

SCOREwater

Smart City Observatories implement REsilient Water Management

DELIVERABLE D5.3

RECOMMENDATIONS FOR FUTURE DEVELOPMENT OF TECHNOLOGIES FOR WATER MANAGEMENT

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ABBREVIATIONS

Abbreviation	Definition
CKAN	Comprehensive Kerbal Archive Network
CRISP-DM	Cross Industry Standard Process for Data Mining methodology
ICT	Information and Communications Technology
IoT	Internet of Things
SDG	Sustainable Development Goals
SES	Socio-Economic Status
SME	Small and Medium-sized Enterprise



PROJECT ABSTRACT

SCOREwater focuses on enhancing the resilience of cities against climate change and urbanization by enabling a water smart society that fulfils SDGs 3, 6, 11, 12 and 13 and secures future ecosystem services. We introduce digital services to improve management of wastewater, stormwater, and flooding events. These services are provided by an adaptive digital platform, developed, and verified by relevant stakeholders (communities, municipalities, businesses, and civil society) in iterative collaboration with developers, thus tailoring to stakeholders' needs. Existing technical platforms and services (e.g. FIWARE, CKAN) are extended to the water domain by integrating relevant standards, ontologies, and vocabularies, and provide an interoperable open-source platform for smart water management. Emerging digital technologies such as IoT, Artificial Intelligence, and Big Data is used to provide accurate real-time predictions and refined information.

We implement three large-scale, cross-cutting innovation demonstrators and enable transfer and upscale by providing harmonized data and services. We initiate a new domain “sewage sociology” mining biomarkers of community-wide lifestyle habits from sewage. We develop new water monitoring techniques and data-adaptive storm water treatment and apply to water resource protection and legal compliance for construction projects. We enhance resilience against flooding by sensing and hydrological modelling coupled to urban water engineering. We will identify best practices for developing and using the digital services, thus addressing water stakeholders beyond the project partners. The project will also develop technologies to increase public engagement in water management.

Moreover, SCOREwater will deliver an innovation ecosystem driven by the financial savings in both maintenance and operation of water systems that are offered using the SCOREwater digital services, providing new business opportunities for water and ICT SMEs.

EXECUTIVE SUMMARY

This deliverable is the first of two that reports on the activities from task 5.3 with the following aims.

- 1) Analyse and generalize the experiences from a) the demonstration cases, collected in task 4.2 and in task 5.2 as well as b) other deliverables addressing social and organizational barriers and enablers.
- 2) Generate lessons learned from these to a) further development, testing and revision of technologies and services as well as b) exploitation and dissemination and c) for innovation management challenges.

A challenge describes both opportunities and barriers, and an enabler provides means to manage a challenge. The framework for the deliverable is based upon identifying process facilitators (e.g. workshops) and discursive abilities/devices providing enablers that partners used in order to make sense across organizations and professional communities (developers and users) as a means to develop and deploy digital technologies and services.

IVL lead the work and edited the deliverable. Gothenburg city (CGEA), city of Amersfoort (COA) and Barcelona waste and wastewater company (BCASA) provided experiences as stakeholder and data provider, through user involvement. IVL Swedish Environmental Institute, Eurecat (EUT), Talkpool (TP), Civity (CIV) provided experiences from development and implementation work (focusing on stakeholder engagement and user involvement). They all contributed to the deliverable through meetings and writing one section each. Analysing the same processes from different points of view provided interesting insights into the development process and implications for the coming phases of the project.

The Gothenburg section expresses how insights from cooperation issues from before the project, were turned into a well-designed collaboration process (process facilitator) between developers and users/stakeholders. In Gothenburg, engaging with various departments within the municipality and with external stakeholders has been a continuing learning process for IVL (case study leader). IVL gradually presented various opportunities within the project, both in Amersfoort and Barcelona, which has been very much appreciated by the stakeholders. In this way, the engagement process has also enabled stakeholders to envision a number of opportunities that the new technologies empower that can be continued beyond SCOREwater.

Moreover, due to a fruitful collaboration between developers and stakeholders, both Gothenburg and Barcelona cities now envision even more opportunities and ambitions, some of which might be realized within the project, some outside.

Both Amersfoort and Barcelona also analyse how insights from different organizational issues influenced their design of process facilitators and discursive abilities. The Amersfoort section shows the influence from a) the different organizational structures and motives between the municipality, the for-profit companies and citizen volunteers and b) the differences in work processes between their policy makers and data analysts, people that seemed to be previously unfamiliar with working together. The first issue was addressed through finding common ground in the objectives (added value as a discursive device) and the second through designing a common process - going from simple to more complex hypothesis.

In the Barcelona case, BCASA realized a) that they needed to “translate” their needs and concepts with regard to wastewater maintenance to other Catalan partners and b) that they needed to involve and engage both workers and managers at several departments for the SCOREwater project so that they understand, see and value the benefits it provide and therefore engage in and support the SCOREwater project. EUT, TP and CIV expressed fewer specific challenges than the case studies, using familiar and proved process facilitators and discursive devices (CRISP-DM business modelling and user stories).



The deliverable provides implications for several WPs. The specification process in WP1 can learn from successful processes within the cases. Useful insights from the cooperation with stakeholders, process facilitators and discursive devices could benefit from learning across the city case studies (WP4) and they could be disseminated beyond the project (WP7). Due to successful stakeholder management, there is a need to carefully prioritize among many suggested applications of SCOREwater technologies and there is a need to design replication plans based upon previous experience from platform development (WP6). WP8 could suggest policy means that would enhance innovation based upon the process facilitators identified (e.g. how to collaborate with citizens groups).



1. INTRODUCTION: CONTENT, PURPOSE AND METHODS

The grant agreement defines the objective for WP5 as to identify and analyse social and organizational enablers for the development, deployment, use, evaluation and implementation of the technologies and services in SCOREwater. WP5 will thereby both analyse the work in other WPs and help to improve them. A challenge describes both opportunities and barriers, and an enabler provides means to manage a challenge.

This deliverable is the first of two that reports on the activities from task 5.3. The Grant Agreement for SCOREwater states two objectives:

- 1) Analyse and generalize the experiences from a) the demonstration cases, collected in task 4.2 and in task 5.2 as well as b) other deliverables addressing social and organizational barriers and enablers.
- 2) Generate lessons learned from these to a) further development, testing and revision of technologies and services as well as b) exploitation and dissemination and c) for innovation management challenges.

The deliverable describes and analyses a) partners' aims for their participation in the project, b) the organizational and social challenges related to these aims as encountered during M1 to M23 in the project, c) how the challenges were managed, d) what lessons for enablers they provide and e) future challenges within the rest of the project, with implications for further work.

In deliverable D5.4, these objectives will be addressed again (and also the gender objective within task 5.3), now for later stages of the project, including implementation and use addressing issues such as dissemination and adoption, thus engaging with stakeholders organizational readiness for change.

The deliverable was carried out through short workshop sessions and meetings with partners, integrated within activities in WP4 and separately. Moreover, it is also based upon notes from STC and consortia meetings. IVL led the work and edited the deliverable. Gothenburg city (CGEA), city of Amersfoort (COA), Barcelona waste and wastewater company (BCASA) provided experiences as stakeholder and data provider, that they had experienced through user involvement, and they contributed to the deliverable through meetings and writing one section each. IVL, Eurecat (EUT), Talkpool (TP), Civity (CIV) provided experiences from development and implementation work (focusing on stakeholder engagement and user involvement) and contributed to the deliverable through meetings and writing. This approach provides opportunities to describe and analyse partners' different perspectives on the same development and deployment processes.

Partners were provided with a template for describing the process, including questions to guide their writing. Table 1 provides an overview of the contributions, thus explaining what the pronoun "we" refer to in different chapters.

Table 1. The project partners' contribution to this report.

Chapter or section	Partner	Author
Executive summary	IVL	Sanne, J.M.
Chapter 1-4	IVL	Sanne, J.M.
Chapter 5.1	CGEA, IVL	Evertsson, J., Moldan, F.
Chapter 5.2	COA	Meijer, H.
Chapter 5.3	BCASA	Martínez Ruiz, A., Chesa Marro, M-J.
Chapter 5.4	EUT	Rubion Soler, E., Ribalta, M.
Chapter 5.5	TP	de Bruin, B.
Chapter 5.6	CIV	Vanmeulebrouk, B.
Chapter 6	IVL	Sanne, J.M.

1.1. CONTEXT IN THE PROJECT

The deliverable is the third of four deliverables in WP5 (Social and organizational enablers). The first was a literature review and framework for engaging stakeholders, involving users when developing technologies and services for the water sector, as well as implementing and evaluating them (Sanne et al. 2021a). Further, the framework resulted in an excel-based guidance for social and organizational enablers. This guidance has been integrated as a step in the workplan template. Before starting the work on a deliverable, all WPs must prepare a workplan, and thus they apply the guidance from WP5, if applicable to that workplan. The second deliverable (Sanne et al. 2021b), uses the Gothenburg case study to define a baseline for the improvements to be made through sensors and AI services, and adds valuable findings that support the successive iteration of the objectives and solutions as well as its effective implementation. The baseline is useful to measure the impacts in a later stage of the project. The deliverable identifies necessary organizational routines to make the sensors and AI services effective in practice.

The current deliverable is based upon six chapters that partners have provided draft texts for, prompted by guiding questions developed from the work plan. The guiding questions are also based upon the guidance and the findings from the D4.2 and D4.3, evaluating the progress and challenges in the SCOREwater case studies.

The deliverable will support and analyse users' and technical experts' experiences from prototyping, implementing, and testing, and provide recommendations for further development work in revising the platform and the resilient management tools. Preliminary analyses regarding innovation management challenges will be carried out. Specifically, the results are fed as implications to WP1, WP4, WP6, WP7 and WP8.

1.2. STRUCTURE OF THE REPORT

Following the introduction we outline the framework, including relevant theoretical starting points, the ensuing research questions and guidance for partners' contributions, baseline assessment of the cases studies and successive evaluations in WP 4. Then follows the findings chapters 3-6. Chapter 6 present the partners' perspectives on relevant organizational and social challenges in M1-M23, how they managed the challenges, the enablers they identified, and the future challenges partners foresee. Finally, we return to the research questions and analyse how the findings empower us to answer them and the ensuing implications for the following project time, specified by the various WPs and what they need to attend to, in order to provide for a successful result.

2. ANALYTICAL FRAMEWORK

This deliverable primarily analyses the first half of the project period (M1-M23). In this period, stakeholder recruitment and engagement are crucial, and for the later part also user involvement in technology design and deployment. The framework is based upon research on organizational enablers and success factors for project management in interaction between communities of developers and stakeholders (Müller et al. 2014) and on sensemaking across professional communities and organizational contexts (Sandberg and Tsoukas, 2020). The framework conceptualizes enablers as processes and tools that can be used to manage project management challenges, that is overcoming barriers.

In the grant agreement, we defined innovation management as the management of the process to create innovation from idea to market introduction. An understanding of market, regulatory, organizational, and technical problems, with a goal of successfully implementing appropriate creative ideas is needed for a successful exploitation of technologies and services to be developed. Barriers to effectively reach the expected impacts include technical, behavioral and legal/organizational issues.

Legal and organizational barriers include e.g. inadequate incentives to long-term investment and maintenance, inadequate regulatory regimes that do not provide enough incentives for environmental monitoring, the need of a proven business case for new tools to be accepted by stakeholders etc. The project is explicitly designed to address these barriers to some degree.

The literature review in D5.1 (Sanne et al. 2021a) highlights a number of issues that previous research has identified as salient for developing technologies and services in the water sector. We will describe how some of these were addressed in the design of the SCOREwater project and outline challenges in their realization, later analysed in the report. We will also analyse salient issues that were not addressed when designing the project and how challenges related to these issues were identified and managed.

This deliverable aims to evaluate and analyse *whether* and *how* the challenges were identified and addressed by partners and what we as a project can learn from that for future activities within, as well as beyond, the project. Thereby, to some extent we open up the “black box” of interdisciplinary innovation, tapping on the tips and tricks of the trade of professionals involved.

2.1. FRAMEWORK FOR INNOVATION IN THE WATER SECTOR AND IMPLICATIONS FOR THE PROJECT

A review of successful project management describe **processes and tools** needed to manage stakeholder engagement, recruitment and user involvement, created from the need to translate and transfer objectives and knowledge between the communities of developers and the stakeholders (Müller et al. 2014), including their various end-user communities, as part of developing and testing technologies and services.

These processes and tools can be seen as sensegiving (Maitlis and Lawrence, 2007), providing **enablers** to shared sensemaking across project partners. Sensemaking processes frequently is made more complicated by their distributed nature (Sandberg and Tsoukas, 2015), involving multiple people in various social and material settings (e.g. for-profit companies vs public authorities, workers vs managers). Müller et al. (2014) conceptualize enablers as comprising process facilitators and discursive abilities, used to overcome challenges arising in cross-disciplinary projects.

Process facilitators provide the necessary structure, process and frame of a project, adapted to the specific requirements and organizational context, enabling fruitful interaction across various communities, such as between developers and stakeholders, including their various end-user communities (various departments, or various occupational groups such as operators versus engineers etc.).

Discursive abilities “involve organizational actors’ abilities to construct and articulate the world involving their expertise, legitimacy and opportunity” (Müller et al. 2014, p. 1314). These “language skills” enable translation and transfer of knowledge and values across the developer and end-user communities. For the SCOREwater project, we suggest the concept of **discursive devices** to create shared meaning across these communities, comprising of (a) *tools* such as such as user stories, business models and games, and (b) *language devices* that bridges across specific professional areas, (e.g. through the use of metaphors and images such as “pains” and “gains in business model creation”).

2.1.1. IDENTIFYING, RECRUITING AND ORGANIZING STAKEHOLDER ENGAGEMENT

The section first outlines **salient challenges and how potential enablers** were designed from the start of the project. Then it summarizes the remaining challenges for the process facilitators and discursive devices needed.

Water is often managed through a network of public and private actors at different levels, with different perspectives and goals, and different strategies and instruments. There is a need to involve both the users of innovative ICT solutions as well as a broad spectrum of other stakeholders (e.g. municipal and state officials and policy makers) in technology development processes. Efforts need to be put on identifying stakeholders and ensuring that all stakeholders are aware of each other's roles, responsibilities, and mandates.

Enablers: The SCOREwater consortium was intentionally designed in line with requirements for interdisciplinary collaboration and stakeholder engagement as a means to innovation, including several parts of the value chain for the services to be developed. The consortium brings together 14 partners carefully selected for their complementary knowledge and experiences demonstrating smart resilient water management. The partners are internationally renowned experts in hydrology, sensor technology, machine learning, data communication, platform development, modelling, stakeholder engagement, business development, citizen engagement, social science, and public communication.

Different means of engagement: Clearly, with such a heterogenous combination of partners in, the process facilitators need to be *designed to combine all partners' specific goals* (such as business plans or policy objectives) and organizational logic (e.g. for profit, citizen engagement, public body). The process facilitators also need to provide good opportunities for partners to make sense across the consortium, such as through workshops, as a means to create synergies and added value. However, in addition, each partner needs to have or develop the necessary discursive devices, using:

(a) *Tools* such as user stories (CIV), CRISP-DM (EUT), business models (TP) and design thinking (Barcelona partners), visualization, games (all cases).

(b) *Language* that bridges across specific professional areas, to create shared meaning (e.g. through the use of metaphors and images such as “pains” and “gains in business model creation”).

Processes and tools needed: What arrangements for identifying, recruiting, and organizing stakeholder engagement is needed for each case study and for different purposes regarding development and deployment of technologies and services? What other challenges arose during the project?

2.1.2. ADDRESSING END-USER NEEDS AND EXPECTATIONS

The section first outlines **salient challenges and how solutions** to some of them were designed from the start of the project. Then it summarizes the remaining challenges for the process facilitators and discursive devices needed.

Innovation needs to attend to several objectives simultaneously: Traditionally, the goal of an innovation process is to find enablers that function in the intersection of technical feasibility, economic viability, and user desirability. In SCOREwater, positive environmental and health impact is a necessary addition to these three. Enabler: This was designed to be addressed through a) process facilitators: interaction of various expertise and stakeholders and through b) discursive devices such as business models.

