cities2030

D6.3 Service-based open collaboration space development report

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Deliverable D6.3

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Abstract	This deliverable (D6.3, M24) describes the intermediate version of the Service-based Open Collaboration Space (SOCS), which integrates digital technology solutions for increasing stakeholder's collaboration

[1] R: document, report (excluding the periodic and final reports); DEM: Demonstrator, pilot, prototype, plan designs; DEC: websites, patents filing, press & media actions, videos, etc.; OTHER: software, technical diagram, etc.

	performance levels and decision-making accuracy. We particularize the development methodology defined in D6.1, for the SOCS approach, considering current state of the art components such as geospatial information processing technologies or FIWARE catalogue components are used in cloud and docker deployment environments. The deliverable includes the technical description of the developed applications and services, considering the use of standardized and common user interfaces with other technological solutions, to allow their interconnection with existing infrastructures. Specifically, the intermediate version of the SOCS includes the following components: Cities2030 community, Good Practices, Innovation management platform, blockchain-enabled marketplace for SFSC and a general description of four other components that will be developed in the second period of the project (M24 – M48). User manuals of the main components are shown in Annexes I to IV.
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Legislation

Legislation H2020 Framework Programme – Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 – The Framework Programme for Research and Innovation (2014-2020) (OJ 347, 20.12.2013, p. 104).

Euratom Research and Training Programme (2014-2018) – Council Regulation (Euratom) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 – The Framework Programme for Research and Innovation (OJ L 347, 20.12.2013, p. 948).

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Glossary and abbreviations

SOCS	Service-based Open Collaboration Space
CRFS	City Region Food Systems
AI	Artificial Intelligence
ICT	Information and Communication Technologies
KPI	Key Performance Indicators
UFSE	Urban Food Systems and Ecosystems
WP6	Work Package 6
D6.3	Deliverable 6.3
T6.3	Task 6.3
FAO	Food and Agriculture Organization
IoT	Internet of Things
IPv6	Internet Protocol version 6 (IPv6) RFC 8200. https://www.rfc-editor.org/info/rfc8200
NLP	Natural Language Processing
SSRI	Social Space for Research and Innovation
MAA	Multi-Actor Approach
SOCS	Service-based Open Collaboration Space
BDVA	Big Data Value Association
DSBA	Data Spaces Business Alliance
IPFS	InterPlanetary File System
JSON	JavaScript Object Notation
RPC	Remote Procedure Call
dApp	Distributed Application
WGS84	World Geodetic System 1984
REST	Representational State Transfer
No-SQL	Not only SQL (Structured Query Language)
API	Application Programming Interface

SMTP	Simple Mail Transfer Protocol
GIS	Geographic Information System
WMS	Web Map Service
WFS	Web Feature Service
OGC	Open Geospatial Consortium
XML	eXtensible Markup Language
SFSC	Short Food Supply Chain
GSFI	Global Food Safety Initiative
BC	Blockchain
VC	verifiable credentials
JWT	JSON Web Token

1 Introduction

In this first Section, the context and global overview of Task 6.3 is described, with a special focus on document D6.3, which is the outcome from this task and collects the development and validation efforts of the Service-based Open Collaboration Space (SOCS), a subsystem of the S2CP platform developed in WP6.

1.1 Short description of the CITIES 2030 project

The main goal of Cities2030 is to create a future proof and effective UFSE via a connected structure centered in the citizen, built on trust, with partners encompassing the entire UFSE. Cities2030 commit to work towards the transformation and restructuring of the way systems produce, transport and supply, recycle and reuse food in the 21st century. Cities2030 vision is to connect short food supply chains, gathering cities and regions, consumers, strategic and complement industry partners, the civil society, promising start-ups and enterprises, innovators and visionary thinkers, leading universities and research across the vast diversity of disciplines addressing UFSE, including food science, social science and big data.

1.2 Short description of the WP6 Package

This work package will gather, design, and develop the main components and technological tools to establish a data-driven CRFS management platform for data collection, analysis and representation in multiple interfaces. An initial requirement acquisition will lead to the proposal of a common technical architecture for Cities2030, for with supporting data set will be incorporated to be considered for data analysis and representation. Particularly, a service-based open collaboration space will be incorporated, to be used by Cities2030 participants to improve their multistakeholder dialogue processes. In this space, blockchain technology will be employed to provide some proof of concepts of token-based monetization processes, and reflect multi-stakeholder interaction in a reliable and transparent way. Documentation and software

repositories will be available for policy labs and living labs to develop their own solutions with assistance from WP6.

1.3 Purpose of D6.3 Report

The objective of document D6.3 describes the work performed in Task 6.3, which develops components and interfaces to design, implement and provide digital technology solutions for increasing stakeholder's collaboration performance levels and decision-making accuracy. Current state of the art components such as geospatial information processing technologies or FIWARE catalogue components are used in cloud and docker deployment environments. Some components such as a marketplace for optimization of multi-stakeholder dialogue processes and blockchain utilities for token-based monetization processes are described.

The implemented SOCS provides a space where decision making processes and KPI comparisons can be shared and make available among living labs, policy labs and other action groups.

1.4 Relation of the Report with other WPs and deliverables

This deliverable has a direct relationship with WP6 and in particular with task T6.1 "Requirements and reference architecture" which will provide the Cities2030 technical architecture, based on the experiences of participants from previous project platforms and compatible with other already established ecosystems.

The link between tasks T3.7 "Data-driven CRFS management system ideation" and T6.3 is the establishment of final user requirements and development guidelines that will become technical requirements to be considered in the development of the SOCS and that will determine the tentative list of components to be developed, following a co-creation methodology with WP4 and WP5.

Finally, the requirements of the stakeholders and the use they would like for the future data-driven CRFS management platform have been provided thanks to the relationship of this task with the WP4 and WP5 work packages. WP4, in this sense explores policy-framed and technology-based scenarios, build competences at city level, and deploy policies at regional level towards compliance with the aforementioned policy framework.

In the case of WP5, it structures and accelerates innovation processes incorporating the design, pilot, validation and deployment of cutting-edge food-related technology. The synergy of WP5 with this deliverable is clear, since the innovations that WP5 reports will be facilitated by the use of the SOCS whose requirements we are collecting in this report.

1.5 D6.3 structure

The structure of this deliverable is as follows:

Section 2 describes the work methodology considered for T6.3 (from WP6). Although this methodology refers only to the part of the S2CP platform architecture that has been developed in the context of T6.3, it is an approach that is fully compatible with the general working methodology of WP6 and with the CDM development methodology of the S2CP platform.

In Section 3, the detailed design of the S2CP service ecosystem is presented. This design basically includes 8 components, among which there are also state-of-the-art solutions, such as those used in the provision of geospatial services, or FIWARE technologies used in real-time monitoring of industrial systems. This section includes two subsections. The first is focused on the description of each of the components and services designed, with special attention to the components for monitoring KPIs in the different laboratories and CRFS; blockchain-based solutions for monitoring the value chain through a digital twin; and the necessary mechanisms to generate a communication space between the project agents and society. The second section

is focused on describing the standardized and common interfaces at the technological level that the different components implement and that allow their interconnection with other pre-existing infrastructures.

Section 4 describes the *Cities2030 Community* component at a technical configuration level. This component aims to generate a communication space between the participants in the project and society. For this, the space will have direct communication features (such as forums), display of customizable information (such as the lab space), and description of daily activities in a more informal and dynamic way (mainly through a blog tool). A user manual of this component is included in Annex I.

In Section 5, the *Good Practices* component is presented, whose purpose is the dissemination and publicity of the good practices collected and developed in the context of the Cities2030 project. The component will be based on a web catalogue, whose edition can be collaborative among all the members of the project. This section contains a technological description of the component and its configuration. Annex II includes a user manual of the Good Practices component.

Section 6 is dedicated to a platform for managing innovation, experiments, and KPIs. This platform receives the name of *Social Spaces for Research and Innovation - Multi-actor Approach (SSRI-MAA)* tool. It is focused on providing the different Labs that participate in the project with an ecosystem for the monitoring and follow-up of their innovation processes, with special attention to the measurement and follow-up of the indicators of success they have defined. The platform is described from a technical point of view, and a user manual is included in Annex III.

Section 7 is dedicated to describing the implementation of a marketplace of the agri-food value chain: *Blockchain for Short Food Supply Chains (SFSC)*. The platform will handle data from different transactions developed at Urban Food System Environments (UFSE) and will provide some proof of concept of token-based monetization processes, in a reliable and transparent way. In this section, a detailed technical description of the operation of this digital twin will be made, as well as an approach to its operation from the point of view of the end users. A user manual of this component is included in Annex IV.

Section 8 offers an overview of the maturity status of the components described above, as well as briefly describing those systems that are expected to be developed in the next stages of the project. The first subsection describes in detail the state of maturity of the previously described components, some of which have already been released for operation by users, while others are in initial versions. The second section focuses on describing the components that will be implemented in the next stage of the project, with special attention to real-time monitoring services based on state-of-the-art solutions such as FIWARE or containerized services (Docker); geospatial services to show the geographical distribution of the different agents throughout the different CRFS on a map system; and various marketplaces with different purposes, based on monetization with tokens.

Finally, in Section 9, the conclusions of the document and future lines of work are presented.

As additional content, the Annexes I to IV contain the user manuals developed in the context of the task and delivered to end users to help integrate and transfer the technologies developed, according to the workshops carried out up to the delivery date of this version the D6.3.

1.6 Roles and responsibilities

Lead partner role: UPM (P20) coordinates the activities, provide guidance, steer implementation and secure alignment, implement activities to deliver planned outcomes.

The rest of task participants: Uni.lu (P35), ITC (P30) and SINNO(P19) develop the task simultaneously at EU level and beyond and contribute to the focus group.

2 Methodology for the development of the S2CP service ecosystem and Service-based Open Collaboration Space

The objective of S2CP service ecosystem and its Service-based Open Collaboration Space (SOCS) is the provision of technological solutions to increase the collaboration between Cities2030 actors and improve the performance and precision in the decision making. For this, a set of technological components capable of providing users with the required services must be designed and implemented, including the implementation of standardized and common user interfaces with other technological solutions, to allow their interconnection with existing infrastructures.

To carry out the implementation tasks, each one of the identified components will be led by one of the members of the task. A joint meeting will be held every two weeks, in which the status of the developments will be reviewed, those issues that must be transversal to the entire task or work package will be harmonized, and the task agenda for the next period will be proposed. The following table shows those responsible for each one of the components that are part of the service ecosystem of the S2CP platform[4].

Table 1. SOCS components and responsible partners

Component	Geospatial services	Cities2030 community	Good practices	Multi-actor approach tool	Blockchain enabled marketplace for SFSC	Supply chain transparency Use Case	Real-time monitoring
Responsible	UPM	UPM	UPM	SINNO	ITC	UNIL	UPM

The components will be developed in parallel, with several development cycles in accordance with the CDM methodology and the schedule planned for WP6 (described in D6.1). In any case, in order to achieve the planned Development Objectives within the established times, a work methodology will be followed that we briefly describe in the following subsections:

2.1 First phase

In the first phase, the requirements captured in T6.1 will be considered to proceed with the joint design of the SOCS, as well as the specific design of each of its components. The requirements and components identified within the general architecture (see D6.1) will be analyzed among all the members of T6.3 in order to identify, on the one hand, the software elements to be implemented, as well as their interrelationships, and on the other hand, the application interfaces to be integrated to allow the interaction between the S2CP platform and the previously existing infrastructures. These interfaces should be common in the state of the art, and it is always possible to conform to some commercial or research standard. Section 3 presents the results of this design process. In particular, Section 3.1 details the general design of the service ecosystem and its components; and Section 3.2 details the standardized application interfaces that are integrated into the aforementioned architecture.

2.2 Second phase

In the second phase, development work will begin in accordance with the general CDM methodology. To this end, an agile development scheme will be followed, in which Labs will be interacted with on a regular basis,

[4] The order of appearance of these components in the deliverable D6.3 does not meet any reason of relevance, development maturity or frequency of use by the Labs. It is agreed to follow the order described in section 5.2 of D6.1 where S2CP components are proposed for the first time.

either through specific workshops for the general public or through individualized and personalized bilateral training meetings for each of the Labs. As it is planned in the WP6 schedule, so far, 3 general workshops have been held with Labs. These workshops are the following:

- "WP6 and labs" workshop. 16th December 2021
- "WP6 and labs" workshop. 20th January 2022
- Analyze the challenge with WP6. 10th June 2022

The materials from these meetings, which were recorded to facilitate subsequent consultation of all the details by users, were made available on Correlate, the official platform of the project.

Additionally, many bilateral meetings were held with Labs to help them adopt the technological tools. Without providing an exhaustive list of said meetings due to their high number, we would highlight the following:

- Training meeting between UPM and Vicenza on the use of the Cities2030 Community component.
- Training meeting between SINNO and Seinäjoki on the use of the SSRI-MAA tool.
- Training meeting between SINNO and Trodos on the use of the SSRI-MAA tool.
- Multiple and ongoing relationships between ITC and Murska Sobota on the use of the digital twin of the supply chain.

Due to the bilateral nature of these meetings, the materials were delivered directly and privately to the participating Labs.

In general, all these meetings focused on those components planned for development in the first macrocycle of the CDM methodology (see D6.1). These components are: Cities2030 community (described in Section 4), Good Practices (described in Section 5), the innovation management tool, SSRI-MAA tool (described in Section 6), and blockchain-enabled marketplace (described in Section 7).

These components present different levels of maturity, since they cover the first complete macrocycle (M1 – M18) and a first part of the second macrocycle (M18 – M36). In Section 8 we can find both a description of the real maturity level of the components, as well as an analysis of the services that will be deployed throughout the second and third macrocycles of the CDM methodology in the context of T6.3.

2.3 Third phase and summary

Finally, once the final components are released, they are made publicly available to the entire consortium through the Cities2030 project website. In addition, specific user manuals for each of the components were made available to all Labs, which can be consulted in the Annexes of this deliverable.

The following figure represents the methodology followed in T6.3 and its relationship with the different sections of this document.

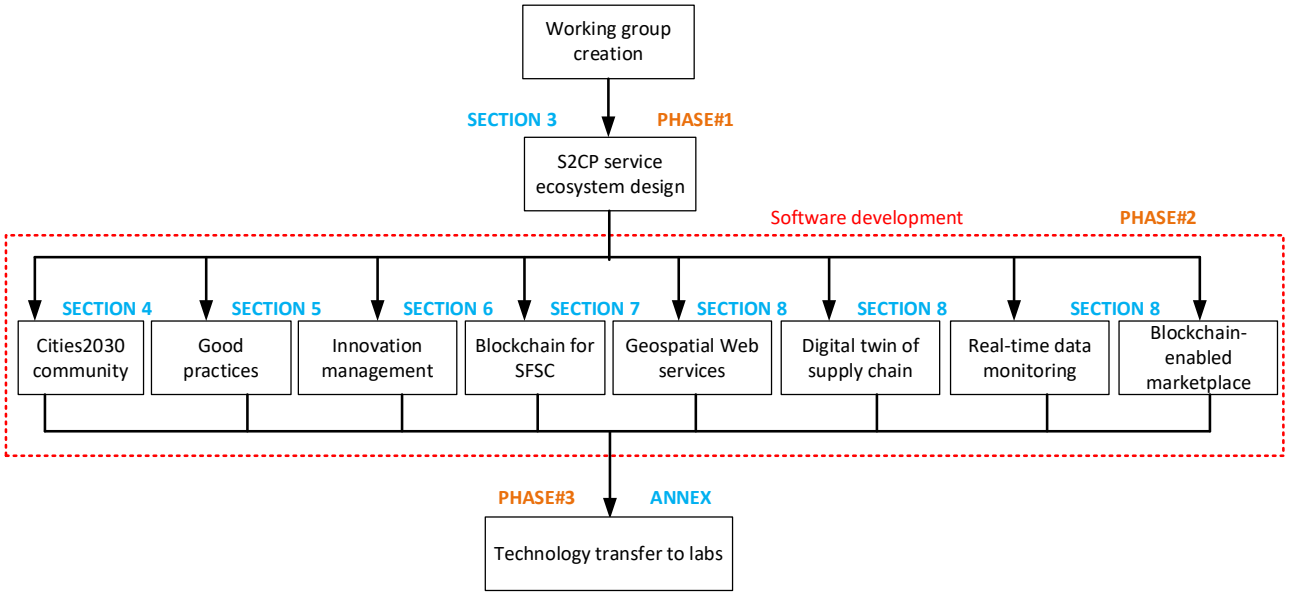


Figure 1. Methodology for the development of the SOCS

3 SOCS and S2CP service ecosystem: design and architecture

This section describes the architecture of the services ecosystem of the S2CP platform, as well as the standard interfaces that allow the interconnection of the platform and its services with existing infrastructures in the different Labs.

The first subsection is dedicated to presenting the general architecture of the service ecosystem, and briefly describing the components that comprise it. Subsection 3.2 contains an overview of interfaces common to state-of-the-art and internal and external systems that are used in the service ecosystem components.

3.1 Services and components

The following figure shows the proposed architecture for the services scheme. As can be seen, it is one of the subsystems identified in the general architecture of the S2CP platform in document D6.1.

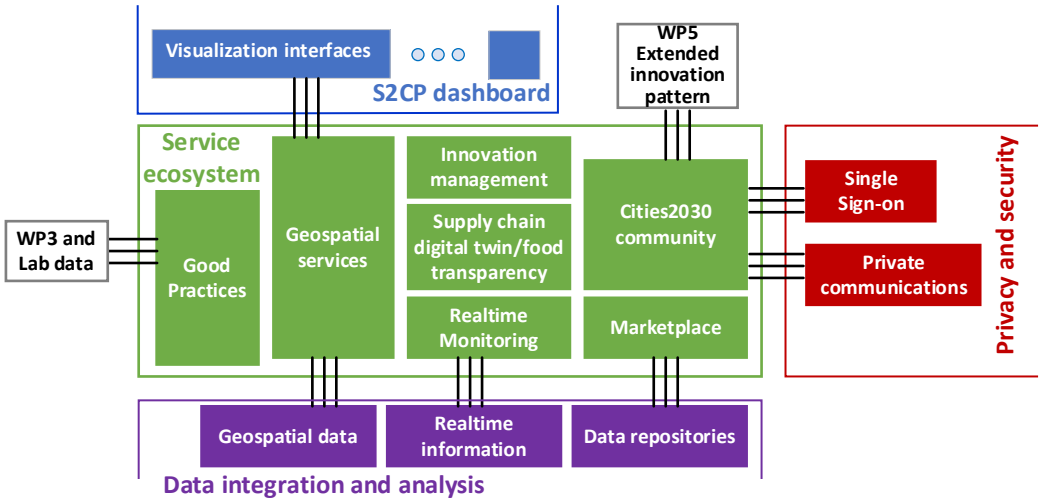


Figure 2. Service-based Open Collaboration Space architecture

Next, the components that are part of the SOCS architecture are detailed, and their relationships with other components of T6.3, WP6 and also their dependencies or relationships with other WPs.

3.1.1 Cities2030 community

Cities2030 community is an open collaboration space used by Cities2030 participants to improve their multi-stakeholder dialogue processes. This component facilitates community building among Cities2030 partners, as well as focus group creation (around CRFS topics) and cross-fertilization. It is useful to disseminate and share information on events, activities and results to target groups and to control the amount and quality of information shared externally. It was developed taking into consideration the open innovation methodology defined in WP5 (WP5 Extended innovation pattern), so that labs can extend their WP5 activities, generating useful information for the communication space.

