present in their streets.

The reason for their choice lies in the complete alignment with the criteria described earlier in this document. The needs of the communities were completely aligned with DECODE aims and this allowed us to experiment with granular data permissions, SotA technologies and IoT. Also, the community has a mature platform

(smartcitizen.me) backed by a strong developer base. Lastly, the community was active and engaged due to the ongoing project and no large blockers could be foreseen in order to complete the project in due time.

Once the selection was finalized, we proceeded to perform an inception session with members of the community, their technical team (based at the IAAC) as well as their dynamization team (Ideas for Change) on June 14-16th 2017. The session was led by Thoughtworks, with material and critical inputs from IMI, DRIBIA, Dyne and Thingful. The objectives of the pilot where sketched on the workshop as well as the initial architecture blueprint.

Design

Throughout this phase, the needs for the different pieces of software to be developed where explored, as well as the base infrastructure of the chosen community. In this sense, we worked on exploring the open hardware kits of SmartCitizen as well as their API. Also an agreement of the precise scope of the pilot was achieved with the community, using a technique based on DOs and DON'Ts as seen in figure 18.

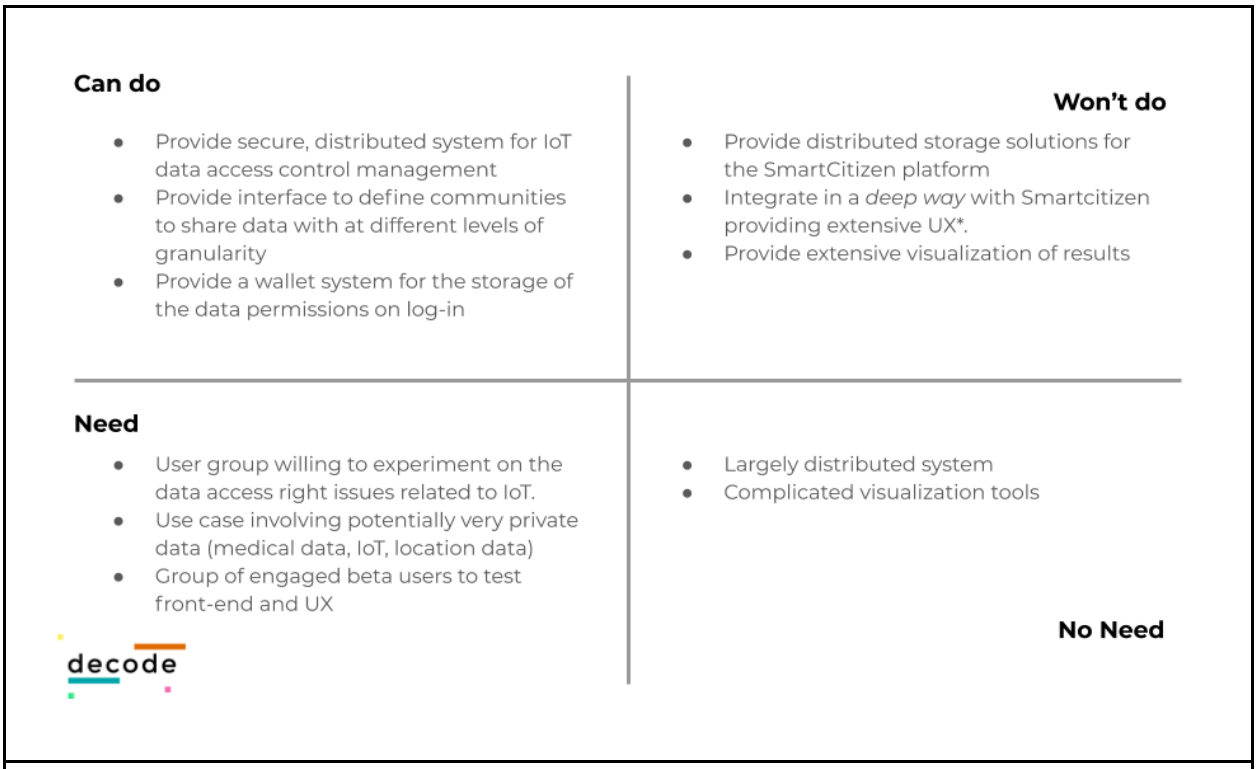


Figure 18: IoT pilot scope (DO's and DONT's)

Planning

With a clear scope, the final stages of planning were performed, including the composition of the user engagement plan with multiple workshops and meetups and most importantly the definition of the technology to be built for the pilot (see below). Besides the consortium technical meetings about implementation, a discovery meeting (April 24th 2018), an internal kick-off (July 19th 2018) covering user journey, technical architecture and pilot measurement, and also a threat modelling session (October 23rd 2018) were held with the participation of TW, Dribia, IMI, SC, Eurecat as well as TH. The results of the session can be consulted in the appendices, as well as the sketched attacking scenarios for the defined architecture. In this phase, the responsibility to deliver the entire tech stack for the pilot was agreed to be led by Thingful; the details are provided in deliverable *D3.9 "IoT privacy-*

enhancing data sharing: integration with pilot Infrastructures". At this point, a regular biweekly meet-up of the entire team involved in the IoT pilot was organized, as well as communication channels (Telegram and Trello) put in place. It is relevant to mention the constant involvement of the community tech lead, at this stage of the pilot process, in order to ensure successful adaptation of technology developed.

Delivery

The delivery phase was kickstarted on April 24th 2018 with a workshop. On this phase, the objective was to put in place all the scale models developed by TH (more on technological stack below) and connect it with the efforts performed in BarcelonaNow. This included the design of the different APIs, identification of susceptible pieces of software to be reused from the DDDC pilot and development. On this front, significant efforts were devoted to successfully unify most of the technological stack and make its design reusable for the three Barcelona pilots, in what can be considered a great success.

To achieve real impact, and not to delay work with users, a decision was taken in this phase to develop a DECODE Web-app in order to deliver the user interface necessary for the pilot. It was designed with the aim to be easily ported to the DECODE (Smartphone) App. This was much later successfully performed, acting as proof of the ease of adoption of DECODE technologies by new services (see deliverable *D4.14 "Final DECODE app release. App published on multiple platforms"*).

Once a scale model was in place, SC partners proceeded to adapt their existing device onboarding to include the interaction with the web app. Also, SC hosted in their own infrastructure all the open source software stack developed by the partners, which was conveniently dockerized for easy adoption.

Measurement and promotion

The last phase of the pilot was conducted to test all of our efforts with real world users. The pilots were kick-started on October 18th 2018 at a big event in Fabra i coats (Barcelona), as reported in deliverable *D5.6 "Deployment of Pilots in Barcelona"*, with a public presentation. Then, a series of workshops were organized.

This phase partially overlapped the one on delivery, as users from the engaged community were involved in several user experience testing sessions lead by Eurecat, SC and TH respectively. The input from those sessions was iteratively added to the ongoing development and is better explained on deliverable *D4.10 "UX/UI for DECODE app development integrated to BCNNow"*.

A series of five *Meet-ups* and workshops were organized with the community to work on a variety of subjects, described below:

DECODE PILOT PLANNING

Activity	Kick off DECODE PiloT	W1: IoT and data governance pilot launch	W2: Personal data awareness and entitlements	W3: Technology onboarding	W4: Data awareness	W5: Final action and wrap up
Dates	October, 18th	November, 7th	December, 5th	June, 18th	July, 1st	September, 30th
Place	Fabra i Coat	KUBIK	KUBIK	IAAC	IAAC	IAAC
Action	Creation of an information brochure about the pilot and a recruitment list for involve participants	Workshop introduction and activity of awareness (IFC). Also, a presentation of key aspects (DECODE, IOT Technical and Legal Aspects)*.	Activities to identify preferences of the participants and co-design what data to share, who with, under which conditions and for what purpose. *Decide what we will be measured. (Hypothesis: collective and individual)*	Data gathering campaign.	Activity of data visualization	Celebration and next steps

Figure 19: IoT pilot workshop calendar

Kick off DECODE Barcelona pilots

Date and location: October 18th 2018 / Fabra i Coat building, Barcelona	**Participants:** 200
Goal: - To present the project and pilot to a broad audience of people interested in data ethics, FLOSS and commons-based peer production. - To identify a community of potential participants. - To establish a cohesive narrative along with the DDDC pilot.	**Outputs:** - Information brochure about the pilot - Recruitment list to involve participants. - Methodology and materials to facilitate a data governance roundtable at workshop.

Figure 20: IoT pilot kickoff (October 18th 2018)

WS1 Citizen Science Data Governance Launch

Date and location: November 7th 2018 / KUBIK, Barcelona	**Participants:** 40
Goal: - To galvanise a community of pilot participants who are interested in taking part in the DECODE pilot. To decide upon who will host the 25 Smart Citizen Kits at their homes or offices. - To communicate and discuss DECODE's and the pilot's goals. - To introduce the BarcelonaNow data platform. - To elicit individual and group perceptions and experiences on data sharing awareness. - To debate, co-create and assess data sharing scenarios.	**Outputs:** - Data domme to share private #DataConfessions - Insights on perception of risks and benefits associated to sharing the different data collected by Smart Citizen Kit (SCK) Sensor. - Co-created scenarios based on the discussions and participants' perceptions of benefits and fears of using SC. - Collaborative mapping of hosts for the community sensors (SCK).

Figure 21: IoT pilot workshop 1 (November 17th 2018)

WS2 Personal Data Awareness and Entitlements

Date and location: December 5th 2018 / KUBIK, Barcelona	**Participants:** 45
Goal: - Building on the insights from the first workshop, to debate upon participants' data sharing preferences and scenarios and agree on a citizen science campaign strategy that maximises the collective benefit. - To co-design dynamic attribution rights that will be used to govern the contributed data in alignment with the citizen science intervention objectives and the participants' agreements. - To foster a debate around data sharing and	**Outputs:** - Collaborative citizen science intervention goals, hypotheses and sensor deployment strategies. - Co-designed conceptualisation of the attribution rights, through a data governance protocol.

contribute to the Data Commons Manifesto.	

Figure 22: IoT pilot workshop 2 (December 5th 2018)

WS3 Technology Onboarding

Date and location: June 18th 2019 / IAAC, Barcelona	**Participants:** 20
Goal: - To introduce participants to the new SCK 2.1. To configure the Decode webApp for each participant to create their Decode identity. - To use and test the custom application aimed at onboarding participants to the Smart Citizen Kit by allowing them to pair their Decode identity with the sensor device and select the new attribution rights (WS2). - To introduce participants to the BCN Now dashboard and how they can visualise their data according to the selected attribution rights. - To train participants so they can autonomously set up their sensors at home/office.	**Outputs:** - Skills to set up Decode WebApp - Skills to set up the SCK and assign attribution rights to data using the onboarding application - Skills to visualise data in the BCN Now dashboard

Figure 23: IoT pilot workshop 3 (June 18th 2019)

WS4 Data awareness

Date and location: July 1st 2019 / IAAC, Barcelona	**Participants:** 17
Goal: - To make sense of the collected data through visualisation explorations using custom activities and the BCNNow platform. - To engage participants in data sensemaking and analysis activities. To discuss finding based on their observations/ data. - To discuss potential iterations of their citizen science campaign and consider whether the attribution rights used are successful or not in the given context.	**Outputs:** - Data visualisation explorations - Insights from the collected data - Iteration plan on citizen science campaign and attribution rights

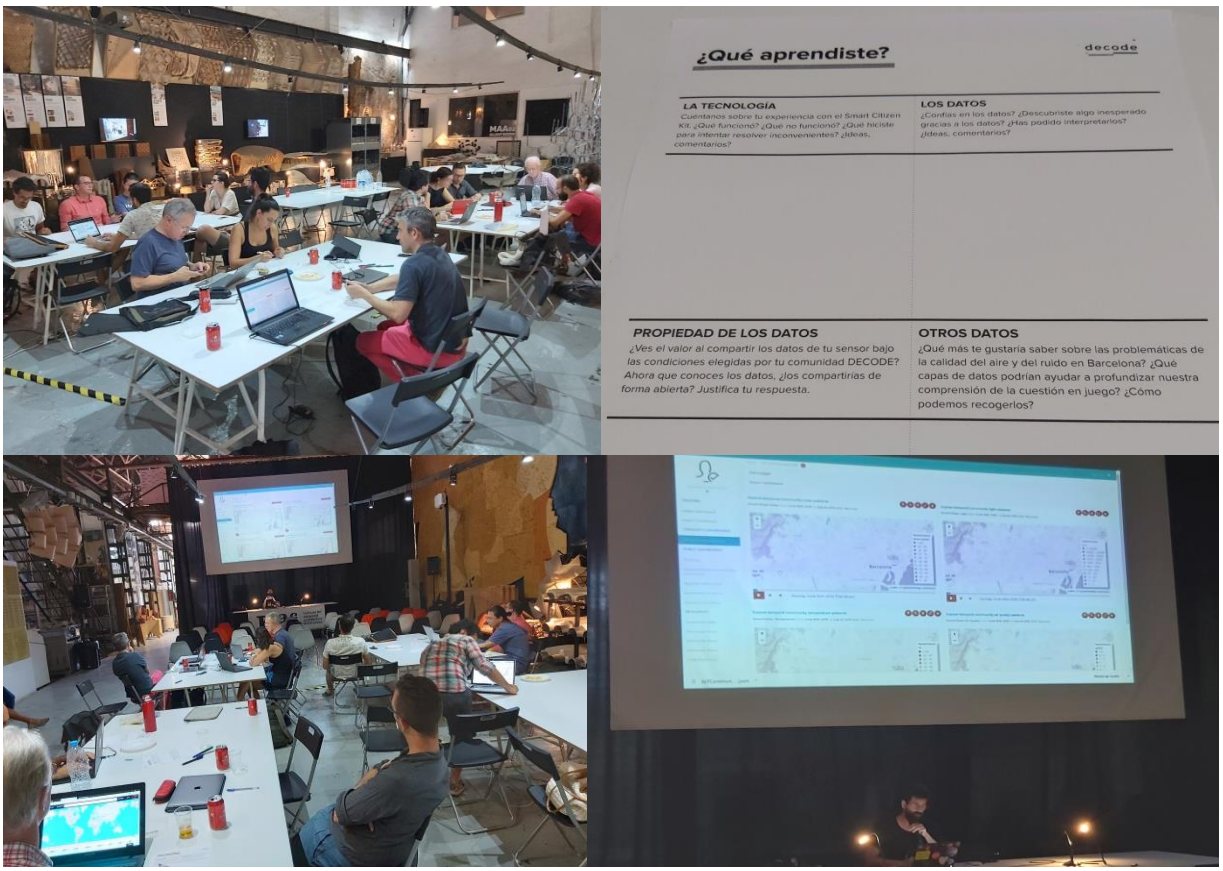


Figure 24: IoT pilot workshop 4 (July 1st 2019)

WS5 Final action and wrap up

Date and location: September 30th 2019 / IAAC, Barcelona	**Participants:** 15
Goal: - To show to the community next steps about DECODE technology and the sustainability plans - To perform data analysis activities and draw conclusions from the data generated individually and collectively. - To discuss the appropriateness of using attribution rights for data governance. - To provide feedback on the tools, methods and overall experience. - To co-create potential routes for action based	**Outputs:** - Data analysis and results - Insights on the appropriateness of the DECODE data governance approach - List of next steps.

on the results.	