Lack of end-user involvement: There is often a lack of end-user involvement in many development projects, which can lead to lower effectiveness or end-user resistance as the enablers do not respond to end-user needs or fit into their everyday practices. Enabler: this was addressed through involving stakeholders encompassing various end-user communities.

Transforming user customer expectations and needs into requirements is a challenging task for many developers. *Different involvement methods* need to be chosen based on type of user or stakeholder addressed, but also based on the goals of the involvement action, or the type of knowledge the activity should bring to the process. From a developer standpoint, different levels of customer statements are not structured with sound logic. Enabler: SCOREwater was designed to use a number of established methods for this purpose, each one related to a specific purpose: user stories, business models, CRISP-DM (data mining) and design thinking.

Experimenting and brainstorming in real-life contexts should be used to gain insights and ensure that the enablers fit the users' everyday life practices. In SCOREwater, users are involved in the development processes. This means for example that operating technicians needs to be involved in the processes in order to decrease the likelihood of user resistance and ensuring that the proposed enablers can and will be implemented in their everyday work as planned. Enabler: no process facilitators or discursive devices were designed to address this challenge.

Iterative processes involving users can better ensure that the developed enablers respond to user needs. For example, design thinking emphasizes the need for constantly defining and redefining the problem to be addressed. Openness in the design process is needed also in SCOREwater. Enabler: an iterative process was designed into the project's various phases.

Need to involve people with different expertise, using adequate processes and tools. It is important to understand people not as technologically inferior but appreciating them as skilled users, as well as to involve users with different types of expertise and competence. This is relevant to keep in mind in SCOREwater when enablers are tested. Enabler: no process facilitators or discursive devices were designed to address this challenge.

Attending to wider issues within the project: The development of the ICT tools also brings important questions to how the development process connects to wider issues within the project concerning citizen engagement, educational purposes, regional differences, and exploitation beyond the case studies. Enabler: Partly designed in through serious gaming, interactive exhibitions at Universeum.

It is also necessary *that the development process is based upon an analysis of users' everyday practices* and what factors that shape it such as assignments, budgets, skills etc. Enabler: no process facilitators or discursive devices were designed to address this challenge.

Enabling processes and tools: How were the process facilitators and discursive devices used to address issues of a) attending to provide value in the intersection of different goals? b) the potential lack of end-user involvement and c) transforming user customer expectations and needs into requirements? What challenges emerged and how were they managed? How were the other issues addressed?

2.1.3. IMPLEMENTING AND EVALUATING TECHNOLOGIES IN STAKEHOLDER ORGANISATIONS

The latter part of the project is more engaged in data analysis, implementation into work practices and evaluation of the value of the services provided. This is only touched upon in the future oriented parts of the various partner studies. This section highlights some of the issues identified in the literature review in D5.1 (Sanne et al. 2021a) that needs to be addressed.

Implementation is a dynamic and often iterative process with different logics. Implementation strategies need to be calibrated to both the specific innovation and the socio-economic and organisation contexts. There is a need to assess the potential match between the new practice that results from the implementation of a new technology or service and the organisational capacity and readiness for change when designing the implementation strategy, for each case and across cases. This could e.g. be a way to prevent "user resistance" due to changing workflows. This is a challenge that has not been addressed in the project design.

Evaluation strategies: When designing evaluation strategies one needs to consider the why, how, who, what, and for whom questions. In SCOREwater, these questions will need to be addressed by all WPs from their different perspectives. A mixed methods approach that both allows for local adaptation and for generalising conclusions across and beyond cases is recommended. Evaluation will be designed as to provide knowledge about the effects that locally, and beyond the cases, and what is needed to further support their successful replication beyond the consortium and beyond the project. This is a challenge that has not been addressed in the project design.

2.1.4. SUMMARIZING THE FRAMEWORK

Table 2 categorizes the challenges identified in the framework for social and organizational enablers (Sanne et al. 2021a) and if and how enablers towards managing them were addressed in project design as expressed in the grant agreement, expressed as facilitators or discursive abilities/devices to achieve sensemaking across communities and thus a successful interaction towards progress. The challenges are organized in four categories, showing a) stakeholder identification, recruitment and organization, b) addressing end-user needs and expectations, c) implementing technologies and services within stakeholder organizations and d) evaluating technologies and services. The framework summarizes the challenges that partners are expected to encounter.

Table 2. Challenges for social and organisational enablers in the SCOREwater project. Designed and lacking solutions.

Challenge category	Challenge	Process facilitator	Discursive ability/device
Identifying, recruiting, and organizing stakeholder engagement	Water is often managed through a network of public and private actors	Designed: matching consortium	Not relevant
	Different means of engagement	Not designed beforehand	Partly designed: user stories, value chain analysis and value proposition canvas
Addressing end-user needs and expectations	Innovation needs to attend to several objectives simultaneously	Designed: interaction of various expertise	Designed: discursive devices such as value chain analysis and value proposition canvas
	Lack of end-user involvement	Designed: involving stakeholders with various end-user communities	Not designed beforehand
	Transforming user customer expectations and needs into requirements	Not designed beforehand	Partly designed: user stories, value chain analysis and value proposition canvas
	Experimenting and brainstorming in real life environments	Not designed beforehand	Not designed beforehand
	Iterative processes involving users	Partly designed into project process	Partly designed: user stories, value chain analysis and value proposition canvas
	Need to involve users with different types of expertise and competence	Not designed beforehand	Not designed beforehand
	Attending to wider issues within the project	Partly designed: serious gaming, interactive exhibitions	Partly designed: serious gaming, interactive exhibitions
	Development process is based upon an analysis of users' everyday practices	Partly addressed in design	Designed: discursive devices such as value chain analysis and value proposition canvas

Challenge category	Challenge	Process facilitator	Discursive ability/device
Implementing technologies in stakeholder organizations	To assess the potential match between the new practice and the organisational capacity and readiness for change (organizational readiness for change)	Not designed beforehand	Not designed beforehand
Evaluating technologies and services	Why, how, who, what, and for whom	Not designed beforehand	Not designed beforehand
	Design for local adaptation and for generalising	Not designed beforehand	Not designed beforehand

Chapters 3-6 will provide more data on how these issues were addressed and with what effect. In the conclusions, we will summarize the findings and how they contributed to the required sensemaking and enactment (design choices and the like).

2.2. RESEARCH QUESTIONS AND GUIDING QUESTIONS

Based upon following framework, two research questions were formulated:

RQ1: What were the relevant challenges in M1-M23 regarding social and organizational barriers and enablers?

RQ2: Implications: What could be the relevant social and organizational barriers in the M24-M48? How should they be managed to identify enablers?

To operationalize data collection and analysis, the work plan suggested five overall issues to be addressed in the deliverable and provided guiding questions for these as a way to help partners generate valuable and interesting stories and reflections (chapter 6), as suggested by the guidance framework.

What did you aim for?

Describe the main aims for your work with the case study (e.g. early warnings, good practices for managing water within construction projects, separating different kinds of water for different flows). One way to do this could also be through the business cases identified. This is the starting point for the partner/s in each section of chapter 6, the added value that their participation in SCOREwater would bring about.

Major challenges that we identified during M1-M23

- How did you find the right stakeholders? Why are they necessary - what do they enable?
- How to keep up the interest among stakeholders/users over time?
- How did you manage to find the right contacts within stakeholder organizations for permit etc.? How do you interact with them? What is the purpose of the interaction?
- How did you identify and engage with the real end-users within stakeholder organizations? How do you interact with them? What is the purpose of the interaction?
- How did you overcome different language and knowledge domains (e.g. computer engineering vs water engineering)?
- How did you manage to cooperate with other partners?

How we managed these challenges during M1-M23

Provide a process description, be specific, tell a story from start until now, based upon the aims. Use a time-line to visualize different moments in time and describe what happened at these occasions.

Major lessons learned: potential enablers

For example:

- How did you communicate over time?
- How did you organize teamwork, communication and problem-solving across partners as means to manage challenges?

Future work: what are the challenges that lie ahead (M24-M40)

For example:

- Are there any additional stakeholders or users you will need to engage?
- What interaction with users will be needed?
- What are the implications for other parts of the SCOREwater project? For other projects?

3. BASELINE ASSESSMENT OF STAKEHOLDER ENGAGEMENT

The baseline assessment made in M6 (Matschke Ekholm et al., 2019), focused on the potential stakeholders to the project SCOREwater. It described organizations, their needs, abilities, and conditions as well as their role and contribution to the project. Involved stakeholders and/or project partners were described per demonstration case, and their needs, abilities and contribution were identified as far as possible. These first descriptions will serve as a base for continued work in WP4 and the iterative evaluation of the demonstration cases. The deliverable reported both generic challenges such as the heterogeneity of the partners in each case study regarding organizational logic and specific professional knowledge and language, access to data and to sensor deployment.

3.1. BARCELONA

Data provision: One potential hinder for engaging stakeholders related to the provision of confidential information to the SCOREwater platform; the data provider might be reluctant to give access to SCOREwater to access confidential data. Another potential hinder relates to time needed for the deployment of the monitoring stations to address any unexpected technical issues. No potential enabler provided.

Implementation: The most important barrier on the implementation and use of SCOREwater platform in the stakeholder's day-to-day life relates to the difficulties to change workflows, if there is no clear return at the social, economic, or environmental level. This might happen in public governmental agencies where changing working protocols is rather complex. *Potential enabler:* The importance is to keep a long-lasting and continued update on SCOREwater developments in Barcelona.

Organizational logics: Most of the identified stakeholders are public. One of the most important stakeholders for the development of the project is BCASA, because they are data providers and final users at the same time. An issue that needs to be further looked into in the Barcelona case, as well as in general for the project, is how the SCOREwater platform can be integrated to different stakeholders' structures, workflows etc. No potential enabler provided.

3.2. GOTHENBURG

Provision of already available data: The case would benefit from accessing already gathered data from construction sites, which today are owned by several companies. *Potential enabler:* One solution can be to develop supporting document to be able to use already gathered data.

Access to measurement locations: Some of the measurement positions may not be owned by project partners or stakeholders related to them. *Potential enabler:* To use them, will in that case, need an agreement with the companies owning the part of the grid which are of interest.

Access to data created during the project: Regarding data created within the case study we do not see any barriers at the moment to make it public and easily accessible. The stakeholders are a mix of public and private companies with different interests and expectations of the case study. This will provide feedback from much needed different points of view. The process itself is expected to provide enablers.

3.3. AMERSFOORT

Implementation: Firstly, some of the data that we wish to include in the analysis is closed data. We need to examine whether this data can be published on the SCOREwater platform. Secondly, we have noticed that many of the words we use in the project lead to different expectations.

Language: We need to establish clear definitions of terms used, such as a digital model/digital twin, groundwater model, hydrological model, flood alarm, test bed and sensor network.

Organizational logics: The stakeholders identified are both public and private. Citizen science is difficult to plan as it thrives on the availability and energy of volunteers. This is a challenge, as we need to ensure that activities are aligned properly. As such, it is important to make sure that their needs and requirements are clear and do not conflict. If they do, the required cooperation between public and private stakeholders may be in danger. *Potential enabler:* The process will be iterative to ensure that the interests and goals of internal and external stakeholders will be met. The iterative process will be ongoing during the project, therefore, a certain degree of flexibility in the project plan is necessary to ensure ongoing commitment, participation, and enthusiasm of stakeholders.

3.4. SUMMARY

All the case studies highlight that **sensemaking** across partners and stakeholders is challenging due to a large variation in structures, language, workflows and interests among partners and other stakeholders and the challenges these pose. First, coordinating different organizational logics across partners and stakeholders, require appropriate process facilitators, such as agreements for gathering data and coordinating common tasks but also processes and tools for achieving common goals. Secondly, for mutual understanding, requiring both process facilitators such as workshops/meetings and discursive abilities (such as language) for sensemaking across professional communities.

4. SUCCESSIVE EVALUATIONS OF THE CASE STUDIES

Two successive evaluations in WP 4, addressed a number of issues suggested by the guidance on social and organizational enablers (and a few other issues). Deliverable 4.2, based upon a questionnaire to partners in WP4, and reported in M24 (Matschke Ekholm, 2020a) aimed to share and bring forward experiences in order to identify issues early and thus improve methods for managing the project. The evaluation was carried out through a survey and sent out to partners in the project, mainly involved in WP2, WP3, and WP4. The evaluation identified key factors which may have hindered the process or enabled progress. The deliverable found hinders regarding standardization with the FIWARE platform and new standards for exchanging information. Communication and collaboration between partners and between partners and stakeholders were perceived good and essential but could also be improved. Users had not yet been much involved. No specific action apart from following up on identified challenges was suggested.

Deliverable 4.3, reported in M19 (Matschke Ekholm, 2020b), used both scales and open-answer questions. The evaluation focused on barriers and/or enablers for implementation in real environment in the three cities (experiences regarding for example deployment of sensors, set up of models etc.). There had been a few challenges in the deployment phase, mostly regarding engagement of partners, and information between WPs. However, most of the respondents also think that communication and collaboration is working well in the project, even though issues of different languages and professional backgrounds were raised as in the following quote:

In this consortium, with so different backgrounds, it is important that we arrive to a common language and that we take advantage of shared knowledge and experience.

The interdisciplinary set-up of the consortium, as well as the inclusion of partners with different, although complementary roles in the value chain course was designed into the project structure to match the complex character of the innovation process, but it also create challenges we need to address. The complexity of innovation also caused, internal organizational issues:

The most important lesson learned is that digitalisation of the water sector is more complex than I thought and that organisational issues is a big part of the complexity. We have to work in a more integrated way in the city which is a quite tricky thing in such a big organization.

An internally clear objective, a specified targeted end-user and relevant resources for the specified product development and deliverables should have been formulated at the project start. In that way our contribution, both to SCOREwater and our internal business plan would have been greater.

The complexity of digitalization (or rather digital transformation) in the water sector require a match between on the hand, the data delivered and the services being developed, with on the other hand, the corresponding internal division of expertise and assignment as well as overall stakeholder assignments.

In sum, sensemaking across partners and stakeholders is challenging due to their heterogenous character and the complexity of required interaction. Thus, there is a need for process facilitators (structures) and discursive abilities/devices that matches this complexity and heterogeneity. The evaluations show the need to attend to issues such as a) *to involve users with different types of expertise and competence*, b) that the development process is based upon an analysis of *users' everyday practices* and c) identifying and applying appropriate processes and tools for *transforming user customer expectations and needs into requirements* through e.g. *experiment and brainstorming*. Potential enablers include creating a shared language, working in a more integrated way, and further specifying the end-user and relevant resources needed.

When the data is coming in later in the project, these complexities will also require a matching **organizational readiness for change**, i.e. choosing and preparing the appropriate users for analysis and evaluation. This deliverable will to some extent follow up on these observations and analyse to what extent the mentioned challenges have been managed.

5. LESSONS LEARNED FROM ADAPTING RESILIENCE TOOLS TO FLOODING AND STORMWATER MANAGEMENT

Deliverable 5.2 (Sanne et al. 2021b) reported on the activities from Task 5.2. The objective was to a) contribute to improve resilience to releases of contaminated water in the Gothenburg case study and b) to identify social and organizational enablers for the development and effective use of technologies for digitalization of water management. For this purpose, we used tools developed for identifying, visualizing, and evaluating/acting upon data addressing resilience in critical infrastructures, defined, and quantified through indicators.

The best practices for introducing and adapting the resilience tools were to do “homework” properly (that is to identify the relevant baseline) and to interact intensively to identify and define stakeholder issues such as:

- 1) What is the regulatory context setting the rules of the game?
- 2) Who are the relevant actors, their responsibilities, and their possible contributions?
- 3) What are their problems and motivations (pains and gains)?
- 4) What added value can the tools provide?
- 5) How can the purpose of using the tools best be aligned with and add to the overall project/case study objectives?