As it can be seen in the previous figure, as it concorporates single sign-on functionalities (see authentication function developed in the Privacy and Security subsystem, T6.4), it can be used as an entry point to the S2CP platform.

3.1.2 Good practices

The CRFS Good Practices is a map platform for the good practices in innovations done within Cities2030 Project. Allows the introduction of innovation activities by any Cities2030 partner, so that a catalog of information can be compiled, for filtering, searching, and consulting (considering FAO pillars and MUFPP indicators).

This component has been the media for innovation of D3.7: 100 innovation frameworks for CRFS. Thus, this component includes the search efforts of the WP3 partners and the Labs in innovations in Europe, interesting to adopt in the study cities, to build innovations on these already proven good practices.

3.1.3 Innovation management platform: multi-actor approach tool

SSRI-MAA tool is a Web-based tool that aims to register and monitor the innovation at a well-defined Social Space. The main objectives of SSRI-MAA are:

- Catalog and monitoring of SSRI actions and action plans.
- Catalog and monitoring of stakeholders and their representativeness.
- Monitoring of SSRI maturity levels and progress.
- Context, Policy & Performance indicators catalog and monitoring (KPIs).

3.1.4 Blockchain enabled marketplace for SFSC

The Blockchain enabled marketplace for SFSC will secure intelligence and coordination actions by delivering an accurate system to record transactions in supply chain, also contributing on four key enablers of resilience and sustainability: security, ecosystem services, livelihood (e.g., growth) and equity (e.g., inclusivity).

Each SFSC stakeholder (except the consumer) is going to be equipped with a BC-related digital identity, whereby every SFSC stop will handle a BC transaction, digitally signed by a registered and verified SFSC stakeholder (e.g., producer, delivery service etc.). Each BC transaction will handle basic BC-related information (i.e., timestamp, digital identity, signature), as well as specific food (i.e., type, harvest region, harvest datetime, etc.) and logistic related information (i.e., LOT number, type, etc.). The proposed end-system will also enable the storage of digital proofs (i.e., harvest or delivery photos etc.), which can be stored on a related IPFS or Swarm network. The BC network consist of a *Hyperledger Besu* (Ethereum) Consortium Type BC network

One of the key components of the solution is also a mobile client, with which customers of food products access traceability records. A mobile device enables them to scan products QR code with the phone's camera and review the trackability record of a food product on a screen.

3.1.4.1 Other blockchain-enabled marketplaces:

Marketplaces will be developed for optimization of multi-stakeholder dialogue processes, in which blockchain is employed to provide some proof of concept of token-based monetization processes, in a reliable and transparent way.

These types of blockchain developments are very particular to the domain problem they seek to solve and require some difficulty for non-expert users to adopt said technologies. Some prototypes have been experimented with at the beginning of the second phase of development (M18 to M24), which we will mention in Section 8 as future developments.

The functionalities to be implemented in these marketplace solutions are the following:

- Registration of suppliers and consumers of digital assets.
- Use of the token concept (non-fungible token and fungible token) commonly used in blockchain systems for monetization.
- Provision of transaction traceability mechanism through blockchain.
- Security functions, such as authentication (secure access to the platform), authorization (possibility of access to the assets acquired) and guarantee in transactions (thanks to the blockchain infrastructure and direct access to the management of monetary assets.

This component is related to Task 6.2 for the management and possible purchase and sale of repositories, and with Task T6.4 for the provision of security mechanisms and Smart Contracts.

3.1.5 Geospatial Web Services

Geospatial CRFS Web Services use state of the art communication standards for geospatial data formatting, download, and access, following the maxims of interoperability with other geospatial systems, and the independence of the place or time in which the information to be represented was generated.

To achieve this compatibility, the designed system uses the standards of the Open Geospatial Consortium, such as the Web Map Service[5] and the Web Feature Service[6], which offer application programming interfaces common to all geospatial services and compatible with other geographic information systems deployed in all the world.

These geospatial services will allow the visualization of geospatial information from T6.2, by loading it into the database and accessing it through geographical information provision servers. Likewise, they will require a web visualization layer, which can consume the information and represent it in the form of cartography, to the end user. For this, this component will need integration with the S2CP dashboard that is being built in task T6.5.

3.1.6 Food transparency solutions (Unisot)

Food transparency solutions will be provided by UNISOT, a cost-efficient Software-as-a-Service based on blockchain infrastructures. UNISOT solutions can be used to track products from the first raw product producers – to logistics, production, distribution and all the way to the end consumer – preventing waste and unethical practices. Each partner can prove and share detailed product information, enabling customers to make environmentally friendly and sustainable choices.

UNISOT provides several key functions which are crucial in today's Lean/Just-in-Time Global Supply Chains, supporting their growing demand on speed, flexibility, sustainability and information accuracy.

- Global Interoperability

[5] OpenGIS Web Map Service (WMS) Implementation Specification: https://www.ogc.org/standards/wms

[6] OGC Web Feature Service (WFS) Implementation Specification: https://www.ogc.org/standards/wfs

- Proofs of Sustainability, Quality, Origin, and Ingredients
- Chain-of-Custody
- Track & Trace
- Product-Lifecycle-Traceability

3.1.7 Real-time monitoring:

Monitoring efficiency in food systems is paramount for CRFS actors. The real-time data monitoring infrastructure can receive information and events produced sensors (IoT HW platform), process the information in context-based systems and finally generate information repositories for real-time visualization or monetization.

To do this, a set of containerized services will be used (based on Docker technologies) that integrate solutions from the FI-WARE architecture (Orion Context Broker, QuantumLeap) with cloud services (CrateDB).

One use that this component will have will be the monitoring of the environmental conditions of the workers in a food production facility, linked to the Arganda Lab (Spain). The rationale for this use case is that the monitoring of food production processes in terms of energy consumed or sustainability indicators is paramount for food processing companies. A dashboard considering current production processes and their relations to other stakeholders will allow to understand inefficiencies for better decision making.

3.2 Common Application Programming Interfaces

In order to be able to interconnect the S2CP platform, and more specifically its ecosystem of services, with other pre-existing infrastructures in the different Labs, the developed components integrate common state-of-the-art interfaces. Each of these interfaces will be described in detail in the section dedicated to the corresponding component. However, in this section, an overview of all possible components and their standardized interfaces is provided. The following table displays this information in an organized manner.

Table 2. Summary of API and data considerations for SOCS components

Component	API model	Data considerations	Description and observations
Cities2030 community	REST API for third-party applications and websites Authentication: OAuth Google Maps JavaScript API and Mapbox API key	Data to be stored in SQL-based database, and periodically backed-up.	OAuth technology provided Single-sign-on functionality, that can be used by the rest of SOCS components for common login interface.
Good practices	REST API for practice registration con consultation. Authentication: passport-local auth strategy (user/pass).	Data and authentication sessions to be stored in MongoDB no-SQL database. Backups to be periodically generated.	Leaflet.js will be employed for map visualization. It provides standardized access to OpenstreetMaps tileset. Geographic locations to be expressed in WGS84[7].
Innovation management	Docker API for container management.Nginx proxy server for reverse proxy communications. Message broker will use MQTT (MQ Telemetry Transport) protocol. Email manager uses SMTP interfaces. REST API to serve and store data from frontend component.	Data is planned to be stored in MySQL database. User media files like images will be stored into a docker volume. Backups of database and media files to be periodically generated.	API REST authentication and user sessions use JWT Tokens. All communications between frontend and REST API are encrypted. React.js library has been used for frontend implementation.

[7] WGS84 information page: https://gisgeography.com/wgs84-world-geodetic-system/

Blockchain for SFSC	The solutions will use Hyperledger Besu JSON-RPC API methods which enables interaction with a Besu Ethereum node. API is developed, using Node.js technology and runs in Docker container.	Data is stored in following systems: • MongoDB • Ethereum Smart Contract • IPFS network (InterPlanetary File System) • SFSC business management system software	JWT (JSON Web Token) standard is used for authorization and encryption of communication
Geospatial Web Services	OGC standards WMS and WFS will provide common APIs for geospatial information visualization.	Data persistence will be ensured by PostGIS database (POstgress + spatial extension) + Geoserver setup.	Style visualization will be provided using client-side web programming. Styling GeoJSON data coming from Cloud-based environment.
Food transparency solution	Interfaces to Metaverse public blockchain. Integration with common Enterprise Resource Planning (ERP)	Data for this use case will be provided by a specific scenario defined by a CRFS lab. Digital product passport with QR access will be provided.	Data among submodules are not sharing. UNISOT platform is used for demonstration only and proof of blockchain technology in the food supply chain.
Real-time monitoring	Web communications (HTTP/TCP) for sensor data logging. NGSI v2 interface for notifications.	QuantumLeap will persist Data to a CrateDB database. CrateDB SQL to storing sensor information updates.	Timeseries will include multiple samples per minute. Some cloud-based infrastructure must be provided to support scalability.
Blockchain-enabled marketplace solutions	Web3.js will provide an interface for interaction to Ethereum blockchain. XML-RPC will be used for connecting to Eth wallet.	Data repositories will be stored in IPFS. Information regarding transactions will be stored in Solidity smart contracts.	A block explorer will be provided to demonstrate reliability in transactions (monetary asset management).

4 Cities2030 Community

This section describes the Cities2030 Community component, the open collaboration space used by Cities2030 participants to improve their multi-stakeholder dialogue processes.

4.1 Data sources

The information used for the creation of this component comes mainly from the processes established in WP4 and WP5 to create an open innovation structure around the CRFS Labs objectives and capabilities. The absence of tools in the project to improve communication between the labs, together with user requirements about the advantages of having a communication space, have been the triggers for the design of this component.

The relevant information sources, taken into account for the implementation of this component have been:

- WP4: Policy lab innovation methodology
- T5.2: Extended Innovation Pattern (EIP)

Next, we will describe both data sources:

The innovation methodology of the policy labs has been launched in the framework of WP4. This methodology defines a series of phases for policy co-creation, which are listed below:

- Phase #0: Get the information about your CRFS (agents, relations, etc.) from different sources
- Phase#1: Analyze the current state of your CRFS
- Phase#2: KPI selection and action points

- Phase#3: Public communication and social dissemination

To align this proposal of phases to the communication environment of the Cities2030 Community, the elaboration of the CRFS Action section has been proposed, which maintains working groups for each of the key thematic areas of the Cities2030 CRFS framework. In that section, policy labs can establish a communication space around CRFS themes. The objective is to review initiatives, provide solutions and discuss approaches from other labs and the state of the art.

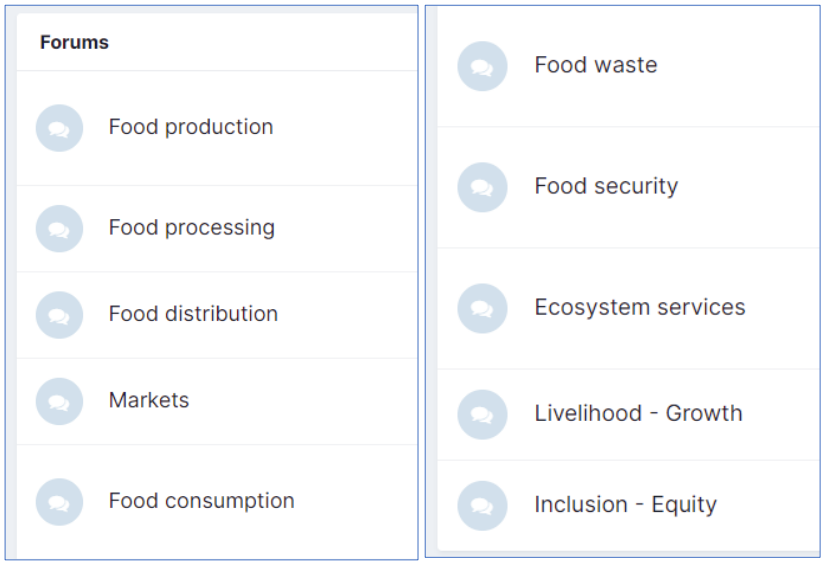


Figure 3. Community structure to support policy-cocreation

Another relevant information source is the definition of the Extended Innovation Pattern (EIP) proposed in task 5.2. By this means, communication between stakeholders is facilitated to read additional materials, carry out tasks to promote development and innovation activities, create content for communication & dissemination, assess impacts, and gather pieces of evidence for Key Performance Indicators.

A forum page was created for the communication of results on EIP and general discussions, for their visualization by all the cities partners. Below, it can be seen a screenshot of the information currently contained in the forum and of public access for the partners of the consortium:

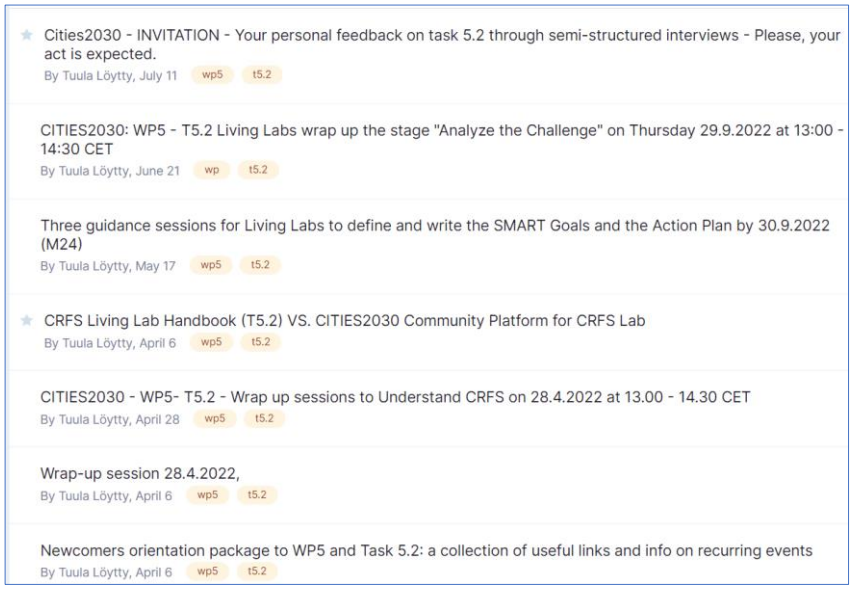


Figure 4. EIP support in Cities2030 community

EIP makes a Handbook available to Labs, through which Labs can advance in the processes of creating their collaborative ecosystem following the open innovation paradigm. From the Communities component, a structure has been created so that the Labs can follow up on the EIP according to the following phases proposed by WP5:

- #0 CRFS Living Lab for Developments and Innovations
- #1 Understand CRFS
- #2 Analyze the Challenge
- #3 Experimenting
- #4 CRFS-LL Dashboard

The differences and common characteristics have been studied to establish a reference framework for how to engage labs in each of these solutions. In the following figure we can see a summary of this analysis:

	The Handbook for CRFS Living Labs at Google Drive	Cities2030 Community platform for CRFS Labs at S2CP
Target groups	CRFS Living Lab partners, peer CRFS Living Labs, other consortium partners, and EC auditors. INTERNAL target groups.	Project partners, CRFS Labs' stakeholders (even an own forum) and the big audience. EXTERNAL & INTERNAL target groups.
Language	English	English and also local language at stakeholders' own forum
Purpose	***For CRFS Living Labs' Back Office operations*** • To implement Extended Innovation Pattern • To grasp the overall roadmap from Y2 to Y4 • To propose guidance • To "make people" and "equip people" • To promote co-work between WPs and tasks • To document the planning of activities, events, meetings • To document the process • To report the progress and performance • To gather evidence of actions, measures, results and KPIs	***For CRFS Labs' communication and dissemination activities*** • To facilitate community building among Cities2030 partners, and beyond • To facilitate focus group creation (around CRFS topics) and cross-fertilization • To follow up and communicate with Cities2030 partners, and beyond • To facilitate giving and receiving feedback and comments among partners • To disseminate information on events, activities and results to target groups • To share events through the calendar and invite partners and stakeholders • To gather digital files into Labs' calendar on events, workshops,meetings etc. • To disseminate project results (e.g. best practices) to target groups • To control the amount and quality of information shared externally
Content	Documentation and evidence of CRFS Living Lab partners co-design, co-creation and efforts: ideations, plans, discoveries, observations, links to references and sources, reflections, activities, events and results.	CRFS Labs' communication with and for target groups CRFS Labs' activities and events in calendar for target groups CRFS Labs' findings and results dissemination to target groups
Level of standardisation	The standardized starting point, but room for variation and unique implementation, as long as set requirements are fulfilled.	Open, flexible and adjustable according to CRFS Labs' needs and requirements.

Figure 5. WP5's Handbook vs WP6's Community differences and synergies

Following this summary, a proposal has been made within the Communities component, where labs can be supported to complement the work of the Handbook. As an example, the structure created for the Arganda Lab is shown, although the structure is not fixed and could be decided by those responsible for each lab.

Figure 6. Communication structure for Arganda Lab

4.2 Detailed functionalities

The most relevant features of the Cities2030 Community are described below:

- Facilitate community building among Cities2030 partners
- Facilitate focus group creation (around CRFS topics) and cross-fertilization
- Facilitate giving and receiving feedback and comments among partners
- Disseminate and share information on events, activities and results to target groups
- Gather digital files into Labs' calendar on events, workshops, meetings etc.
- Control the amount and quality of information shared externally

These functionalities are presented on the platform through various tools, which we present below:

Lab community pages

The lab community pages allow the CRFS lab to create a social network profile and manage the provision and access to content. Lab owners and their delegates have administration permissions, and can accept invitations, structure their lab sections, and post calendar events, forum posts, and graphic evidence of innovation activities.

The following figure shows the access page to 4 labs as seen on this platform:

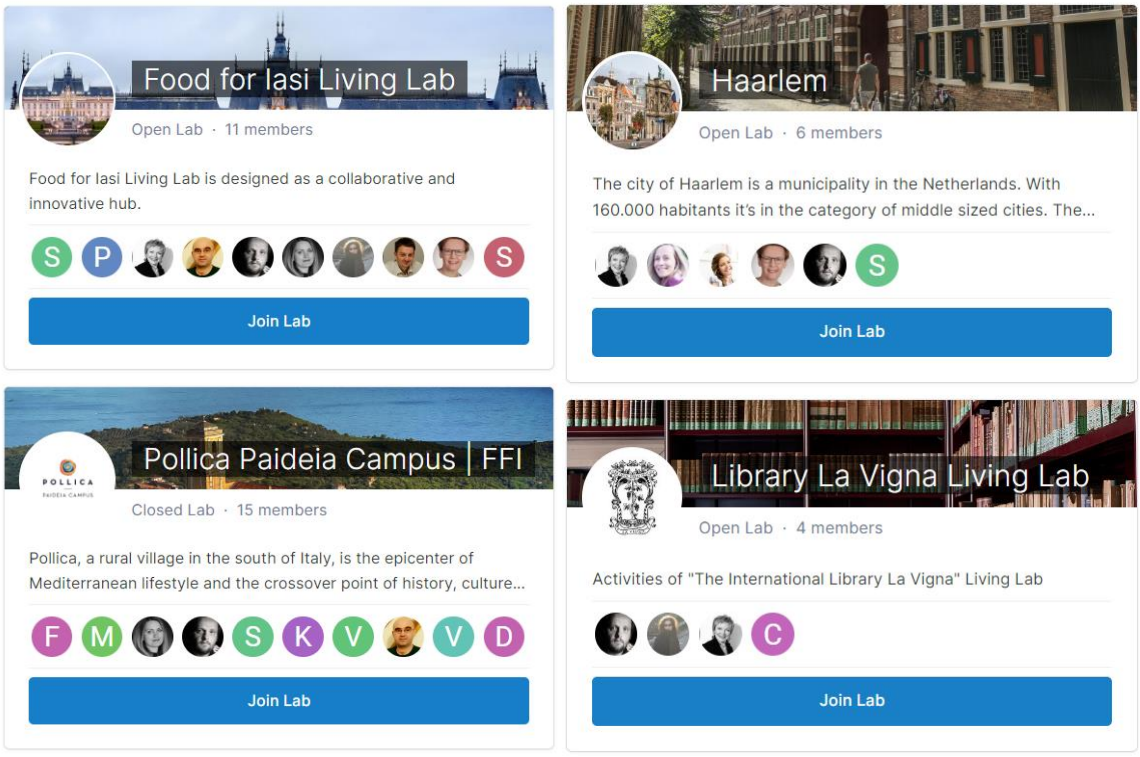


Figure 7. Lab community pages

Discussion Forum

Apart from hosting lab activities, the Communities platform is also used to support the WP3 CRFS Alliance, for which the Forum functionality is used. The forum is divided into sections and the visibility level of each section can be configured, providing a layer of security so that external stakeholders, or other unidentified parties can access project content.