Figure 25: IoT pilot workshop 5 (September 30th 2019)

In the following table is showed the Decode devices statistics in September 7th:

Table 2: Device statistics

id	pilot_site	name	user_name	ratio_readings_days	total_days_last_reading	total_readings	town
9680	Barcelona	elaragon	elaragon	94.39%	78	106015	Barcelona
9693	Barcelona	Eixample - Metro Entença	rocioh	94.32%	78	105937	Barcelona
9696	Barcelona	Prius2	Andreas Manz	91.68%	77	101658	Sant Quirze del Valles
9678	Barcelona	LAMkit	Liliana_Arroyo	81.14%	78	91134	Barcelona
9702	Barcelona	VEGETALANDIA	andreaba78	81.82%	77	90723	Barcelona
9669	Barcelona	Congres	Congres	75.76%	71	85092	Barcelona
9692	Barcelona	CANSERRA1	CanSerra	74.30%	78	83459	L'Hospitalet
9700	Barcelona	Ritzy Spark Stag	sans46	68.30%	77	75729	Barcelona
9672	Barcelona	Derecho.com	Ergra	65.26%	78	73304	Barcelona
9753	Barcelona	hal2001	Sinhue	73.72%	69	73251	Barcelona
9673	Barcelona	eguilaz	asier.eguilaz	60.64%	78	68111	Barcelona
9687	Barcelona	Guillaume&Ana	Guillaume&Ana	59.92%	58	67302	Barcelona
9682	Barcelona	Imma	Ferbenito	52.24%	78	58681	Barcelona
9670	Barcelona	Data ninja	Data_ninja	48.80%	38	54812	Barcelona
9676	Barcelona	prometeu88	prometeu	48.48%	46	54456	Barcelona
9679	Barcelona	BLAI	EFFi	47.47%	38	53323	Barcelona

id	pilot_site	name	user_name	ratio_readings_days	total_days_last_reading	total_readings	town
9677	Barcelona	SANT FELIU LL. - EL PLA Raulito	Raulito	46.96%	78	52740	Sant Feliu de Llobregat
9701	Barcelona	XaviN	XaviN	38.54%	41	42728	Barcelona
9690	Barcelona	Ula\'s kit	ugalss	34.64%	54	38904	Barcelona
9764	Barcelona	SensorGlories	team	30.25%	38	28315	Barcelona
9765	Barcelona	ohRobot	Macaobcn	16.91%	11	15832	Barcelona
9674	Barcelona	FGutiKit	FranciscoGutierres	13.56%	22	15236	Barcelona
9686	Barcelona	weatherRobot	Macaobcn	13.24%	13	14872	Barcelona
9667	Barcelona	testdecode	team	3.58%	2	4023	Barcelona

It is important to note that the last workshop includes members of the communities involved in both DDDC and IOT, and it represents another step towards the establishment of a real data commons in the city of Barcelona, thanks to the collaboration of the network created throughout the project with key actors and participants in the city. Also, the series of meetings served to contribute ideas to the ongoing DDDC process, with proposals added to the Manifesto.

In order to get detailed information about the activities results and participant feedback, see the deliverable D6.7 “Project communication, exploitation plan, events report and overall project impact” .

Technology

Most of the details provided here are based on both the initial blueprints presented in *D5.6 “Deployment of pilots in Barcelona”* as well as the more technically detailed, *D3.9 “IoT privacy-enhancing data sharing: integration with pilot infrastructures”*. We summarize them here for reference and ease of reading.

The pilot is aimed at addressing the above mentioned citizens worries with its technical design. It uses a DECODE interface (Web-app or smartphone app) to connect to the Smart Citizen infrastructure and link the sensors provided by SmartCitizen to their users with their DECODE keys. Via encryption schemes facilitated by the custom DECODE developed, easy to use, cryptographic scripting language Zenroom which is described in the deliverable *D3.3 “Data Privacy and Smart Language requirements, its initial set of smart rules and related ontology”*, the users can select diverse sharing data policies from predefined groups that have been previously discussed and agreed within the community. Those policies are drawn from a service called “Policy store”, which allows for further policies to be created using appropriate methods. The policies are enforced by a component called “Stream

Encoder" that ensures that the policies defined by the user are applied to the data *before* storage. This is one of the key innovations and strengths of the pilot. For each policy, the user must obtain a cryptographic credential via DECODE interface that acts as proof that the user belongs to a community that has agreed to use the aforementioned policy.

Once the set-up is complete, the users can then obtain personalized views of the different dataset generated and shared according to different rules in the BarcelonaNow tool by using the generated credentials by the DECODE interface. Last but not least, the data is located in an encrypted way on a storage hosted at SmartCitizen.

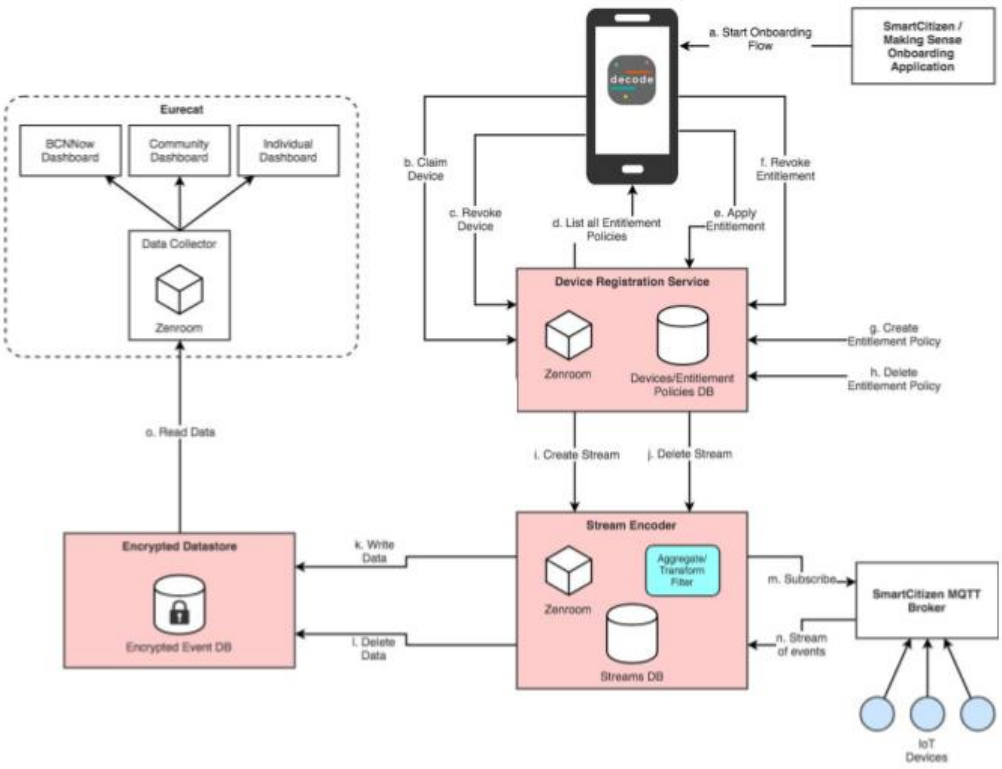


Figure 26: IoT integration. A design by Thingful

A schematic view of the scale model design is presented in figure 26.

In the following we provide further details on the components used in this pilot.

Web App & App integration

Two different user interface products have been developed in this pilot. On the one hand, a web app[14] including all the basic functionality of the pilot was built by Thingful (and presented alongside all the rest of technological stack in deliverable *D3.9 "IoT privacy-enhancing data sharing: integration with pilot infrastructures"*). Such a web-app was tested with the users, both in UX sessions previous to its launch as well as with the community by gathering

[14] https://github.com/DECODEproject/decodeweb

feedback after its usage. On the other hand, this web-app is currently adapted to the DECODE smartphone app[15] in a second iteration by a joint effort of Dribia and Thingful, to enhance its usability and give complementarity to the entire stack. Details on the app can be found both on *D4.10 "UX/UI for DECODE app development integrated to BCNNow"* as well as *D4.14 "Final DECODE app release. APP published on multiple platforms.*

Zenroom

The language used for all cryptographic operations is Zenroom[16], in line with the standard used in all the BCN Pilots. Concerning the smart contracts, the ones for credential generation as well as BarcelonaNow log-in are also reused from the other pilots. A different encryption scheme is however used for the *Smart Encoder*, thus, the pilot has allowed to extend the Zenroom language to new cases and applications, including its porting to Golang (base programming language of the IoT components) as well as python (base language of the BarcelonaNow components). For more details see related deliverable *D3.9 "IoT privacy-enhancing data sharing: integration with pilot infrastructures"*.

Policy store, data store and smart encoder

The policy store[17] is composed of 3 elements: An API that handles the calls to the service, a database that stores the defined policies and a hub to interact with the smart encoder and perform the necessary cryptographic operations. It is written in Golang.

The encrypted data store[18] is a POSTGRES database that handles simple methods to add data to it and retrieve data from it. It does not require authentication because all the data in it is encrypted, and in principle anyone can access it to decrypt it using their own keys/credentials.

Last but not least, the smart encoder[19] is a lightweight component developed in Golang. It dynamically applies the data transformations to the streams generated by the sensors, and sends modified versions of the original data (one per each policy) to the encrypted datastore. While currently the stream encoder is hosted in the infrastructure of Smart Citizen, its design is meant to be installed in the hardware of the sensors themselves, as to ensure and *end-to-end* fully transformed and safe scheme for the users (this way, whenever the data leaves the device, it is already transformed besides being encrypted).

Credential issuer

The pilot uses the same credential issuer from the DDDC pilot, in this case, allowing for *re-issuable* credentials for a given community. That is, issuing the same credential to all users belonging to a community, thus ensuring their anonymity.

IoT in numbers

Table 3: IoT pilot in numbers

[15] https://github.com/DECODEproject/decodev2

[16] https://zenroom.org/

[17] https://github.com/DECODEproject/iotpolicystore

[18] https://github.com/DECODEproject/iotstore

[19] https://github.com/DECODEproject/iotencoder

IoT results summary	
Meetings	7
Numbers of deployed sensors	24
Numbers of policies designed and deployed	2
Numbers of readings >	1,7M
Number of attendance to sessions >	330
Number of impacted people >	500
Number of datapoints generated >	3,2M
Number of days with data gathered	93
Percentage of time with the infrastructure available	89,5

From the numbers above, the success of the pilot is evident. On the social front, continuous engagement has been achieved with both online and in person input from users and participation to workshops. Relevant outputs have been generated in this front (see the report "Pilot plan and communities meetings" in the appendices).

On the technological front, the platform has worked except for some minor time intervals and we have gathered user feedback to enhance its usability. Mainly, user comments related to the difficulty of interacting with many different services, fact which needs to be addressed in future iterations of the project (see below).

Lessons learned, impact, sustainability and future steps

The close contact with the communities throughout the pilot, as well as the interesting challenges posed by it has led us to draw some conclusions from the experience, summarized below.

In terms of limitations for this pilot we would like to point out that it was not possible to use the final version of the DECODE App in this pilot which would have been the preferred option by the Consortium. The reason for this was the combination of changes of technological ownership of tasks as well as the necessity to carry out the pilots in a consecutive manner in Barcelona. In order to ensure full technology test related to the project goals, the decision taken was to develop a webApp solution devoted to the pilot, while the DECODE App was being developed. The other limitation worth mentioning in this case was the language. While community were native

local some partners involved were not native speakers and therefore translations were needed within the consortium in order to being able to incorporate user's needs. Nevertheless due to the transition of development from Thoughtworks to DRIBIA this limitations was surpassed. Last but not least, it would have enriched the pilot to increase the dissemination, through City Hall channels, to gain reach, but again, due to election calendar this suffered some interferences and legal restrictions..

Social

The workshops have clearly made emergent the fact that participants are very worried about their privacy. This is good news, however, they seem to do so in a general, abstract way. Throughout the workshops, when asked about practical risks the use of IoT devices inside home environments might pose, users needed a lot of encouragement from technically savant participants to spur discussions. However, these discussions once started, led them to connect to actual impacts.

For direct risks, what neighbors could easily identify were basically the ones related to security (disclosing when they are at home) as well as the fear that knowing the levels of noise they are exposed to might lead to a decrease in the value of their properties. After discussions, other risks emerged such as targeting risks by private companies (insurance businesses charging higher fees to occupants for instance).

On the practical side, different activities have been carried out:

- *Data confessionary*[20], activity first completed during the first workshop (Nov 2018) and subsequently adopted in other meeting such as the *Data Control Wars*.
- Activity about filling a matrix about risks and benefits associated to share the different data collected (Nov 2018).
- Impact assessment survey to evaluate the participants awareness of data sharing and privacy. The same survey was performed by the community after the first workshop (Nov 2018) and after the last workshop (Oct 2019).
- Heuristic evaluation on the technical onboarding and set-up of the sensor with DECODE technology. It was performed in the third workshop (June 2019)
- Data discussion and assessment regarding key topics such as technology, data ownership, additional data. It was performed in the fourth workshop (July 2019)
- Interviews with participants during the last phase of the pilot.

These activities have shown that many people are aware that most of the *online* activities they perform constitute a risk, however they do it anyway. The reason for that is basically two-fold: (a) they value the *easiness* of doing so and are not aware of practical alternatives and most importantly (b) they have difficulties reconciling with the concept of the "*everything is stored"*. The second point is quite interesting, since it might be connected to our biology: Such a concept is alien to our nature (our brain) and thus we tend to believe that the information we give away will somehow be forgotten after some time.

A direct conclusion emerging from these observations is that letting people choose about data sharing practices without providing them background on the *potential uses* of these data *and direct examples of it* (not only the way it is intended to be shared) is useless. If you are not in a position to know what can *potentially* be done with your data, you are in no position to make a *fair choice* on the rules that govern its sharing.

In this front, we can thus summarize the impact achieved in three aspects:

- We have derived innovative practices for workshops from co-creation and joint research. We have implemented them throughout the pilot meetups, with special relevance on the Data confessionary.

[20] The data confessionary is an exercise where people are asked to enter an igloo-like structure and write down their "data/privacy" sins on post-its and display them on the wall. The ending result is an interesting *collage* of bad practices that the users willingly and knowingly perform on their day to day internet activity. It helps both communicating as well as raising awareness for other users on the topic of data ownership.

- A consistent group of between 25 to 50 users has been formed, with dynamic activity and regular attendance to meet-ups and workshops, as well as input provided online.
- Data awareness has been raised among participants, connecting with other interested communities such as the DDDC one, or the salus cooperative among others.

Besides, we have also collected other relevant perceptions on data sovereignty and privacy perception among the participants.

- They have provided positive feedback in relation to DECODE project and the pilot, they have expressed their interest in the next steps of the community.
- Many participants had interest and basic notions about privacy and data governance.
- They are in favour to take collective action with data collected because they have detected environmental issues so far unknown.
- Some participants have changed their habits, taking into account the data shared.
- Some of them had to provide explanations about the sensor and data collection, which produce a collective awareness about privacy.
- The location of the sensor has an impact on the will of the participants to share the data generated.

In order to get detailed information about the activities results and participant feedback, see the deliverable *D6.7 "Project communication, exploitation plan, events report and overall project impact"*.

Last but not least, the IoT pilot fulfils the DECODE initial objective of building an effective data commons where participants are in full control of how their data is shared and with whom, and sets a founding stone to expand these practices in the fully sensorized world where we currently live in.

A complete description about the development of the workshop can be found in both "Pilot plan and community meeting" reports (see Appendices)

Legal

The legal front is mostly related to the choice of policies for data sharing. It is important to mention that a schema for granular policies for IoT data sharing has been field tested successfully by users, and a basic set of policies put into place. Yet, two aspects soon became apparent throughout the project, both connected to the deployment limitations of the policies at a full granularity level:

1) The universe of possible policies is gigantic, since the more granularity you want to allow users to decide, the more options you need to cater for. This makes it impossible to store all potential policies both on the technological side but also on the user side (not all options can be shown to users). Thus, it forces some authority to make *decisions on behalf of the users*, at least on the way they are presented to them. For example, in our pilot we allowed for 3 potential transformations:
    a. Averaging data over a time period
    b. Binning data: Showing not the actual values but coarse grained ones based on predefined categories.
    c. Thresholding data: Only displaying data if it exceeds a certain threshold

Imagining only three options per stream of IoT data transformation after generation (there are many more), this simple set-up already adds up to 27 options. Making it four mounts it up to 64 and so on[21]. Since each policy defines a version of the data stored to share with others, this makes the complete tuning of all of them an impossible endeavour (it would require infinite space to store them all).

2) The available policies involve many technicalities that can have a profound impact. While being based on simple mathematical operations, most members of the community have trouble understanding it. Hence, expert input was needed to select appropriate ones in each case.

[21] The relation is $P=O^T$ where P is the number of policies, O the number of options and T the number of transformations.

Additionally we need to note that the above schemas are fully general and can be extended with ease to other, potentially more risky environments such as *crowd gathering health data* for the public good. Both aspects point to a key factor in interacting with the community: Users delegate those choices to the platform, either willingly or unconsciously, in an all-or-nothing policy. This means that they either chose to trust the community (and accept *mostly anything* presented to them) or they don't and hence leave it. Thus, while the technological aspect of granular entitlements can be achieved, the social component (the *community*) must be present on a practical side, and good practices enforced to ensure fairness, transparency and accountability to the end users.