Similarly, the replication of the tools in Amersfoort and possibly Barcelona require doing the “homework” and engaging in identifying baselines and business cases as well as how to implement them into existing practices. The social and organizational enablers identified to make best use of the technologies and services to be developed and deployed in the SCOREwater project were related to the communicative and organizational abilities to react to disturbances (polluted discharge of water above granted volumes) and how to use the improvements in sensor technology and AI solutions. The business case provides an example of how added value could help to improve current practices at construction sites and provide arguments for the possibility for more stringent regulation and oversight due to improved technology. This includes e.g. workplace routines for acting upon alarms, as well as more frequent reporting to authorities, based upon real-time monitoring and using AI technology for proxy indicators. The business case can be seen as **discursive device** to translate the data into useful information to users. The workshops used to develop the indicators are examples of appropriate **process facilitators**.

6. CASE STUDIES OF MANAGING CHALLENGES REGARDING SOCIAL AND ORGANIZATIONAL ENABLERS

6.1. GOTHENBURG CASE (IVL, GGEA)

This section is based upon contributions from Josefine Evertsson, Gothenburg city Environmental Board (CGEA) and Filip Moldan (IVL). The section addresses challenges regarding stakeholder identification, recruitment, and organization.

6.1.1. WHAT WE AIMED FOR

The current infrastructure in the city of Gothenburg provide a number of challenges to the municipality for maintaining and operating the stormwater system (where entirely separated from wastewater system). To name a few: The problems (clogging in sewers or polluted discharge for example) in the sewer system are usually dealt with only after the problem has occurred and it can be long after it should have been addressed to avoid various adverse effects in discharged stormwater or recipient waters. This can result in unnecessarily costs which could have been avoided if a predictive alarm system that signalizes variations in trends as soon as these indicate that a problem is emerging.

In addition to the current infrastructure, the next 20 years, more than 100 billion Euros will be invested in construction, reconstruction, expanding and densifying the city as well as the city infrastructure. Gothenburg is a coastal city whose water resources are important for drinking water, recreation, fishing, and tourism. The ongoing infrastructure and construction projects in the city generate new pollution pathways in form of heavy traffic, build-up of polluted sediment and re-mobilization of polluted ground at construction sites.

The West link (Västlänken) and other construction projects cause large risks of particles and pollutant transport via the stormwater and combined sewers, increased wastewater overflows, or direct surface runoff to the water bodies in the city. The West Link will be a train tunnel that will increase capacity and reduce the vulnerability of rail traffic in the region. The West link is one of Sweden's largest infrastructure projects. Gothenburg municipality has the responsibility for the monitoring and compliance of the Water Framework Directive of the water bodies and are specifically concerned for two smaller rivers, Kvillebäcken and Mölndalsån, as tributaries to Göta Älv which is both a drinking water reservoir and transports directly to the sea. Citizens are concerned about the costs of the infrastructure investments and the potential environmental impact. In line with Sustainable Development Goals (SDGs) 12, 11 and 6, the city aims to implement compliance with the non-deterioration principle during infrastructure developments (“Weser judgement”) and control of wastewater overflows according to the Urban wastewater directive. This background provides two aims for the city’s participation in the SCOREwater project.

On-line measurements: In the West-link project, Swedish Hydro Solution measures online and manually outgoing construction stormwater, delivers data to NCC, which compiles the report and disseminates to the Swedish National Transport Administration (the procurer of the construction project), the City's Environmental Administration, and the Sustainable Waste and Water department as well as the Regional County Board (the main regulatory board in national construction projects). In the project West Link project, reporting is done monthly in short reports summarizing water quality data including deviations and incidents and more exhaustive in quarterly and yearly reports. It is obvious that monthly reports cannot be used as a basis for taking actions when the situation requires it, e.g. when heavy rains are approaching or already ongoing. At present, it is difficult to obtain measurement data from online measurements due to the scarcity of resources, traditional technologies (partial manual sampling) as well as traditional communication routes in the city. To be able to react in time when such events occur, the city and other stakeholders working in the city planning, need to have access to real-time data. This communication scheme is ineffective in preventing problems while they occur. For our participation in the SCOREwater project, we aimed for online measurements with alarm functions that each of these actors has access to in real time in order to react as soon as possible.

Shared data platform: A second aim for our participation in the SCOREwater project would be to develop shared data-platforms, collect data, identify where the problems will occur next time and monitor those points live. The data from existing local platforms that collect precipitation-, flow rate, and water level measurements on recipient or catchment level could provide additional live-data to such shared platform. However, there is currently no data platform where water quality monitoring would be collected continuously, visualized, and shared among stakeholders in real-time, neither in the City of Gothenburg, nor nationally in Sweden. To be able to work proactively with water quality issues in storm sewer pipes and recipient waters, the development of a shared data platforms is needed where state-, regional-, and local stakeholders are able to monitor, share and follow live-data from construction sites and other activities in cities. Furthermore, such a shared platform could be used for real-time data monitoring with alarm function that enables stakeholders to act as soon as an occurrence of impaired water discharge is observed, by retaining water or switching to alternative measures that minimize the amount of discharged polluted flows.

6.1.2. MAJOR CHALLENGES THAT WE IDENTIFIED

This section focuses on challenges related to partner interactions and data users and stakeholder involvement. This aspect of the project is of critical importance for the case study as the stakeholder involvement increases the chance that the project addresses the questions about the construction stormwater from the stakeholder point of view. Three challenges were identified:

- 1) Identification of key stakeholders and engaging them with the SCOREwater project
- 2) Establishing communication, winning stakeholder confidence
- 3) Keeping stakeholders' engagement over time

One difficulty, related to the second challenge, which we had not anticipated was previous experience from earlier co-operation or just interaction among the stakeholders and project partners. In some cases there has been a certain degree of initial scepticism based on a history of less-than-optimal, previous co-operation among some parts involved. It should be noted that the challenge of keeping stakeholders engaged over time is not identified in the framework on social and organizational enablers (Sanne et al. 2021a).

Moreover, in a larger group of people it needs to be anticipated, that stakeholders involved at the beginning might change their jobs, go on a leave (e.g. parental leave, sabbatical, etc) or get different responsibilities in their current jobs. To meet this challenge, it is important not to allow too long periods of time without communication to stakeholder and to actively seek interaction even if things are not acute or critical. For the same reason it has been beneficial to strive for involvement of more than one person from each organization. Both at the meetings and in communication through other means such as central SCOREwater information channels or case study related information in targeted emails.

6.1.3. HOW WE MANAGED THESE CHALLENGES

Identification of key stakeholders and engaging them with the SCOREwater project: Understanding the structure of the West link project was the first step to identify key stakeholders relevant to the case study. The West Link project is owned by the Swedish Transport Administration (Trafikverket) that reports to the regional regulatory county board (Länsstyrelsen). The Transport Administration is responsible to take adequate measures to fulfil requirements, defined by an environmental court, and further specified in a control program (see Sanne et al. 2021b). On local level, the regulatory Environmental department and the department for Sustainable Waste and Water in Gothenburg receive the same monthly reports as the regional county board. Performance issues, treatment deficits and temporary discharge of highly polluted water during peak-flows are to be reported directly to the authorities by e-mail.

Understanding the structure of the West link project was the first step to identify key stakeholders relevant to the case study. Several key players are involved as project partners and were therefore given candidates as key stakeholders. These include the Environmental department and the department for Sustainable Waste and Water in Gothenburg, Swedish Hydro Solutions, the company responsible for water treatment at West link construction site Central station (where the majority of monitoring activities was implemented), the project partner Universeum involved in integrating knowledge from the SCOREwater project into educational programs and Talkpool, i.e. the project partner responsible for sensor data communication. Furthermore, we have involved Transport Administration, construction companies involved at the site, and representatives from the City of Gothenburg wastewater treatment plant.

After compiling a list of potential stakeholders, the case study lead partner (IVL) sent out a short project information outlining the SCOREwater project, case study Gothenburg and its role in the whole project. Together with this information we described the importance of the stakeholder involvement and attached an invitation to the first stakeholder meeting offered. We invited the stakeholders to both, learn more about the project but perhaps even more importantly opened for possibilities to have an impact on the case study. Which was also the very reason why we had the first stakeholder relatively early in the project, that is before all important decisions about the planned monitoring programs were in place.

The first stakeholder meeting was held in September 2019. The group consisted of eleven project partners, three representatives of construction companies, two representatives of authorities, and two consulting companies. The meeting had four goals:

- 1) Increased common general understanding of the SCOREwater project. In particular, the demonstration case study that will be conducted in Gothenburg.
- 2) Disseminating information and creating interest around the demonstration case study in Gothenburg
- 3) Develop a proposal for the placement of sensors linked to the project.
- 4) Discuss a proposal on which metrics are of interest to measure linked to the project.

The four goals were by and large achieved, and the meeting concluded that further co-operation is of high importance and mutual benefit. We consider the first meeting, including the possibility to learn to know each other as one of the factors which made on-line meetings much easier and productive. The meeting was very much hands-on and helped to shape up the monitoring program which was in the middle of implementation phase by taking into account all aspects on sensors placement and type raised at the meeting (Moldan et al., 2021).

The second stakeholder meeting was held in March 2020, attended by 18 participants: representing all case study project partners (twelve participants), two construction companies, and four representatives of authorities.

The third stakeholder meeting was held in November 2020 as an online meeting and attracted 14 participants representing ten project partners, two authorities, and two construction companies. The third stakeholder meeting had two main goals: to update and discuss progress of the case study including work plans relevant in the near future but also to inform on how the case study feeds into different parts of SCOREwater and what were the ongoing interactions with other WPs. A special session was devoted to WP5, developing the work on resilience (Sanne et al. 2021b) presented at the meeting by the WP5 leader. Another increasingly important theme of the stakeholder meeting was increased activities on information dissemination and use of SCOREwater data for informational and educational purposes.

Each of the - so far three - stakeholder meetings had a slightly different focus which followed the maturing process of the project. That has been, to our understanding, a key factor in keeping the stakeholder interest and active participation. The fully blown pandemic with all the travel- and meeting restrictions certainly did not make keeping the stakeholder group involved easier, but the stakeholder interest in SCOREwater did not decrease despite that.

6.1.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

The chances that SCOREwater will contribute to solving as wide range of issues related to managing stormwater in the city of Gothenburg and elsewhere as possible, increase with stakeholder involvement.

Establishing communication, winning stakeholder confidence: Our strategy to manage this potentially serious difficulty has been managed by open communication, keeping problems from previous interaction separate from SCOREwater, analysing what the problems were and making sure that the parties involved will not get into similar situation during SCOREwater. After the stakeholder group has been established and started to make an impact on the case study progress, the next challenge has been to keep stakeholder initial interest up, make it last and develop further. To achieve that, the two key elements were to communicate how the input from stakeholders has been reflected in the daily work of the case study and secondly expanding the scope of the stakeholder involvement by gradually bringing to their attention additional aspects of the SCOREwater project such as work on the increasing systematic resilience, business cases, communication and visualization. In this effort we have also gradually brought to the attention of stakeholders in Gothenburg the goals and achievements of the other two case studies: Amersfoort and Barcelona. Further work on this issue resulted in the ongoing series of three virtual cross stakeholder meetings where those interested are given a chance to consider the outcomes from the other case studies if these generate results potentially useful to stakeholders of Gothenburg case study. This is very likely the case as the responsibility and interests of majority of stakeholders and partners is typically significantly wider than the particular case study.

Keeping stakeholders' engagement over time: After the stakeholder group has been established and started to make an impact on the case study progress, the next challenge has been to keep stakeholder initial interest up, make it last and develop further. To achieve that, we communicated how the input from stakeholders has been reflected in the daily work of the case study and secondly expanding the scope of the stakeholder involvement by gradually bringing to their attention additional aspects of the SCOREwater project such as work on the increasing systematic resilience, business cases, communication and visualization. In this effort we have also gradually brought to the attention of stakeholders in Gothenburg the goals and achievements of the other two case studies: Amersfoort and Barcelona. Further work on this issue resulted in the ongoing series of three virtual cross stakeholder meetings where those interested are given a chance to consider the outcomes from the other case studies if these generate results potentially useful to stakeholders of Gothenburg case study. This is very likely the case as the responsibility and interests of majority of stakeholders and partners is typically significantly wider than the particular case study.

Two lessons we would like to propose are:

- 1) **Process facilitator:** The necessity to maintain several levels of activities so that overcoming one type of difficulties (e.g. in sensor deployment) does not overshadow other - more distant, but not less important - project perspective.

- 2) **Discursive processes:** The communication policy is very important and demands caution. It has been useful to inform stakeholders about activities and opportunities in the other case studies and to allow for an exploration about potential other uses for the technologies involved. Stakeholders have expressed many other ideas that can be used in this or other projects, increasing their commitment and engagement in the process. Examples of these opportunities are presented in the next section.

With no exception the stakeholders involved in Gothenburg case study are high performing experts with multiple responsibilities. It is equally necessary to make sure that the information from the project is relevant and of interest for the stakeholders. It is extremely important to design out communication plans beforehand so that it is not at risk of being perceived as too voluminous, not to the point, more frequent than needed or irrelevant.

6.1.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

Generalizing solutions beyond the project: In the wider perspective the main challenge is to turn relevant results from the SCOREwater project into decisions on how the regulations for construction water should be designed. In that way the case study results would have potential to contribute to cleaner storm water at other construction projects and in other cities. Stakeholder involvement might need to evolve in order to achieve this goal and we are currently looking for ways how to attract stakeholders interested in storm water handling, from different cities and countries.

Applying the same demand on all construction projects: All construction projects are unique, and the self-control must be adapted to the activities to be carried out. If the business is subject to authorization or notification, more precise requirements for self-control apply and large construction projects have often a control program decided by the supervisory authority that applies in parallel with the rules on self-control. Minor excavation work that is not subject to notification or permit requirement may fall under the radar, but they can mean a lot of water pollution - during their short life. By developing a shared data platform for collecting live-monitoring data, even small entrepreneurs can have the possibility in the future to send live-data of discharged flow quality (with basic parameters like turbidity, pH, conductivity) to the same platform. To enable this, a standardized data transmission recommendation should be on place that enables the entrepreneur prior to each construction activity the planning for compatible sensor, data-transmission and datatype for the project. Can SCOREwater make recommendations so that a larger proportion of projects (if not all) can be made safe by recommendations and guidelines for construction stormwater monitoring and reporting?

Managing the effects of heavy rains: Polluted water during peak flows contains high amount of pollutants washed off from construction sites and in case of intense rainfalls these flows need to be retained before treated on site or discharged through overflows without treatment into storm sewer pipes and adjacent recipient water. During such events the amount of treatable water is limited, and the treatment performance of polluted water decreases resulting in discharge of heavy metals, PAH's nutrient and other pollutants in storm sewers and recipient waters.

Managing water from blasting work: Blasting can lead to temporarily significantly increased nitrogen levels in the construction stormwater. Ensuring that water that has treatable nitrate levels is directed to the water treatment plant and not directly to the recipient without at the same time risking channelling to the treatment plant lots of water with low nitrogen levels that cannot be treated is a challenge. This is a major problem that may well lie outside the scope of SCOREwater. However, more technology development is needed when it comes to the treatment of nitrogen and dissolved pollutants on site. Today we miss the technology for treating polluted flows with high nitrogen content or high dissolved fraction (P, heavy metals) content.

While these are real-world challenges relate to issues dealt with within SCOREwater, solutions are only partially subject of SCOREwater in general and this report in particular. Some of the issues were addressed in D5.2 (Sanne et al. 2021b) and more will be addressed in later stages of the project. There are also some issues where SCOREwater will generate knowledge that might help to find solutions, but that work is clearly outside the scope and of the time frame of the SCOREwater project.

Of the challenges mentioned, only the first is related to project management issues. The reason for this probably due the stakeholder perspective from Göteborg municipality.

6.2. AMERSFOORT CASE (COA)

This section is based upon contributions from Huug Meijer, City of Amersfoort (COA). The section addresses managing conflicting goals and organizational logics between different stakeholders that need to cooperate, as well as between different communities within the municipality.

6.2.1. WHAT WE AIMED FOR

In the city of Amersfoort case the overall goal is to contribute to the redevelopment of the city in such a way that it becomes more resilient to climate change. More specifically, we want to use data and technology to effectively deal with issues related to risk of flooding, heat stress and drought. Within the SCOREwater project, we have:

- Deployed a sensor network to gather real-time measurements.
- Worked together with citizens science collective Meet Je Stad (in English: Measure Your City) to develop sensors to measure soil moisture.
- Developed a digital model of the sewerage system and started developing a flood early warning system.