Figure 8. Map of sections created in Forum

Calendar

The last functionality to mention is the calendar. A calendar is implemented to disseminate and share information on events, activities and results.

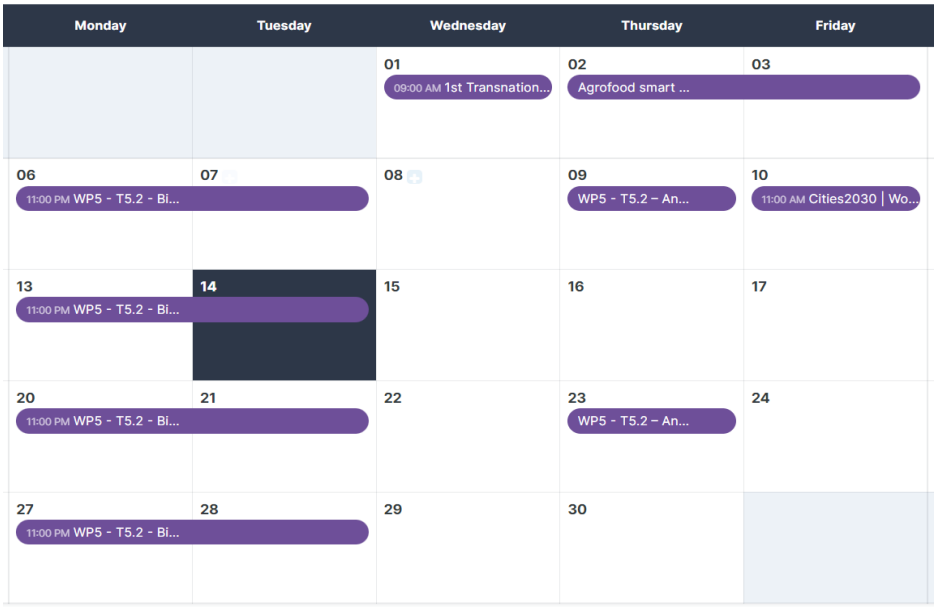


Figure 9. Cities2030 Community calendar

Future planned functionalities

Taking advantage of the large number of registrations between the Cities2030 and also the Alliance partners, we consider that the following functionalities may be relevant in the next phase of development:

Blogs

To help in the dissemination tasks and to connect with the efforts that are taking place from WP7, the incorporation of a Blogs tool is proposed, which facilitates the publication of news related to the activities carried out within the framework of the Labs. Dissemination actions are currently being carried out on social networks, but additional support in the form of a forum would introduce improvements over the current approach, in relation to the following points:

- There is no character limitation to offer the news, so the labs could publish complete articles.
- There is no limitation regarding the number and quality of images. This would allow a detailed photographic report to be made.
- The information would be stored on the project platform (Cities2030 Community), which would facilitate the search and access to information by the Cities2030 project participants.

Data sharing mechanisms

It is proposed to incorporate a functionality by which users can upload their data repositories and share them among all registered users. Monetization mechanisms will also be studied to enable new exploration strategies in the capture, analysis and presentation of CRFS data.

4.3 Interfaces and user interaction

Finally, we describe how users interact with the application through the defined interfaces. The table in Section 3.2 provides a summary of API and data considerations for SOCS components. In the case of the Community component, the use of authentication is specified through the OAuth protocol, which allows single-sign-on functionality and profile-based access to different points on the web. Also, the use of mail interfaces (SMTP) for email communications about the registration process and other notifications. In addition, the Google Maps JavaScript API for the positioning of the labs and registered users in case they provide information about their location in the registration process.

Regarding the registration system, the user must complete their project profile, indicating if they are a partner in Cities2030 consortium, the name of the organizations and the CRFS lab(s) in which he/she belongs. The following figure shows the interface that allows users to define their profile on the platform.

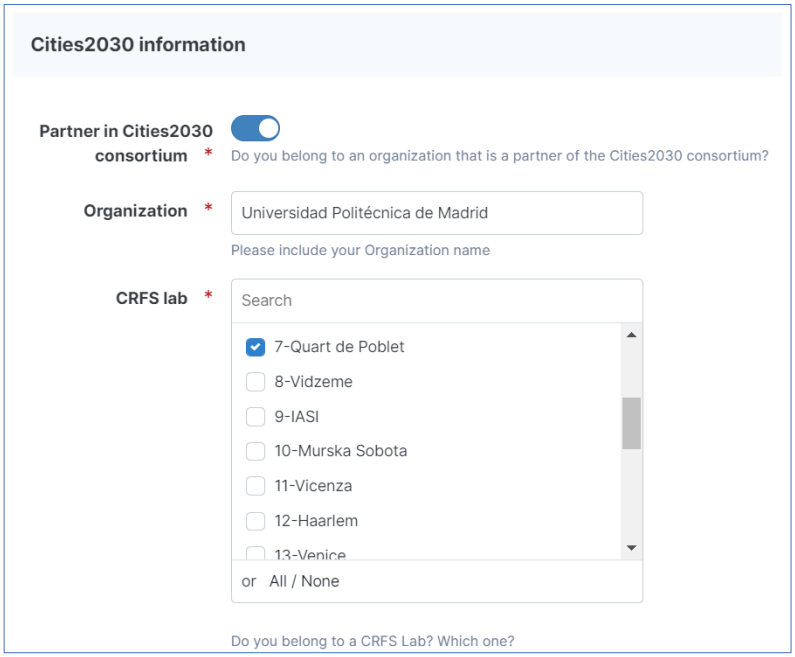


Figure 10. User profile options in Community registration process

The information provided will allow the lab owners to have more information to authorize the contributions of these users in the communication space, as well as the platform administrators to include them in groups with different permissions. In the following figure they can be seen the groups created and the members registered in each group at the date of preparation of this deliverable.

GROUP NAME	MEMBERS
Administrators	2
Alliance Partner	25
Cities2030 partners	49
Guests	1 guest (Online)
Moderators	0
Registered	4

Figure 11. Map of sections created in Forum

Each of these groups has different permissions to access certain functionalities. For example, Alliance partners can see the labs created but can only access their content with prior authorization from the lab owner. They can also see the calendar but not register events. Instead, Cities2030 partners can register events, but cannot create or delete lab pages without authorization. Administrators can perform these authorizations, in addition to changing the group of all registered users.

As can be seen in the figure, so far, we have 80 registered users, considering cities2030 partners, alliance partners, and other roles.

In relation to communications with users outside the platform, the SMTP mail servers are used to validate registration, send notifications to a user, and for platform administrators (managed by UPM) to receive requests, such as the authorization for the registration of a new Lab on the platform, for example Haarlem:

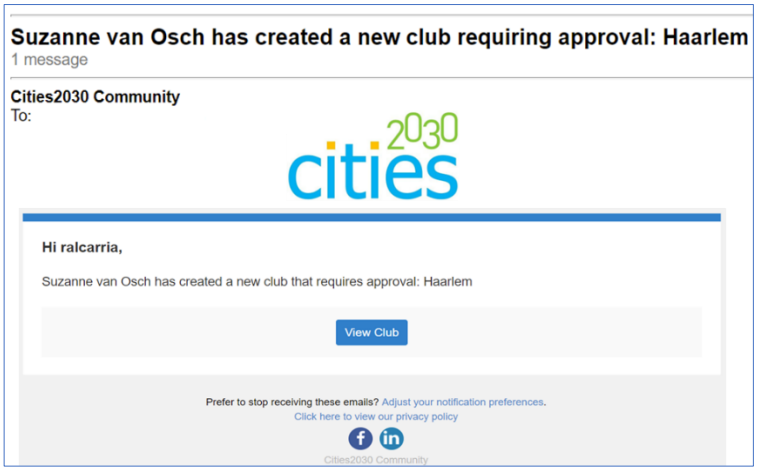


Figure 12. Email notification to admins for Lab approval

Finally, the API provided by Google Maps is used to represent users and labs, as can be seen in the following figure, where all registered labs are represented.

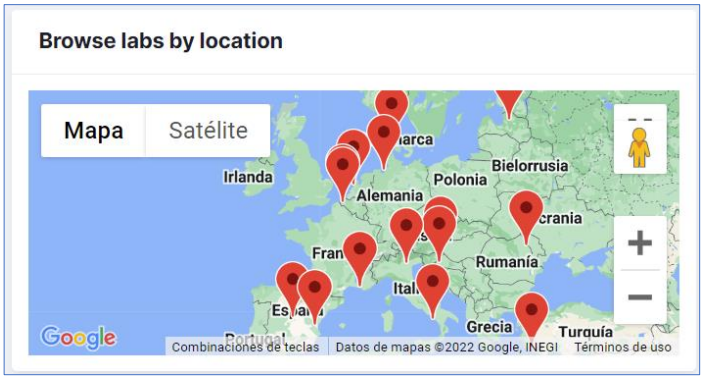


Figure 13. Use of Google Maps API for map of labs (left) and profile of each lab (right)

As some indicators: 17 labs have been created into the platform.

One last mention to the calendar, which constantly contains approximately 7 events per month, ranging from internal project meetings, coordination meetings, WP6 workshops with Labs and also food events in Europe, such as the Agrofood smart specialization event in June 2022 in Roeselare, Belgium.

Linking to the information in this section, Annex I presents a user guide detailing the main screens and the way that Cities2030 users have to land on the platform.

5 Good practices

This section describes the Good Practices component, a map-based platform to allows the introduction of innovation activities by any Cities2030 partner, so that a catalog of information can be compiled, for filtering, searching and consulting (considering FAO pillars and MUFPP indicators).

5.1 Data sources

The main data source for this component is T3.6, which results in "The 100 Innovation Framework". This framework aims to explore and map the novel trends in several applicable spheres of the food system, identifying emerging digital and technological solutions, start-ups, practices of local communities, findings of international research projects and other initiatives that promote positive transformation in CRFS.

This task has collected 140+ innovations and good practices from more than 20 countries (e.g., the EU countries, Iceland, North Macedonia, Turkey, the USA, Canada and other). Innovations were clustered in Cities2030's 10 key thematic: food production, processing, distribution, markets, consumption, waste, food security, social inclusion & equality, ecosystem services, and livelihood & growth.

A Google Form survey was created by P25 for Cities2030 partners to collect innovations from their network, considering the following sections:

- Partner collecting the innovation
- Innovation title
- Description of the innovation. (What is it? What problem or issue it helps to solve in the CRFS? Who are the main beneficiaries or users? How is it implemented?)
- Thematic area (from Cities2030's 10 key thematic)
- Impact on CRFS (What positive impact innovation has on CRFS?)
- Innovation potential for learning or transfer (How and why the innovation potentially could be interesting for other cities or regions to learn from?)
- Source of information on innovation: 1) organization name (developer or implementor), 2) website or active social media account (Facebook, Twitter, Linkedln, etc.)
- Location of innovation (city, region, country)
- Representative picture

This fields where mapped to the ones that are provide via the "Good practices" tool, as it is seen in the following table:

Table 3.Field mapping between 100 Innovation framework and Good practices SOCS component

"The 100 Innovation Framework" fields	"Good practices" fields		
Partner collection the innovation	Username / Email		
Innovation title	Title		
Description of the innovation	Description		
Thematic area	Field		
Impact on CRFS	Description		
Innovation potential for learning or transfer	Type		
Source of information on innovation	Link		
Location of innovation	Region	Country	Geographic coordinates
Picture	Image(s)		

A web form was provided so that partners could register their collected innovations. Some pictures of the good practice registration process can be seen in Annex II.

Once the articles are registered, they are saved in a no-SQL MongoDB type database, following the structure of the figure below:

Figure 14. Database structure for Good practices component

The reason for choosing this database is that it allows information to be stored with different structures. This allows tool developers to subsequently modify the set of fields that describe the innovation (see previous table) and not have to change the structure of the database.

In the database we use three different schemas, one for the published Good practices, another for the Good practices before validation, and a last schema for users. Each of these schemes has a certain type of data, in addition to offering a wide range of functions, which allow us to create, modify, delete or consult data, which facilitates their management. Information about authentication sessions is also stored in the same database, which is being backed up regularly.

5.2 Detailed functionalities

Next, we detail the functionalities of this SOCS component:

- Authentication in the form of Registration and Login / Log out.
- Different user profiles: administrator / moderator / publisher user / visitor user
- Provision of map for spatial visualization of contributions. The map shows the points with a cluster-based control, so that the markers are aesthetically more uniform in areas of greater accumulation of points.
- Provision of filters by country. Search bar for textual filtering.
- Provision of controls for article organization by date and title.
- Article validation mechanisms, prior to publication: An administrator checks the articles proposed by other users, being able to delete them if they consider that they are not correct or validating them and adding them to the catalog if not.
- Programmed from scratch at the project development time. Free source code and available on Github.
- Deployed in a virtualization server (Cloud system) in facilities of *Universidad Politecnica de Madrid* (P20).

We are going to detail the last two points, since the rest of the points are described in greater depth in the following section on interfaces and user interaction:

The programming of the Good Practices component has been done using the following libraries and languages:

NodeJS: It is an environment that works at runtime, normally used for the server side, and based on javascript, although not exclusively limited to it.

Express: It is one of the most well-known web frameworks of Node, used in this project due to its addressing possibilities and its route handler, making it much easier to send parameters for later use in another direction.

Leaflet: It is an open-source JavaScript library used for creating interactive maps in web applications. Used in this project due to its ease of learning and implementation when adding it to the project under development, allowing the latitude and longitude coordinates of each of the articles in the web catalog to be displayed.

Passport: It is a library that allows us to carry out the authentication process when registering or connecting to our application. In addition to make it possible to access certain routes only by having a session started, and distinguishing users by certain roles, granting some permissions or others as appropriate.

Mongoose: It is a library that is used in a NodeJS application that has a MongoDB database. It allows defining schemas with typed data and, in doing so, allows us to create a model following one of the previously defined schemas.

Bootstrap: It is a library that is used for the design of web applications, allowing an adaptable and cleaner interface, with easy learning and that offers a multitude of options when it comes to improving the visualization, in this project it has been used, among other things, for the header of the page.

Session: Through this library, we can save the session data on the server, allowing better management when a user connects to the catalog, being able to remain connected as long as they want.

The following figure shows the GitHub repository where the application is located:

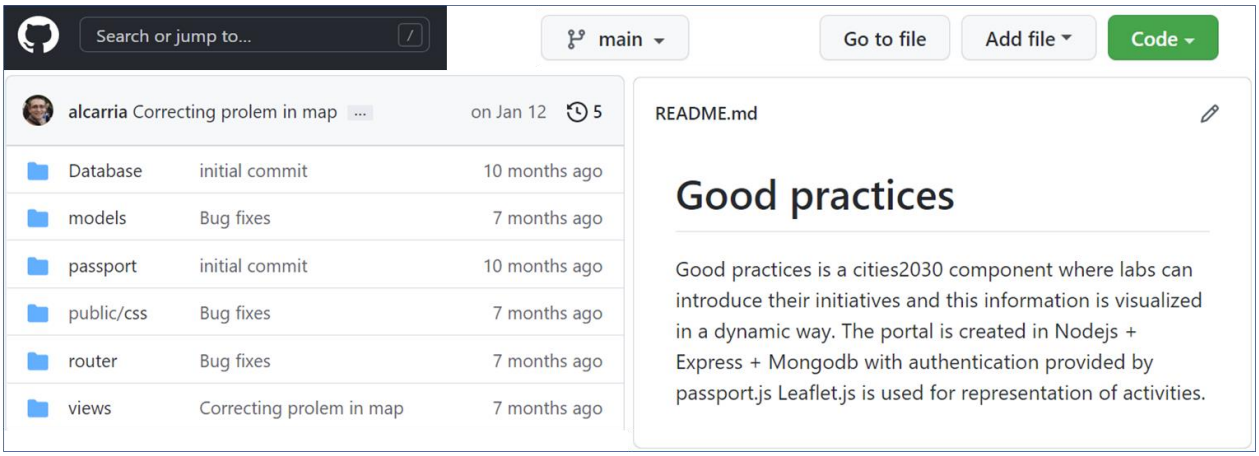


Figure 15. Github repository with Good practices source code.

Finally, the component is deployed on a cloud server with the following characteristics: Linux architecture (Ubuntu 20.04 LTS) with the following hardware characteristics: Dell R540 Rack 2U, 96 GB RAM, two processors Intel Xeon Silver 4114 2.2G, HD 4TB SATA 7.2K rpm.

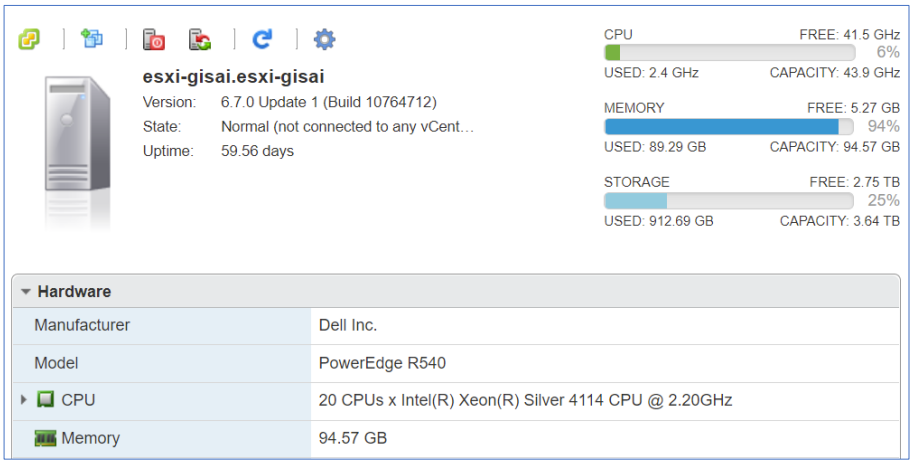


Figure 16. Cloud server used for Good practice deployment

5.3 Interfaces and user interaction

In this section we have the interfaces with which users interact in the use of this application. We will describe the validation view, the main administrator view, and the map interface.