Technological

As stated before, the main impediment for communities is the lack of technological knowledge. Even though the developed software is open and free, and even with the fact that the community is composed of technology inclined profiles, its development has been heavily dependent on the consortium tech partners.

Sadly, what users value, and thus the main driver for adoption, is not the underlying innovative *back-end* that determines the *quality and provenance* of what they can do but the views of what they can see. This means that the most expensive part in terms of resources is not developing the tech but rather making as usable as possible for the average user.

This was the main driver to propose the development of the fully fledged BarcelonaNow pilot, initially only partially planned on the proposal of work. But this also teaches us a tough lesson: while UX development is difficult and expensive in general, it is much more difficult when dealing with distributed, federated and PET focused services. The universe of available options and choices to do on behalf of the user is much more limited, and this constraints enormously the user journeys and the options for UI. In other words, this requires much more inventive and capacity to transmit to users what is happening, in order to (a) let their experience be as smooth as possible while (b) explaining correctly what happens so as to empower them on the domain of data sovereignty.

On this front, the impact and results of the pilot can be simply identified:

- Development of a fully innovative architecture, allowing for *end to end* data transformation and control by users has been set into place. The architecture effectively federates a variety of services, thus distributing the infrastructure and controlling capabilities of actors (power). Those services can be further distributed, for example by setting up multiple copies of it or fully distributing the proposed database schema.
- We have put Zenroom to get a new test case, enhancing its flexibility and adapting it to new languages (Go). The fact that the entire stack is open source makes it easy portable to other scenarios such as health data and community crowdsourcing other dataset. Of special interest is the case of donating data for research purposes.
- The re-use of credentials as well as parts of the technological stack from the DDDC pilots is also a living proof of the flexibility of the DECODE ecosystem. In this case, we have been able to successfully fit into the same framework two seemingly very different scenarios.
- In the same vein, the successful integration of the web-app functionalities into the app is also a test case for ease of implementation to new service with minimal effort. This was also one of the main value propositions present in the original work plan and is addressed on the relevant deliverable *D4.14 "Final DECODE app release. App published on multiple platforms*.

Future steps

The sustainability of the tools developed in this pilot is ensured by the long process of candidate selection performed at the very beginning of the project. The smartcitizen hardware and software project is mature and will continue to operate, as will the community of interested users formed in the pilot.

The successful test of the developed infrastructure, and the fact that it is already integrated into SmartCitizen, opens the door for its use as a *default* rather than an experimental part of the onboarding process. SmartCitizen

has expressed interest in using the base code of the DECODE App to generate their own version of the app for this specific use, as well as reuse the log-in mechanisms developed for BarcelonaNow for the sharing of data.

Last but not least, members of the interested community of the pilot were also part of the European project CitieshealthEU where are designing and running experiments to explore how the pollution in their living environment is affecting their health, and as a part of their experimentation they have distributed 1000 strawberry plants in the 10 districts of Barcelona, these plants absorb polluting particles from the environment and help them to create a map of pollution in Barcelona. This project shows how other ways to collect environmental data from the city while maintaining users-privacy are being explored, as DECODE and IoT pilot demonstrate. They are also other members who are involved in salus cooperative. Thus, synergies were created with them, which is a collective of people wishing to explore the possibility of sharing health data from patients in a privacy enhancing way. This objective is basically the next stop for the project: Having tested the technology with data that are harmless (or with a low degree of potential risk), the next step should be to re-use the tools and ideas to adapt it to health data on a day to day use. There is growing interest in this aspect and this would constitute a breakthrough for the composition of a large data common with an explicit common good objective in mind and enormous impact.

Pilot 3: BarcelonaNow

The BarcelonaNow pilot was conceived as a transversal system for providing value to both the DDDC and the IoT pilots of the DECODE project. In this regard, efforts in this pilot have focused on deploying a versatile toolbox of data visualization features based on free open source software with large adoption and community support. In comparison to IoT and DDDC which largely focused on deploying and testing distributed architectures with real citizens, BarcelonaNow served as a DECODE ("meta")pilot to effectively extract the practical value of the data commons from the project pilots in Barcelona.

Specifically, the pilot was intended to provide citizens with interactive dashboards of open data from the City Council of Barcelona together with data from the Decidim instance and the Smart Citizen sensors. The exploration and visualization of these data has allowed citizens to generate knowledge with the aim of addressing relevant urban challenges (e.g., noise pollution) in a participatory and, hence, more democratic manner.

Pilot Objectives

The global objective of BarcelonaNow pilot is declared in deliverable *D5.1 "Barcelona Open Data, Sentilo and IRIS API available"*:

> *To contribute to the public good and public participation by leveraging public and open data, privately donated data via the DECODE platform and also using private data in a responsible and privacy-aware way.*

In subsequent deliverables *D5.3 "Data analysis methods and first results from pilots"* and *D5.6 "Deployment of pilots in Barcelona"* concrete pilot objectives were defined:

1) To enable citizens with little or no technical expertise to create their custom visualizations by leveraging the provided functionalities, while controlling the access and sharing of their own data in a privacy-enhancing manner.
2) To create an ecosystem in which citizens, as well as other stakeholders (e.g., policy makers and city administrators) can share and co-create visualizations to increase public awareness on city issues, supporting an open, transparent and democratic city.
3) To expose data through an API, so other services and interfaces can be developed on top of the backend, and a highly modular, so that other data sources can also be integrated by adding appropriate data collectors to the backend, and the infrastructure can be easily deployed for other cities.

To accomplish the first two objectives the different iterated versions of BarcelonaNow were tested with participants of the DDDC and the IoT PILOT. The third objective was intrinsic given the constant collaboration with technological DECODE partners (Dribia, Dyne and Thingful) and the City Council of Barcelona for the collection and exposure of public and private data.

Phases

Exploration & Selection

In the exploration phase, different existing dashboards for urban data exploration were reviewed:

- **Madrid Dashboard**[22] aims at experimenting with smart city services and fine-tuning them before deploying them at large scale. The platform currently offers two services, namely people flow monitoring

[22] http://ceiboard.dit.upm.es/dashboard

based on wireless tracking and environmental monitoring. For instance, the people flow monitoring information and the environmental information can be considered to smartly control the university heating, ventilation, and air conditioning systems. The dashboard cannot be personalized and the limited use cases reduce the number of potentially supported citizens.

- **UK City Dashboard**[23] summarizes quantitative data about the major United Kingdom cities on a single screen. It primarily shows weather, environmental, transportation, and energy demand with color-coded numerical values. Although it provides a bird-eye city view, the overall selection and representation of real-time data is not translated from raw numerical values to a format that might be easier to be digested by non-technical users. Moreover, it does not give them context with data over recent hours, days, and months.

- **Edmonton Dashboard**[24] enables citizens to visualize pre-defined snapshots of city data integrated from various official sources together with simplified and descriptive indicators under consistent color-coding, iconography and fonts. Furthermore, the dashboard enables users to do a deeper historical analysis with interactive tools to filter data. However, no real-time operational data is available and it consequently misses a lot of potential use cases.

- **Amsterdam Dashboard**[25] is able to show data on a map view, displaying points representing discrete information , and a partition view, where each partition displays a certain category on which city elements are projected. The statistics are presented on blocks of 24 hours. However, it does not handle massive amounts of streaming data and dashboard personalization per user.

- **Dublin Dashboard**[26] pulls together data from the city council, the government departments and several existing smart city and social applications. The dashboard contains hundreds of data representations grouped in different modules, including overall statistics from the city and information from key points in the city. However, it does not enable users to modify the default visualizations. Moreover, it is not an open-source initiative and no way to create key performance indicators is presented.

- **Boston Dashboard**[27] helps residents to track the city's progress with a set of baseline metrics and plans on several areas, including education, job creation, infrastructure, housing and commuting. The platform does not have a real user dashboard, but provides a smart tool to enable users to develop their own visualizations. However, the tool is not intended for users with no or little technical skills, such as citizens, since it embraces advanced operations like manual raw data querying.

These comparison served to select open source technologies like MongoDB, Apache Kafka, Flask, jQuery, Bootstrap, D3.js and Leaflet with clear advantages in terms of flexibility, usability and personalization, so the BarcelonaNow system can be employed for wider scenarios and use cases

Design

The first approach to the design of BarcelonaNow emerged from the inception sessions that described the pilot as a way to provide personalized recommendation and privacy aware data mining to citizens (see deliverable D1.1 chapter 4.3.1.2 Pilot Inception Report). Then data sources from Barcelona City Council were reviewed to design a backend system of data collection and storage capable of integrating sources from very different nature. As

[23] http://citydashboard.org/choose.php
[24] https://dashboard.edmonton.ca/
[25] http://citydashboard.waag.org
[26] http://www.dublindashboard.ie
[27] https://boston.opendatasoft.com

reported in *D5.1 "Barcelona Open Data, Sentilo and IRIS API available"*, the available sources were ODI (Open Data Infrastructure), ASIA (agenda of all public activities), IRIS (citizen claims), Sentilo (IoT sensor platform) and CityOS (open operating system of the city). While the first three sources were available through the public API, data collectors for Sentilo and CityOS required a connection with a private access token (technical details are provided at deliverable *D5.2 "CityOS connection"*). The final agreement of the precise scope of the pilot was achieved with the community, using a technique based on DOs and DON'Ts as seen in figure 27.

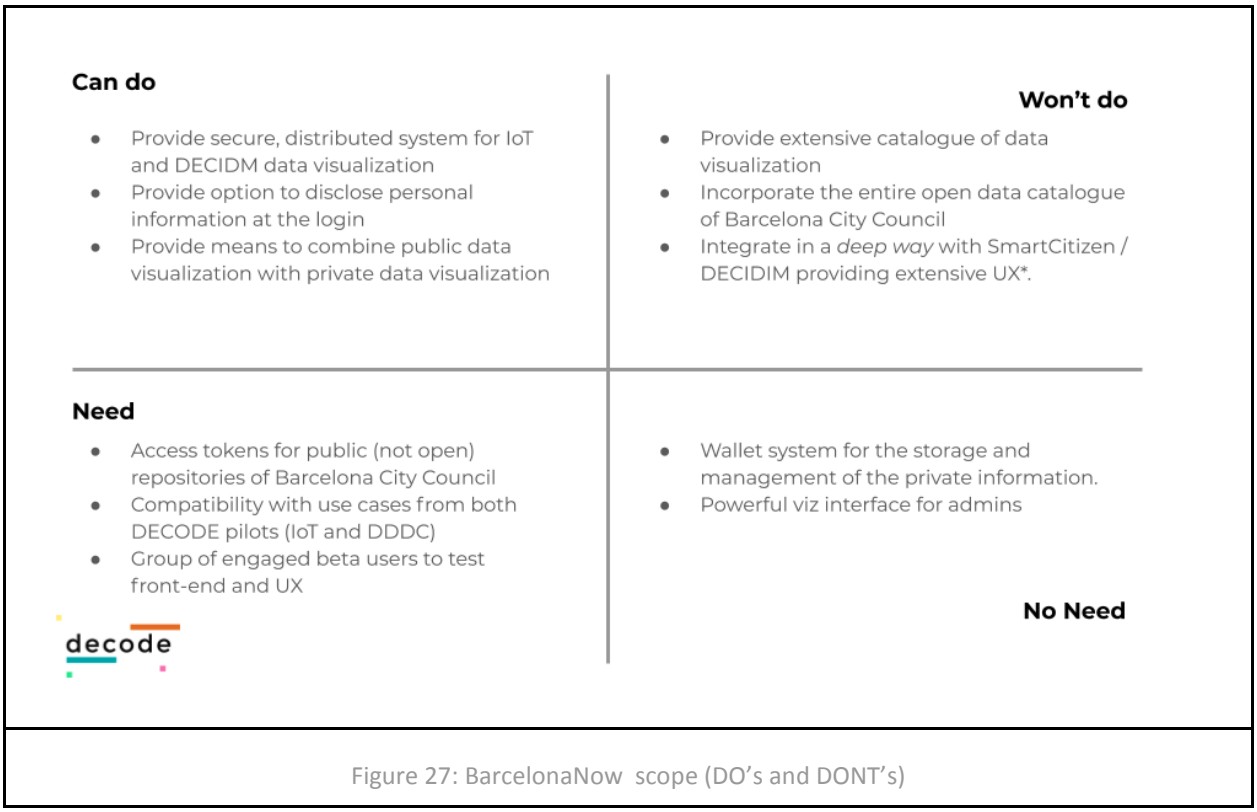


Figure 27: BarcelonaNow scope (DO's and DONT's)

Planning

The planning phase consisted on the schedule of major improvements in BarcelonaNow to fulfill the requirements of different user profiles and of participants from the DDDC and IoT pilots. Given that many participants of pilots accessed the DECODE infrastructure via mobile devices (e.g., through the DECODE mobile app), the first improvement of BarcelonaNow consisted of making the frontend components (dashboard, widgets, etc.) resizable in order to fit on smaller screens (see details in *D5.4 "Prototype Data Visualization Tool"*).

User Experience sessions

In December 2018, User Experience (UX) sessions were held to identify new features and existing problems in order to design and to develop an improved version of the prototype to be ready for the DDDC and IoT pilots. Nine participants were recruited for the sessions (six women and three men), eight of whom had completed higher education (graduates and postgraduates), while one had secondary education. Most of the participants were between the ages of 25 and 44, while two of them were in the 45-64 age range. There were mixed levels of previous experience with dashboard technologies and data visualization, with approximately half the participants

reporting intermediate or advanced levels, the other half reporting no experience or a basic level, and no participants reported expert skills.

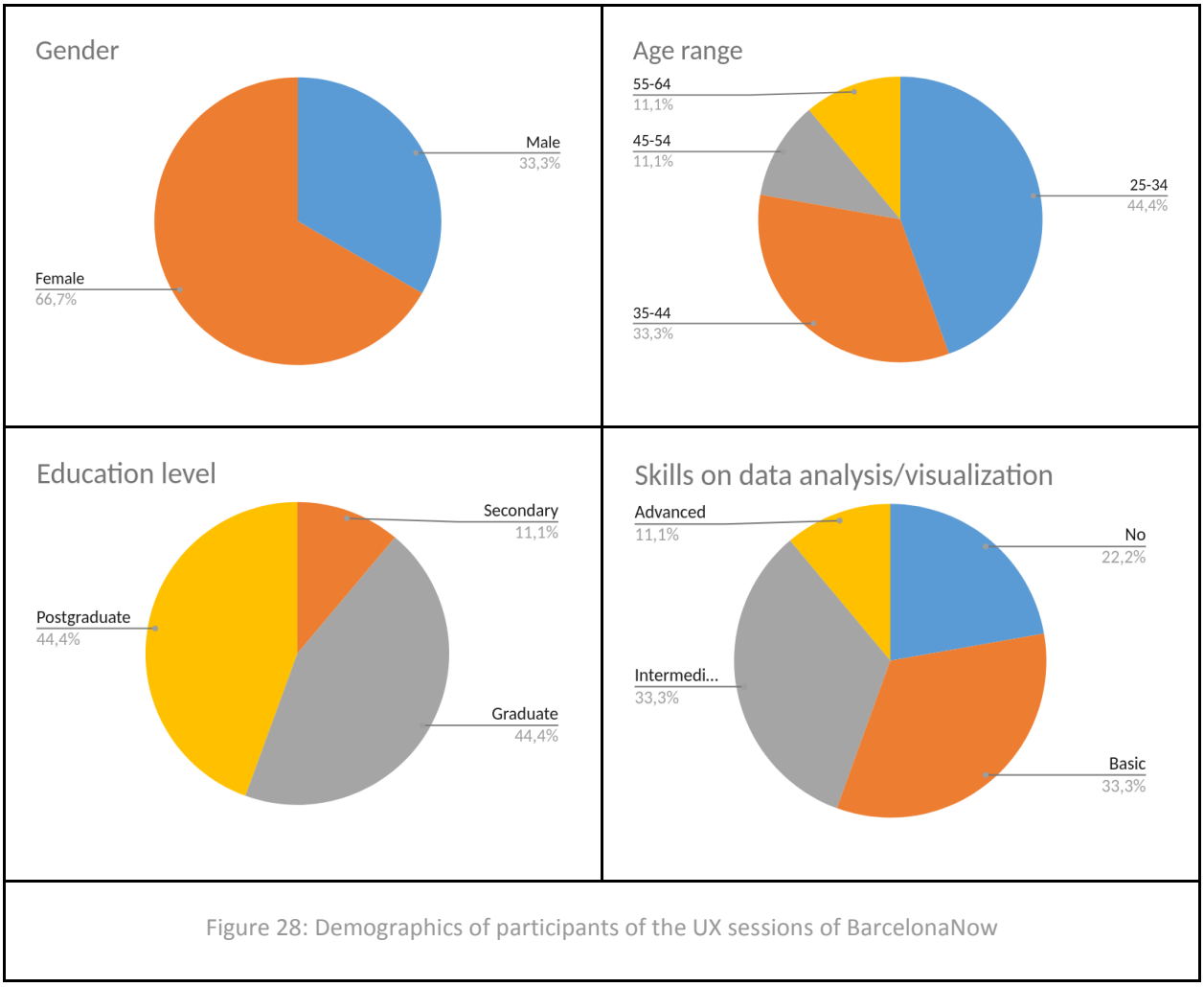


Figure 28: Demographics of participants of the UX sessions of BarcelonaNow

After an introductory presentation to BarcelonaNow that included the main features of the dashboards, the participants were presented with 3 scenarios consisting of specific questions to be answered through the interaction with dashboards, followed by a questionnaire that included 7 questions about their general user experience with the tool, and a final open question in which additional information was requested. The scenarios were as follows:

- **Scenario 1**: Exploration of data from noise sensors
  - a) Which sensors have the highest noise levels? (by default, June 11, 2018)
  - b) There is a sensor located in Santa Coloma de Gramanet, what time of day were the highest noise levels recorded? (by default, June 11, 2018)
  - c) Finally, let's try the option to edit widget to better understand the configuration of dates and geographical grouping;, which neighborhoods registered the highest noise levels in January 2018?