These activities are not all finished; the flood early warning system is still being developed and our collaboration with the citizens science collective will most likely continue for the entire SCOREwater project. This section describes the insights that we have derived from our activities up until this point. An important aspect of the Amersfoort case is that we believe that key to reaching our objectives is collaborating with both commercial organizations and citizens. By working together with these different stakeholders, we can make use of their unique capabilities and insights. As a result, together we can create the most value with the data and technology we are using. How we collaborated with the different involved organizations, what challenges arose and how we managed them will be described in the following paragraphs.

6.2.2. MAJOR CHALLENGES THAT WE IDENTIFIED

There were different major challenges that we identified as having the potential to hamper progress in the Amersfoort case. These are potential issues arising from collaborating with a) both commercial parties and citizens, b) potential issues arising from working together with citizens from a governmental perspective, and c) potential challenges related to translating data into meaningful insights.

Collaborating with commercial parties and citizens

The first challenge we encountered while working on the SCOREwater project stems from the fact that the project partners within the Amersfoort case have different organizational structures and goals. These partners include commercial organizations such as Civity and Hydrologic, a governmental organization (the city of Amersfoort) and a non-commercial organization: the citizen science collective Measure Your City. All three types of organizations have a different structure, different people, different interests, a different way of working and different perspectives on how to work together in a way that fits with their respective organizations. All four organizations work together within the SCOREwater project, although their perspectives on why they want to do so partly differs.

From a commercial perspective, collaborating within the SCOREwater project is interesting for a number of reasons. The first is that it allows commercial organizations to further develop their products and services and test these in practice. The SCOREwater project is a means to accelerate innovation. Their aim is to develop knowledge, products and services that can be monetized in commercial projects after SCOREwater. This monetizing is key to ensuring the health of these commercial organizations.

For citizens from the citizens science collective, the perspective is very different. They do on part rely on public funding (for developing and purchasing sensors, for organizing workshops etc) but they also rely on volunteers who put their effort into the collective because they feel it brings progress to the world. This is one of the goals of the citizens science collective Measure Your City: to bring progress by developing and using open-source sensors to measure climate-related indicators. And they do this in such a fashion that everything is 'as open as possible', implying the use of both open source components and publishing all gathered data as open data.

Where this can become challenging is when the two meet. Many companies rely on closed systems/closed source components to earn their money and protect their products and services. This may come from legitimate reasons: the desire to earn money to ensure the long-term viability of their organization. However, it may also hamper collaboration with governments and citizens because they often want products and services to be as open as possible, as openness result in lower entry barriers for other interested parties to use the developed products and gathered data.

Within the SCOREwater project, the city of Amersfoort is involved as one of the project partners as well. From the city's perspective, both commercial organizations and citizen science collectives are valuable parties to collaborate with. Commercial organizations are important because they provide valuable products and services. And working together with citizens on important topics such as climate change and digitization is key to effectively dealing with these issues. So from a city perspective, key to the project's success is to collaborate effectively with both types of organizations.

Governments collaborating with citizens: The second challenge revolves around collaborating with citizens from a governmental perspective. The latter is of course what we have at the city of Amersfoort. As with all governmental organizations, we are funded by public money. We need to ensure that this public money is well spent. Furthermore, as governments on all levels are political systems their culture tends to be focused on reducing different kinds of risks, including legal risks and reputational risks. For projects this implies that government officials spend much time writing detailed project plans that describe activities, proposed results, and a motivation on why the proposed activities are a good thing to do.

Although this is both legitimate and suitable for many projects and processes, when it comes to innovation projects this is challenging. In innovation projects the outcome is often difficult to define upfront because of the nature of the project: it is new and thus unknown and uncertain. Designing an approach that both meets this innovative nature and matches the risk-averse nature of governmental organizations is challenging because whereas the latter implies detailed project plans with clear and predefined results, the former implies constructing a process of trying many different approaches or products, building on the ones that work and learning from the ones that do not. This, however, may result in results that could not have been foreseen at the time of constructing the initial project plan.

What makes it even more challenging is the nature of citizens science. At Measure Your City, citizens build their own sensors, develop their own hypotheses, and have their own data platform. The initiative relies on a combination of public funding (to buy components, to organize workshops) and the labour of volunteers. Volunteers who are intrinsically motivated to do the work because they believe it brings progress to the world. As a result, one of the most important goals that people who work for/on the collective have is to ensure that the energy of volunteers is maintained and stimulated. It is what drives them intrinsically that forms the basis of the success. This may be a certain topic or line of activities right now, but in 2 or 3 years from now it may be something different. Plus: some of the volunteers may have moved to another city or lost interest, whereas others have joined with new ideas and perspectives.

When we come back to the risk-adverse nature of the governments, this is key to why challenges arise. On the one hand, all collaborating parties (including the governmental ones) believe in building a process that is flexible and stimulates the energy of volunteers because it promotes a fruitful collaboration. It has proven to lead to innovative solutions, new insights, data, and collaborative efforts that add value to our policies and our city. On the other hand, the municipality and other governmental bodies work in risk-averse systems that sometimes require officials to predefine what they will deliver in projects and collaborations upfront, sometimes even up to 5 years from now. Combining this is quite a challenge.

Translating data into meaningful insights: As stated earlier, an important part of the project revolves around data. In Amersfoort, we are using sensors to measure indicators such as soil moisture, temperature, humidity, and precipitation. However, simply having access to raw data does not add value. It is the combination of visualizing data, forming hypotheses, and analysing data to come to answers to these hypotheses that adds value. During the first workshop with between data analysts and policy makers, quite some time was spent to get to know each other's perspectives. One of the key insights we had here is that there were different knowledge gaps that had to be resolved. These included a knowledge gap between policy makers and data analysts, but also a knowledge gap between the different partners that were described above. For example, the policy makers were not used to drafting hypotheses in a way that allowed for proper analyses, whereas the data analysts were unaware of the ins and outs of how policy was drafted.

The challenges identified relate to both the stakeholder and the user-involvement categories and provide important insights into challenges for managing innovation projects across communities.

6.2.3. HOW WE MANAGED THESE CHALLENGES

This subsection will describe how we managed the different challenges, including how we dealt with them in the past and will try to deal with them in the future.

Collaborating with commercial parties and citizens: In the SCOREwater project, the project partners tried preventing potential issues from arising by focusing on creating shared value. In our case, the shared value revolves around having access to each other's data. For Civity, this data adds value to their platform, as it becomes more valuable to use. For Hydrologic, data allows them to make their models better. For the citizens science collective, having access to more (accurate) data allows them to make better analyses of what is happening in their environment and how well their sensors are performing. And for the city of Amersfoort, both the data and the services that are built on it provide value. By combining this on the SCOREwater platform, all parties gain value from contributing.

In terms of activities, we organized several meetings early-on in the project to discuss this and to explore how the collaboration with the different project partners would ideally work, what was needed to do so and what it could bring for the different partners. The aim here was to come to a shared understanding of each other's perspectives and to start creating shared value without harming any of the prerequisites that the different organizations have. Both the potential to create shared value and the prerequisites were explicitly addressed during these meetings.

One of the things that was discussed here is that the city of Amersfoort has a central role in aligning different activities and perspectives. As a result, the municipality periodically discusses progress with each of the partners to make sure that activities are aligned, and synergy is ensured. This will remain an important part of the project for its entire duration because the platform and the project are not finished. Furthermore, with each of the activities or deliverables the focus lies not just on doing what the responsible project partner believes is best but sharing those ideas to explore where the potential for maximizing the shared value lies. An example of what this leads to in practice is that the project partners agreed that the algorithms developed by HydroLogic to validate measurements from the temperature sensors will be shared with the citizens from Measure Your City. As such, value that is created is shared among partners.

Lastly, to share our insights and spark discussion among interested parties we have organized a workshop to discuss this issue on the 25th of March 2021. During this workshop we have focused on the collaboration from each of the perspectives: citizen scientists, municipality, and a commercial party (Civity). By organizing the workshop, we have shared our experiences with interested parties from outside the SCOREwater project to allow them to make use of the knowledge we have gathered as well.

Governments collaborating with citizens: For the SCOREwater project, we have tried resolving this by regularly meeting with the citizens we work with to discuss progress, investigate what is going well and what needs additional attention and to take joint action when it is desirable. During these meetings, no predefined agenda is used. Instead we start with a status update on what is happening, what is going well and what needs attention. Afterwards, joint action is determined. Even though this has partially resolved the issues, one lesson learned here is that the systems governments are using to organize subsidized activities do not fit well with the nature of citizen science.

From a citizen (working on citizens science) perspective, a more ideal situation would be to write project plans in such a way that it describes activities that will be taken and processes that are proposed, without including predefined end-results (in terms of number of citizens engaged or topics that have been 'covered'). The logic here is that ideally, a process would be constructed that allows for intended results to shift as the project progresses to focus on added value instead of predefined end-results. In terms of process, this also implies that regular contact between governments and collaborating citizens is key to success. And for governments, it implies allowing end-results to be defined in a different manner.

Translating data into meaningful insights: We included different project partners within these activities because their perspectives on the added value of the data differs. As such, they bring other perspectives that we intended to include in the workshops and the follow-up activities:

- *Civity* is the developer of the SCOREwater platform. Providing access to data is the key feature of the platform, and as such knowing what users want to do with the data provides input for Civity to further develop the platform.
- *Hydrologic* works on artificial intelligence models that make use of data. As such, it is important for them to know the needs of end-users (both when it comes to the data and the AI-models).
- Citizens from citizens science collective *Measure Your City* develop and use sensors to analyze their environment. The SCOREwater platform gives them access to additional data sources that they can use to refine their analyses.
- *The city of Amersfoort* uses data for urban planning. By having access to real-time and accurate data, they are able to do so in a more effective way.

Apart from several smaller meetings we have organized two workshops on this topic. The first was exploratory and included representatives from the city of Amersfoort (including both people responsible for the analysis of data and people responsible for making policy), Civity, Hydrologic and citizens science collective *Measure Your City*. Together, we explored what data we are gathering, what other data sources exist that we might use, and what insights we want to obtain from analysing the data.

To follow-up the first workshop, the city of Amersfoort organized a second internal workshop with its policy makers and data analysts. During this workshop, the policy makers presented a detailed overview of the hypotheses they would like to have answered. The data analysts prepared an overview of internal and external data (sources) that could be used to answer the hypotheses. An important part of the workshops focused on what policy makers intend to do with the data, and what prerequisites this brings to the data and the dashboard it is presented in.

6.2.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

From the description above we can summarize several ‘lessons learned’:

Collaborating with commercial parties and citizens: When it comes to building a fruitful collaboration with partners that have different organization logics (e.g. commercial and non-commercial), focusing on creating shared value is key to the success of projects. This is not something that can be done ‘in once’, but requires constant attention for the duration of the project.

Governments collaborating with citizens: In the collaboration between governments and citizens science collectives, sometimes existing structures don’t fit well with the nature of this collaboration. Together we (governments and citizens scientists) need to explore how we can alter these structures to be better able to support these initiatives in such a way that it suits with both types of structures.

Translating data into meaningful insights: Going from data to meaningful insights is a complex effort which requires multiple sessions where policy makers and data analysts together explore related topics and determine activities needed to make this transition possible. Policy makers tend to construct hypotheses that are very complex and include many different variables. This makes sense from their perspective as the real-world includes many different variables and knowing how they ‘work together’ is useful from a policy making perspective. However, from a data analysis perspective it is desirable to go from simple to complex hypotheses, as it makes analysing the data easier. Furthermore, discussing this in a group-setting lead to shared understanding of how this process works and why it is important to go from simple to complex hypotheses in such a way, that a certain relationship and effect (e.g. when there is no rain, soil moisture levels will decrease) is favoured. Also in this interactional context, focusing not only on the data but also on the added value it brings to the different parties led to better shared understanding.

These insights provide valuable knowledge for designing process facilitators, focusing on creating shared value for different user groups.

6.2.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

In terms of future work, we believe that several challenges need to be addressed to ensure the project’s success in the future. In terms of building the fruitful collaboration we mentioned earlier, focusing on creating shared value will be an ongoing activity that is important to address in each of the (upcoming and ongoing) activities. One currently actual example of this is the Hackathons that the city of Amersfoort is organizing together with the citizens science collective Measure Your City: after having set-up the structure project partner Future City was asked to collaborate on the promotional activities. By doing so, Future City is able to expand the SCOREwater-network while at the same time it becomes more likely that more participants join the hackathon, thus enhancing the change of success of the hackathons and creating shared value for all three parties involved.

The collaboration between the city of Amersfoort and citizens science collective Measure Your City deserves special attention here. As we mentioned earlier, sometimes the structures that governments work with to or fund organize projects don’t fit well with the nature of citizen science. This topic is something that is periodically discussed and evaluated together to see if find better ways to deal with this can be found. A ‘best practice’ has yet to be found, but by addressing this regularly both between the partners and with other organizations working on these types of initiatives the project partners try to move into a direction that is better suited for this type of initiative.

This will remain work in progress and something that governments and citizens will have to work on together to find ways that work from both perspectives. The city of Amersfoort has discussed this several times with the citizens from Measure Your City. Furthermore, the citizens science collective has reached out to officials from the European Commission to discuss this topic. We believe that this is something that that should be addressed on a European level as well, because there are many citizens science collectives in Europe that are expected to be facing similar issues. The city of Amersfoort and citizens from Measure Your City are more than willing to discuss our insights and work together to develop a process or framework that works from both perspectives, something we believe would bring a great boost to citizen science in Europe.

Lastly, an important goal of the project is to go from data to meaningful insights. Currently we are in the midst of collecting more data and preparing for analyses. Later in 2021 the data analysts will do the actual analyses. Afterwards, we will organize another workshop to combine the insights from the analyses with the ideas and insights of the involved policy makers to go from data to insights.

This subsection shows both future activities within the project but also process facilitators and how they could be transferred to other contexts.

6.3. BARCELONA CASE (BCASA)

This section is based upon contributions from Maria-José Chesa Marro and Ariadna Martínez Ruiz, Barcelona Cicle de l'Aigua, SA (BCASA). The identified challenges concern a) translating needs and concepts from the stakeholder (BCASA) to other partners and b) engaging various end-user groups within BCASA.

6.3.1. WHAT WE AIMED FOR

One of the main objectives of BCASA is the continuous improvement in decision-making regarding the maintenance of the city's sewer system. In this way, it is intended to solve part of the city's odour problems. For this purpose, a citizen complaints app, and a program for extensive knowledge of the sewerage network provide us with great knowledge of citizen assessment and the best management sewerage tools, respectively. The SCOREwater project gave the opportunity to carry out a study where the idea of providing a solution providing increased possibilities to make citizens' concerns priority.

BCASA plays two roles in the project: that of the stakeholder and that of the end-users of the product to be extracted from the data analysis in WP2 - Data Analytics and Machine Learning techniques for a water-smart society. We aim to implement efficient maintenance that has a direct impact on the well-being of citizens, and also provide a safer environment for maintenance workers.

The municipality of Barcelona has a web-based platform for citizens to report on incidents, claims, complaints, and suggestions, called BCN-IRIS. This citizen channel allows reporting complaints. The information is used to provide a faster and more effective response to the problem of retention of sediments, fats and greases, and other problems that can occur in the sewer network, causing offensive odours problems to the citizens. In 2017, SEWERNET, an open source platform was created by BCASA, to optimize the maintenance of the sewerage network and improve the monitoring of the work performed, for innovative cleaning management of the sewer network of Barcelona. BCASA's objective was to transit from conventional sewer maintenance (with established cleaning frequencies) to dynamic maintenance. This platform will cover the entire sewerage network, i.e. for visitable and non-visitable network. The tool aids decision making with pre-established rules such as degree of dirtiness. The collection of several years of data and the expansion of knowledge in sedimentation behaviour models were established as objectives. The inspection and maintenance technicians of sewage from BCASA report their data using SEWERNET. The ability to obtain data, edit, analyse, and visualize this data, has become one of the foundations of what is called intelligent management. SEWERNET enables, the analysis of the efficiency of the sewer network inspection and cleaning, as well as the analysis of the structural information of the network to make decisions on possible improvement works.