The validation view allows the administrators of this platform that, in the event that there is an article to be validated, the administrator can decide whether to validate the article, which will cause it to be removed from the database of possible articles and added in the main table of articles or delete it if required data is missing or inappropriate content is found. The following figure shows the data from the article validation environment.

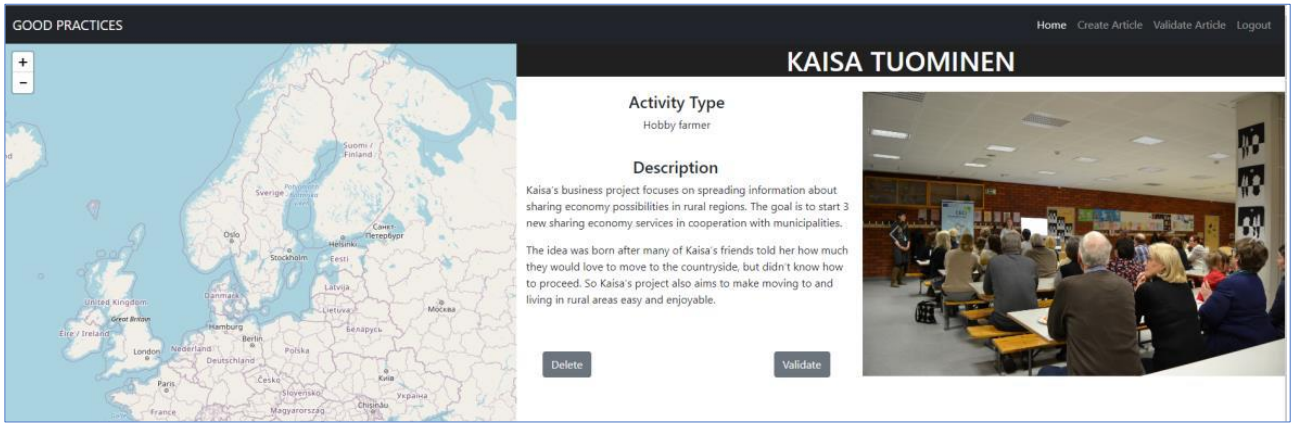


Figure 17. Good practice validation by administrators

The main admin view appears when the user logs in as an administrator. The main page is shown in this way in which new options appear, specifically the option to delete the articles or modify their content.

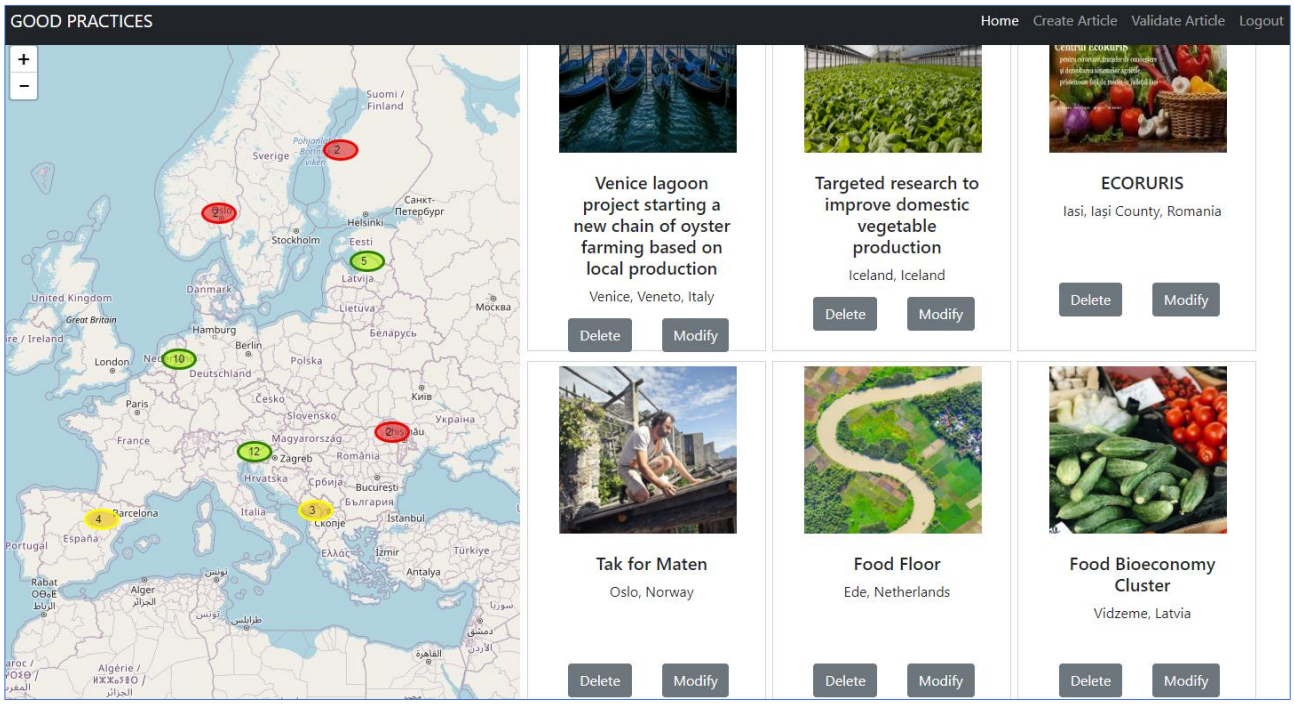


Figure 18. Main view with admin rights

In this last image the map can be seen on the left of the screen. Leaflet.js technology is employed for map visualization. It provides standardized access to OpenstreetMaps tileset. The *Markercluster* controller is used for smooth visualization in places where markers may be in close proximity.

On this page the administrator can modify and delete articles already validated. Once the administrator decides to update one of the articles, he/she only must press the "Modify" button, this action takes the administrator to the page shown in the following figure.

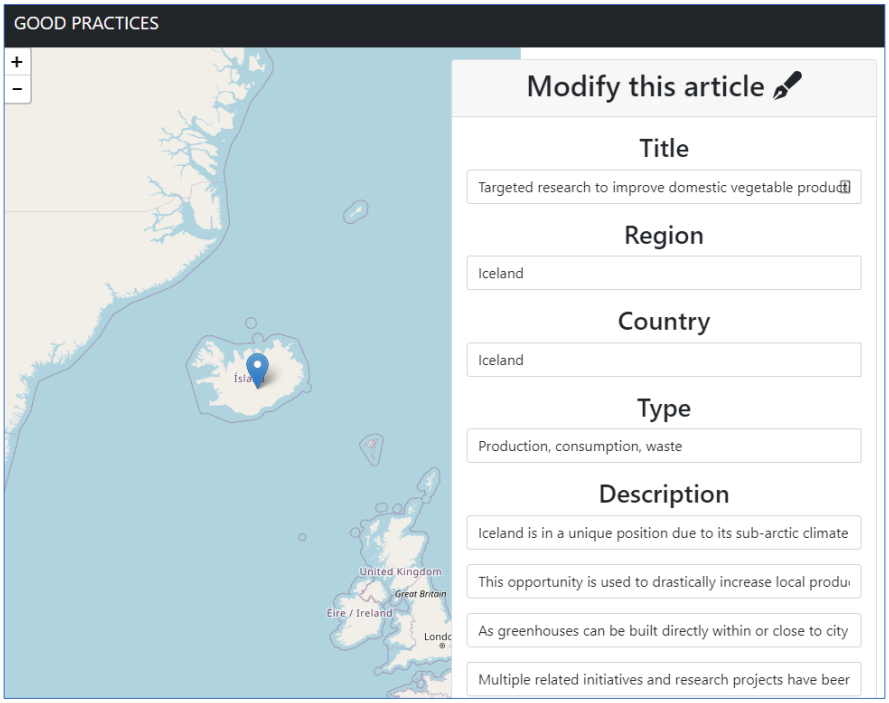


Figure 19. Good practice modification once validated

Once there, it is only needed to modify the fields of the form that is displayed, and when validating, a pop-up window appears asking if we want to keep the changes or cancel them. If we decide to keep them, the navigation is returned to the main page, where the modified is accessible to check the changes made.

Annex II presents a user guide detailing the main screens and the way that Cities2030 users must land on the platform.

6 Innovation management platform: SSRI-MAA tool

In their search for mechanisms to improve CRFS, Labs must carry out a complex process of innovation. This process must be guided at all times by a series of indicators, whose evolution throughout the entire process must determine the success or failure of the proposed innovations. For this reason, it is essential that in the experimentation phase of the different innovation methodologies of the Labs, there is a mechanism for the definition and monitoring of KPIs; as well as for the definition of objectives, agents involved, etc. This service ecosystem component of the S2CP platform satisfies this need while managing Social Spaces for Research and Innovation (SSRI) and their stakeholders.

EIP-AGRI[8] fosters an iterative innovation model for the development of research into practical applications and the creation of new ideas thanks to interactions between actors ("cross-fertilization") and the sharing of knowledge. The interactive innovation model is implemented through the SSRI-MAA (Social Space for Research and Innovation – Multi Actor Approach) tool.

This methodology is fully aligned with Open Innovation Methodologies and Living labs promoted by Europe since 2010 and with the experiences and lessons learnt for Rural Development Policies through Local Action Groups, (LAG). Operational Groups (OG).

SSRI-MAA is a Web-based tool that aims to register and monitor the innovation at a well-defined Social Space. The main objectives of SSRI-MAA tool are:

- Catalog and monitoring of SSRI actions and action plans.
- Catalog and monitoring of stakeholders and their representativeness.
- Monitoring of SSRI maturity levels and progress.
- Context, Policy & Performance indicators catalog and monitoring (KPIs).

Also, it is important to highlight that SSRI-MAA tool is not intended to be a networking nor collaborative platform. The entities and forms that manages are the following:

- Social Space definition and stakeholders.
- Objectives and actions.
- Catalog of stakeholders and its representativeness in the SSI.
- User stories, user needs addressed.
- Catalog of actions and outcomes.
- Test & Trials.
- Ethical issues and social-market framework management.
- SSI KPIs monitoring & impact.
- Actions monitoring & impact.
- DSS and Dashboards.
- Catalogs, (Type of actions, KPIs, etc.).

[8] https://ec.europa.eu/eip/agriculture/en/european-innovation-partnership-agricultural

6.1 Data sources

SSRI-MAA tool collects the following kinds of information:

- User's personal information like name, surname, address, phones, social networks and email.
- Stakeholder's information, including name, type, social networks and representativeness. This last field refers to numeric values of the maturity of the stakeholder in a variety of strategic areas.
- Social Space Information, including name, description, photo, context indicators and goals.
- Actions information. It refers to actions made by stakeholders in the scope of a Social Space. It includes name, description, date, type, indicators and goals.

It also collects both text and numeric fields in its web forms. It is also capable of importing data through JSON, CSV and XML formats. It includes both Text and numeric fields as well.

The size of data sources will be small in the context of WP6. It will include at least four or five social spaces with some stakeholders, actions and working groups inside.

The data from Cities2030 labs will only be reused in the scope of the Cities2030 project in order to generate reports about social space performance and activities.

Users access data in the tool through a web-based application (frontend) that communicates with REST API. This component validates data provided by frontend and finally stores it by using a database system.

Data validation has three phases:

- Front-end validations. Field validations performed in web-based forms. These validations are performed in client side.
- REST API Validations. The API services check data provided by frontend and validate each field. Once all fields are correct, data is sent to database system.
- Database validations. MySQL performs the last validations before inserting data into the database.

MySQL has been chosen as database system to manage all the persistent data of the tool. The number of data entities, their relationships and the complex of data model are the reasons to choose a SQL database and MySQL provides a powerful, secure and fast database engine to manage the data of social spaces.

The relational schema has five main entities: user, social space, stakeholder, action and working group. Each stakeholder, action and working group belongs to a social space so they store a foreign key of their social space in their tables.

There are other secondary entities like goals, indicators and members. These entities are also related to a social space.

6.2 Detailed functionalities

The main functionalities of SSRI-MAA tool include Social Space, Stakeholders, Working groups and actions management. All functionalities are implemented as web-based forms. Each information entity like Social Space, Stakeholder, Working group or Action, is created or updated through its web form.

When the user is inside social space form, it will see five blocks or sections available in the top bar of the tool: general information, strategic goals, stakeholder and actions The first two sections include fields to manage social space. The third one shows the Stakeholders management tool. Fourth is for Working groups and the last, for Actions.

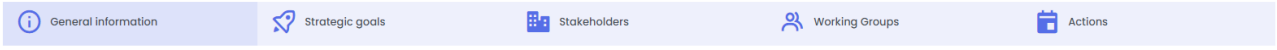


Figure 20. SSRI MAA Tool social space form upper menu

General information section includes general fields like name, logotype, main goal of social space, context description, problems addressed, area covered, type of activity, type, country and region. It is also possible to define keywords to classify the social space in the Tool.

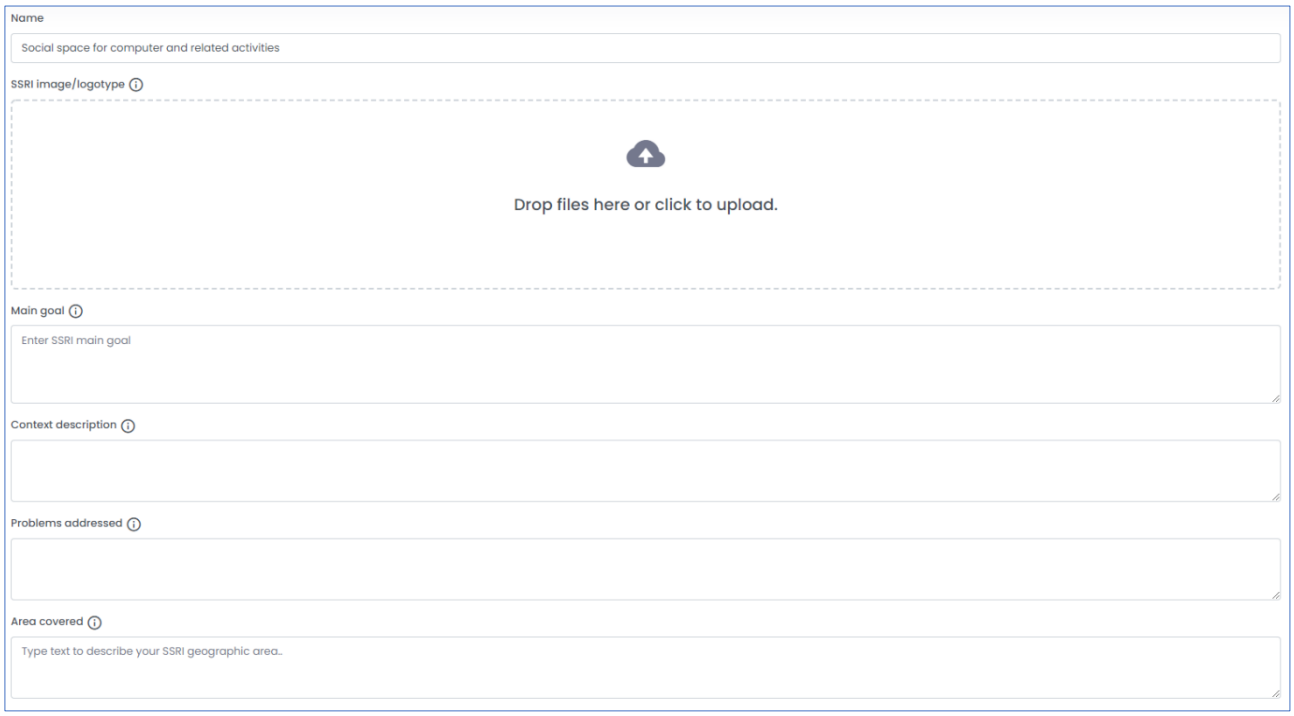


Figure 21. SSRI MAA Tool social space general fields

Social Space form also allows defining one or more context indicators. For each context indicator users can fill the name, description, values and year.

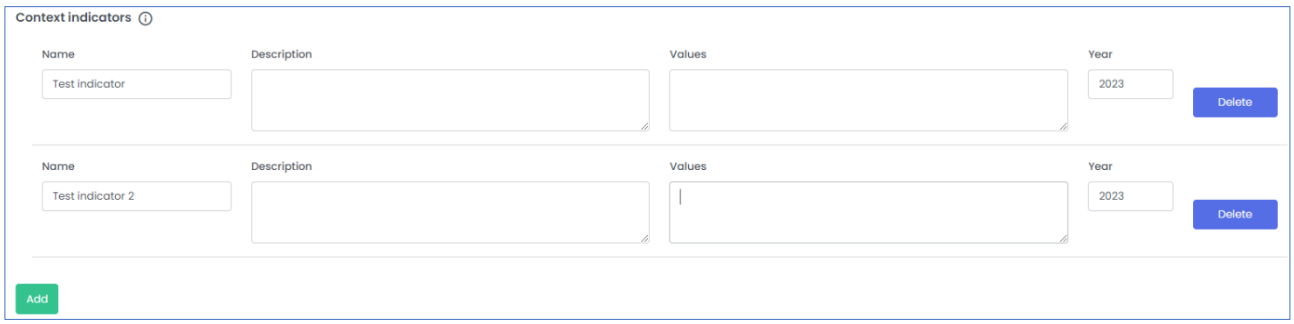


Figure 22. SSRI MAA Tool context indicators

In the Strategic goals section users can define the strategic goals for the context of the social space. Per each strategic goal users can include the name, description and expected outcomes.

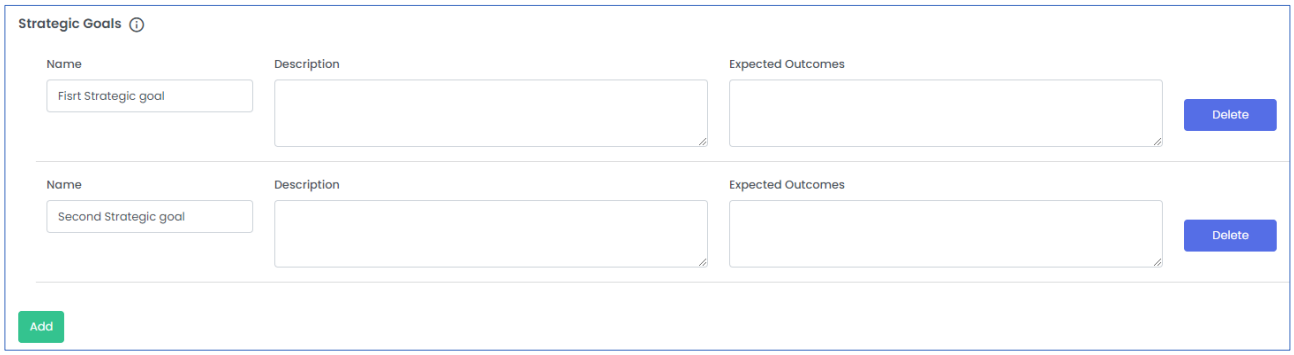


Figure 23. SSRI MAA Tool strategic goals

Stakeholders section lets users create, update, or delete stakeholders in the context of a social space. The create/edit form lets us manage fields like name, type, contact details, address, social networks, website and representativeness of each stakeholder.