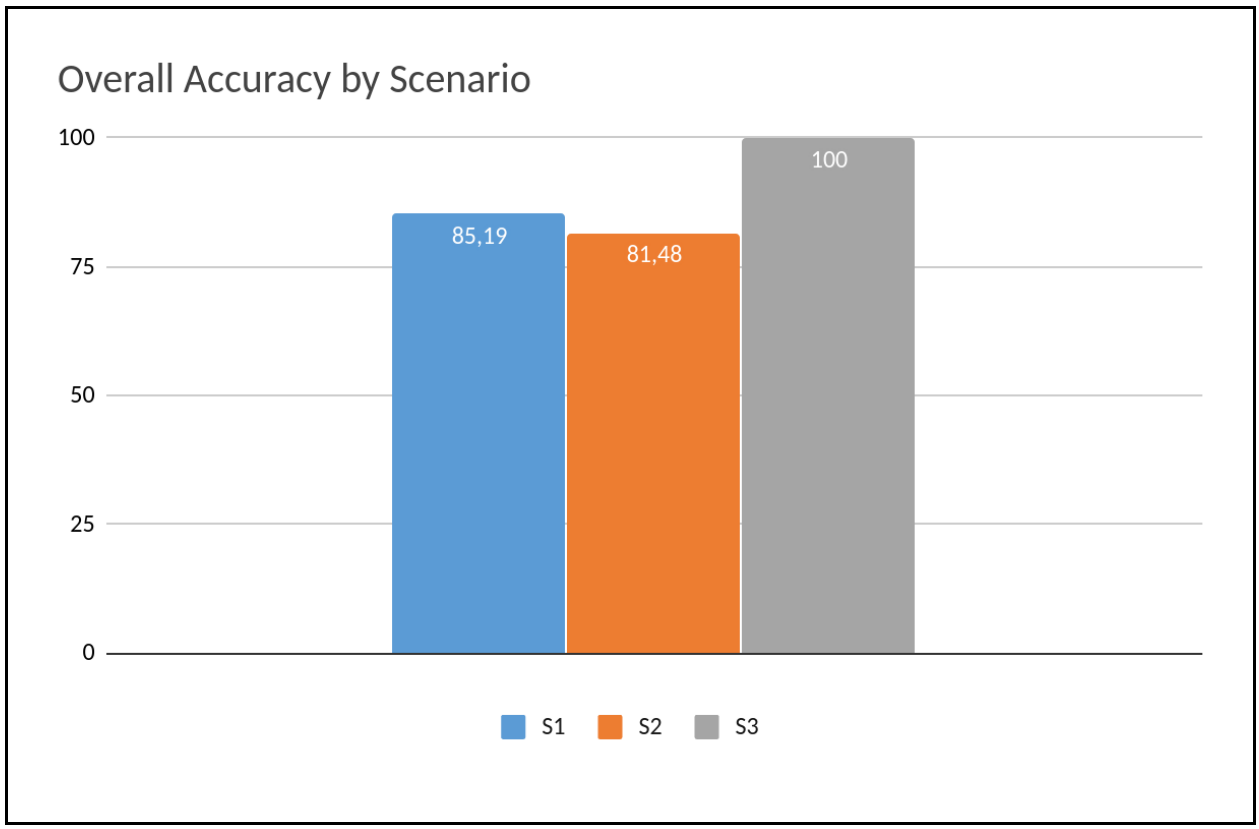
- **Scenario 2**: Exploration of data about tourist accommodations

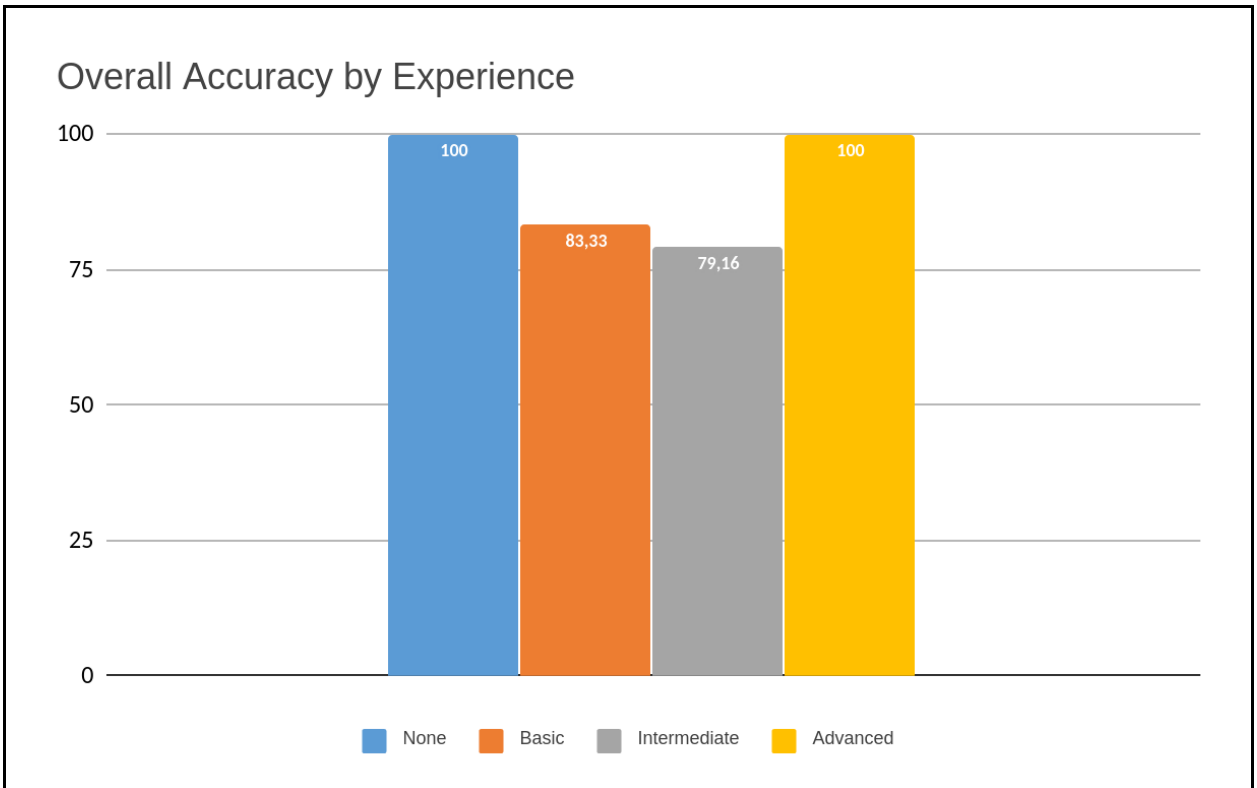
- a) Which district has the highest tourist offer in Airbnb?
- b) Which district has the most hotels?
- c) Since 2008, in which year was the rental contract per square metre cheaper in l'Eixample?
- d) Given the year of the previous answer, which district had the lowest rental price?

- **Scenario 3**: Creation of dashboards
  - a) Create a dashboard from scratch with a heatmap about complaints from IRIS with the word "soroll" from June 1, 2017 to May 21, 2018.
  - b) Now add a new layer with the noise sensors from June 1, 2017 to June 7.

Accuracy (Task Success)

Accuracy was generally high, six of the eight scenario based questions were correctly answered by at least eight of the nine participants. Overall accuracy was 87.5%. The next graphs show overall accuracy by scenario, experience level, and the combination of both.




Overall Accuracy by Experience
100
75
50
25
0
100
83,33
79,16
100
None
Basic
Intermediate
Advanced

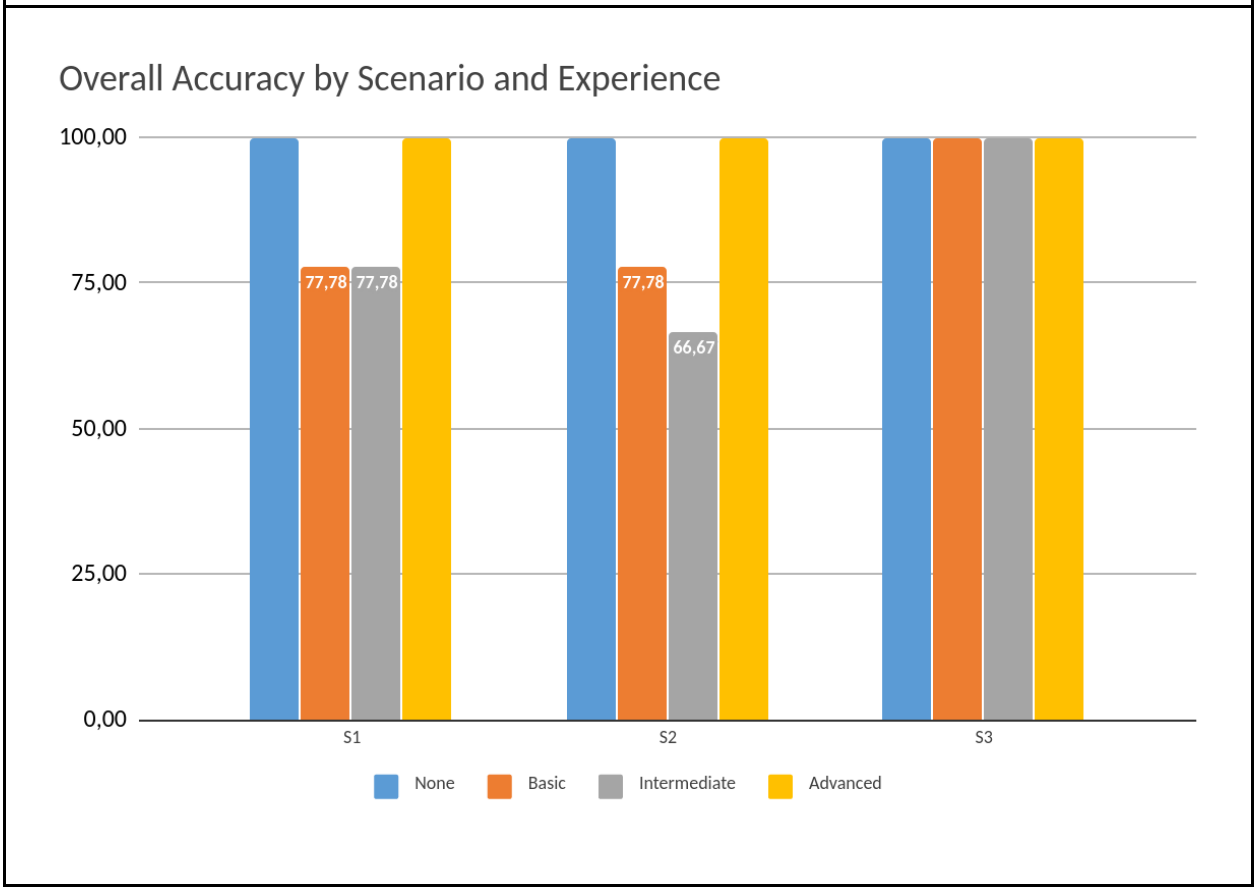

Overall Accuracy by Scenario and Experience
100,00
75,00
50,00
25,00
0,00
77,78
77,78
77,78
66,67
S1
S2
S3
None
Basic
Intermediate
Advanced

Figure 29: Accuracy of the UX sessions of BarcelonaNow by scenario, experience level, and both

Scenario 1 included three questions related to noise levels. The first question simply required to identify which sensors registered the highest level of noise in a given time period. It should be noted that the correct response consisted of four sensors, with the response being codified as correct only if all four were identified, but in fact all responses included at least three correct sensors, so accuracy was actually very high, more so considering that this was the first question. In fact, the second question, which required to identify the period of maximum levels for a specific sensor, was correctly answered by the 9 participants. The third question required to use date configuration and geographic grouping to identify the noisiest neighbourhoods in a given period. Again, accuracy was nearly 1oo%, with mistakes consisting of partial responses rather than full errors.

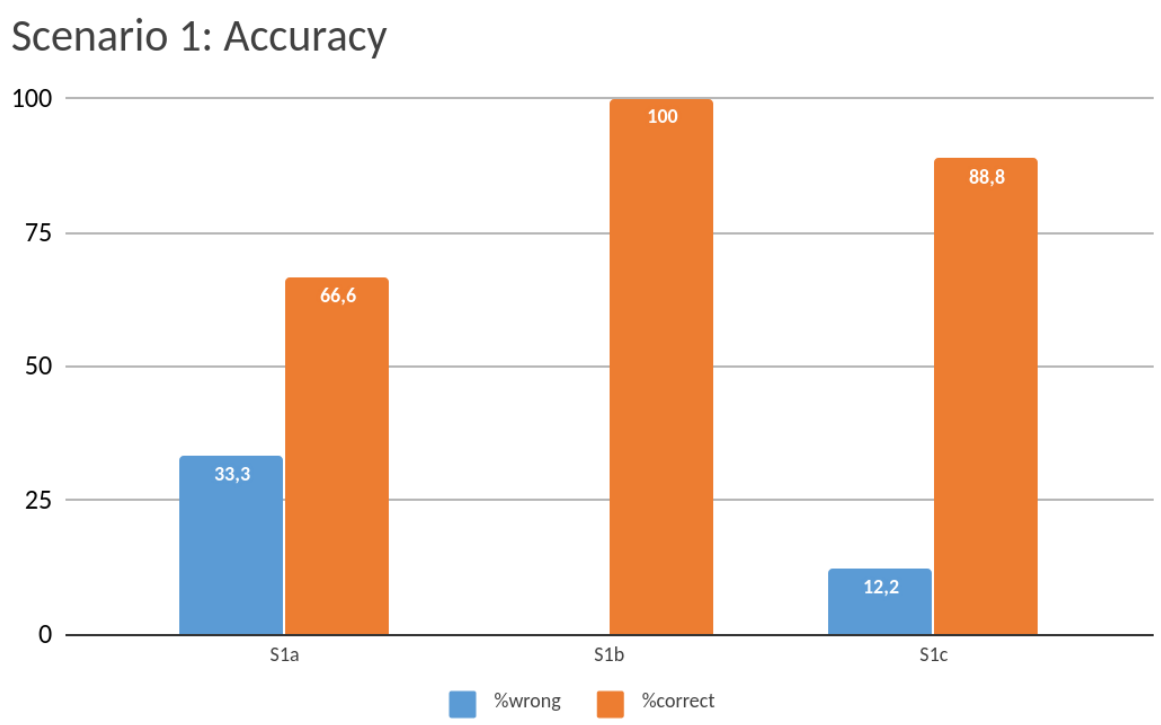


Figure 30: Accuracy of Scenario 1.