Aligning two tools to improve sewage maintenance: One of the main activities in the SCOREwater project for BCASAs participation is the ability to align two needs in a single objective, such as to carry out efficient maintenance of the city's sewers, react to the nuisance of odours to citizens and thus give a better response to this problem. For the union of these two needs in a single objective, D4.7 (Martínez Ruiz et al., 2020), has been carried out regarding the improvement of the union of data between the two programs with which we work SEWERNET (maintenance) and BCN-IRIS (citizen complaints about odours). The SEWERNET platform has been improved by adding data sensitive to odour problems and data analysis work is being carried out for modelling in WP2. BCASAs needs and issues, as stakeholder and end-user, (Kersbergen et al., 2021), such as non-optimized inspections and maintenance of the network, corrective actions, odour problems and presence of improper waste disposal (wet wipes and other hygiene waste, oils, greases, etc.) affect sewer maintenance in a more demanding way.

Surveying health status: By studying the flow of wastewater in three neighbourhoods, it will be possible to understand the environmental and health habits of citizens and companies through indicators of illicit activities such as the manufacture of explosives, drugs and prohibited products. This objective requires the installation and correct operation of three monitoring and sampling wastewater stations in each one of three selected neighbourhoods (Zammit et al., 2020). The stations monitor water quality continuously and in situ for some parameters and are able to collect samples to be analysed in the laboratory. The continuous monitoring of physical-chemical parameters provides information on the use of the sanitation infrastructures. The laboratory analysis of 15 parameters shall provide information on the state of health of the population as well as the possible abuse of medicinal products. The comparison of the physical-chemical and microbiological data from the analysis of wastewater, in relation to the three studied neighbourhoods, will give us unique information, enabling the Barcelona partners to compare the habits of three different neighbourhoods with different socio-economic status (SES). This objective involves all the partners in the case study since the results of the various studies depend on the proper functioning of the three monitoring stations.

6.3.2. MAJOR CHALLENGES THAT WE IDENTIFIED

Explaining the BCASA organization, needs and concepts in sewer maintenance to partners: One major challenge detected was that the partners of the group of the Barcelona case study understood how BCASA works, the needs and concepts in terms of sewer maintenance. This happens because the partners of the Catalan consortium are formed by a group of entities with different profiles such as ICRA and Eurecat which are entities dedicated 100percent to research, and BCASA which is a public company of management and operation of the water cycle within the municipality of the city of Barcelona. Another example would be the difference in professional profiles, since IERMB, for example, is more specialized in sociological concepts and not as technical as in the case of BCASA or S::can.

Installation and operation of the quality stations required coordination of the different partners involved in this work.

These challenge concerns both the articulation and the translation and transfer of BCASA organization, needs and concepts to other partners. They relate to previously identified challenges for stakeholder recruitment and organization (coordination) as well as end-user needs and expectations such as transforming needs to products and services.

Need to extend the dissemination of the SCOREwater project to the whole BCASA staff. The WP2 modelling work is led by Eurecat, so one of the biggest challenges we have found has been to be able to transmit the needs, the way of working and the knowledge acquired during all the years of field work in BCASA to people outside the organization, who are not used to and do not know the working environment of the Barcelona sewerage system. In May 2020 we realized that we needed to better explain the SCOREwater project to the entire BCASA staff. Without the involvement of different job profiles, this project will not have the expected success and impact. We need that the operator who physically inspects the sewer, the technician who projects the new networks, the general manager, to be 100 percent knowledgeable about the SCOREwater project and to be able to contribute all their knowhow.

This challenge relates to various end-user involvement issues such as attending to several objectives simultaneously and involving and engaging all relevant end-users.

6.3.3. HOW WE MANAGED THESE CHALLENGES

In order to identify the needs of users and stakeholders, various workshops have been and will take place, using methods from design thinking: 1) Exploration, 2) Ideation, 3) Prototyping.

Extend the dissemination of the SCOREWATER project to the whole BCASA staff and other relevant public bodies

WORKSHOP 1 - EXPLORATION

BCASA hosted the **first stakeholder workshop** (Exploration) on 16th September 2019. The purpose of this workshop was to share the strategic lines of the project and to have the feed-back of experts in the areas of Water Cycle, Waste, Health, Sustainability, Digitalisation, Manufacturers of wipes, etc. A detailed report can be found in the deliverable D4.1, (Matschke Ekholm et al., 2019). A wide range of stakeholders within four different categories were represented.

Water Cycle and Waste: Water Catalan Agency (ACA), Waste Catalan Agency (ARC), Municipal Directorate of Waste, Spanish Association of Public Water Cycle Operators (AEOPAS), Catalan Association of Public Water Operators (AMAP), Aqua Publica Europea (APE), Catalan Zero Waste Strategy, Engineering Chemical and Environmental Laboratory (Lequia-UdG)

Sustainability: Council for Sustainable Development (CADS), Catalan Urban Agenda 2030, Metropolitan Area of Barcelona Government (AMB)

Health: Catalan Health Public Agency (ASPCAT), Barcelona Health Public Agency (ASPB), Biomedical Research Institute of Girona (IDIBGI), Oncology Institute Vall d'Hebron (VHIO), Foundation University Institute for Primary Health Care Research Jordi Gol i Gurina (IDIAPJGol)

Clusters: Catalonia Digital Cluster (ACDC), OpenData Barcelona, Catalan Water Cluster (CWP), Network H2O, Wet Wipes Manufacturers - UBESOL

WORKSHOP 2 - IDEATION - SEWER MANAGEMENT

The **second workshop** (Ideation) was arranged with the whole BCASA team on 28th and 29th May 2020. Four groups were organized in this online workshop, due to the COVID19 restrictions. The workshop was organized by ICRA, Eurecat and BCASA, and involved 25 BCASA workers. The first objective of this workshop was to identify the problems of the entire staff of BCASA, public operator of the water cycle in Barcelona. The second purpose of this workshop was to know the vision of the workforce in relation to the digitalization of the water sector.

The week before the workshop, BCASA participants completed a survey, showing that a high percentage of BCASA workers who do not know or who do not answer regarding the benefits of digital tools, so it is clear that more explanation of digital advances is needed. Regarding the current problems/Pains identified by BCASA have been 42 percent lack of data mining; 21 percent Entering sewers (problems of working inside sewers); 16 percent lack of data; 11 percent lack of knowledge and digital tools and 10 percent lack of data quality control. The advantages of digitalization/Gains identified have been 50 percent enhancing planning/optimal resources; 27 percent enhancing the quality of life of workers; 11 percent enhance knowledge; 8 percent decrease environmental damage and 4 percent increase transparency.

The workshop Sewer management, held in BCASA in May 2020, was based on the following points:

- 25 participants with different profiles (bottom-up) were selected for the workshop
- End-user main expense is sewer maintenance
- BCASA maintenance is based on many years of experience for preventive actions and corrective actions
- BCASA is already using different sensors (level, quality, piezometer)
- BCASA is already using models (SEWERNET) and consumer data to feed on-line platform (IRIS)

The program for this workshop was: 1) SCOREwater Introduction; Current sewer network maintenance and management; 2) Profiles definition; Needs identification; 3) Value proposals.

To be able to count on all the human capital of BCASA, always keep in mind the pains and gains of the whole organization, meetings have been established every 2 months. In these online meetings the heads of service and the directors of each area of BCASA (Planning, Projects and Works, Operations, Personnel, Legal Services, Administrative Services), participate to know the progress of the project and they can contribute with their knowledge to improve the process. A minute of each meeting is drawn up and the most important aspects identified are transferred to the SCOREwater Catalan cluster.

WORKSHOP 3 -IDEATION - HEALTH AUTHORITIES

A third online workshop (Ideation) was organized by ICRA and IERMB the 3rd of December 2020. Lluís Corominas from ICRA presented the research being carried out in the field of Wastewater-Based Epidemiology (WBE) as part of the Barcelona Case study of the SCOREwater project to health scientists and medical doctors. A fruitful discussion and brainstorming session on future applications of WBE from the medical perspective followed. BCASA is looking forward to exploring these insights in the upcoming sampling campaigns.

Explaining the BCASA organization, needs and concepts in sewer maintenance to partners

WORKSHOPS AND MEETINGS WITH OTHER CLUSTER PARTNERS

Biweekly meetings were scheduled for the Barcelona case study. In these biweekly meetings, when the need to go deeper into a specific topic has been identified, specific meetings have been proposed. In this way all partners involved have become familiar with our own language, technical terms, and the needs at the company level to improve the maintenance of the city's sewage system.

In the case of the work done with Eurecat in WP2, different meetings were held with BCASA experts to explain the context of Data analytics and Machine Learning:

- Where specific presentations were made on Geographic Information Systems thematic.
- Modelling of the network in rainy weather.
- Contributions from sewerage field work experts.

From these meetings the necessary data for Eurecat were defined and together with the data a dictionary was attached so that these could be better understood at concept level.

6.3.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

During the course of this first period of the SCOREwater Project, all the partners involved in the case of Barcelona have been familiarized with the concepts and knowledge of the tools used in BCASA and the needs that exist at the city level in relation to the objective of continuous improvement of sewerage maintenance.

Process facilitators for coordination among partners: Having a lead partner (ICRA) in the case of Barcelona, has made it possible for this partner to manage possible conflicts and guide the work and coordination of the work. Establishing a minimum number of biweekly meetings and requiring specific meetings if necessary.

Identifying and transferring various end-user requirements: In addition, from the different meetings (project meetings, stakeholder meetings, etc), it was possible to identify the need to hold a stakeholder meeting internally at BCASA, so that the project partners could see different points of view in the same organization, which was carried out transversally in the different work profiles involved in sewerage maintenance within BCASA.

Discursive devices to improve mutual understanding: the main discursive device used was design thinking.

6.3.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

Based on the work of these data and the models that can be taken from the Eurecat work in WP2, if these are positive, they could be used to feed the SEWERNET platform to be able to make the decision-making on the maintenance of the sewerage. In addition, without the need to make so many incursions into the sewer system and thus improve the quality of life of workers. Also, with this improvement, possible odour problems could be prevented according to which areas of the network.

For the next period of the project (M25-M40) different challenges are foreseen, some of which are already being worked on and others will be worked on as they occur, and the results of the different studies are available. The most outstanding challenges that may arise for the following months are to achieve a good operability of the three Monitoring Stations, coordination of different types of maintenance, sampling, etc., with the different partners of the Barcelona case involved in these works.

From this work BCASA also wants to take advantage to work on an internal objective of the company that consists in the valuation of the implementation of a network of Monitoring Stations, based on the economic valuation of what is involved in the construction of these, their maintenance and the results obtained with them. This internal objective is framed in the context of the protection, improvement and conservation of water bodies, since Barcelona has a unitary sewerage system (wastewater and stormwater go through the same sewer) and its losses go directly to the subsoil, so there is a contribution of these to groundwater bodies. Therefore, if BCASA could have a monitoring network of possible industrial and/or commercial discharges, it would be possible to work on early warning to prevent contamination of water bodies (groundwater and coastal).

Another challenge is to raise awareness at the citizen level to prevent the discharge of improper products into the sewage system, as well as to control self-medication and thus prevent these drugs from reaching the water cycle. BCASA sees several opportunities for using the data from SCOREwater that the company would like to explore:

- Identification of workshops at the European level, to address specific awareness issues such as wet wipes disposal, as it is known to be a common bad habit in many European countries.
- Study the possibility of carrying out Early Warning at the epidemiological level, detection of drug manufacturing and explosive
- Based on the results of WP2, study the possibility of obtaining faster and real-time simulations, since having this type of tool would be a great advance for the operators of the sanitation network in terms of decision making.

Apart from the need to further develop machine learning and coordinate the use of the monitoring stations, BCASA, just like Gothenburg municipality, emphasizes potential further exploitation of the technologies and services developed in the project.

6.4. EURECAT EXPERIENCES (EUT)

This section is based upon contributions from Edgar Rubion Soler and Marc Ribalta, Eurecat (EUT). The section addresses challenges related to the translation and transfer of knowledge between developers and end-users.

6.4.1. WHAT WE AIMED FOR

The most relevant role of Eurecat in SCOREwater is to design and deploy the data-driven models for the Gothenburg and Barcelona use case. That implies to interact with the use cases to determine business objectives, understand the data, create new features, clean the data, and finally create the data-driven models and validate them.

For the Barcelona use case, Eurecat introduces the idea of predicting sediment accumulation in all the sewer grid using spatial prediction, that is, considering not only physical properties of the section but also properties of the nearby sewer sections and sediments to predict the sediment build up in a specific section. Moreover, models to data quality assurance are designed such as models for drift detection (e.g. increasing or decreasing measurements due to accumulation of dirt on the sensor) on water quality sensors or abnormal wastewater flow patterns detection.

For the Gothenburg use case, Eurecat introduces a solution to early warning of pollution events on water of construction sites based on Novelty Detection, that is, detecting abnormal patterns in the water quality measurements.

6.4.2. MAJOR CHALLENGES THAT WE IDENTIFIED

The main challenge was the sharing of results, that is, **to communicate in an understandable way** the main results obtained by the data-driven models and how they work. For that, the results obtained during the evaluation phase (e.g. determination coefficient, confusion matrix) were translated to business criteria (e.g. percent of error in the prediction).

6.4.3. HOW WE MANAGED THESE CHALLENGES

In our case, the stakeholders are part of the SCOREwater project, BCASA and Swedish Hydro Solutions AB. Moreover, they are essential to obtain usable data-driven models and therefore they are part of the design process of the models, giving support to understand business and data, validate first hypothesis used to build the models (e.g. assumptions based on data, new relevant features, among others) and assess the models. By this reason, they are totally involved by using the Cross Industry Standard Process for Data Mining methodology (CRISP-DM), a robust and well-proven methodology to develop data mining solutions iteratively interacting with the different stakeholders (Shearer, 2000). Through CRISP-DM the stakeholders participated in the design and validation process of the models, to ensure the alignment of the solution with the final expectations of the stakeholders.

In both use cases, Barcelona and Gothenburg, the communication was focused through one responsible of the use case, which referred the communications to the appropriate contacts within each organization. The communication with Swedish Hydro Solutions AB was managed through IVL with the aim of overcome possible language barriers. Emails were used to solve minor questions (e.g. access or understanding of the data, evidences observed in the data, among others) and Teams meetings were held to discuss approaches and results. Usually, Teams meetings were supported by PowerPoint presentations with the aim of facilitating the understanding of the problem or the reached results. Stakeholders gave support during the partners interactions, providing accurate descriptions of the datasets and domain knowledge, among others. Additionally, stakeholders provided data to be exploited by the data-driven models throughout the project.

The *CRISP-DM* methodology provides a structured approach, based on an idealized sequence of events, to planning a data mining project involving stakeholders. Moreover, it is flexible, and in practice, many of the tasks can be performed in a different order and it will often be necessary to backtrack to previous tasks and repeat certain actions. Figure 1 presents the steps of the *CRISP-DM* methodology.



Figure 1. Structured approach of CRISP-DM methodology

The first stage of the methodology, the business understanding, led to the understanding of which are the different objectives and available resources from a business perspective. Virtual meetings and emails were used to establish contact between Eurecat and BCASA, and Eurecat and IVL to define the objectives from a business perspective, described in D2.4 (Rubion et al. 2021). The interaction with stakeholder representatives involved the identification of the current state of the resources and their representation with the different types of data to describe the data mining success criteria. Later, Eurecat specified the AI objectives (Rubion et al. 2021) in technical terms aligned with the business objectives, as validated by the stakeholders. Moreover, to specify the methods to obtain the data (e.g. APIs to access, user credentials, software programs to interact with the data) and have enough understanding of the different features, a data-catalogue was provided by the stakeholders, which was of great importance during the data-driven models design. Finally, the data mining scoring techniques for the data-driven modes were defined, marking the criteria for a successful outcome to the stakeholders.