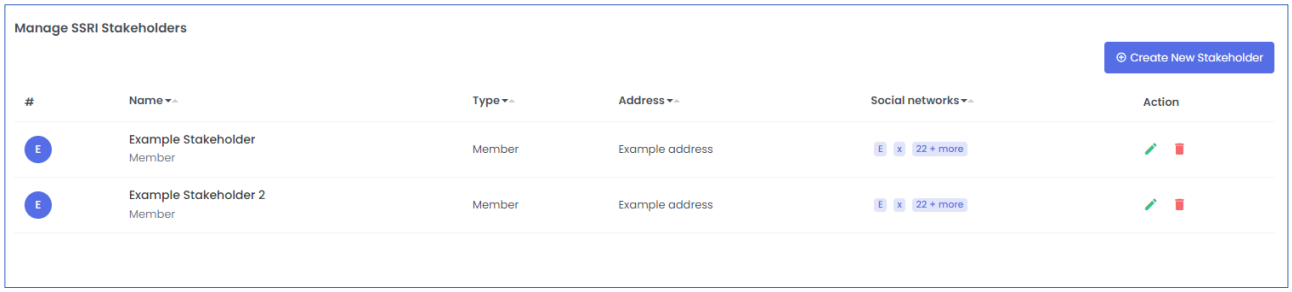


Figure 24. SSRI MAA Tool stakeholder management

The representativeness tool lets manage the impact of the stakeholder in five pillars: Social, Policy-Government, ICT and Infrastructures, Training/Education and Market-Economical. Inside each one of these pillars, users must select the weight of Contribution, Legitimacy, Engagement, and Influence. While the user adjusts the weight of each pillar, a graph next to the bars will be updated at the same time and is showing a polygon formed by the vertices of five pillars of representativeness.

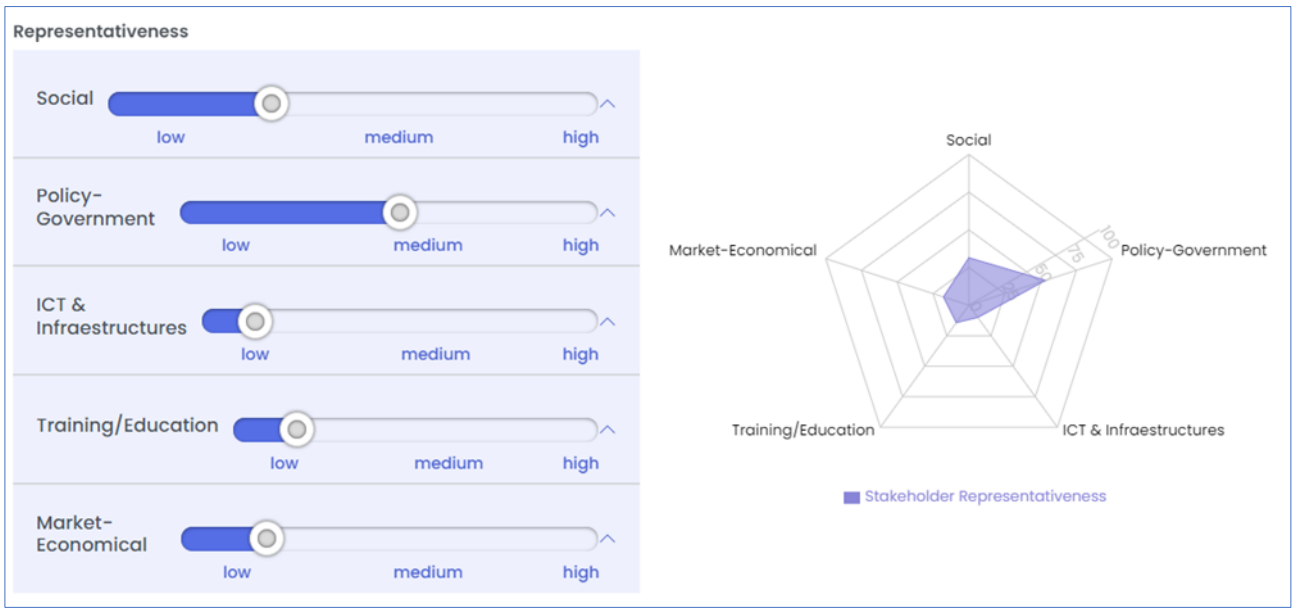


Figure 25. SSRI MAA Tool representativeness

Working groups section lets users manage the teams involved in the different actions performed in the social space. In this section users can create, update or delete each one of these teams. In the working group creation/update form users can enter the name, description and the members of each team. The last section of this tool is for action. In this section we can create, update or delete actions in the context of social space.

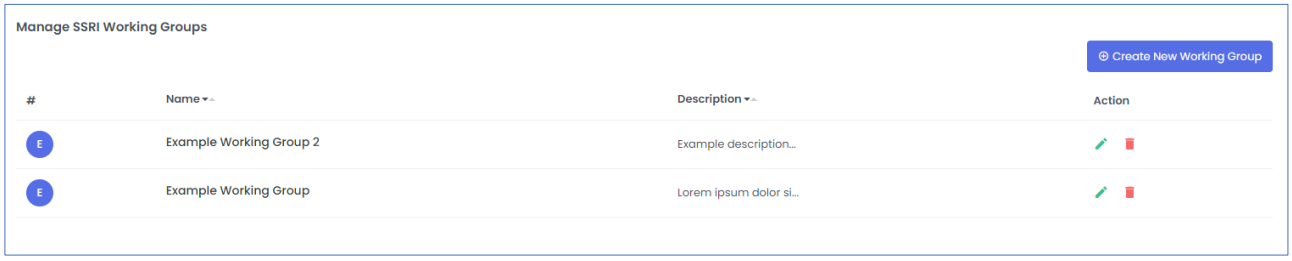


Figure 26. SSRI MAA Tool actions management

In the actions form, users can enter the name, description, member who carries out the action, scope, date, type of action, type of co-creation, outcomes, needs, key indicators, main participants (from working groups of members of the social space) and related goals. Related goals allow to trace the actions and the strategic goals previously defined in the related goals section.

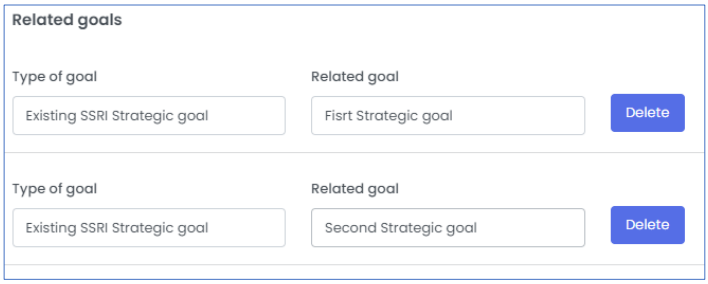


Figure 27. SSRI MAA Tool related goals of action

6.3 Interfaces and user interaction

SRRI-MAA tool provides the following types of interfaces:

- Web-based user interface, which is the main and most common way to interact with MAA tool in order to manage a social space.
- REST Application Programming Interface. This kind of interface is accessed through HTTP protocol and provides analytics from social spaces registered in the platform to granted users.

In web-based user interface user interacts with platform to manage social spaces through two types of components:

- Web forms. These tools let users register or modify information of the main entities of the platform, which are social spaces, stakeholders, working groups and actions.
- Views. Views present information of the previously quoted entities.

In order to dynamize and improve the usability of web forms, SSRI-MAA tool developers have chosen REACT as client-side library. This library lets improve the performance and usability of most complex web tools like the stakeholder or action forms in which users might have to make relations between other platform entities or even analyze the impact of a stakeholder while they see it in a graphical manner.

We have the following current indicators of usage of MAA tool in the context of Cities 2030:

- Number of meetings with labs to guide through the platform: three meetings. Quart de Poblet, Seinäjoki lab and presentation and explanation of the tool in WP6 Workshop to all labs.
- Number of registered users and labs: One registered lab with one user. Registered stakeholders: 1.

7 Blockchain-enabled marketplace for SFSC

Figure 28. Innovation in Short Food Supply Chains

Short Food Supply Chains (SFSC) are chains in which goods/food involved are identified by, and traceable to a farmer and for which the number of intermediaries between farmer and consumer should be minimal or ideally nil. Several types of SFSCs can be identified, for example (1) CSAs (Community-Supported Agriculture), (2) on-farm sales, (3) off-farm schemes (farmers markets, delivery schemes), (4) collective sales in particular towards public institutions, being mostly local / proximity sales and in some cases (5) distance sales. Such type of food chain has specific social impacts, economic impacts at regional and farm level, as well as environmental impacts translating themselves into a clear interest to consumers. SFSCs are present throughout the EU, although there are some differences country by country, in terms of dominating types of SFSCs. In general, SFSCs are dominantly small or micro-enterprises, composed of small-scale producers, often coupled to organic farming practices. Social values (quality products to consumers and direct contact with the producer) are the values usually highlighted by SFSCs before environmental or economic values.

Current food supply systems are coping with increasing challenge of food fraud and consumer trust. Food fraud poses serious risks to public health as well as damaging European food industry at a range of 10-15 billion of Euros annually[9]. Food fraud occurs when food or drink is sold in a way that deliberately misleads or deceives consumers or customers for financial gain. While food fraud is not new, the motivation to adulterate or counterfeit food for financial gain is growing and a new solution is needed. Current food safety management systems are not always designed for fraud detection or mitigation, but new food safety guidelines from Global Food Safety Initiative [10](GSFI) require it.

On the other hand, consumers are more and more conscious and informative about food they eat. They are interested to know everything about food origin, food nutrition, food certificates and other relevant information.

This way we can summarize the main challenges in Short Food Supply Chains (SFSCs):

- Food fraud prevention in the sense of making sure that the source of products is local
- Lack of transparency through the entire SFSC
- Lack of product / producer information accessible to the customer

[9] https://www.fda.gov/food/compliance-enforcement-food/economically-motivated-adulteration-food-fraud

[10] Global Food Safety Initiative homepage: https://mygfsi.com/

- Accessibility of food certification information (integrated, ecological, protected geographical identity) for shopping process.
- Lack of knowledge and resources to equip SFSCs with IT systems

The answer to these challenges is a blockchain-based data-driven UFSE (Urban food systems and ecosystems) marketplace solution. This platform will optimize multi-stakeholder dialogue processes, in which blockchain will be employed to provide some proof of concepts of monetization processes or contract agreements, in a reliable and transparent way.

7.1 Data sources

In order to ensure transparency, traceability and trust of the local food production, blockchain technology (BC) presents the natural technology fit in the so-called SFSC. The core of blockchain technologies is based on digital, decentralized and distributed data storage, in which transactions can be written in order to create permanent records protected against subsequent manipulations. The inability to manipulate recorded data is achieved by cryptographically signing each individual transaction by the stakeholders. Events that occur during the movement of food products along the food chain are added to the BC in the form of time-ordered records.

The key to the success of BC technologies in SFSC is the community of stockholders involved in the SFSC. The stakeholders write relevant data about the food products in the chain of blocks. Each stakeholder contributes data relevant to its phase of food chain. In this way they contribute their part to the traceability of the food product. Each SFSC stakeholder (except the consumer) is equipped with a BC-related digital identity, whereby every SFSC stop handle a BC transaction, digitally signed by a registered and verified SFSC stakeholder (e.g. producer, delivery service etc.).

Each BC transaction handles basic BC-related information (i.e., timestamp, digital identity, signature), as well as specific food (i.e., type, harvest region, harvest datetime, etc.) and logistic related information (i.e., LOT number, type, etc.).

To avoid high transaction costs when using public BC networks, presented solution is based on a consortium type of BC network. The consortium BC network is based on *Hyperledger Besu* solution, which is an open-sourced Ethereum client designed to be enterprise-friendly for both public and private permissioned network use cases. To effectively support the transparency of food products in the SFSC, a wider stack of technologies is required in addition to BC technologies. To avoid restrictions regards the amount of data, that can be efficiently recorded in a BC, the implemented solution stores digital proofs (i.e., harvest or delivery photos etc.) on a related IPFS network. IPFS network is designed for storing and sharing data in a distributed file system. Traceability records of a food products stored in the BC consists of a set of references pointing to digitally signed text documents stored on the IPFS network.

One of the key components of the solution is also a mobile client, with which customers of food products access traceability records. A mobile device enables them to scan products QR code with the phone's camera and review the traceability record of a food product they bought in the marketplace.

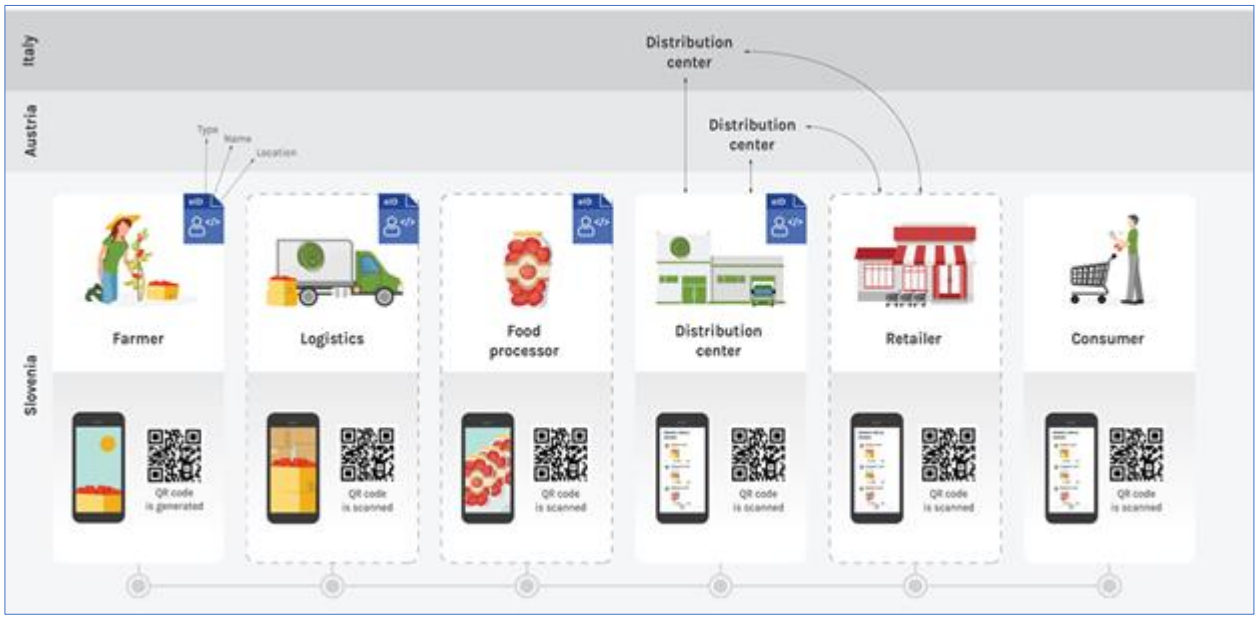


Figure 29. Architecture of Blockchain for SFSC

The system uses the following kinds of information:

- Producers or farmers information like name, surname, address, phones, social networks and email. This information is already included to the existing business management system used by Green Point and requires no additional collection or permissions.
- Social Space Information, including name, description, photo, context indicators and goals.
- Actions information. It refers to actions made by stakeholders in the scope as described above and includes entered data or text but also photos of products and steps

The size of data sources is small apart from photos stored on IPFS that can take some larger volume over time. Data is stored in the following data storage technologies and systems:

- MongoDB
- Ethereum Smart Contract
- IPFS network (InterPlanetary File System)
- Green Point business management system software

The MongoDB open-source NoSQL database stores data about crops, users, SFSC, and transaction logs in the IPFS Network.

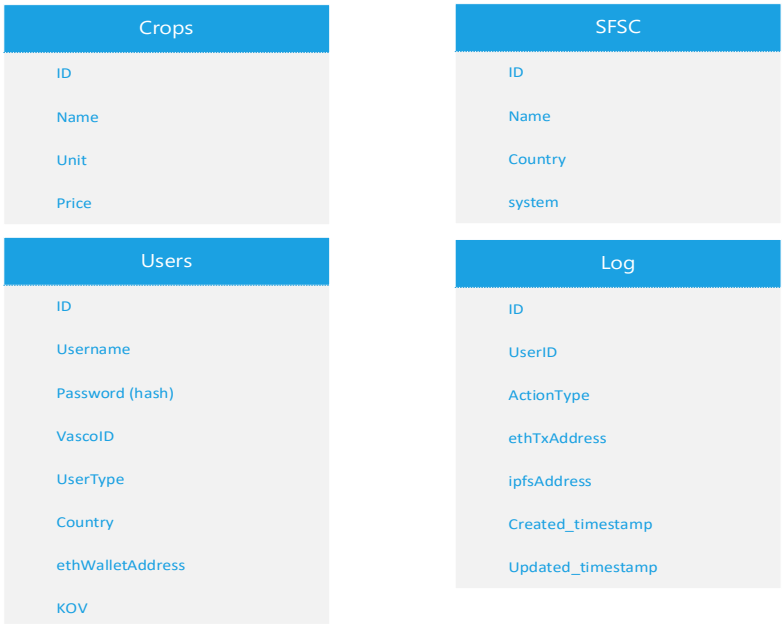


Figure 30. MongoDB schema diagram

In Ethereum, smart contract immutably stores all digitally signed data, which are used to visualize farm-to-fork traceability. These are and not limited: to all tasks done in the field, logistics events, delivery notes, and IPFS addresses.

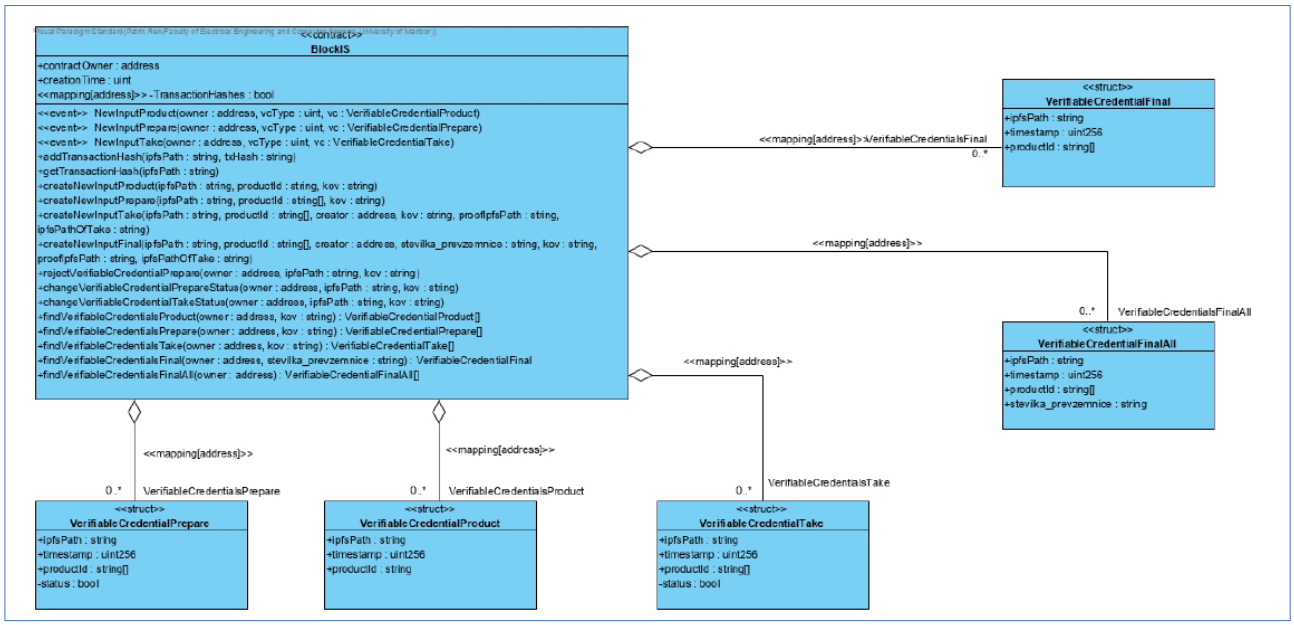


Figure 31. SmartContract schema diagram

In IPFS are stored VC (verifiable credentials), pictures, documents, descriptions of events in SFSC, and production and delivery notes.