Scenario 2 involved three questions on housing and touristic offer. The first question requires participants to identify the district with the higher touristic offer. All wrong responses related to wrongly identifying a district (i.e., participants choosing the adjacent one). Therefore, even wrong responses were very close to being right. As for questions 2 and 3, in both cases, only one of the nine participants was incorrect.

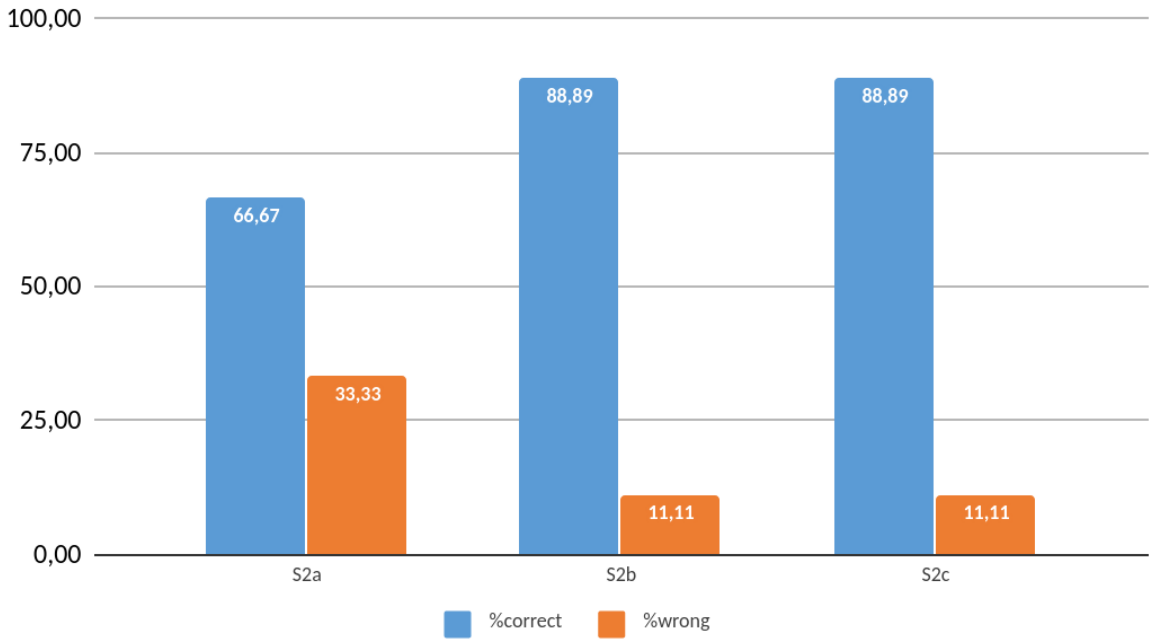


Figure 31: Accuracy of Scenario 2.

Scenario 3 seems to have been the easiest one as all responses to it were correct. Although it could be argued that increasing familiarity with the tool during the session was a factor in this effect, it is still encouraging that such performance was achieved so quickly. Reported experience with dashboards and information visualization does not seem to be a key factor given that even the lowest total accuracy (66%) was actually observed for the Intermediate group in Scenario 2, while both the None and Advanced group achieved 100% accuracy in all scenarios.

Efficiency (Completion times)

Overall average completion time was 32.3 minutes (+/- 3.4 minutes), 2.3 minutes over the reference time. Two participants completed that task in less time (both 29 minutes) and the longest duration was 37 minutes. Next graph shows completion times by experience, with the Advanced group showing faster times that all the rest, this being the only case where previous experience seemed to imply an advantage.

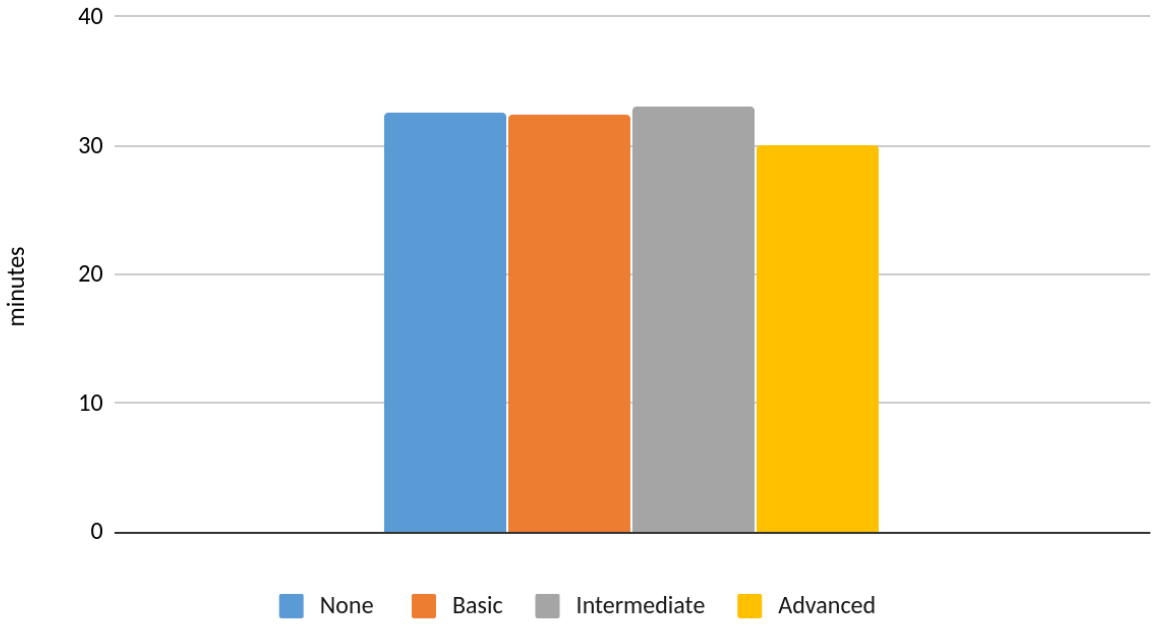


Figure 32: Efficiency by experience

UX questionnaire

The questionnaire was shared at the end of the session and included items for perceived aesthetics as proposed by Lavie and Tractinsky[28], and for perceived usability as proposed in the Post-study Usability Questionnaire[29]. As can be seen in the graph below, all scores are above the mean, with broadly better scores in the aesthetic aspects (cleanness and visual pleasantness are indeed the better scored factors), and usability aspects being scored lower, especially in what refers to orienting within each specific screen. These results are very much in line with the qualitative feedback, reported in the table below.

[28] Lavie, T., & Tractinsky, N. (2004). Assessing dimensions of perceived visual aesthetics of web sites. *International journal of human-computer studies*, *60*(3), 269-298.

[29] Lewis, J. R. (2002). Psychometric evaluation of the PSSUQ using data from five years of usability studies. *International Journal of Human-Computer Interaction*, *14*(3-4), 463-488.

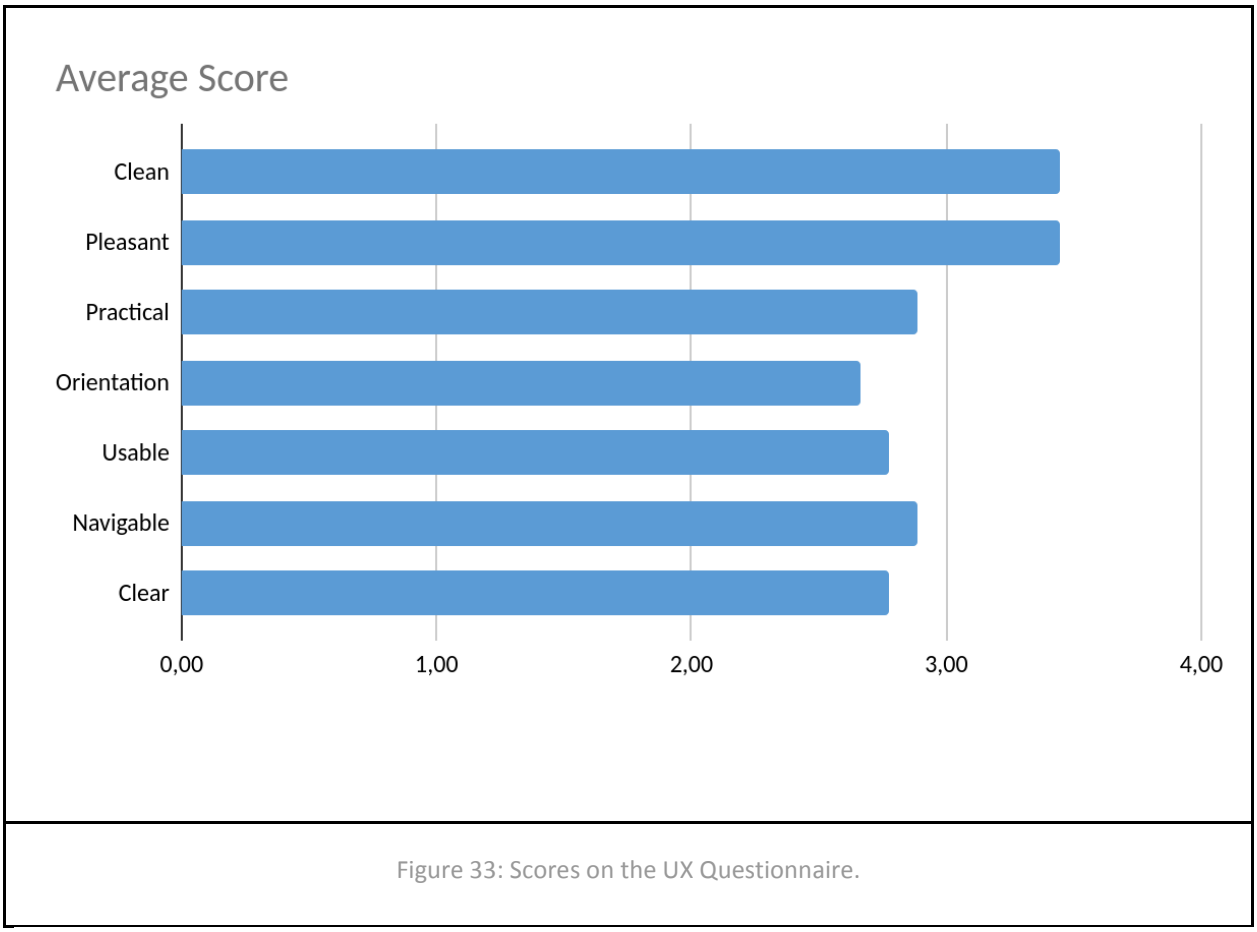


Figure 33: Scores on the UX Questionnaire.

The UX sessions of the BarcelonaNow system casted generally positive results, with high levels of efficiency and effectiveness, as well as the obtention of useful qualitative feedback. Even though the amount of data at this point does only warrant a descriptive analysis, it is obvious that participants were able to obtain the required information from BarcelonaNow.

Table 4: Qualitative feedback provided by the participants

Es una idea innovadora, interesante para gente curiosa, se obtienen muchos datos que se pueden explotar (tanto para mejorar la calidad del aire, como de ruido de Barcelona). Sería interesante que la población pudiera acceder a los datos recopilados, siempre de manera que no se indique exactamente el piso donde el sensor se encuentra ubicado; puede indicar la posición en un mapa sin decir exactamente el piso. Así como también es importante que no se pueda enlazar el sensor con la persona que lo tiene (nombre y apellidos).
Me parece una herramienta súper potente, robusta y con gran potencial, aunque por el momento muy orientada a datos. Si la idea es que pueda ser usada por ciudadanos y no se necesite ser un experto o hacer un training para ver la información sería muy útil añadir una capa de experiencia de usuario (pensada desde el punto de vista del usuario)
1- El nivel de inglés del usuario puede ser un problema. *2- El término widget puede llevar a confusión. ¿Por qué no sustituirlo por "escenario"? No sé si es esa la equivalencia.* *3- Cuando he eliminado por error un widget de un dashboard no he sabido añadirlo de nuevo. He tenido que cerrar BarcelonaNow y volverlo a abrir.*
en la sección de eventos, las fichas donde se ven los detalles del evento puede mostrar contacto con organizadores, es un poco simple
Creo que faltan textos de ayuda para el usuario, para que sea más fácil moverse por el sistema.

La visualización es minúscula, no se ve bien. Si se usa CTRL+ y se va a seleccionar opciones (como p.ej. acotar entre fechas), no puedes hacer un scroll hacia abajo para ir a "Apply". Se debería poder hacer un click en el mapa para que ocupe toda la pantalla. Todo debería de estar en español para que sea utilizable para todos. Para salir de "Edit", debería de poner "Ok", pero pone "Edit". Los widgets temporales tardan mucho en cargarse. Mientras se construye un mapa temporal, si clicas en otro mapa, quedan superpuestos. En los mapas, cuando los has agrandado, aparecen los símbolos +/- en varios sitios. Al editar fechas, en los calendarios que aparecen, deberían poder cambiarse meses y años por separado.
create a very very clear tutorial
En principio es difícil enterar que mapa vas a trabajar, eso pasa nos primeros 2 minutos después es fácil, creo que as áreas límites de cada barrio tiene que aparecer de mediato en el layout

Extension for the DDDC pilot

The first extension of BarcelonaNow for the DDDC pilot was documented in *D5.4 "Prototype Data Visualization Tool"* and consisted of deploying a data collector for proposals and meetings of Decidim instances, in particular, from the instance owned by the City Council that hosted the PAM participatory strategic city plan process[30]. This collector also required an extension of the frontend to display new data visualization widgets based on bar plots and scatter plots.

The Decidim collector served as well for the meetings and proposals hosted at the DDDC Decidim instance for the participatory process to elaborate the Data Commons Manifesto[31]. The latest extension of the collector allowed the system to retrieve and store:

1. survey answers from Decidim,
2. anonymized aggregated demographics about participants who obtained a credential for signing the DDDC petition,
3. the final number of signatures to the DDDC petition.

In addition, the personalized login via the DECODE mobile app was developed for this pilot.

[30] https://www.decidim.barcelona/processes/pam
[31] https://dddc.decodeproject.eu/processes/main

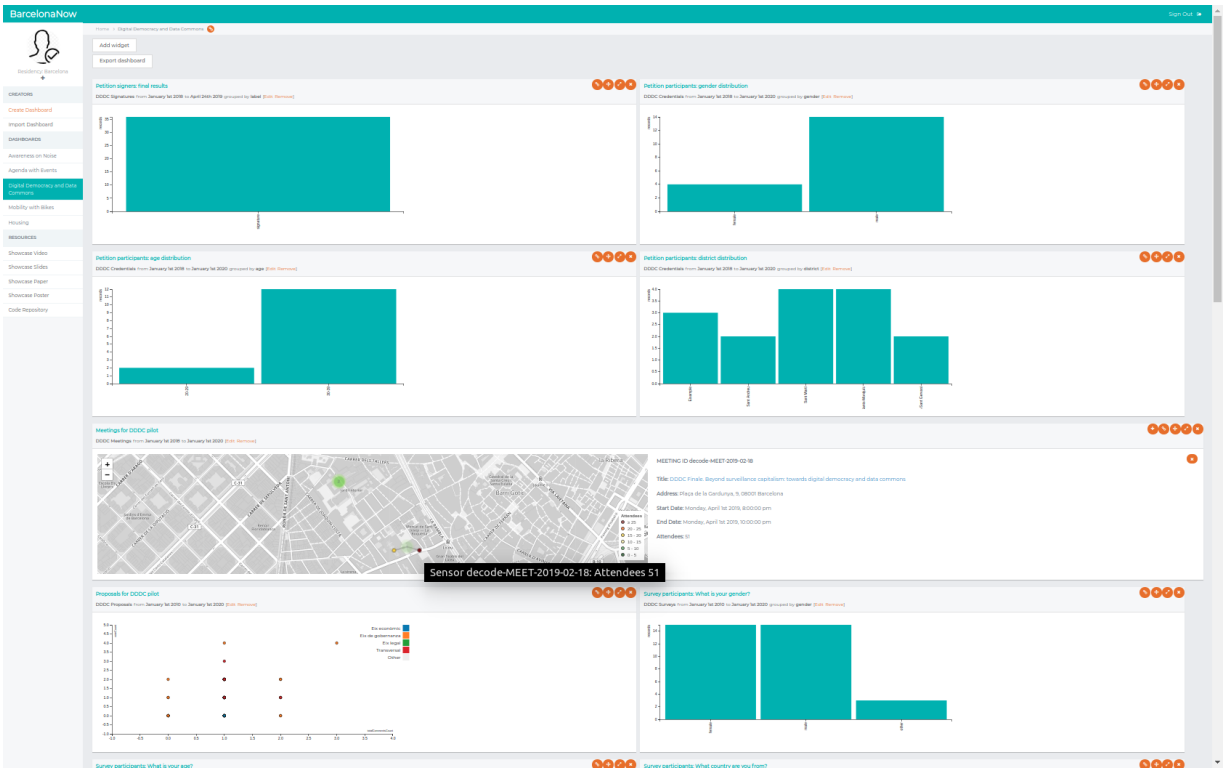


Figure 34: Dashboard in BarcelonaNow for the DDDC pilot with visualization about signatures, credential owners' demographics, meetings and proposals.