The second stage: The stakeholders provided to Eurecat the data listed in the project resources to explore and analyse them and extract the understanding. The data was collected, described, explored, and verified from the data quality point of view based on different requirements to train a data driven model (e.g. size, correlation, type of variables, number of historic cases explained). Some of the points evaluated are the size of the datasets, the number of different classes (e.g. in anomaly detection, it is important to have a good number of anomalous cases). The Barcelona case had seven data sources, which were merged obtaining 2,453 registers and 23 fields (e.g. node, section, sediment measures, property details, section type, length, material, velocity, among others). Basically, the data sources contained physical information about each section in the sewer grid and sediment levels. The Gothenburg study case had one data source, which contained water quality parameters (conductivity, flow, pH, and turbidity). The data contained 545,701 registers and 19 fields (e.g. time, conductivity, pH, flow, supply voltage, daily total volume, among others).

Multiple interactions between Eurecat and the stakeholders were required in order to support the data understanding and validate the first findings and initial hypothesis. For example, the initial hypothesis in the Gothenburg case regarding smoothed turbidity and the slope of smoothed turbidity for a rolling window was checked, demonstrating that these features are able to discriminate between warning state or normal state of water quality. Figure 2 presents how warning states (red dots) and normal states (green dots) can be separated by using and hyperplane, demonstrating visually this hypothesis.

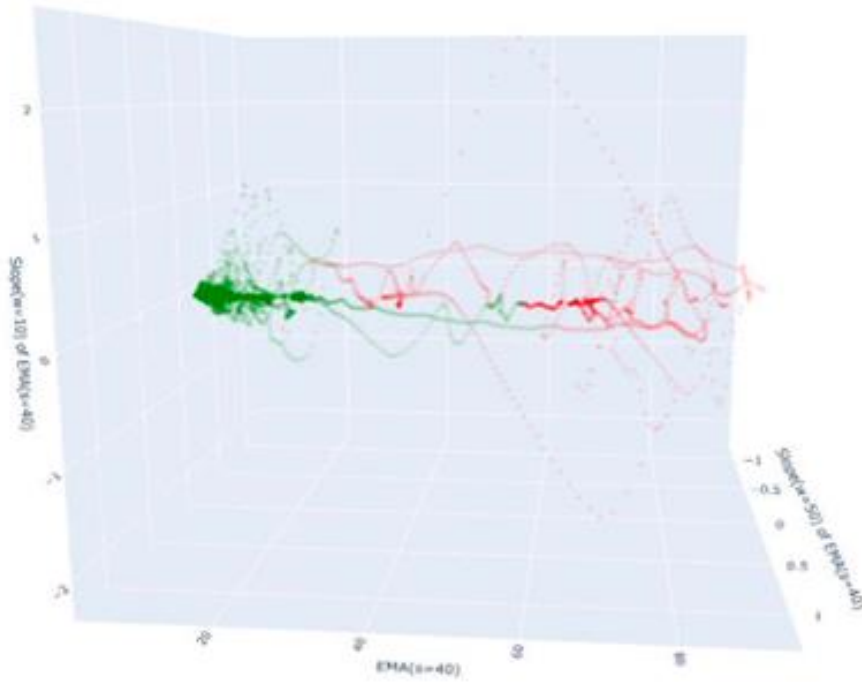


Figure 2. 3D view of features for class separation of water quality. (red: warning state and green: normal state)

Related to Barcelona study case, the different analysis demonstrated that there was a high correlation between the sediment accumulation level of the sections with near or similar sections. Then, this approach was validated with BCASA and later, followed to the data-driven model design.

In both cases, Gothenburg, and Barcelona case, all the information was collected and shared through power points and notebooks (see Figure 3), providing the tool to discuss the main results.

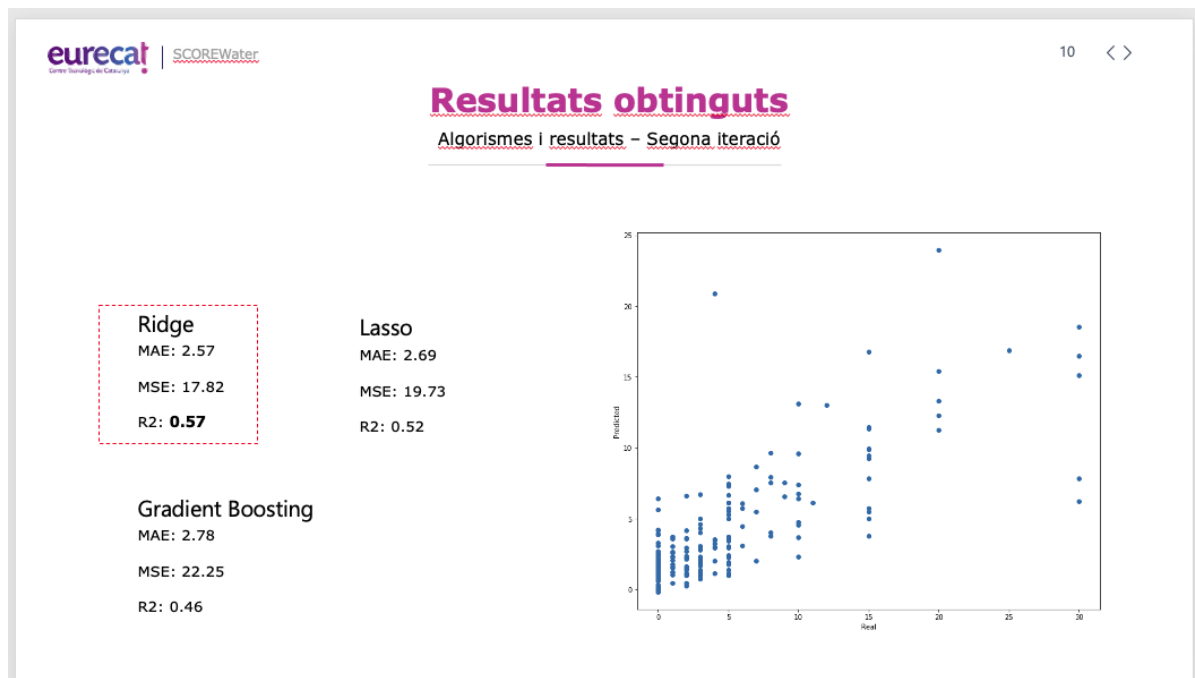


Figure 3. Sharing of hypothesis validation and first findings

More detailed information on the conclusions drawn during the validation are presented on D2.4 section 4 and 5 (Rubion et al. 2021).

The third stage, data preparation, was focused on producing the dataset to be used during the modelling stage, including tasks related to select data, clean data, construct data, integrate data, and format data. This stage was mainly conducted by Eurecat, nevertheless the decisions made were constantly validated by the stakeholders (since they have more knowledge about their own data).

At the fourth stage of the process, which is aimed at designing accurate models, Eurecat carried out the tasks without stakeholder interaction. Eurecat selected the data driven algorithms, generated the train-test environment, built the models, and assessed them.

Instead, **at the fifth stage**, evaluation, Eurecat worked together with stakeholders to assess the efficiency based on Machine Learning scoring metrics such as coefficient of determination, median absolute error, precision and recall score, and generalization of the model designed throughout the previous stage (to create a model which can be exploited on another location, that is, ensure the transferability), and to determine next steps. Then, the degree to which the designed model fitted with the business and AI objectives was assessed jointly with domain experts, that is, the stakeholders.

6.4.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

As explained in previous sections the partners communicated periodically in meetings and emails to solve the difficulties that appeared when developing the machine learning models. Identifying these difficulties and communicating iteratively with the stakeholders, enabled a fast response and didn't create a bottleneck that could delay the current work to do. The use of an iterative approach to build the data-driven models has allowed to include frequent opportunities to evaluate the progress of the project against its original objectives, helping to minimize risk of getting to the end of the project and finding that the business objectives have not really been addressed. Additionally, it has also allowed to adapt and change the definitions without impacting the project advance.

The CRISP-DM approach provides a powerful tool (discursive device) for translating and transfer knowledge and interests across developer and end-user communities, attending to challenges regarding the transformation of needs into requirements, attending to different goals simultaneously, involving users with different types of expertise and development processes based upon an analysis of users' everyday practices. In this case though, IVL substituted for the actual end-user.

6.4.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

In the coming months, there are no additional stakeholders to be engaged. Nevertheless, the engagement of the current stakeholders should be maintained through CRISP-DM methodology. The interactions with the users will be addressed to enhance the data-driven models, identify, and understand new data sources, plan new hypothesis, and validate them and the models. Moreover, the deployment of the data-driven models will implicate to data platform work in WP3, by integrating FIWARE platform with the models.

6.5. TALKPOOL EXPERIENCES (TP)

This section is based upon input from Boris de Bruin, Talkpool (TP), describing how value propositions and business models were used as discursive devices to translate and knowledge and objectives, such as user experience and workflow practices, between technology developers and end-users, and to keep stakeholders engagement over time.

6.5.1. WHAT WE AIMED FOR

Our aim with the work in WP6 was to understand what value propositions and business models could be created that would enable SME's in the water- and digitization industries to provide value to actors involved in the water cycles. This creates new market opportunities for sensor providers, software providers and system integrators to work together and/or to provide solutions to the market.

6.5.2. MAJOR CHALLENGES THAT WE IDENTIFIED

The challenge here is to **translate the stakeholders input into business models**. In doing this, one has to communicate across different knowledge domains. Next to that it was important to **keep the stakeholders engaged in the process**.

6.5.3. HOW WE MANAGED THESE CHALLENGES

The stakeholders were pre-defined by other WPs. When developing the value propositions, the stakeholders played a key role, since many of them are actually working with real-life problems that SCOREwater aims to resolve. Their input has served as the basis for creating value propositions, as well as served as a starting point for understanding the market and value chains. For managing the challenges, we've used three tools: the Osterwalder business model canvas, value proposition canvas and the value chain model (Porter, 1985).

The first tool used is the value chain model. This maps all the different actors involved in a value chain, to understand the position of and relationships between different actors. This is not limited to suppliers and customers but includes influencing stakeholder organizations. This tool is also used to identify where in the chain a value proposition should be made in the interface between a supplier and a customer. One will get different value propositions dependent on the position in the value chain. Figure 4 shows an example of how this tool has been applied. From left to right it shows the different suppliers of a system, which is then offered to a construction company, who is working for the road authority. The tool helped to identify that although the construction company is the direct customer for the system, the demand is ultimately created by the road authority. Important to note is that the tool also shows that the road authority is influenced by another stakeholder, namely the county administration. This tool was presented by the partners that were working on deliverable 6.2 (Kersbergen et al. 2021), during the stakeholder meetings, and filled in together with the stakeholders. Afterwards, this was further reviewed, challenged, and improved during the work for finalization of deliverable 6.2.

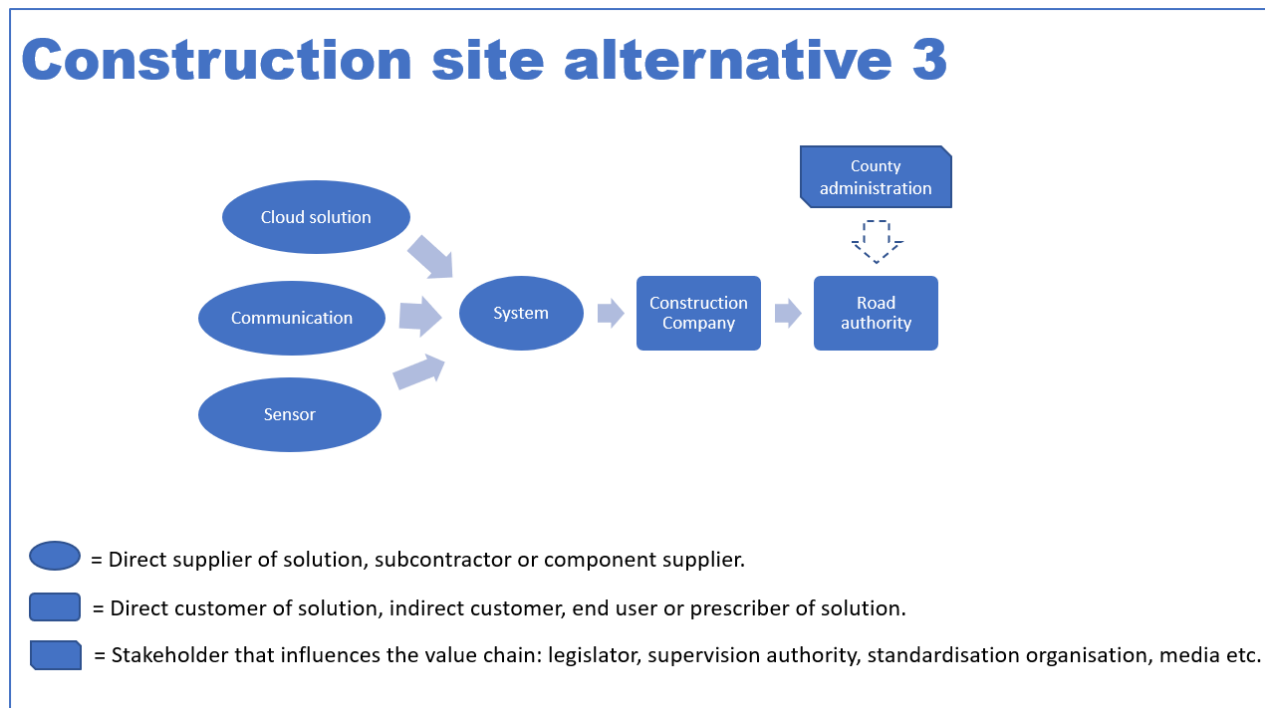


Figure 4. Value chain model

The second tool used is the value proposition canvas (Figure 5). This tool lists on one side the customer’s jobs (i.e. the different activities the customer is involved in), the customer’s gains (i.e. what would improve the customer’s activities) as well as the customer’s pain (i.e. what is hurting the customer’s activities today, such as high costs or time usage required). On the other side of the canvas you find the value proposition, which is the offering we’re considering putting on the market through the SCOREwater project. It is explored what gains and pain relievers these products and services can provide to potential customers. Where this matches with the actual gains and pains of the customer, there is a strong value proposition. The input for the Customer Profile side of the tool is based on input from the stakeholder meetings.

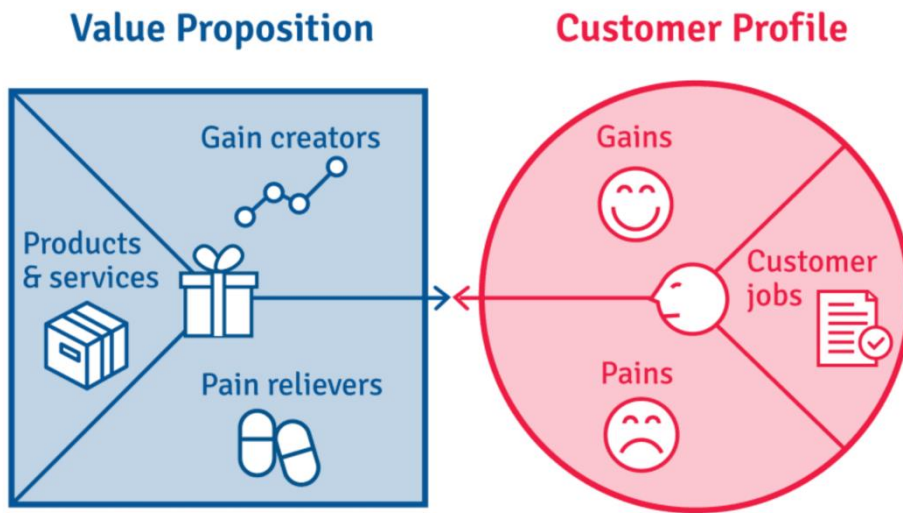


Figure 5. Value proposition canvas

The third tool used is the Osterwalder business model canvas (Figure 6). This helps mapping all gathered information into a business model, serving both as a checklist to ensure that no aspect of a valid business model has been forgotten, but also shows the relations between different parts of a business model.