In Green Point, business management software are stored data about farmers and partners, products logistics, and business events in Green Point.

7.2 Detailed functionalities

Green point (Zelena točka) is a Short Food Supply Chain, which is based on (1) supporting farmers to produce local products, (2) connecting them into a cooperative and educating them on branding, (3) collecting their local products, (4) distributing products through Green Point Trans to the business customer and (5) selling products through the Green Point to consumers. The Green point is founding member of Digital Innovation Hub AGRIFOOD (DIH AGRIFOOD), helping its target groups and members in digital transformation of their businesses.

Since Green Point acts as a distribution center, organizing a SFSC in the North-Eastern part of Slovenia (Pomurje region). It is a priority to start solving the problem of food fraud by preventing counterfeiting of local food origin and ensuring that final customers have an origin guarantee. There are namely a lot of cases where local producers claim to sell third-party (imported) products as their own products.

We intend to solve above mentioned challenges by introducing blockchain technology at all the levels of the supply chain, starting with the farmers who are producing local food, continuing with logistics / storage operations and finishing with all sales channels in the SFSC (physical stores, webstores, gross sales), while making sure that current software solutions is integrated with the blockchain technology.

In a system there are following types of users:

- Farmer (Producer)
- Carrier (Logistics)
- SFSC
- Admin

Users in systems are stored in the MongoDB database and are created automatically with the API call to the Green Point business management system. The administrator of the platform has to manually set up only user type in SFSC.

Users can enter and save in the system information about sowing, growing, and harvesting the crops. After products are ready for delivery, the user creates a delivery note. At delivery of goods in Green Point, the user with scanning of QR code on the delivery note creates receiving sheet. Data from receiving sheets are automatically also stored in the Green Point business management system and web application for printing product declarations, via API call.

The system provides real time response while saving and displaying events in SFSC. Scalability is assured using modern cloud technologies for hard and soft infrastructure, like virtual machine and Docker containers.

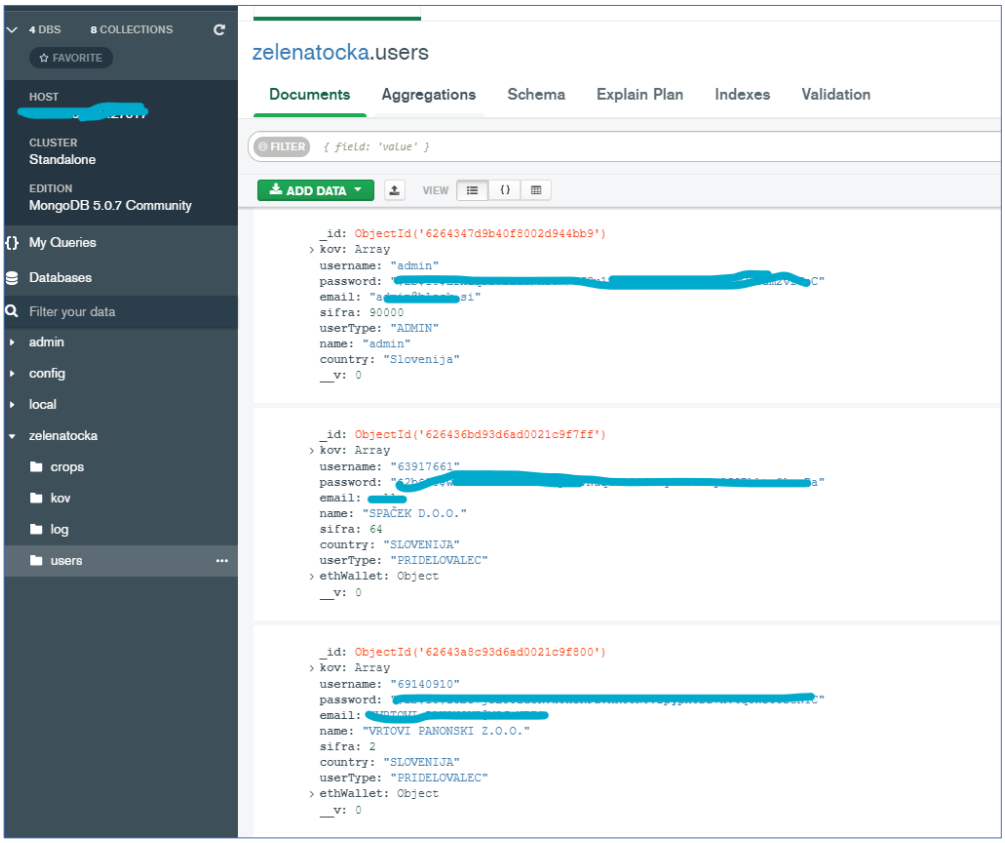


Figure 32. Users collection in MongoDB

The blockchain-enabled marketplace for SFSC use a Consortium Type Blockchain (BC) network based on Hyperledger Besu solution. There are 30 nodes, all are located in eastern half of Slovenia. The solution is enabling farmers, food producers, food processors and other actors to automatically generate digital BC-certificates for specific food types in the form of non-fungible ERC 721 tokens, while consumers are able to verify the SFSC-related food, its origin, and journey simply by scanning relevant QR codes placed on products. Each BC transaction is able to handle basic BC-related information (i.e., timestamp, digital identity, signature), as well as specific food (i.e., type, harvest region, harvest date/time, etc.) and logistics-related information (i.e., LOT number, type, etc.). The solution also enables storing digital proofs (i.e., harvest or delivery photos etc.), which can be stored on a related IPFS or Swarm network.

Blockchain Explorer is used for monitoring and analyzing raw data about transactions and digital signatures in the blockchain.

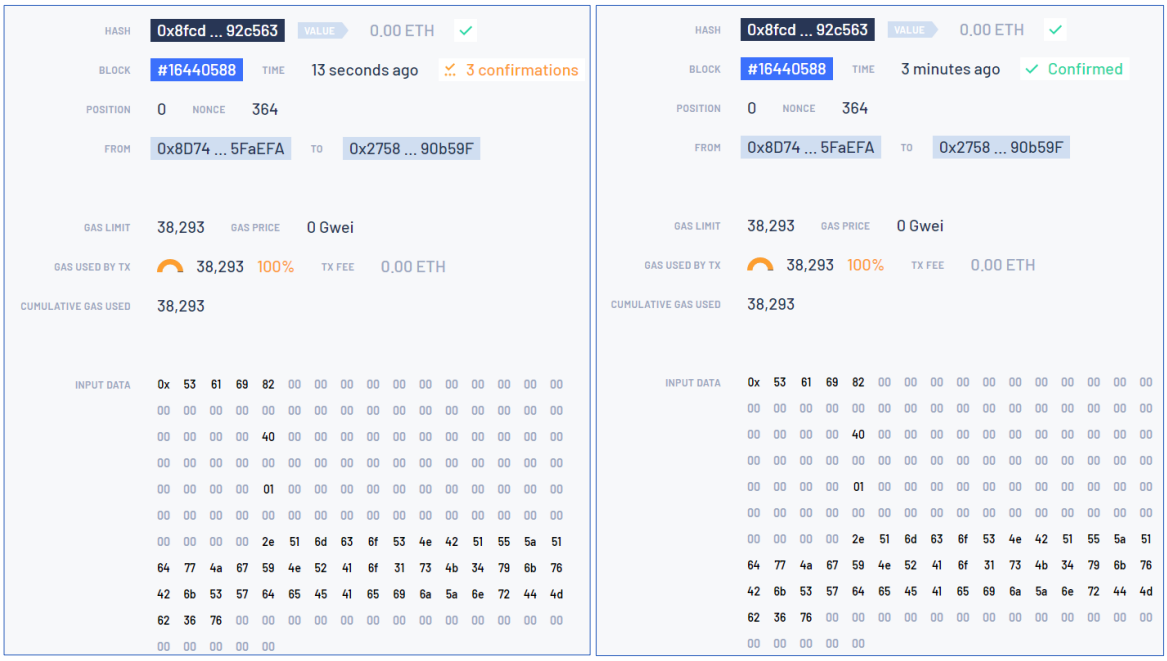


Figure 33 (left). Blockchain Explorer – unconfirmed transaction, (right) confirmed transaction

7.3 Interfaces and user interaction

Custom, in-house developed REST API provides transfer and storing of data between different components of the system (Web interface for users, Blockchain, IPFS, and Green Point business software). API is developed, using Node.js technology and runs in Docker container. JWT (JSON Web Token) standard is used for authorization and encryption of communication. The screenshot below shows an example of creating verifiable credentials for delivery note and respective JSON schema.

REQUEST

```
POST /vc/create/vc2
Content-Type: application/json
Authorization: Bearer <token>

{
    "creator": "0x67ddd598c20119E260723840d6aA8006E21C1458",
    "recipient": "0xd787523F32f2b728EB1f6c7Cf02976f5c1EA610b",
    "subject": [
        {
             "_id": "00016",
             "description": "Super paradižnik. Sveži!",
            "quantity": 100,
            "unit": "kg",
            "date": "2021-02-13"
        }
    ],
    "proof": ["QmQzbNBjeF6FznoDhvkYk5AJGJ36LNrX7CG2tReQxSMxUM"],
}
```

RESPONSE

```
200
```

Figure 34. Example of API call in Blockchain-enabled marketplace component

The User Interface is designed with focus to end users (farmers) and customers who all mainly use mobile phones but there is also a management and administration part that is mainly used on desktop devices by store employees. As a summary we currently use 4 different access point for interaction with the traceability system:

1. Presentation of product traceability data on zelena-tocka.si webpage. This site is also used for actual web shop of the store but was upgraded to also present the detailed traceability information in similar form and also to take the customer to the area where he can make additional purchases from the web.

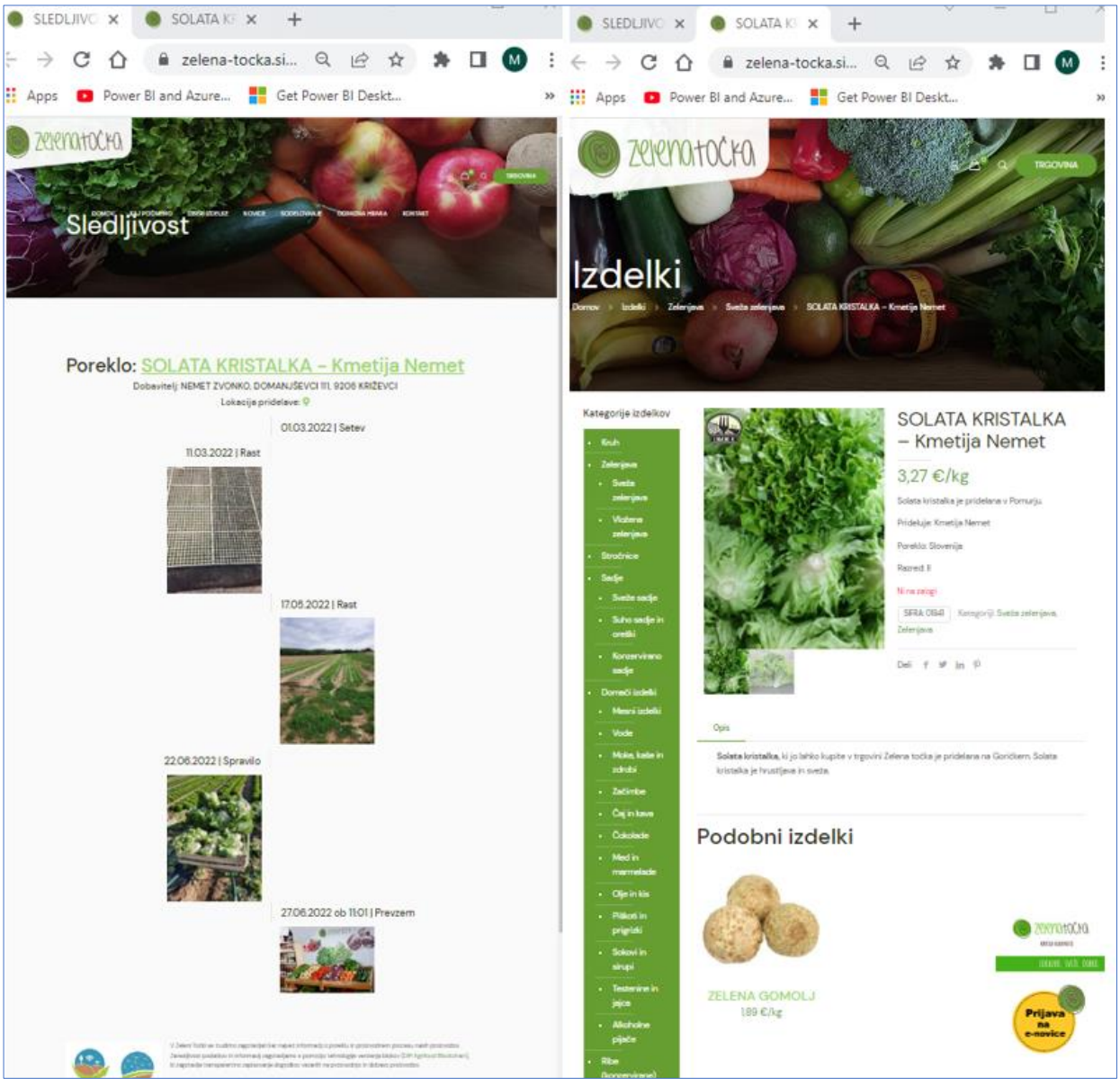


Figure 35. Presentation of product traceability and Green Point web shop

2. Access to traceability platform for management and administration is used by main administrators to assign and configure identities for platform users (farmers, food processors, etc.) and to view all

the data in the traceability platform. Furthermore, this access is providing functionality for printing product declarations with QR codes (with thermal printer) for placement to products. It is also planned to upgrade the UI with functionality for printing labels for self-service scales.

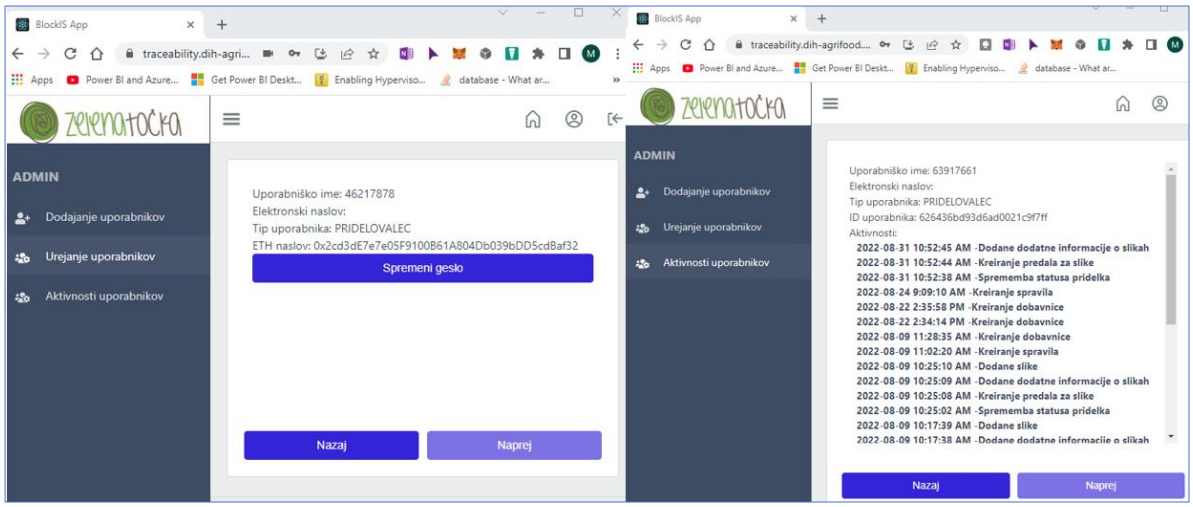


Figure 36. Example of user management and view of users activity

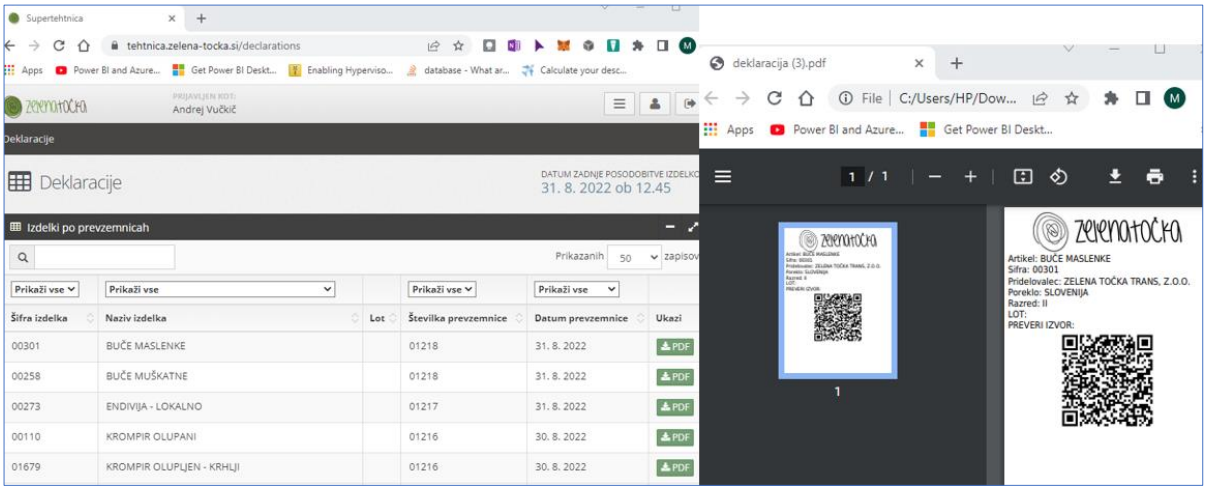


Figure 37. User interface for printing declarations

3. The user interface for farmers/producers and store employees for handling the events in SFSC is designed using responsive web techniques to provide the best user experience on all device types.