Extension for the IoT pilot

The extension of BarcelonaNow for the IoT pilot was specified in *D5.6 "Deployment of Pilots in Barcelona"* stating the system had pull data from the encrypted datastore using the corresponding Zenroom script and private key. Also, BarcelonaNow was indicated responsible for generating a login validation request to be sent to the users' app and hence restrict access to IoT pilot community participants. These actions therefore required to generate a specific data collector powered by Zenroom, integration with the DECODE webapp for user access control, and separated mongodb collections for public and private dashboards configurations. As a result, 6 dashboards were configured corresponding to different time intervals (1 day, 7 days, 30 days) and different community policies ("All Public" and "Simplified data") with widgets of sensor data from 4 different nature (light, noise, temperature and air quality). Technical details of this extension are provided below.

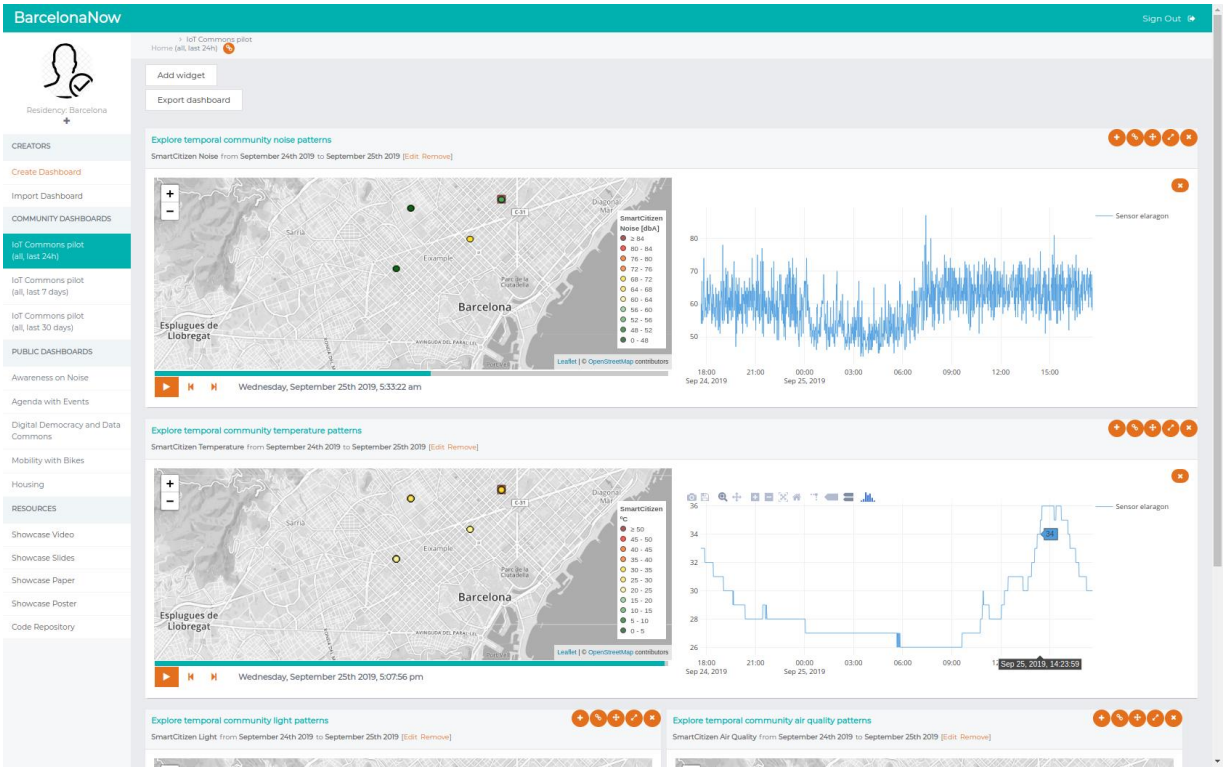


Figure 35: Dashboard in BarcelonaNow for the IoT pilot

Delivery

BarcelonaNow has been developed as a free open source software in a collaborative manner within the DECODE GitHub repository[32]. While this has allowed the replicability and extension of the system by any interested stakeholder, ongoing efforts at the time this deliverable was written are focused on releasing a dockerized version. This delivery is expected to maximize the adoption of the BarcelonaNow system beyond partners of the DECODE consortium.

Measurement and promotion

The first complete prototype of BarcelonaNow, released in March 2018 and documented in *D5.3 "Data analysis methods and first results from pilots"*, was already capable of collecting, processing, exposing and visualizing heterogeneous data from public repositories and platforms of Barcelona. This version of the prototype was presented at The Web Conference 2018 (former WWW conference) receiving the best demo award (Marras et al., 2018).

Figure 36: Best Demo Award to BarcelonaNow at the Web Conference 2018

[32] https://github.com/DECODEproject/bcnnow

Later versions of BarcelonaNow were then disseminated in different venues:

- **MakerFaire Barcelona 2018:** the annual meeting in Barcelona to gather hundreds of engineers, artists, designers, hackers, craftsmen, programmers, scientists from the Maker Movement.
- **The Smart City Expo World Congress 2018:** the world leader event for the whole smart city ecosystem.
- **The 2018 conference of the Data Transparency Lab**: the annual event launched by Telefónica to discuss on innovation, research and data ethics..

Figure 37: Presentation of BarcelonaNow at the 2018 conference of the Data Transparency Lab

In order to get detailed information about the activities results and participant feedback, see the deliverable D6.7 “Project communication, exploitation plan, events report and overall project impact” .

Technology

The technologies of the first prototype of BarcelonaNow were detailed in deliverable 5.3 (see figure above). The backend system consists of data collectors based on Python to retrieve data from (BCN City Council/external) public and (DECODE) private sources to be stored in a mongodb database. Data is accessible through an open API powered by Flash which is consumed by the frontend. Dashboards of the frontend are based on web technologies

(HTML+CSS+JS), including popular free open source JavaScript libraries (e.g., Bootstrap and jQuery) together with libraries specific for data visualization features (e.g., plotly, D3.js and Leaflet).

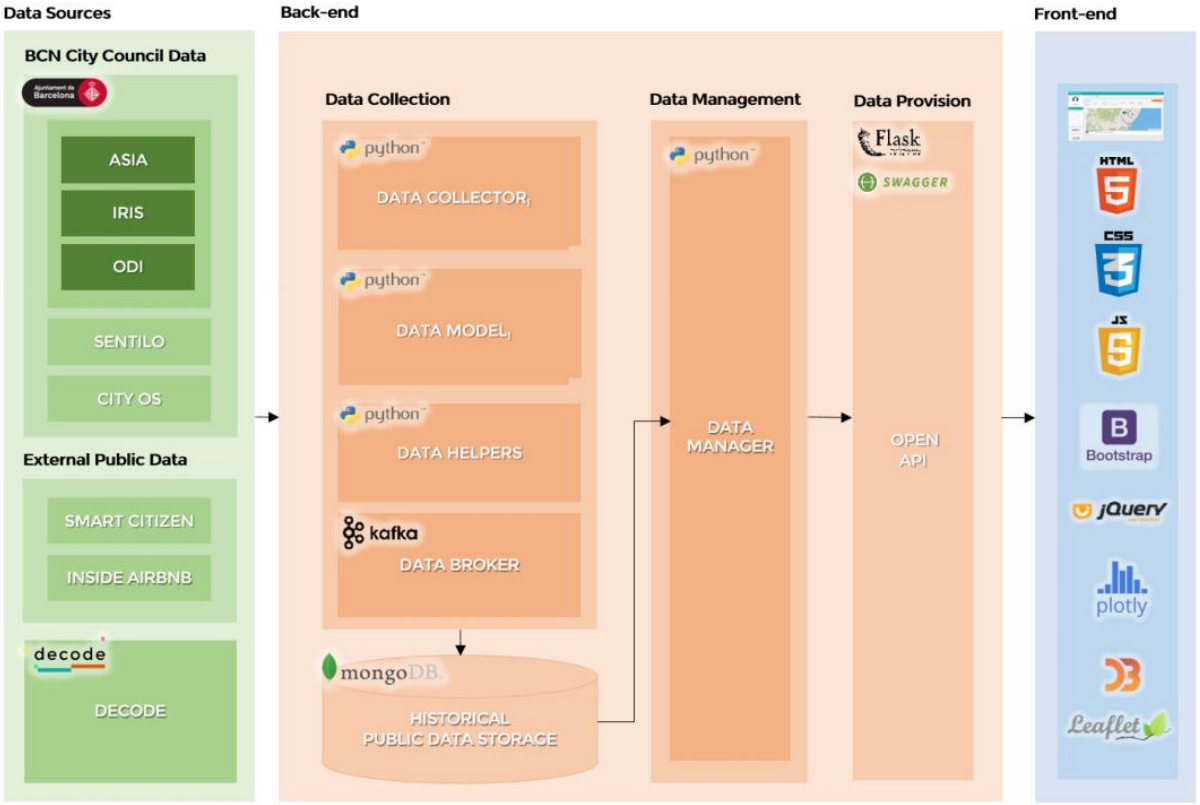


Figure 38: Reference architecture of Barcelona. A design by Eurecat in D5.3 "Data analysis methods and first results from pilots"

The extension of Barcelona for DDDC and IoT pilots required the integration of Zenroom for data encryption/decryption and a SQL server to store information about pilot communities and dashboards which serves to configure the rules for user access control. To illustrate such extension, a schematic view of BarcelonaNow through the mobile app is presented in the Figure below.

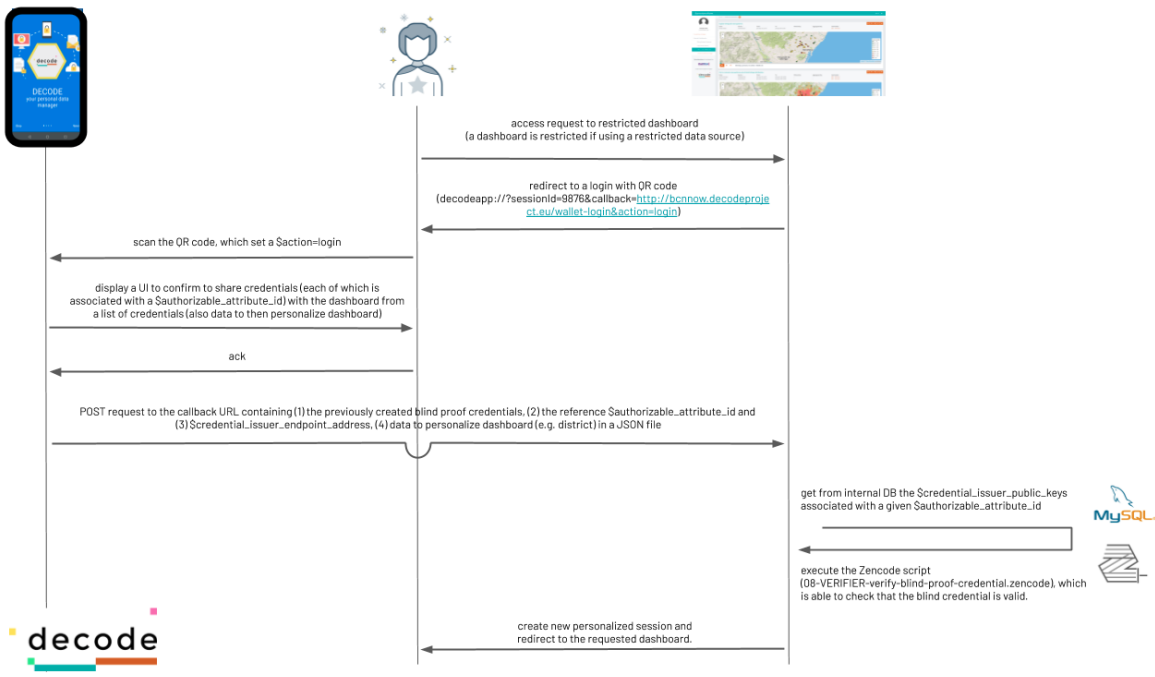


Figure 39: BarcelonaNow login using the DECODE mobile app. A design by Eurecat

In the following we provide further details on the components used in this pilot.

User Access Control

There are two different approaches to access BCNNow Dashboard.

1) The first one is a public open access for which no user credentials are required. This login only has access to open public datasets and public dashboards.
2) The second one is a community closed group access. This approach is used in different pilots for giving access to authorized users only belonging to a community on the community dashboard. We discuss this in detail below.

Community based external User authentication

A Community in BCNNow is a collection of dataset and dashboards which are only accessible based on an authorized login. Community based login is an external authentication process where BCNNow dashboard is assessed based on a mobile and web app to validate the credentials of a user. In this approach BCNNow uses

zenroom to validate the credentials provided by the app of a user against the credential issuer endpoint attached to the community. If the credentials are valid the login of the user is validated and she/he is given access to all the dashboard in that community. BCNNow do not know at this point who the user is but only that the user credentials are valid for the given community. The details of the workflow is given in the figure above.

The whole login setup requires two main steps:

1) **Creation of the community:** In this step a community is created in BCNNow and a credential issuer endpoint is mapped to it. This step is done by an outside entity which maintains the credentials and community memberships of the user. This entity can be any service which provide user registration or community management for example the smart citizen application in case of IoT pilot. The api specification to create a community is provided here

   https://decodeproject.github.io/bcnnow-dashboard-docs/#tag/Create

   Once a community is created the data set definitions and their corresponding data collectors are added into the BCNNow API using the BCNNow api framework. Details of the Data collectors and how they work are given in the next section (Data Collectors).

2) **Login Validation:** In this step a user having the DECODE app and the required credentials can login to the BCNNow for a given community. Currently we have integrated this for two pilots i.e the DDDC Pilot and the IoT Pilot. The login starts with a QR code which contains a unique session id and a call back URL for login validation. Scanning the QR code invokes the decode app on the mobile app. The mobile app then finally sends the credentials to the call back URL with the session id in the QR image. If the credentials are correct the session id is validated and the user is allowed access to the dashboards and data set of the community. The api specification for the call back URL is given here:

   https://decodeproject.github.io/bcnnow-dashboard-docs/#tag/IoT-Login

   The session id is valid only for one use and for 1 hour after issue. if the login is not validated with-in one hour the session id expires and the user need to restart the login process.

Data Collectors

Data collectors in BarcelonaNow are the scripts in Python responsible for retrieving data from different public and private sources that is stored in the mongodb database. The deliverable *D5.3 "Data analysis methods and first results from pilots"* provides the technical details of how the heterogeneous formats of data were integrated in a JSON-based unified base record structure together with optional location field structure and payload field structures. The flexibility of this approach already allowed the development of extended collectors for data about touristic house offer, monthly rent price and hotels, and data from Decidim instances (technical details of the extensions are reported in deliverable *D5.4 "Prototype Data Visualization Tool"*.