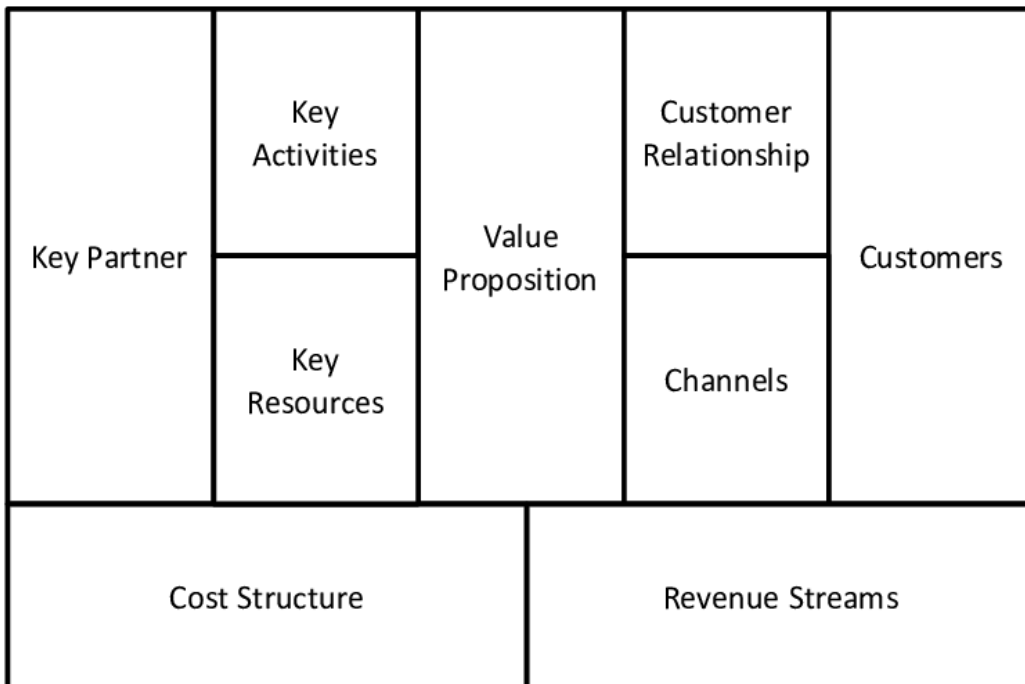


Figure 6. Osterwalder business model canvas

The stakeholder analysis was done in other WPs. We have not yet interacted with real end-users within stakeholder organizations, other than the ones that are part of the project. In the meetings we have discussed their user needs for using a platform like the SCOREwater platform, by making user stories. We've done this by asking questions about who in the organization would be using SCOREwater's products or services and what challenges this would help them overcome. Much attention was given to the user experience and what workflow practicalities the user must deal with.

6.5.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

For example, in Gothenburg we participated in workshops with Value proposition canvas with the stakeholders (potential customers): Kretslopp & Vatten, Miljöförvaltningen, Swedish Hydro Solutions, Skanska, NCC.

We overcame different language and knowledge domains (e.g. computer engineering vs water engineering through the business model methodology, during meetings with clear communications and an atmosphere that allowed for many questions to be asked. This has been created by discussing the barriers openly at the start of the meeting. All the stakeholders were very open-minded. Of key importance here is that all stakeholders have benefit from explaining their points of view, since they believe that the success of the project contributes to their own success.

6.5.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

There is an opportunity to engage with other ICT 4 Water projects, of whom participants might be interested in the solutions coming out of the SCOREwater project. Talkpool will be joining these meetings to further explore this. Once a first viable solution can be launched, it will be interesting for the users to start working with it and provide feedback. They would be able to indicate how well the solution fits their needs. There are no major implications for other parts of the SCOREwater project for other projects on an organizational level.

6.6. CIVITY EXPERIENCES (CIV)

This section is based upon input from Bas Vanmeulebrouk, Civity (CIV). It addresses challenges for the design of the data platform arising differences across end-users and cases in a) data collection methods, b) degree of specification and c) organizational logics.

6.6.1. WHAT WE AIMED FOR

The main goal for WP3 is to develop a software platform (the SCOREwater platform) that connects providers of data with users of data. The platform should act as a broker between providers and users of data. It should translate proprietary data output from different sensors (and other sources of data) into easy to use input data for creating a user-friendly app, run a data driven model or create an attractive visualization of the data in the form of a dashboard or a map. The SCOREwater platform should be able to support all three cases (Amersfoort, Barcelona, and Gothenburg) with this functionality. Interoperability (which refers to the ability of systems to interact with other systems) is very important for various reasons: it allows for replication of the solution in other environments, outside of the project, with other software components which implement the same interface. And it allows the SCOREwater platform to be part of a federative network of similar platforms.

The SCOREwater platform is described in the grant agreement: a platform based on FIWARE principles containing amongst others a marketplace should be created to support the three cases by connecting providers of sensor data to users of those data. Two early deliverables (1.1 and 1.3) provide additional requirements for the SCOREwater platform. Deliverable 1.1 reviews types of sensors, their communication protocols and data driven models commonly used in the water sector (Corominas et al. 2021). The SCOREwater platform should be able to support both the types of input data as running data driven models described in this deliverable.

Deliverable 1.3 aimed to define the three demonstration cases of Barcelona, Gothenburg, and Amersfoort (Escolà et al. 2021). Each demonstration-case city established an experimental plan, a list of the installed or to be installed sensors, the communication protocols between sensors and databases, the number of auxiliary data sources to connect and the data treatment process. To define the three demonstration cases of Barcelona, Gothenburg, and Amersfoort, each case city established an experimental plan, a list of the installed or to be installed sensors, the communication protocols between sensors and databases, the number of auxiliary data sources to connect and the data treatment process.

6.6.2. MAJOR CHALLENGES THAT WE IDENTIFIED

Three different challenges were identified that could hamper the development of the SCOREwater platform.

Different ways of collecting data across cases: From the 1.1 and 1.3 deliverables, it can be concluded that data will be collected within the frame of all cases, but the way in which these data will be collected differs between the cases and the data will be used for different purposes.

Different levels of specification: After the delivery of D1.1 and D1.3, the different cases were at different levels of specifying what they would need from the platform described in the grant agreement. For the Barcelona case on the one hand, a detailed list of what data was going to be collected was available and it was already known what this data was going to be used for. For the Amersfoort case on the other hand, defining some of the use cases and finding the data to go with that use case was part of the project. With this respect, the Gothenburg case was somewhere in between the Barcelona and Amersfoort cases: the use case was known and some of the data sources had been selected, but there were also still a couple of uncertainties with regard to other data sources.

Different organizational logic: The consortium is quite heterogeneous, with partners with for example different approaches to licensing. In the Amersfoort case for example, the Civity and Hydrologic companies (with a business model based on proprietary business licenses) are working together with the Measure Your City community science collective (who attach great importance to making everything available using an open license).

6.6.3. HOW WE MANAGED THESE CHALLENGES

Since WP 3 focuses on using software to implement the SCOREwater platform, a software quality model was created to be able to weigh all interests. This software quality model is discussed in deliverable 3.2. aiming to select adequate open-source software components, data models and standards (Hof and Vanmeulebrouk 2021). This software quality model is based on ISO 25000 and provides a framework to evaluate different software components. The model does not go into as much details as ISO 25000 allows, but it uses the high-level ISO 25000 characteristics to evaluate software. Input for this evaluation was obtained from the various stakeholders in the project.

To resolve the challenges outlined above, the requirements for the platform had to be further specified to meet these diverse needs. A method was needed to determine the functionality of the platform with sufficient flexibility, but also to select the proper open standards to implement and at the same time support the different business models and facilitate replication outside of the project. The main challenge for WP 3 was to identify common denominators between the different cases and stakeholders within the project. These relate to functional aspects of the SCOREwater platform (who can do what with the platform under what boundary conditions), aspects related to the system (technical) administration of the platform and legal aspects related to licensing.

To evaluate the different software components, different groups of stakeholders with relevant end-user communities were consulted, using the user story method (Lucassen et al. 2016). There are different groups of end-users involved with the SCOREwater platform such as end-users working for an organisation providing data (data providers) and end-users working for an organisation using data (data users). Data provider end-users in this case are the companies and organizations collecting data within the frame of SCOREwater. Another stakeholder category are system administrators working for the platform provider. In this case, Civity is the platform provider. The same organization within the project can hold multiple stakeholder groups in different capacities. The platform owner is important as well obviously, but this is part of WP 6.

Table 3 lists the characteristics and what stakeholder group the information to be able to evaluate the characteristic was obtained from. Functional aspects were dealt with together with representatives of end-users, technical administration aspects were discussed with system administrators and legal aspects were discussed with contract specialists.

Table 3. ISO 25000 characteristics

Characteristic	Stakeholder used as source for evaluation
Functional suitability	End-users (user stories)
Performance efficiency	End-users (user stories)
Compatibility	End-users (user stories)
Usability	End-users (user stories)
Reliability	End-users (user stories)
Security	System administrators
Maintainability	System administrators
Portability	System administrators
Licensing	Contract specialists

End-users (user stories): To obtain input for functionality, performance, compatibility, usability and reliability, user stories were created together with representatives of end-users. A user story describes a software feature from the end-user perspective. User stories play an important role in translating requirements for a software component from an end-user perspective into something a software developer can implement. They should describe who can do what with a certain feature and - most importantly - why. If there is no added value in a user story, if it is impossible to describe why a user story should be implemented, there is no point in implementing it. User stories are used to translate high level requirements to manageable pieces of software which can actually be implemented. A user story has added value if a task from someone involved (often an end-user but could also be an administrator for example) can be done better (with higher quality), more efficiently or in a more secure fashion for example. Anyone involved in the project can submit user stories. Usually, a common template is used to describe a user story which consists of a number of components: the actual story (the who, what and why), acceptance criteria (describing what should be implemented to fulfil the user story, if the acceptance criteria are met the user story is considered to be done), additional background information and a question-and-answer section.

User stories are discussed in so called stakeholder meetings. Stakeholders can be end-users, but since it is often not possible to invite all end-users for such a meeting, the participants in the meeting have to represent those not present. During a stakeholder meeting, the person who came up with the user story explains what problem the user story is going to solve and how the user story will accomplish this, discussing potential ambiguities which could lead to sharpened acceptance criteria, an extension of the background section or additional questions and answers being added to the Q and A section of the user story. Anyone can come up with questions, answers should be given by persons who are familiar with the topic the user story deals with.

User stories are not only discussed during stakeholder meetings, but in the so-called refinement session as well. In preparation of the refinement session, the user stories are improved by persons involved in the actual user story. In the refinement session, the developers responsible for the actual implementation of the user story discuss the user story, clarify it where needed, come up with questions which need answering before the user story can be implemented and split a user story in multiple smaller user stories if possible. In case of uncertainties which cannot be solved during a refinement session, the user story may be referred back to the stakeholder meeting for further clarification.

Since not all user stories are equally important, prioritization of user stories will take place after stakeholder consultation, again in a stakeholder meeting. As with any meeting, it is important to make sure all participants have their say to make sure there is sufficient support for decisions. The chairperson of the meeting has an important role to make sure everyone's voice is heard. Usually, the chairperson is the product owner. He or she is responsible for a certain product or product portfolio (in this case the SCOREwater platform) and acts a linking pin between stakeholders in the stakeholder meeting and the development team in the refinement session. The SCOREwater stakeholder meetings were held in the form of workshops during the consortium meetings.

The first workshop took place in November 2019, during the second SCOREwater consortium meeting in Barcelona. Attendants were split into three groups, one per case. Each of the groups came up with a couple of user stories for their case. These were presented and discussed in a plenary session. Together with the user stories which can be distilled from the grant agreement, these provide a good starting point to further specify the functionality of the SCOREwater platform.

The second and third workshops: Subsequent consortium meetings, the third and the fourth, were organized online, making it more difficult to properly involve all participants. Such a meeting becomes more one-way traffic, with the chairperson of the meeting giving a presentation with less feedback from participants. Working together on a white board is difficult and there are no shared coffee breaks to ask for an explanation or come up with new ideas in a less formal setting. To compensate for this, input was gathered during one to one meetings Civity had with other project partners. For example, when discussing connecting a sensor data source to the platform, it is easy to discuss what is needed to properly implement this. The problem is that input from certain stakeholder groups who circulate in parts of the projects were Civity is not that present is easily missed. We tried to manage this by presenting the SCOREwater platform extensively during the third and fourth consortium meeting and by providing stakeholders with early access, allowing them to provide feedback and speak up if they noticed issues. This has worked for at least some of the partners: IVL and Gothenburg started investigating potential replication of the SCOREwater platform outside of the project and other partners (mainly in the Amersfoort case) started to provide additional datasets for the platform.

Having gathered the input from all the cases (which involved asking for clarification from the different stakeholders), we ended up with following user stories. For Amersfoort:

- 1) The building manager who wants to receive a warning for imminent flooding which allows him or her to take action to prevent damage
- 2) The urban planner who wants to use information related to heat stress to be able to come up with a more climate change resilient design of the public space
- 3) The operational water manager who could use data related to sewer systems and rainfall for predictive maintenance purposes.

In Barcelona, a user story related to predictive maintenance of the sewer system was created. Other user stories in Barcelona related to ISO37120:2018 KPI reporting (download, notification) and access to various data sources (sensor data, DNA, and chromatogram data from sewage samples).

In Gothenburg the user stories related to:

- 1) Monitoring of wastewater from construction sites
- 2) Predictive maintenance of the storm water network
- 3) An early warning system for water pollution in recipients.

And although these user stories are quite heterogeneous, they also share a lot of common denominators which were translated into platform functionality by identifying them:

- All users should be able to upload data (either near real time sensor data or static data) to the SCOREwater platform using different methods
- These data should be stored in a so-called time series database
- To provide access to these data, using various API's should be available, for instance to be able to run data driven models or create dashboards.
- To be able to support different licensing models, data providers should be able to control who has access to metadata and data.
- For predictive maintenance purposes, users should be able to subscribe to alerts once certain thresholds are exceeded.

And the fact that we now have those user stories with their common denominators solved the challenge of the different cases being at different level of specifying what they were actually going to do. The heterogeneity of the data sources resulted in functionality to be able to ingest data from different data sources in the SCOREwater platform (the first bullet). To deal with different organizations with different business models resulted in the fourth bullet: data providers should be able to control themselves who has access to their data.

Part of the functionality was already foreseen in the grant agreement. What was new though was the importance of being able to upload static information (either actual independent data sources or metadata regarding measurement devices or stations) and alerting. This functionality was described in a user story.

System administrators: To obtain input for security, maintainability and portability, other stakeholders were consulted. These stakeholders do not represent end-users, but they represent system administrators, the people who would have to provide the hard- and software infrastructure the SCOREwater platform was intended to run on. To get input from system administrators regular meetings were held with the system administrators responsible for hosting the SCOREwater platform during the project. This ensures a proper functioning of the SCOREwater platform during the project. The hard- and software infrastructure present is tailored towards the platform. For example, since we are using CKAN which is based on Python 2 which is no longer supported by the Python community (and thus poses a security risk), an operating system (CentOS 7) was selected for which Python 2 is still supported until 2024. Any security issues in Python 2 will be resolved by the maintainers of CentOS. Furthermore, the system administrators identified Grafana security issues and came up with recommendations on how to work around those. 3Scale was not recommended by them because of difficulties in installing it and the large amount of resources it uses (portability). We are switching to Gravitee to work around those.

Contract specialists: To evaluate the licensing of the software, people with legal knowledge specializing in contracts were consulted. The person responsible for evaluating licenses at Civity investigated to licenses of the software under consideration. A licensing issue with 3Scale was identified, after which an alternative was selected.

6.6.4. MAJOR LESSONS LEARNED: POTENTIAL ENABLERS

Apparently, the ISO25000 and the user story method provided useful discursive devices for translating and transferring knowledge and needs between developers and end-users, attending to challenges regarding the transformation of needs into requirements, attending to different goals simultaneously, involving users with different types of expertise and development processes based upon an analysis of users' everyday practices.

6.6.5. FUTURE WORK: WHAT ARE THE CHALLENGES THAT LIE AHEAD

In addition to the stakeholders which have been playing a part in developing the SCOREwater platform so far (end-users, system administrators and legal people) from the point of view from the SCOREwater platform, we hope to involve the same groups, but then working for organizations not involved with SCOREwater within the frame of our replication efforts.