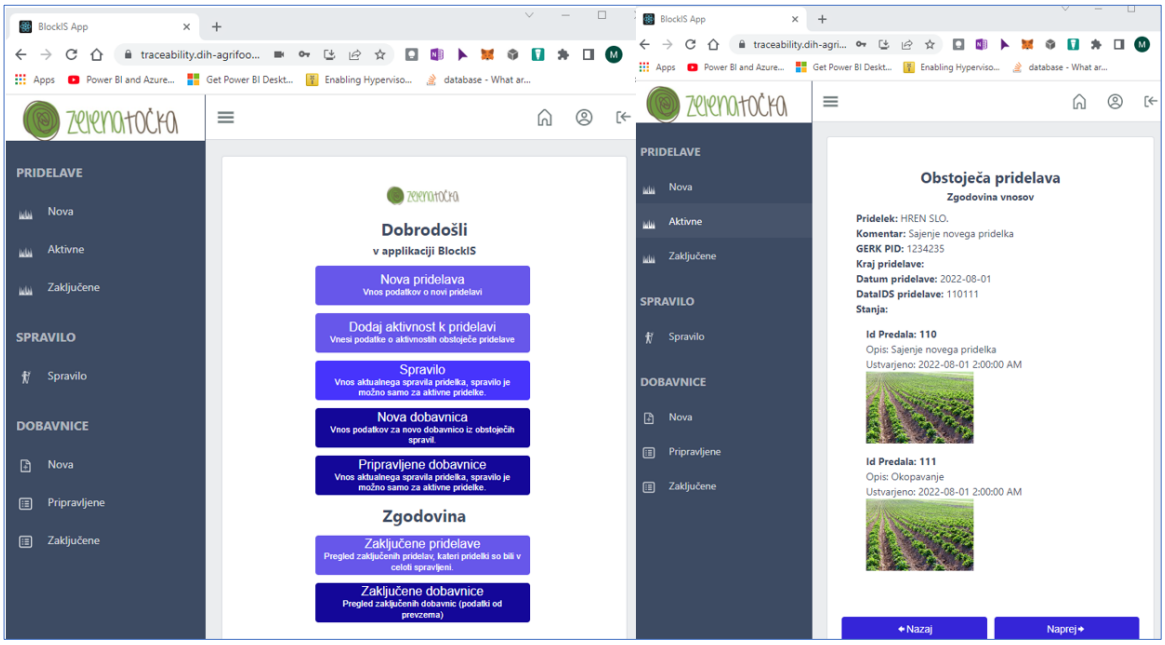


Figure 38. User interface for farmers (Slovene language)

4. Access to Green Point's business management system for entering all the required data related to producer and products was already existing, but due to the need for some new data to be received via API, slight modifications have been done. In addition, processes for internal work with a business management system have been prepared and tested.

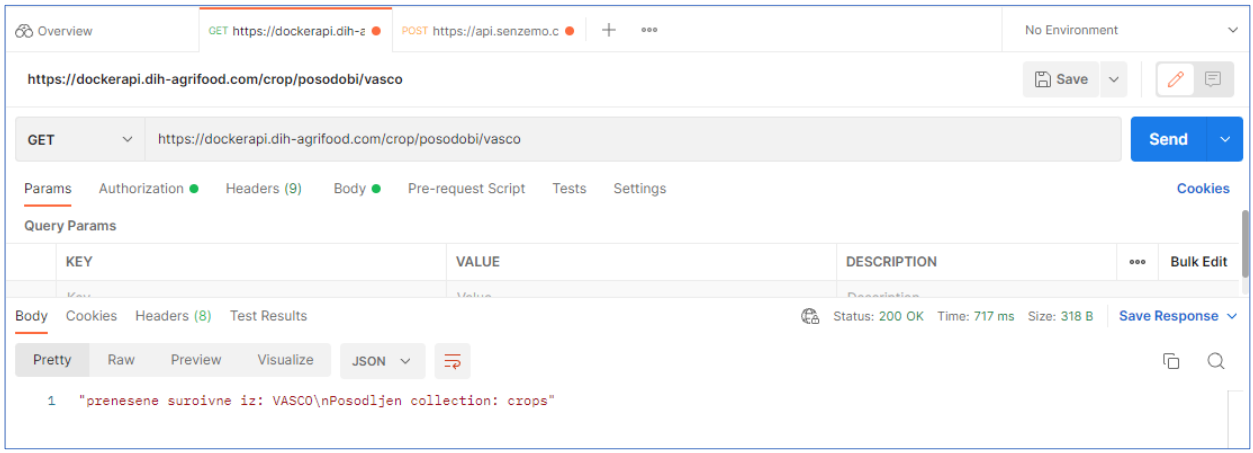


Figure 39. Example of API call for Green Point business management system

8 Current development state and scheduled (future) components

The previously described components are not all at the same level of maturity. As described in D6.1, the CDM that guides the development of the S2CP platform includes 3 development macrocycles. Given that at the time of delivering this document (M24) only the first macrocycle has fully elapsed, as well as 1/3 of the

second, there are components that have already been released for production, while others have only been presented in initial version.

In this section we intend to describe in detail the state of maturity in the development of the different components, as well as to propose the main lines for the work in the second half of the project (M24 – M48).

8.1 Maturity level of components

According to the Development methodology, in the SOCS, we consider that the components go through certain levels of maturity, which we define below, from the lowest level to the most mature state:

Non-functional (under design): This level is the lowest in terms of maturity level and indicates that the component is still in the design stage. This implies the following states:

- Component title, general description and main functionalities are available.
- Secondary functionalities have not yet been defined.
- Technologies to be used, tools and development frameworks yet to be defined.
- The development phase has not yet started

Non-functional (under development): The component has passed the design stage and is in production. It implies the following:

- Component definition has been completed: Complete functionalities.
- Technologies to be used, tools and development frameworks have already been defined.
- There is no preview version yet that can be tested.

Basic functionality (prototype): The component is still under development, but versions have been released that allow it to be shown to other WP6 partners and the CRFS Labs.

- There are preliminary versions, functionalities partially implemented.
- The software has some deployment support, either locally or on a test server.
- It is still early for this software to be used by partners other than the entity that is developing it.

Alpha version: The component is still under development. Functional versions have been reached whose test allows us to see the usefulness of the tools.

- Functions implemented almost in its entirety.
- The software is deployed on a test or production server and is accessible by external stakeholders.
- The software can be used by partners although its regular use is not recommended, as it is not stable and information loss may occur.
- The software is almost ready to be exploited

Fully functional (initial exploitation): The component begins its exploitation phase. Its use is stable.

- The software can be used by partners with a low risk of data loss or unexpected errors.
- The component is deployed in a production environment and its access is enabled for stakeholders.
- There has not yet been a massive use of this component.

Fully functional (showcasing results): This is the last level of maturity that we have defined for the SOCS. It has the following properties:

- The software is in its final version. Maintenance and small bug fixes still need to be done.
- Stakeholders use the software frequently and perceive its usefulness to meet their objectives.
- The content of the component (generated information) can be used to analyze usage and can provide relevant information on the behavior of users in the environment.

Below is a table presenting the SOCS components along with their maturity level as of the D6.3 delivery date:

Component	Cities2030 Community	CRFS Good Practices	SSRI Multi-Actor Approach	Blockchain-enabled marketplace for SFSC
Maturity level	*Fully functional (initial exploitation)*	*Fully functional (showcasing results)*	*Functional (initial exploitation)*	*Basic functionality (prototype)*
Component	Geospatial CRFS web services	Digital twin for supply chain	Real-time data monitoring	Other blockchain-enabled marketplaces
Maturity level	*Basic functionality (prototype)*	*Under development*	*Alfa version*	*Under design*

Figure 40. Maturity level of SOCS components

8.2 SOCS and S2CP service ecosystem in policy and innovation labs

This section includes the efforts related to the usage of SOCS components in Cities2030 policy and innovation labs. Table 4 expresses the interest of labs in each SOCS and S2CP service ecosystem component and the status of the integration tasks, according to the methodology of Section 2 and CDM described in D6.1.

It is important to judge this information considering the previously described maturity states, so we will only consider here the 4 components that are described in Sections 4 to 7, and that appear here in the first row of the previous figure (Maturity level of SOCS components), which are the ones with the highest level of maturity.

We made this decision because there are initial components, for which it is very difficult to have yet reached a high state of transfer and implementation in laboratories. In any case, the integration process will continue in the second half of the project (M24 – M48).

On the other hand, while some tools of a transversal nature and not so much will be used by most labs, there are other components that are specifically designed for specific laboratory experiments. For these components, expect the labs where they are implemented to be much less numerous.

Table 4. Interest of Labs in SOCS components and components already tested / used

Laboratory	Technological instruments resulted from T6.1 analysis	Components tested / used so far	Comments and descriptions
1-Brugge	Cities2030 community	Cities2030 community Good practices	New component (Good practices) is incorporated after analysis.
2-Velika Gorica	Cities2030 community Geospatial services	Cities2030 community Good practices	"Geospatial services" is under development for Velika Gorica
3-Trodos	Good practices Geospatial services Innovation management tool		"Geospatial services" is under development for Trodos
4-Vejle	Cities2030 community Good practices	Cities2030 community Good practices	
5-Seinäjoki	Cities2030 community	Cities2030 community Good practices	New component (Good practices) is incorporated after analysis.
6-Bremerhaven	Cities2030 community Good practices Geospatial services	Cities2030 community Good practices	"Geospatial services" is under development for Bremerhaven

7-Quart de Poblet	Innovation management tool Geospatial services Supply chain transparency use case	Cities2030 community Good practices Innovation management tool	New component (Good practices) is incorporated after analysis. "Geospatial services" is under development for Quart
8-Vidzeme	Geospatial services	Cities2030 community Good practices	"Geospatial services" is under development for Vidzeme
9-IASI	Geospatial services	Cities2030 community Good practices	"Geospatial services" is under development for IASI
10-Murska Sobota	Geospatial services Blockchain-enabled marketplace for SFSC	Cities2030 community Good practices Blockchain-enabled marketplace for SFSC	"Geospatial services" is under development for Murska Sobota.
11-Vicenza	Innovation management tool Geospatial services	Cities2030 community Good practices	New component (Good practices) is incorporated after analysis.
12-Haarlem	Cities2030 community Geospatial services Innovation management tool	Cities2030 community Good practices	New component (Good practices) is incorporated after analysis. "Geospatial services" is under development for Haarlem.
15-Marseille		Cities2030 community	
16-Arganda		Cities2030 community Good practices	Real-time monitoring and Blockchain-enabled marketplace are currently in implementation and design phase respectively..
New upcoming labs			
Agrotopia		Cities2030 community	Interested in Digital Twin of food supply chain. New Lab coming from Alliance partners.
The International Library La Vigna		Cities2030 community	New Lab coming from Alliance partners.
Muğla		Cities2030 community	New Lab coming from Alliance partners.
Pollica Paideia Campus		Cities2030 community	New Lab coming from Alliance partners.

It should be noted in the table above how new Labs have appeared that are being incorporated into the innovation processes of WP4 and WP5 (that is why they are not numbered) and that, meanwhile, have already been established in some of the SOCS components. This is in line with the objective of the SOCS to serve, not only the initial Labs, but also that its use can be extended to the CRFS of other cities that are not directly represented by the consortium partners but by Alliance partners.

8.3 Future developments

According to the development methodology outlined in WP6, there are three development and implementation macrocycles. The current document (submitted in M24) covers the entire first macrocycle and a first third of the second macrocycle. However, there is a period that is not reflected in this deliverable, and that will be described in a later document. As an illustration, we describe in the following subsections the components and services that in the context of T6.3 will be developed and implemented in the second stage of the project (M24 – M48).

8.3.1 Geospatial CRFS Web services

This section describes the *Geospatial services component* from a technological point of view. This component will be based on state-of-the-art technologies and common and standardized application interfaces in commercial products and in the world of research. This component will show the geographical distribution of the different agents throughout the different CRFS on a map system and will be connected to the Geospatial Information components of T6.2 and the dashboard visualization components of T6.5.

8.3.1.1 Component description

This component allows that information about different projects managed by the cities within their CRFS can be published in OGC standardized services and cartography. It will therefore be possible to generate maps with different types of visualization, from heat maps to evaluate the density of elements in a certain zone, and the area of influence, to the provision of marker controls such as clusters, to improve the spatial visualization of markers that they are highly concentrated. The following functionalities have been taken into account for the development of this component:

- Filtering by categories, to obtain a spatial vision of the distribution and relevance of locations or points of interest.
- Integration of spatial datasets coming from T6.2 (Geospatial information component).
- Provision of information in standardized APIs, using OGC's standards Web Map Service[11] and the Web Feature Service[12].
- Personalized visualizations, thanks to the integration into the S2CP dashboard (T6.5). Possibility of performing spatial operations or complex analysis in the S2CP dashboard.

8.3.1.2 Current status and future works

In the current state of development, there is data from OpenStreetMaps, which has been downloaded through a set of scripts designed for this purpose. The following figure shows an extract of a script (in Python language) to obtain points of interest in the field of food systems, for the city of Bremerhaven.

[11] OpenGIS Web Map Service (WMS) Implementation Specification: https://www.ogc.org/standards/wms

[12] OGC Web Feature Service (WFS) Implementation Specification: https://www.ogc.org/standards/wfs

```
ways = api.get("""
area['name'='Bremerhaven']->.city;
(
  way["amenity"="bar"](area.city);
  way["amenity"="pub"](area.city);
  way["amenity"="bbq"](area.city);
  way["amenity"="biergarten"](area.city);
  way["amenity"="cafe"](area.city);
  way["amenity"="restaurant"](area.city);
  way["amenity"="drinking water"](area.city);
  way["amanity"="fast_food"](area.city);
  way["amenity"="food court"](area.city);
  way["amenity"="ice cream"](area.city);
  way["shop"="supermarket"](area.city);
  way["shop"="bakery"](area.city);
  way["shop"="butcher"](area.city);
  way["shop"="newsagent"](area.city);
  way["shop"="beverages"](area.city);
```

Figure 41. Collecting CRFS points of interest in Bremerhaven city

Once downloaded, we have proceeded to a categorization of the points, a classification and filtering of incorrect results, either because they do not belong to the field of Food Systems, or because they are not within the administrative limits of the cities.

Once the representation symbology has been chosen, the result is shown in the following image:

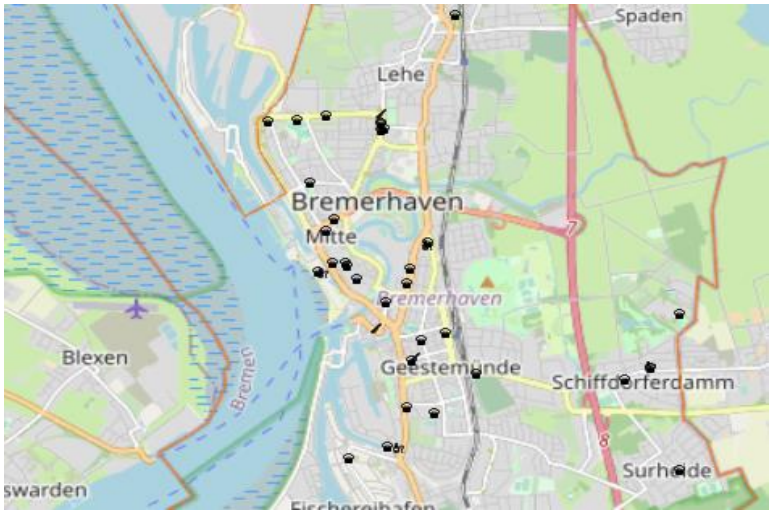


Figure 42. Collected food-related points of interests in Bremerhaven city

Currently the development work of this component includes the import of all these data to a database with geospatial characteristics (PostGIS type).

As future work, the deployment of an information server, compatible with the OGC standards, is needed to offer an API for querying information about the cities of the project from external sources, such as a web page.

Subsequently, an integration task will be carried out, so these API calls and the graphical representation of the information on maps will be carried out from the S2CP dashboard component.

8.3.1.3 Engagement plan

It is intended to support all the labs that appear in Table 4. To do this, it is intended to verify that all the information pertaining to those cities is available. Once this is verified, we need to download and merge that information about the administrative limits of these cities.

Finally, we will disseminate the operation of this component through a user manual, and a set of events where we will make this tool available to the labs, through the S2CP dashboard.

The workshops where this showcase is planned are the R-213 "Second Workshop with pilots" of the M33, where a preliminary version will be presented, and the R-214 "Third Workshop with Pilots", where a version integrated in the S2CP dashboard will be shown. For more information on these Workshops, please see Gantt chart of D6.1 Section 2.3. The participation of most of the labs or at least of the labs that showed initial in this component is expected, according to the table in Section 8.2.

8.3.2 Digital twin for supply chain (Unisot use case)

A use case implementation for the provision of transparency through blockchain in the food supply chain of products integrated in CRFS is currently being planned in the project.

The use case of UNISOT is proposed by the University of Luxembourg. The demonstration of full and functional commercial system of blockchain technology used in food chain processes, should be used as an educational demonstrator for Labs involved in the project. Originally UNISOT uses blockchain technology to collect and analyze data, payments, tracing and data sovereignty in food supply chain.

This platform will secure intelligence and coordination actions by delivering an accurate, almost real-time digital twin of the whole supply chain, e.g. from production to waste management, but also on four key enablers of resilience and sustainability: security, ecosystem services, livelihood (e.g. growth) and equity (e.g. inclusivity).

8.3.2.1 Component description

Main component of the UNISOT solution is based on Smart Digital Twins (SDT). Smart Digital Twin technology that enables any type of Asset, Product or Item to have a Digital Representation in the Global Data Lake. The Smart Digital Twin securely stores any kind of information related to an object, it can be split and merged, and it enables to securely transfer the ownership of all or part of this information to other actors in the supply chain or to authorities.

Basic functionalities of the Smart Twins:

- The creation of Smart Digital Twins is done automatically via ERP plugins or API integrations with production systems. Smart Digital Twins can also be created manually in the UNISOT Collaboration Dashboard or in the UNISOT Collaboration Mobile App when automated creation/data collection has not yet been implemented.
- Adding data like ingredients/parts, location, weight, dimensions, temperature, energy consumption, water consumption, CO2, certificates, videos, etc. can be added automatically or via manual actions. Industry standard templates such as ISO and GS1 are available. Own custom libraries can be used to ensure required information is collected and validated.
- Ownership of the Smart Digital Twin can securely be transferred to another actor in the supply chain network, including selected information e.g. the ownership of a pallet with ordered products or a freight container. Associated information and documents are automatically, securely and auditable transferred to the new owner.
- A Smart Digital Twin can be Split into multiple Child Twins, for example when a production batch of a product is packed into many thousands of separate packages, each new package is now a new Child Twin. The new Child Twins are inheriting all important information and documentation from their Parent Twins, such as temperatures, locations, etc.
- Two or more Smart Digital Twins can be Merged together into new Smart Digital Twins, e.g. when a new product is created by several components or ingredients each of these individual assets or

products Digital Twins and their attached information, such as processing methods, locations, etc. will be merged/inherited into the new Smart Digital Twin.

- All related historical and provenance information for each of the ingredients/components related to a specific asset or product is available to the current owner and can be proved, viewed and analyzed. This functionality also provides a user-friendly way of viewing the complete product DNA tree of a product, verifying each ingredient/component.
- Information of a Smart Digital Twin can be shared selectively as a private secure link, or as a public link intended for anyone. The public link can be used as a unique printed QR code or as an RFID incorporated in a product. Customers or consumers can scan the QR-code/RFID with their phone to get detailed proven information about this specific package.
- Provides a direct chat and communication channel between all actors involved with a specific Smart Digital Twin. Each actor can exchange important updates or ask specific questions regarding a specific Asset, Product or Item throughout its complete lifecycle. This increases the communication efficiency considerably and leaves an auditable communication trail.