The latest extensions of the pool of data collectors of BarcelonaNow have focused on data generated for the Barcelona Pilots. For the DDDC pilot, the first collector was designed for the answers to the survey[33] which was launched at the Decidim instance aiming at gathering sociodemographic information about participants at the beginning of the process. Then, a second collector was developed to retrieve information from participants of the final stage of the process that consisted of signing the petition to the Data Commons Manifesto[34]. The collector relies on the *14-CITIZEN-count-petition* Zenroom contract:

Scenario 'coconut': "Count the petition results: any Citizen can count the petition as long as they have the 'tally'"

Given that I receive a petition

and I receive a tally

[33] https://dddc.decodeproject.eu/processes/main/f/3
[34] https://dddc.decodeproject.eu/processes/main/f/6/petitions/1

When I count the petition results

Then print all data

and the process is as follows:

1. *Obtain attribute_id, credential_issuer_api_url and json_attribute_info_optional from https://dddc.decodeproject.eu/api/*
2. *For each attribute in json_attribute_info_optional (i.e., age, gender, district):*
    a. *Get the hashed bin values using the 50-MISC-hashing Zenroom contract*
        print(ECDH.kdf(HASH.new('sha512'), str(DATA)))
    b. *Get the credentials stats from https://credentials.decodeproject.eu/stats*
    c. *For each hashed bin from credential stats:*
        i. *Store as many records in dddc_petition_credential as occurrences*

3. *For each petition:*
    a. *Retrieve the access_token from https://petitions.decodeproject.eu/?username=XXX&password=XXX (XXX values are given)*
    b. *Retrieve the number of signatures from https://petitions.decodeproject.eu/petitions/<petition_id>/count with (headers={'authorization' : 'Bearer ' + access_token})*
    c. *Retrieve the petition and tally from https://petitions.decodeproject.eu/petitions/<petition_id>?expand=True*
    d. *Execute the 14-CITIZEN-count-petition Zenroom contract*
        Scenario 'coconut': "Count the petition results: any Citizen can count the petition as long as they have the 'tally'"
        Given that I receive a petition
        and I receive a tally
        When I count the petition results
        Then print all data
    e. *Assess that the number of signatures is the same value as obtained in step b*
    f. *Generate as many records in dddc_petition_signature mongodb collection as number of signatures.*

In this regard, the data collector stores aggregated demographics (gender, age range, and district) from those participants who obtained a credential and agreed on sharing their personal data, while data storage about signatories relates only to the number of votes.

Table 5: Tabular attributes integrated in the payload of Decidim data sources for the DDDC pilot.

Payloads	Tabular attributes
Decidim collector - Survey	• ID • GENDER (Answer to the corresponding question) • AGE (Answer to the corresponding question) • COUNTRY (Answer to the corresponding question) • CONTINENT (Answer to the corresponding question) • EDUCATION (Answer to the corresponding question) • WORKSITUATION (Answer to the corresponding question) • ORGANIZATION (Answer to the corresponding question) • CITY (Answer to the corresponding question) • DISTRICT (Answer to the corresponding question) • DEVICE (Answer to the question "Which device do you mostly use to connect to the Internet") • SCALE (Answer to question "In a scale 0-5 (not at all - very much), how worried are you about the management of your data by Internet companies") • INTEREST (Answer to question "What are the issues that worry you the most about the current ways in which data is managed")

Decidim collector - Petition credential	• ID • PETITIONID (ID of the petition corresponding to the credential) • AGE (Age of the participant who holds the credential, null if not provided) • GENDER (Gender of the participant who holds the credential, null if not provided) • DISTRICT (District of the participant who holds the credential, null if not provided)
Decidim collector - Petition signature	• ID • ID • PETITIONID (ID of the petition corresponding to the signature)

For the IoT pilot, the data collector is based on the DECODE IoT Pilot Datastore Client Python package[35]. The process periodically retrieves encrypted data from the endpoint of the datastore[36] that it is then decrypted using the corresponding Zenroom Lua script[37]. In particular, two data communities have been defined in this pilot. While the former consists of the raw data ("All Public" community), the latter consists of filtered data ("Simplified data" community) with the following rules:

- Air Temperature Sensor (ºC): Moving Average (5 minutes)
- Noise Sensor (dBA): Binned Data (<55, 55-65, 65-70, >70)
- Light Sensor (Lux): Moving Average (10 minutes)
- Battery Level (%): Share
- PM 2.5 Sensor (ug/m3): Moving Average (a day)

Data from each community is stored in mongodb collections, one per channel: light, noise, temperature and air quality.

Table 6: Tabular attributes integrated in the payload of Decidim data sources for the IoT pilot.

Payloads	Tabular attributes

IoT collector -
 	
iot__*__bh1730fvc
iot__*__ics43432
iot__*__sht31
iot__*__pm2_5
	• ID
	• NAME
	  ○ BH1730FVC
	  ○ ICS43432 - Noise
	  ○ SHT31 - Temperature
	  ○ PMS5003_AVG-PM2.5
	• DESCRIPTION:
	  ○ Digital Ambient Light Sensor
	  ○ I2S Digital Mems Microphone with custom Audio Processing Algorithm
	  ○ Temperature
	  ○ Particle Matter PM 2.5
	• UNIT:
	  ○ Lux
	  ○ dBA
	  ○ °C
	  ○ ug/m3
	• VALUE (Corresponding value)
	• RECORDEDAT (Timestamp)
	• EXPOSURE ("indoor" / "outdoor")

[35] https://decode-datastore-client.readthedocs.io/en/latest/pages/usage.html
[36] https://datastore.decodeproject.eu
[37] https://github.com/DECODEproject/iotencoder/blob/master/pkg/lua/scripts/decrypt.lua

Interactive Dashboards for Data Exploration

The interactive dashboards for data exploration of BarcelonaNow were first specified in deliverable *D5.3 "Data analysis methods and first results from pilots"*. Dashboards are the frontend of the BarcelonaNow system allowing citizens to create interactive widgets that can be customized in order to extract valuable information from open data generated by Barcelona City Council. As reported in deliverable *D5.4 "Prototype Data Visualization Tool"*, subsequent efforts were devoted to adapt the user interface to mobile devices by optimizing the screen usage through flexible resizing. From then on, the actions performed regarding the frontend to extend BarcelonaNow capabilities have focused on two primary goals:

1) To improve usability based on the feedback reported by participants of UX sessions (held in December 2018)

    a. To allow BarcelonaNow admins to establish relative dates for widgets (e.g., from yesterday to today) in order to show updated data. This features has been implemented by integrating the Relative Time Parser plugin for Moment.js, which is inspired by the Graphite's relative time format[38].

    b. To set the start date of data from any new widget the first date of available data in the database.

    c. Since widgets allow multilayered data visualizations, to present as many legends as data sources in value-based widgets.

    d. To allow geo-clustering in leaflet maps with the aim of solving two UX problems: overlapped data points and information overload.

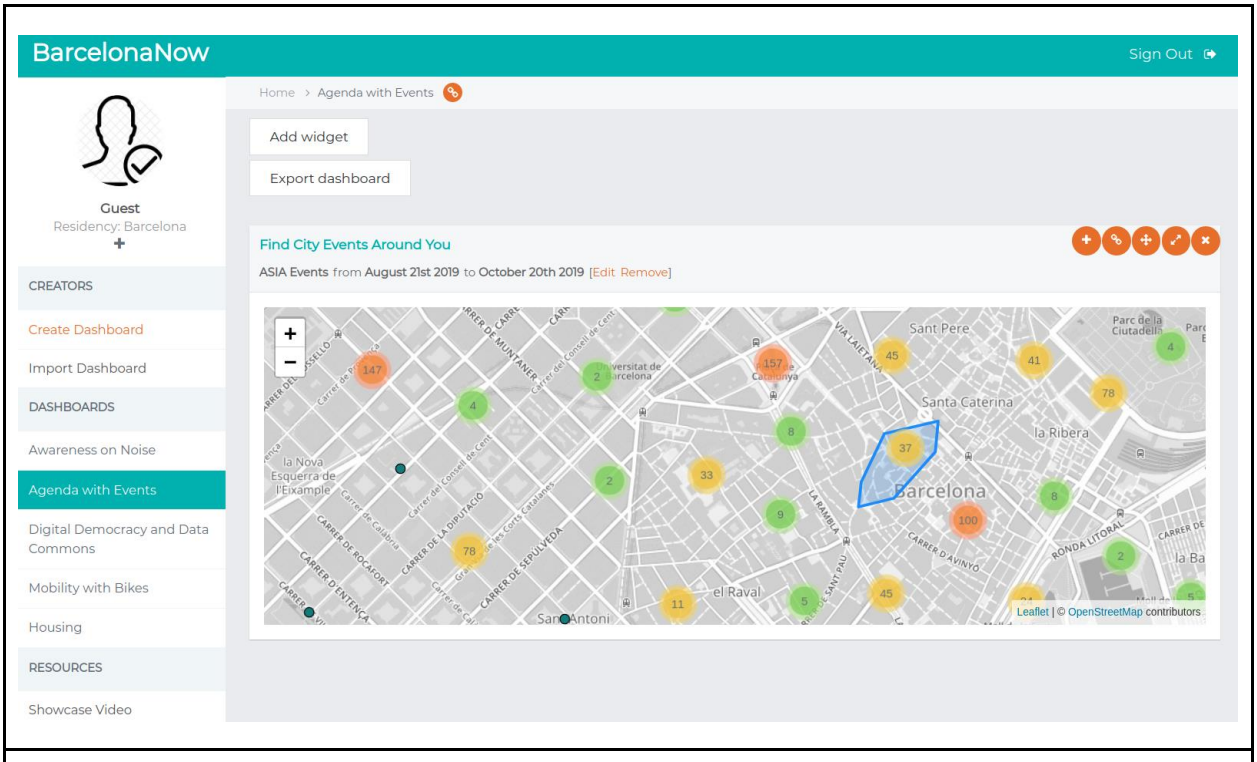


Figure 40: Dashboard of "Agenda with Events" that applies geo-clustering and relative dates

[38] https://github.com/cmaurer/relative.time.parser

1) To provide DDDC and IoT participants with the data visualisation features necessary for the successful execution of the pilots.

    a. To display the personal information provided by participants who logged in with the mobile APP in the DDDC pilot. This personalized access will allow to personalized widgets according to data attributes shared by participants.

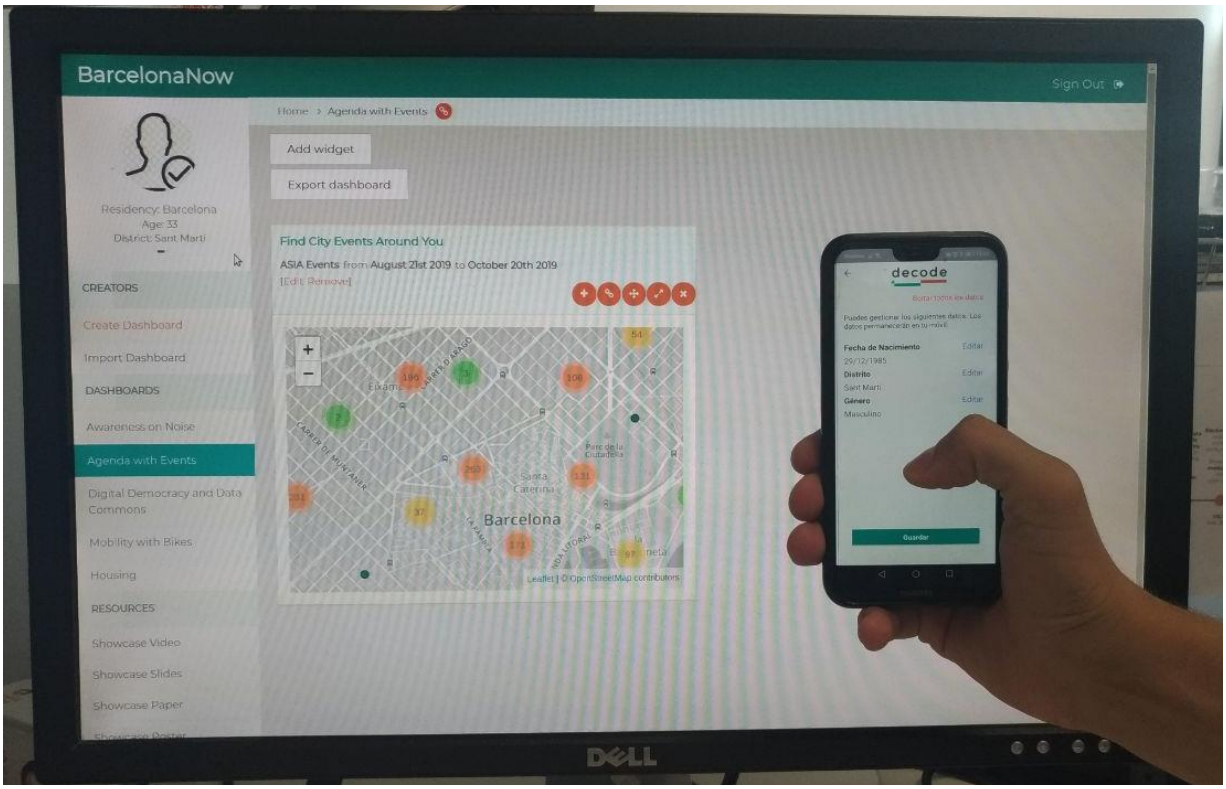


Figure 41: BarcelonaNow frontend displaying personal data shared by a DDDC participant through the mobile app.

b. To extend widgets settings for displaying non geo-located information from Decidim DDDC (proposals, survey answers, credential holders, and signatories) with bar charts and scatter plots.

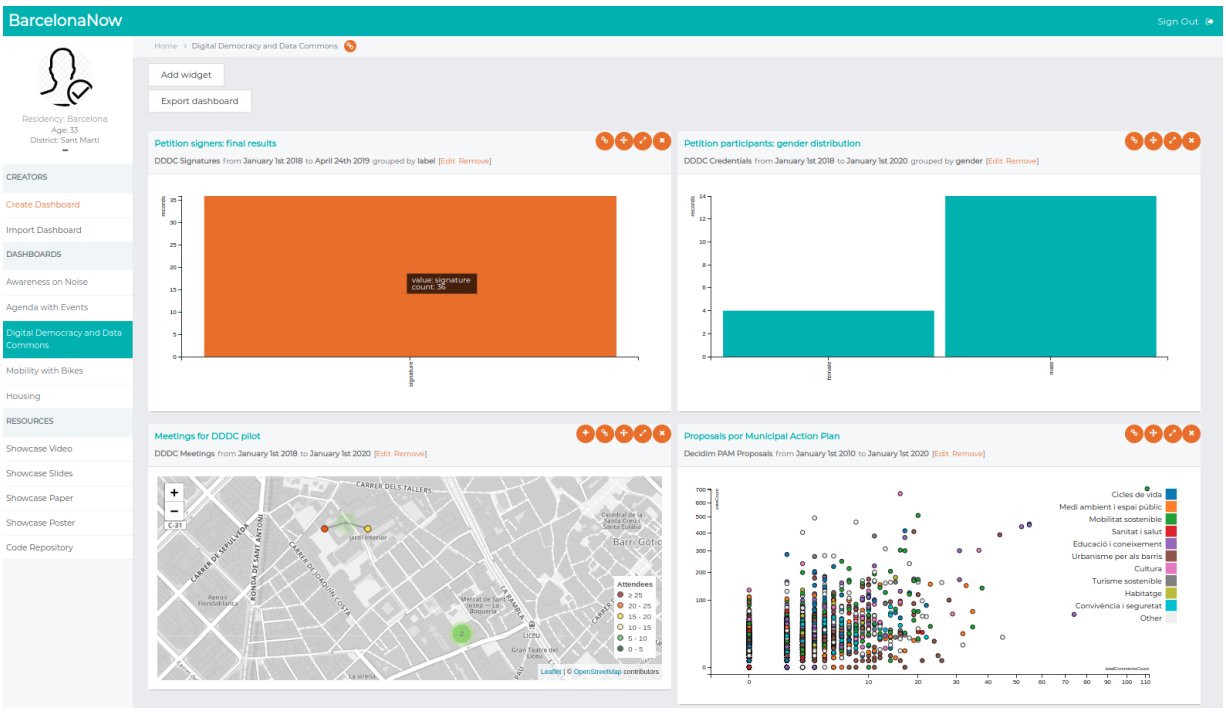


Figure 42: The DDDC public dashboard of BarcelonaNow combining widgets based on maps, bar charts and scatter plots.

c. To display private dashboards with the data generated by the SmartCitizen sensors to those IoT pilot participants who access BarcelonaNow with the web app login.