In order to not make the platform too specific for the Civity hard- and software infrastructure, we are talking to other organizations about hosting a platform such as the SCOREwater platform. A Swedish company working in the IoT domain, Sensative, would be willing to host the platform in Sweden if so called Docker containers can be provided (which should not be a problem). Running a platform in the IT infrastructure of a large government body though may be difficult. They are often constrained by existing IT infrastructure and specific software which might not be supported by preferred suppliers must be installed. Smaller government bodies on the other hand do not have an IT department big enough to support such a platform, so they would be looking for a SaaS (Software as a Service) provider such as Civity or Sensative.

These issues must be taken into consideration when writing the deliverable on replicability which will describe how to replicate the SCOREwater platform outside of the project, with other organizations and after the end of the project. The SCOREwater platform can be used as an example implementation of a FIWARE based platform in the water domain. The SCOREwater platform acts as an example of federative platform based on FIWARE principles in the water domain. Replicability of the set-up with either the same software components or other software components implementing the same interfaces will be tested during the next stages of the project. Organizations implementing a similar platform could use the software quality model described in deliverable 3.2 (Hof and Vanmeulebrouk, 2021) to evaluate the different candidates, but they might make different trade-offs: they might need support for additional standards for instance, to be able to connect to other systems within their organization, they might already have purchased certain licenses (and as a consequence not be restricted to software which is released under an open source license) and their hosting provider will probably have different requirements.

End-users: The main challenges ahead are related to the end-users and their user stories. For the end-users, the next big step is to actually see whether or not the user stories created can be implemented using the SCOREwater platform. This means actually using data from the SCOREwater platform to run data driven models. Although we have already done some experiments to demonstrate that it is possible to use data published by API's in the SCOREwater platform. And a complicating factor will be that visualization/presentation/creation of apps using the results is not part of the project. This might seriously affect the ability to properly demonstrate the platform. To overcome this issue, out of the box software to create dashboards will be added. This software will allow us to configure dashboards displaying time series data without having to program, but there are limited resources available in the project to create useful dashboards. This affects the ability to demonstrate the SCOREwater platform to audiences without a software engineering background

System administrators have two major challenges ahead:

- Keeping the platform up and running and making sure that it can accommodate for the amount of data that is being uploaded and making sure that no data whatsoever is lost.
- Ensure the replicability of the platform so that it can live on after the project. Initial discussion with parties outside of the project have started.

Contract specialists: There are no challenges for the lawyers. What could happen is that in future versions of one or more of the software components used for the SCOREwater platform the license is changed. The lawyers would then have to re-evaluate the license. It is a) not very likely that this is going to happen and b) we could finish the project with the current versions of the software.

The challenges foreseen are both related to continued work with the platform and to replication.

7. CONCLUSIONS AND IMPLICATIONS

Based upon the framework, two research questions were formulated:

RQ1: What are the relevant challenges regarding social and organizational barriers and enablers in the current phases of the project?

RQ2: Implications: What could be the relevant social and organizational barriers in the next phases? How should they be managed to identify enablers?

In the analysis, the social and organizational enablers have been categorized as process facilitators and discursive abilities/devices, based upon research on project governance. In Table 2 in the framework chapter, the literature review was used to suggest tentative process facilitators and discursive abilities/devices that we expected to find in the case studies.

7.1. CHALLENGES REGARDING SOCIAL AND ORGANIZATIONAL BARRIERS AND ENABLERS IN THE CURRENT PHASE

The literature review in D5.1 (Sanne et al. 2021a) highlighted a number of issues that previous research has identified as salient for developing technologies and services in the water sector. Some of these were addressed in the design of the SCOREwater project and chapters 3-6 outlined challenges in their realization. We also highlighted salient issues identified in the review that were not addressed when designing the project and how challenges related to these issues were identified and managed. The deliverable aimed to evaluate and analyse *whether* and *how* the challenges were identified and addressed by partners and what we as a project can learn from that for future activities within, as well as beyond, the project. Thereby, to some extent we try to open up the “black box” of interdisciplinary innovation, tapping on the tips and tricks of the trade of professionals involved.

The Gothenburg section addresses challenges regarding stakeholder identification, recruitment, and organization. In Gothenburg, engaging with various departments within CGEA and with external stakeholders has been a continuing learning process, where IVL (case study leader) gradually presented various opportunities within the project, both in Amersfoort and Barcelona, which has been very much appreciated. Moreover, the engagement process has also enabled stakeholders to envision a number of opportunities that the new technologies empower that can be continued beyond SCOREwater. In Gothenburg, the building companies and CGEA became engaged also through their participation in D5.2 (Sanne et al. 2021b), providing opportunities for using SCOREwater technology. The Gothenburg case study expresses how insights from cooperation issues from before the project, were turned into a well-designed collaboration process (process facilitators) between developers and users/stakeholders. The collaboration enabled lessons learned from the field tests turn into opportunities for adaptations to objectives in the grant agreement. Moreover, due to a fruitful collaboration, stakeholders now envision even more opportunities and ambitions, some of which might be realized within the project, some outside.

The City of Amersfoort section addresses managing conflicting goals, language and organizational logics between different stakeholders that need to cooperate, as well as between different communities within the municipality. The Amersfoort section shows different organizational structures and motives between the municipality, the for-profit companies and citizen volunteers. This issue was addressed through finding common ground in the objectives (added value as a discursive device). The section also shows differences in work processes between their policy makers and data analysts, addressed through designing a common process - going from simple to more complex hypothesis. These insights provide valuable knowledge for designing process facilitators, focusing on creating shared value for different user groups. Amersfoort expresses an ambition to move their insights about collaboration with both for-profit companies and citizen volunteers onto a European level.

The BCASA section shows how the organization identified challenges concerning a) a need to “translate” their needs and concepts with regard to wastewater maintenance to other Catalan partners and b) that they needed to involve and engage both workers and managers at several departments for the SCOREwater project so that they understand and support the project work and see the benefits from it. These challenge concerns both the articulation and the translation and transfer of BCASA organization, needs and concepts to other partners. They relate to previously identified challenges for stakeholder recruitment and organization (coordination) as well as end-user needs and expectations such as transforming needs to products and services. They also identified challenge relates to various end-user involvement issues such as attending to several objectives simultaneously and involving and engaging all relevant end-users.

The Eurecat section addresses challenges related to the translation and transfer of knowledge between developers and end-users. The CRISP-DM approach provides a powerful tool (discursive device) for translating and transfer knowledge and interests across developer and end-user communities, attending to challenges regarding the transformation of needs into requirements, attending to different goals simultaneously, involving users with different types of expertise and development processes based upon an analysis of users’ everyday practices.

The Talkpool section describes how value propositions and business models were used as discursive devices to translate and knowledge and objectives, such as user experience and workflow practices, between technology developers and end-users, and to keep stakeholders engagement over time. TP and partners overcame different language and knowledge domains (e.g. computer engineering vs water engineering through the business model methodology.

The Civity section addresses challenges for the design of the data platform arising from differences across end-users and cases in a) data collection methods, b) degree of specification and c) organizational logics. The ISO25000 and the user story method provided useful discursive devices for translating and transferring knowledge and needs between developers and end-users, attending to challenges regarding the transformation of needs into requirements, attending to different goals simultaneously, involving users with different types of expertise and development processes based upon an analysis of users’ everyday practices.

We can learn a lot from the cities about the specific challenges for the SCOREwater project. The developers (EUT, TP and CIV) express fewer specific challenges than the cities. All three developers use well-proven tools such as user stories, business models (and associated tools) and the CRISP-DM methodology as well as discursive devices coupled to these (such as “pains and gains” or visualizations and calculations) to develop a shared understanding of opportunities and corresponding design decisions. The tools are developed for such purposes and the developers have used them many times before in similar projects, so they know well how to adapt to new customers and new application areas (or “domains”). It is part of core business. The challenges they meet seem to be “normal troubles”, manageable and not very specific to SCOREwater.

The reason that the city case studies are different is probably because an innovation project is different from most activities in municipalities, requiring other process facilitators and discursive abilities, and also because of the need to collaborate with partners with different organizational logics and structure. This is well explained in the Amersfoort case study.

All the case studies report project challenges related to process facilitators and discursive abilities/devices that are needed for making sense across communities in order to close the gap between needs and opportunities for developing new technologies and services. In Table 4 we outline the relevant issues again and summarize the findings from the case studies accordingly.

Table 4. Challenges for organisational enablers and emerging solutions in the first two years of SCOREwater.

Challenge category	Challenge	Process facilitator	Discursive ability/device
Identifying, recruiting, and organizing stakeholder engagement	Water is often managed through a network of public and private actors Additional challenges: <ul style="list-style-type: none"> ➤ Different organizational logics (COA, CIV) ➤ Keeping stakeholder interest over time (IVL, BCASA) ➤ Different profiles (BCASA) 	Designed: matching consortium.	<ul style="list-style-type: none"> ➤ Creating shared value (COA) ➤ Presenting various opportunities to stakeholders (IVL) ➤ Articulating own needs (BCASA)
	Different means of engagement	Not designed beforehand	Partly designed: user stories, value business canvas
Addressing end-user needs and expectations	Innovation needs to attend to several objectives simultaneously	Designed: interaction of various expertise	Designed: discursive devices such as value business canvas
	Lack of end-user involvement	Designed: involving stakeholders with various end-user communities BCASA workshops and meetings	Not designed beforehand
	Transforming user customer expectations and needs into requirements	Not designed beforehand: BCASA workshops	Partly designed: BCASA design thinking
	Experimenting and brainstorming in real life environments	Not designed beforehand Not used	Not designed beforehand Not used
	Iterative processes involving users	Partly designed into project process	Partly designed: user stories, value business canvas
	Need to involve users with different types of expertise and competence	Not designed beforehand BCASA workshops	Not designed beforehand BCASA survey
	Attending to wider issues within the project	Partly designed: COA regarding citizen collaboration	Partly designed: serious gaming, interactive exhibitions Creating shared value
	Development process is based upon an analysis of users' everyday practices	Partly addressed in design BCASA workshops	Designed: BCASA workshops

In summary: SCOREwater partners have encountered most of the expected social and organizational enablers in the first half of the project and they have managed them, sometimes through innovations. The city sections show various complement each other and may learn from each other. The Amersfoort case shows that identifying the different organizational logics and motivations both within the municipality administration and among stakeholders are necessary steps to find solutions. The Barcelona case shows that a broad engagement with relevant managers and workers and using appropriate process facilitators (workshops) discursive devices (e.g. surveys, design thinking) are necessary to ensure a good value from the technologies and to prepare for successful implementation. The Gothenburg case study shows that presenting a broad array of opportunities for the technologies and services that are possible serves to create engagement among stakeholders.

7.2. MANAGING SOCIAL AND ORGANIZATIONAL BARRIERS IN THE NEXT PHASE

BCASA and Gothenburg municipality express several ambitions that have been prompted by the innovation process. Amersfoort express a wish to transfer their experiences from collaborating with citizens across Europe. The developers express their future challenges more in line with the Grant Agreement.

Table 5 shows some of the challenges ahead. In the next phases of SCOREwater, the deployed sensors will provide lots of data, these will be channelled through the platform and they will be processed by the various AI solutions. That is, the technologies and services will be used or implemented among users and they will need to be evaluated. There is a need to design appropriate implementation and evaluation plans (using appropriate process facilitators and discursive devices) and a need to involve appropriate users.

Table 5. Challenges for organisational enablers for the next phase of SCOREwater.

Challenge category	Challenge	Process facilitator	Discursive ability/device
Implementing technologies in stakeholder organizations	To assess the potential match between the new practice and the organisational capacity and readiness for change (organizational readiness for change)	Not designed beforehand Need to design an implementation process Need to assess in replication efforts Learn from BCASA user involvement	Not designed beforehand Need to design adequate devices
Evaluating technologies and services	Why, how, who, what, and for whom	Not designed beforehand Need to assess in replication efforts	Not designed beforehand Need to design for replication efforts
	Design for local adaptation and for generalising	Not designed beforehand Need to design for replication efforts	Not designed beforehand Need to assess in replication efforts

In terms of the various WPs we outline the implications in Table 6.

Table 6. Implications for the next phase of the project.

WP	Implications
WP1 SCOREwater co-development	Learn from the process facilitators and discursive devices used in the city case studies for future specification/revision. Learn from business model tools in WP6 so specifications are focused on needs where there are a willingness to pay.
WP4 Large scale demonstrations	Spread useful process facilitators and discursive devices between the city case studies. Learn from the past to design implementation and evaluation plans.
WP6 Exploitation and replicability	<p>Design replication plans and evaluation plans - based upon the issues identified regarding implementation and evaluation and upon lessons learned from platform development</p> <p>Use additional discursive devices to extrapolate business models (e.g. design thinking, user stories)</p> <p>Prioritize among suggestions for project activities from stakeholders, and suggest other venues for those that does not fit into the project</p>
WP7 Dissemination and communication	Spread the useful discoveries from the cases as inspiration, especially from the city cases, such as the process facilitators
WP8 Project Management	<p>Innovation management can incorporate additional discursive devices (e.g. design thinking, user stories) for sensemaking across professional communities</p> <p>Suggest policy means that would enhance innovation based upon the process facilitators identified (e.g. how to collaborate with citizens groups)</p>

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ANNEX 2 – STOCKTAKING

A final Annex of stocktaking was included in all Deliverables of SCOREwater produced after the first half-year of the project. It provides an easy follow-up of how the work leading up to the Deliverable has addressed and contributed to four important project aspects:

1. Strategic Objectives
2. Project KPI
3. Ethical aspects
4. Risk management

STRATEGIC OBJECTIVES

Table 7 lists those strategic objectives of SCOREwater that are relevant for this Deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 7. Stocktaking on Deliverable’s contribution to reaching the SCOREwater strategic objectives.

Project goal	Contribution by this Deliverable
Identify and mitigate key barriers to implementation of smart, resilient water management at city trans-European level by: i) providing best practice on social and organisational enablers, ii) apply novel smart metering and advanced control procedures.	<p>The deliverable has identified organizational logics and interests that provide hinders to collaboration and value creation</p> <p>The deliverable has also identified process facilitators and discursive devices that enable sensemaking and value creation across professional communities</p>
Increase citizen involvement and engagement in the transition to a water-smart, resilient society by increasing the public perception of the value of water and public engagement and commitment.	The deliverable has identified process facilitators and discursive devices that enable citizen involvement and engagement

PROJECT KPI

Table 8 lists the project KPI that are relevant for this Deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 8. Stocktaking on Deliverable’s contribution to SCOREwater project KPI’s.

Project KPI	Contribution by this deliverable
11 - Behavioural barriers identified and mitigation options demonstrated	The deliverable has identified discursive devices that enable sensemaking and value creation across professional communities
13 - Organizational barriers and enablers identified and mitigation options demonstrated	<p>The deliverable has identified organizational logics and interests that provide hinders to collaboration and value creation</p> <p>The deliverable has also identified process facilitators and discursive devices that enable sensemaking and value creation across professional communities</p>

ETHICAL ASPECTS

Table 9 lists the project’s Ethical aspects and gives a brief explanation on the specific treatment in the work leading up to this Deliverable. Ethical aspects are not relevant for all Deliverables. Table 9 indicates “N/A” for aspects that are irrelevant for this Deliverable.

Table 9. Stocktaking on Deliverable’s treatment of Ethical aspects.

Ethical aspect	Treatment in the work on this Deliverable
Justification of ethics data used in project	N/A
Procedures and criteria for identifying research participants	N/A
Informed consent procedures	N/A
Informed consent procedure in case of legal guardians	N/A
Filing of ethics committee’s opinions/approval	N/A
Technical and organizational measures taken to safeguard data subjects’ rights and freedoms	N/A
Implemented security measures to prevent unauthorized access to ethics data	N/A
Describe anonymization techniques	N/A
Interaction with the SCOREwater Ethics Advisor	N/A

RISK MANAGEMENT

Table 10 lists the risks, from the project’s risk log, that have been identified as relevant for the work on this Deliverable and gives a brief explanation on the specific treatment in the work leading up to this Deliverable.

Table 10. Stocktaking on Deliverable’s treatment of Risks.

Associated risk	Treatment in the work on this Deliverable
No 7 Unacceptable quality of results	Mitigation: sufficient activity and participation of engaged partners, ask the right questions, collect relevant data, analyse well



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