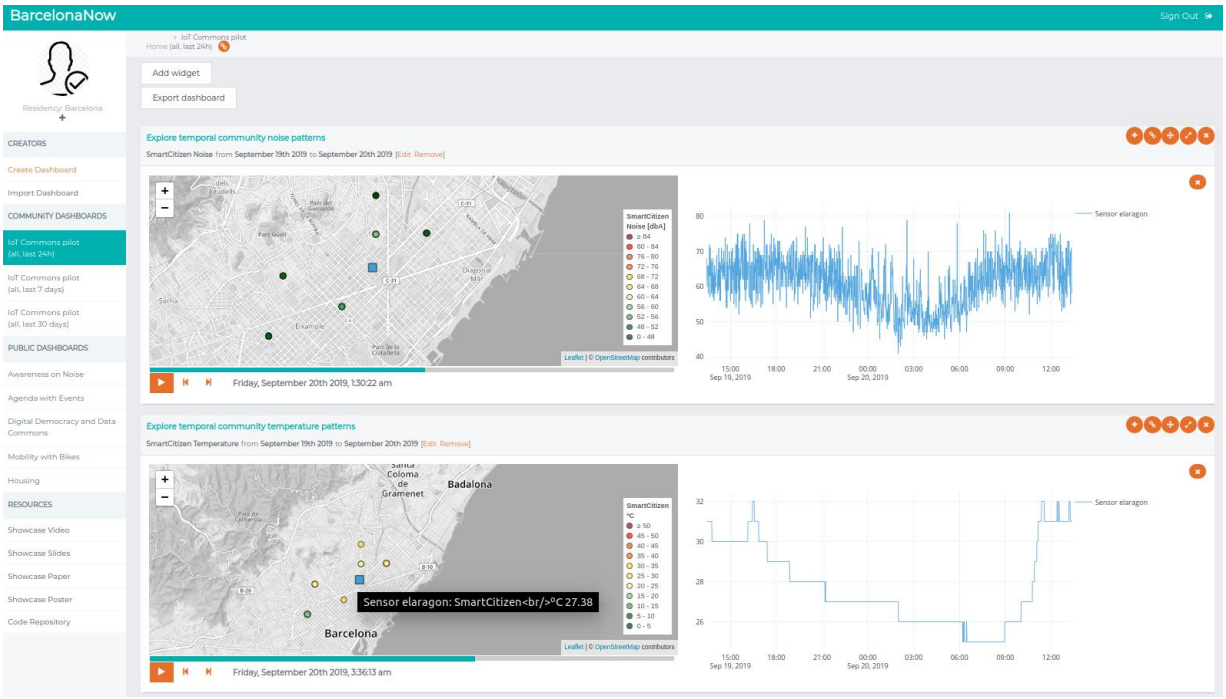


Figure 43: An IoT private dashboard of BarcelonaNow with data from the SmartCitizen sensors.

Finally, a new landing page is being built at the time this deliverable was written to provide beginners with clear indications of the capabilities of the BarcelonaNow system.

BarcelonaNow in numbers

The impact the BarcelonaNow pilot is quantified and presented in the following table.

Table 7: BarcelonaNow impact summary.

BarcelonaNow impact summary	
Monthly visits to website	> 200 (Sep 2019)
Participants in UX sessions (Dec 2018)	9
Dashboards of open data	5
Dashboards from data commons	6
Available datasets	21

The volume of data of the 21 datasets are presented in the following table (IoT datasets are double, one for the raw data and the other for the simplified data).

Table 8:: Datasets available at BarcelonaNow.

Name	Description	Number of records
asia	ASIA Events	28 643
bicing	ODI Bicing Stations	1 331 681
cityos-potencial_fotovoltaic	CityOS Photovoltaic Potencial	170 463
cityos-ptt_carril_bici	CityOS Bike Lanes	299
dddc_meeting	DDDC Meetings	8
dddc_petition_credential	DDDC Credentials	47
dddc_petition_signature	DDDC Signatures	36
dddc_proposal	DDDC Proposals	82
dddc_survey	DDDC Surveys	33
insideairbnb	Airbnb Listings	17 653
iot__*__bh1730fvc	SmartCitizen Light	2 x 1 238 894
iot__*__ics43432	SmartCitizen Noise	2 x 1 234 826
iot__*__sht31	SmartCitizen Temperature	2 x 1 238 974
iot__*_pm2_5	SmartCitizen Air Quality	2 x 1 238 282
iris	IRIS Claims	740 837
ohb	Touristic House Offer	83
ohb2	Monthly Rent Price	120
ohb3	Hotels	83
pam_meeting	Decidim PAM Meetings	410
pam_proposal	Decidim PAM Proposals	5417
sentilo	Sentilo Noise Levels	3 798 968

Lessons learned, impact, sustainability and future steps

This (“meta”)pilot has been designed to serve the other pilots in Barcelona (DDDC and IoT), therefore, contact with both communities has raised various challenges from which to draw conclusions of interest.

Social

The participants of the UX sessions for BarcelonaNow agreed on the usefulness of having a system for exploring urban challenges in Barcelona, specifically for issues of air pollution and noise pollution. Similarly, the participants

also revealed their concern about possible conflicts between visualizing useful citizen data vs. revealing sensitive information of the citizens who generate such data. This reflection also arose in conversations related to DDDC pilot visualization in which the importance of having demographic variables of processes from Decidim should not jeopardize the privacy of the participants. In this sense, this pilot has shown the increasing awareness on the tradeoff to be further examined between potential and limits of the citizen data visualization.

Barcelona is to declare a climate emergency as from 1 January 2020, with the local government activating a package of urgent measures in autumn 2019 to face the current situation. A study published this year has revealed that 351 people died from pollution in 2018[39]. In this regard, ongoing conversations with Barcelona City Council are in place to explore options to adopt BarcelonaNow as a resource for monitoring services available not only to public workers but also to the citizenry.. Beyond Barcelona, cities around the world already have similar catalogues of open data and sensor data. Therefore, the model proposed by BarcelonaNow is easily extensible inside and outside Catalonia, Spain and Europe with a clear potential benefit both for citizens and for the development of new features.

In the case of the integration with Decidim, there is a declared interest in outperform the existing data visualization features. In March 2018, the 10th seminar of Lab Metadecidim[40] was held to review, propose and discuss different collaborative strategies and free technologies to visualize the data repository generated in Decidim in order to improve democratic participation. The conclusions of the seminar included the need to integrate dashboards, as the existing approach of BarcelonaNow, to promote a democratic model of data-driven decision-making. This model was also discussed and identified as crucial in the 14th seminar of Lab Metadecidim[41] in December 2018, which focused on participatory technologies for public policies guided by citizen science.

The greatest risk to this expansion model is the period between the end of the DECODE project and the start of new projects using the BarcelonaNow system. In order to minimize the length of this period, dissemination and promotion actions will be carried out before the project concludes. An illustrative example of this interest in dissemination and generating synergies with similar projects will be the attendance in October 2019 to the presentation of the "Urban Data Desk" project by the Fundació BIT Habitat which aims to generate a new pilot of informative maps for public decision making.

Figure 44: 10th seminar of Metadecidim Lab focused on data visualization techniques (left). Meeting with the Bit Habitat Foundation to explore collaborations with the “Urban Data Desk” project (right)

[39] https://www.barcelona.cat/infobarcelona/en/mobility-and-transport/permanent-low-emissions-zone-to-be-regulated_853712.html

[40] https://meta.decidim.org/assemblies/eix-lab/f/87/meetings/1011

[41] https://meta.decidim.org/assemblies/eix-lab/f/87/meetings/1157?locale=en

Legal

The BarcelonaNow pilot did not generate any sensitive data, but rather made available, in an aggregated way, data from the Barcelona City Council and from participants of the other two Barcelona pilots. In this regard, the work carried out has been consistent with the GDPR legal principles and the norms established from the corresponding data sources (Barcelona City Council and Smart Citizen).

Technological

The design of BarcelonaNow, as well as the motivation of the UX sessions, has always aimed to generate an advanced technology for exploration and visualization of data that would be easily adapted by non-expert citizens. On the one hand, the different tests carried out throughout the pilot have revealed the success of the participants in finding information of interest. On the other hand, most of the participants stated that the initial learning curve was non-trivial. Although most were able to effectively explore the datasets, they reported that it took time to get familiar with the environment. In this regard, the final efforts of this pilot are focused on generating didactic material to increase the accessibility of the system to citizens with different levels of technical skills.

The primary sustainability plan of the pilot is to turn BarcelonaNow into a paradigmatic free libre open source software to explore geolocated urban data in an accessible way to non-expert users. An illustrative example of a similar approach is RAWGraphs, an open source data visualization framework built by the DensityDesign Lab (Politecnico de Milano) in 2013, to make the visual representation of complex data easy for everyone. This framework has not only been a platform publicly available to any user of the Internet but also a free libre open source approach to allow communities to extend, fork and adapt the project. For instance, the 300.000Km/s architecture studio, in collaboration with Barcelona City Council, has forked this project to make a new instance focused on the data from the open catalogues of Barcelona city, Barcelona province and Catalonia. Since much data is geolocated (geojson) but RAWGraphs did not offer any geo-data visualization feature, the fork includes 3d maps visualization powered by deckgl. This reveals the value of free open source technologies for accessible data visualization. In fact, there is an opportunity for cartographic systems since well-known GIS technologies like CARTO[42], that was originally open sourced, are recently adopting increasingly restricted proprietary licenses. In conclusion, BarcelonaNow aims to fill this gap by establishing this system as a free open source standard for urban data visualization.

Finally, the greatest risk to BarcelonaNow's sustainability and extension plans lies in the fact that, to date, the technology has been developed exclusively by members of the lead partner in this pilot (Eurecat). The modular architecture, the free technologies used and the hosting in Github allows the collaboration of other members (inside and outside the consortium). However, it has been identified the need to extend the technical documentation of BarcelonaNow to guarantee that an ecosystem of contributors can emerge in an effective way.

[42] https://carto.com/

Conclusions

With this report the work carried out in Barcelona on the context of the DECODE project comes to an end. It has been a three year journey in which all the involved participants (consortium partners and collaborators alike) have learned insightful lessons on data sovereignty and data commons. With its ups and downs, lights and darkness, Barcelona has been proved to be a perfect playing ground to test all the tools, policies and approaches (technological, policy, legal and socioeconomic) developed in the context of the DECODE project.

On the one hand, the technological front has been relatively easier to manage with regards to the users, but the hardest one to do internally, as interaction with communities has been limited to testing the developed technology. Substantial efforts have been devoted to design and implement tailored solutions for the user groups, gathering requirements and feedback as well as coordinating the diverse development teams. Here, the lesson is clear: Implementing SoTA technology with a diverse ecosystem of experts, services and teams is hard, especially due to the constraints imposed by Privacy Enhancing Technologies in general, and distributed infrastructures in particular. Given the resources at hand, we can conclude that this front has successfully achieved all of its set objectives, including the generalization to a diversity of use cases that share a common framework. More work needs to be done with regards to ease of adaptation to new scenarios, but it can only be tested upon releasing our technology to a wider audience (as will be done in the context of D6.7 “Project Communication, exploitation plans, events report and overall project impact”, see also D4.14 “Final DECODE app release. App published on multiple platforms”).

In the legal and policy front, the collaboration of the City Council has allowed to test the feasibility of the proposed solutions into real world scenarios, making a strong impact regarding innovative data policies and approaches tested by cities. Work has been done elsewhere with regards to potential scenarios. However, legal fit of the solutions will only be properly tested after they have been rolled for a long period of time in production, as legal hazards can be foreseen but are only fully known after real issues emerge. Policy makers at municipal, national, European and global level have been recognizing the novelty and strengths of the DECODE approach, showing strong interest and joining efforts to adopt similar approaches, as in the case of the Cities Coalition for Digital Rights. This Coalition is now a central part of the UN-Habitat effort to extend Barcelona’s citizen-centric smart city approach (of which DECODE is a central part) globally.

The socioeconomic front has been the one where more ground for experimentation and co-creation has been attained. The reason for that is simple: Interaction with communities, most notably non expert individuals, has allowed the DECODE consortium to gain a real-world (*out of the lab)* perspective on the projected pilot development. The conclusions in this axis are diverse and rich.

Firstly, users cannot value what they cannot see. Hence, for them, features like *Privacy Enhancing* or values like *Data Sovereignty* become abstract concepts unless materialized in simple to grasp, manipulate and use objects, actions, software, or devices. Alternatively said, *Data Sovereignty is not only a matter of controlling their own data, but also having effective tools, policies and regulations to make use of it*. In this front, BarcelonaNow shines with its own light, and it provides a clear link to other municipal tools and infrastructures used by citizens when they interact with government’s digital services.

Related to the above point, to achieve relevant user involvement, two ingredients are key. One is providing users with a *Goal*. This implies growing projects around communities, setting a social dimension to them and planning them in a general context, but with a clear, short-term objective at hand (for instance approving a manifesto in the DDDC pilot). The other one is a friendly, easy to use, user experience and interface, which has clearly improved along the pilots. This requires enormous amounts of economic and human resources investment, essentially because the current paradigm (dominated by GAFAM like companies), sets up a high standard to which the users are used to (see further discussion on D4.10 “UX/UI for DECODE app development integrated to BCNNow”). In all the pilots, much work has been done, but there is still a way to go in order to be able to *compete* as an alternative paradigm with the existing ecosystem of apps.

Thirdly, because users need a goal and personalized user experiences, the best idea is to *grow social innovation actions around tight communities* (Metadecidim for DDDC, MakingSense for IoT). This not only helps in gathering

feedback on usability, but also on making sure pilot objectives are aligned with a *real user need*, and hence sustainability and adoption are promoted. Delving in this idea, our pilots have served to develop a set of social tools (*data control wars toolkit, data confessions, surveys, risk matrices…)* that allowed us to communicate effectively with end users, which are non technical. Overcoming this barrier is extremely important, as the balance between simplification and lose of interest due to difficulty is a hard one to manage: Too few details implies an effective *delegation of trust* in the control and use of data that defeats the purpose of the pilots, while too much detail just leads to a total loss of user participation (also defeating the goal of adoption). How to generalize this balance, and develop tools, frameworks and methodologies to properly evaluate, generalize and formalize it is a challenging tradeoff to be addressed in future work. On the purely technical side, this is also an important matter: Developers are not cryptographers, and so, as it is well known from open source communities, *publishing code as is is not enough to guarantee adoption*. Again, communication strategies must be adopted and substantial resources devoted to allow for testing on user adoption and to ensure that the documentation is properly understood. This is a shortcoming of the pilots deployed that should be taken into account in future innovation actions, which can be explained mainly by the lack of resources (time and budget), as well as the inner difficulty of rolling State of The Art technology for the first time.

Finally, as a wrap up of all of the above, a fact becomes clear: Rich, participatory processes (following the quadruple helix model and involving civil society, research, businesses and governments) and co-creation tools are key to new forms of social innovation. Work must be articulated in terms of multilayered sociotechnical ensembles of technologies and social groups and practices, rather than individual tools.

We believe that the Barcelona DECODE pilots are an illustrative example of this vision in terms of management, development and achievements. To a large extent, we have fulfilled all of its set ambitious objectives, and in the process we have learned and shared valuable insights that might be used by other similar social innovative projects. Thanks to our collaboration with existing movements, policy makes and entrepreneurs we believe we have set strong foundations for its sustainable continuation and adoption at wider scales, both in Barcelona and beyond.

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Appendices

- All pilot packs
- Pilot meeting minutes (Oct'17-Feb'18)
- Citizen Science Data Governance (IoT) pilot
    - Pilot meeting minutes (May'18-Oct'19)
    - Discovery meeting
    - Internal Kick-off meeting
    - Threat model
    - UX session
    - Pilot strategy
    - Pilot plan and community meetings (WS1, WS2)
    - Community meetings (WS3,WS4, WS5)
- DDDC pilot
    - Pilot meeting minutes (May '18-May '19)
    - Kick-off meeting
    - Threat model
    - DDDC Finale video
    - DDDC PIA evaluation report