8.3.2.2 Current status and future works

Currently, it is planned to start implementing a scenario for the use case demonstration. One of the most valuable functionalities of the digital twin for supply chain is traceability. Traceability makes it possible to achieve a level of trust between the stakeholders belonging to the value chain. Current label-based certification mechanisms are not enough, as certification can be duplicated or faked. A use case related to the certification of fish in the UK is currently being analyzed, and work is being done to adapt this situation to a professional solution such as the one provided with UNISOT:

Traditionally, fisherman sent simple text messages to register a catch, and that created a new 'asset' on the blockchain. Every time a batch of fish was sold - to traders, and processors, brands, and supermarkets - the blockchain ID was sold with it. That digital identity also tracks the audit information that proves that fish were caught legally and sustainably.

In the process of selling the physical fish, the digital asset representing the fish is also transferred. With this, the system prevents the double-spending of same product, which would affect the properties of sustainability and social responsibility.

With larger fish, like the yellowfin tuna, which can weigh as much as 400 pounds, physical tags attached to the product can be used. Other smaller (and less expensive) fish such as skipjack tuna are tracked and, thus, certified, by package-level. The advantage of using blockchain-based traceability solution is that, due to the underlying technology, it protects the chain of custody, preventing goods (e.g. responsibly-caught fish) to be duplicated or altered with other less documented goods (unknown origin fish).

Although various non-profits and government agencies are working on tracking fish through the supply chain, the different tracking systems can't easily share data. For security reasons, they often can't be accessed by the general public or even participants in the supply chain. As blockchain can provide a public ledger, this can ensure real transparency.

8.3.2.3 Engagement plan

Project partners involved in WP6 agreed cooperation with Inagro, especially Agrotopia in Roeselare Belgian municipality. With 6000 square meters of cultivation area, divided over thirteen compartments - including a facade greenhouse and a space for closed multi-layer cultivation - there is sufficient space to develop, test and demonstrate new technologies in conditions that are comparable to practice. Inagro has there a box with a floor area of 32 square meters for research into multi-layer cultivation. The two high vertical sections in the facade conservatory of Agrotopia are twelve meters high and make it possible to stack crops. A lot of

attention has been paid to climate control techniques. In some compartments, 'The New Cultivation' is even applied.

Figure 43. Agrotopia living lab

Agrotopia facility is perfect match with the advance blockchain technology. In the current development, it is forecasted personal meeting to set up scenario for demonstration and collect necessary information for setting up UNISOT solution.

This showcase will be presented with some workshops as well as live demonstrations for practitioners in the field of Food Systems (project partners especially for cities and living labs). Also, this activity will have some synergies with other EU funded projects. UNISOT company is currently involved in EU4ADVICE project[13], which goal is to settle the foundations and structures required to ensure effective capacity building of SFSC actors through fluent knowledge transfer. It is planned to use both projects as cooperative platform for dissemination.

8.3.3 Real-time data monitoring

Real-time data monitoring component provides a system for receiving events produced by sensors. This S2CP component can collect information generated in a city, farm or other food-related organization, so that information can be later represented for real-time visualization or monetization.

This component requires some data input coming from an Internet of Things (IoT) hardware platform, which must be defined and deployed in the pilot site. The output of this component will be a database containing all captured real-time information, expressed in a semantic and interoperable format (according to data models defined in T6.2), and also a visualization dashboard to facilitate date visualization, filtering and some

[13] https://rural-digital-europe.openaire.eu/search/project?projectId=corda_____he::e24c29f2d3aff256fbe207139cf7e2b6

simple analysis. In the following sections, the component main functionalities will be described, as well as the current status and the future engagement plan.

8.3.3.1 Component description

In the following figure the functional architecture of the solution is represented:

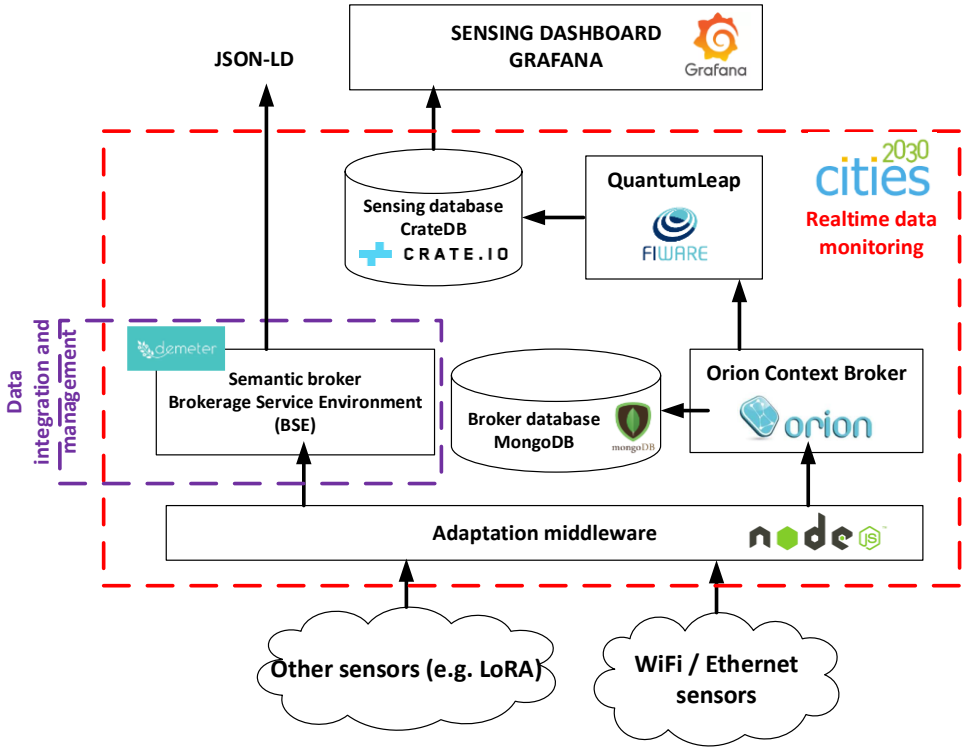


Figure 44. Functional architecture of real-time data monitoring component

As you can see, different types of sensors can supply data to real-time data monitoring, such as WiFi/Ethernet sensors, and other sensors that communicate with well-stablished technologies such as LoRA or SigFox. A connector-based adaptation middleware serves as a communication proxy and transmits information to two types of brokers:

- The semantic broker BSE publishes the interfaces for data consumption through a semantic model compatible with the data integration and management tool, and based on semantic models from previous projects such as DEMETER.
- The Orion Context Broker is a FI-WARE component optimized for sensor data communication, which supports the NGSIv2 protocol.

To provide persistence to the information received by the sensor infrastructure, the QuantumLeap module is used, another FI-WARE component that saves all sensor updates in a CrateDB sensing database.

Finally, this database can be used as a source of information for the representation of the information received in a dashboard, for subsequent analysis, filtering and as a decision support system.

8.3.3.2 Current status and future works

The real-time data monitoring solution is currently under development. Work is currently being carried out on two fronts:

Data acquisition

Data will be captured by smart sensor nodes (powered by an Arduino Mega architecture with an Ethernet W5100 shield), combining various sensors:

- DTH-11 module to measure environmental temperature and humidity
- CCS811 module to monitor the air quality (equivalent CO2 -eCO2- and total volatile organic compounds - TVOC-).

Data structure will be expressed in JSON-LD format, by following DEMETER's Agricultural Information Model.

Component deployment

The components of the firmware (Orion Context, Broker, and QuantumLeap) as well as the databases are being defined for assembly in a Cloud environment. For this, Docker technology is being used, an open platform for developing, shipping, and running applications. Docker enables to separate the applications from the infrastructure so software can be delivered more quickly. Kubernetes technology is also being studied. Kubernetes is an open-source container orchestration platform that automates many of the manual processes involved in deploying, managing, and scaling containerized applications.

Future work will consist of the correct deployment of all the components of the architecture and the performance of data capture experiments, which can finally be represented in the dashboard.

8.3.3.3 Engagement plan

The described component will be employed in the scenario of the Arganda Lab, as stated in Table 4. Arganda Lab describes an Industry 4.0 use case, where data brokering solutions should be provided to improve food transparency and more information related to the food processing scenario, including environmental worker conditions.

An experiment in this lab has been defined:

- Improving the production efficiency and workers wellbeing through an Industry 4.0 sensing platform. Continuous and automatic monitoring should help companies to reduce resource consumption, waste, and improve the wellbeing and working conditions.

The real-time data monitoring component will be used to achieve this goal, considering the sensing platform, sensing database and middleware, the semantic broker, and the sensing dashboard. Through the information displayed in this dashboard, bakery companies may make decisions to improve their indicators.

The engagement plan considers a set of meetings with Arganda lab representatives. Preliminary results of the Arganda deployment experimentation will be presented to other Labs and other Cities2030 partners in R-215 "Fourth Workshop with Pilots" of M40. A user manual will be available for the Labs, and also included in next version of D6.3. For more information on these Workshops, please see Gantt chart of D6.1 Section 2.3. The participation of most of the labs or at least the Arganda Lab is expected, according to the table in Section 8.2.

8.3.4 Data-driven blockchain-enabled marketplace

In addition to the blockchain-enabled marketplace for SFSC, the development of other marketplace solutions as proof of concept of token-based monetization processes is planned. As mentioned in D6.1 (Section 5.2.10) and in D6.3 (Section 3.1.8) the development of blockchain solutions is highly dependent on the data model and therefore on the type of information to be stored. Due to this, these marketplaces will be developed at the request of the labs, in the event that a particular need should be covered.

In this section we will describe one of the solutions that are being developed, which is the Data-driven marketplace solution, in which the Arganda Lab has shown interest.

8.3.4.1 Component description

The data-driven marketplace solution provides a blockchain-based web interface to support the exchange of digital assets with a token-based approach.

The concept of tokenization is developed in this Marketplace through two types of tokens:

- Fungible tokens: A representation of an asset on a blockchain that is interchangeable. Cryptocurrencies are the prime example of fungible tokens because each coin has the same value as any other coin of the same type at any given moment.
- Non-fungible tokens (NFT): A guarantee of ownership that is immutable on the Ethereum or similar blockchain. Although an NFT can certify ownership of any object whether digital or physical, it is mostly used to record the ownership of collectibles and other digital assets.

In the definition of the component, it has been decided to use the concept of Fungible token to create the cryptocurrency that will be used for users to acquire digital resources. In addition, the concept of NFT is used to define each of the digital assets, and it will be explored how the ownership certificate can be changed when a sale process occurs.

The processes through which the exchange of tokens and the discovery, exchange and access to assets are regulated, are codified in the so-called blockchain Smart contracts.

8.3.4.2 Current status and future works

An initial design of the interface is presented in the following figure:

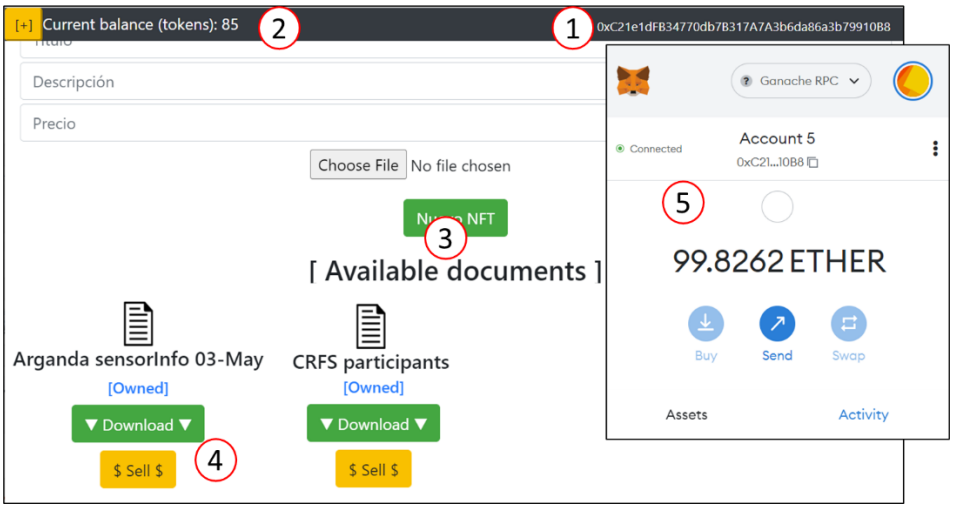


Figure 45. Graphical interface design for data-drive blockchain-enabled marketplace

We describe below the elements that we are taking into account, and which are numbered in the figure. To log in to the marketplace, users must identify themselves with their blockchain account number (1), which also corresponds to their public key in the infrastructure. Once identified, users will receive information about the cryptocurrency balance they have available to make purchases in the Marketplace. In the figure you can see how the user whose account ends in …10B8 has a balance of 85 tokens (2). The interface will allow the creation of a new NFT, which is a digital asset (3), and may include a description and a price. At the bottom of the screen (4) you can see the digital assets that are available in the Marketplace, and if they belong to the user who is logged in (owned), with the option to download them, or sell them to other users for a number of tokens. Finally, the key manager is shown, which allows the execution of the authentication and purchase/sale functions (5). This interface shows the amount of cryptocurrency in Ether that the user has, and also allows changing profiles, in the event that a user has several accounts in the same marketplace.

8.3.4.3 Engagement plan

The development of this component is carried out in parallel with the establishment of the Arganda living lab. At the date of completion of this document, the lab is beginning the "#2 Analyze the Challenge" phase, according to the methodology directed by the Handbook of T5.2.

Specifically, one of the challenges of the Arganda Lab is facilitating food transparency in supply chain. To do that, it is intended to explore possibilities to exchange and monetize product information, relevant data on production, such as the origin of the main foods or a carbon footprint calculation. A marketplace could enhance the process of dealing with providers and offering a more efficient approach in obtaining supply chain information, increasing final information associated with a product.

As mentioned in the previous section, a design phase has begun for a marketplace solution that may be of interest to meet the objective indicated in the previous paragraph. Its deployment is designed for Macrocycle #3 of the CDM methodology (See deliverable D6.1) and, therefore, from M36. Preliminary results of the Arganda deployment experimentation will be presented in the next version of D6.3.

9 Conclusions and future works

In order to be able to implement an ecosystem of services in the S2CP platform, a component-based architecture is designed where each component has a member of the WP as responsible. All those responsible partners meet every two weeks to monitor developments. In addition, with the aim of being able to adjust the services to the needs of the users, workshops and bilateral training meetings are organized where the implemented technologies can be transferred to the different laboratories of the Cities2030 project.

The design of the ecosystem includes both the detailed technological description of the software components and modules, as well as a study of the standardized and common interfaces to the current state of the art used by the different modules to allow interconnection with other pre-existing infrastructures.

Specifically, the ecosystem of services includes the following components: Cities2030 community, Good Practices, Innovation management platform (SSRI-MAA), Blockchain for SFSC (Digital twin), four other components that will be developed in the second period of the project (M24 – M48).

The Cities2030 community component is a communication environment between project participants and social agents. It has functionalities to display static information, mechanisms for asynchronous communication between the different registered people (forums), calendar systems, and functionalities for the dissemination of results in a more informal way, such as blogs.

On the other hand, the Good Practices component is a web portal where the good practices identified by the labs and other Cities2030 partners can be displayed in the form of a catalog. The objective is to facilitate good practice collection in a collaborative way and disseminate the findings of the project among society.

The platform for innovation management (SSRI-MAA tool) seeks to provide labs with an application with which to define the objectives of their innovation process, and very especially also the indicators of success and their experiments. The application will allow defining the initial value of these indicators, as well as monitoring their evolution and determining the success of innovation activities.

Finally, with regard to the digital twin of the value chain, it is a model based on blockchain, allowing all CRFS agents to be in contact by sharing data and transactions on food products.

In the second half of the project (M24-M48), WP6 plans to complete the two remaining development macrocycles, assisting the laboratories in the experimentation and drawing of conclusions phase. The work will focus on a smaller number of components but with greater complexity, especially those that require blockchain technology for their operation. In particular, real-time monitoring services based on state-of-the-art technologies such as FIWARE or Docker will be implemented, geospatial services will allow laboratories

to study territory and carry out their innovation processes in a scientific manner, marketplaces to carry out proofs of concept based on tokenization, and blockchain services for the provision of transparency mechanisms to the different agents that participate in the CRFS value chain.

Annex I: User manual for Cities2030 community

This section presents the user manual[14] delivered to the Labs in the technology transfer process, regarding the Cities2030 Community component. This manual is structured in a series of steps to cover the phases of:

1. User registration in the communication space
2. Lab creation
3. Welcome page creation
4. Dissemination of initial ideas on the CRFS
5. Identification and engagement of lab members and stakeholders
6. Creation of communication plan
7. Creation of context analysis
8. Creation of indicators list
9. Integration of food events in Cities2030 and in the Lab
10. Contribution in Working groups and report results and good practices

Below, each of them is detailed through specific instructions and screenshots.

1. User registration in the communication space

In https://cities2030.eu/single-click-crfs-platform/

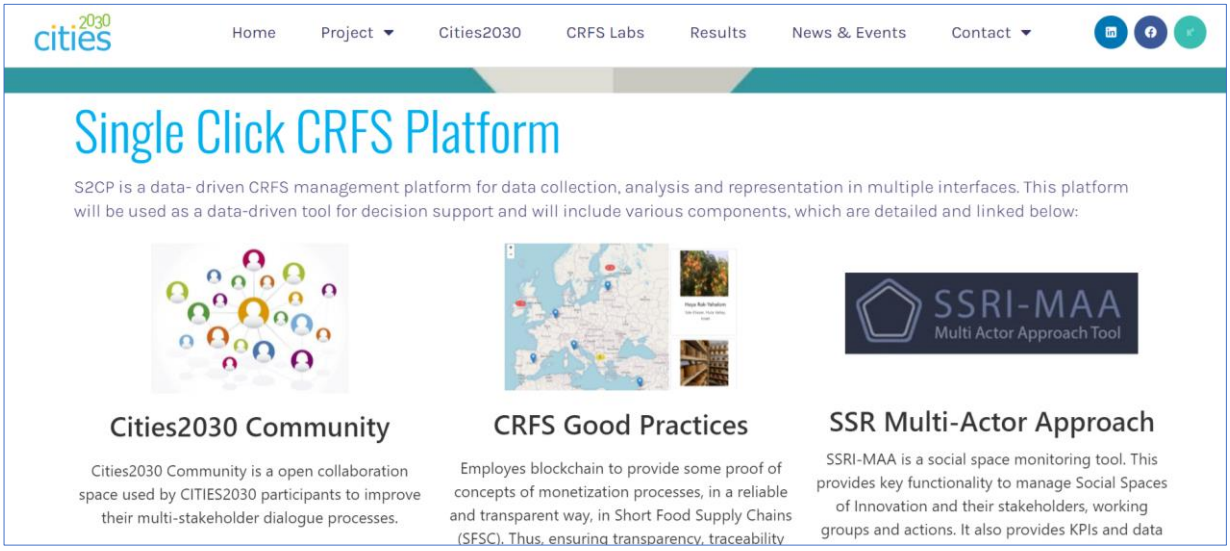


Figure 46. S2CP main page

The first component is Cities2030 Community. In this page, all components with a mature development stage are available. If we click into the name of picture of the Cities2030 community component, we will be redirected to the component main page.

To sign up in Cities2030 Community we must go to the "sign up" menu (top right, blue button) and complete the process.

[14] Due to the format of the user manual, as instructions for partners and labs, in annexes I to IV we wanted to respect the imperative sentence verb tenses (example: Create your lab using the blue button) even though it is not the verbal used in the rest of the deliverable.

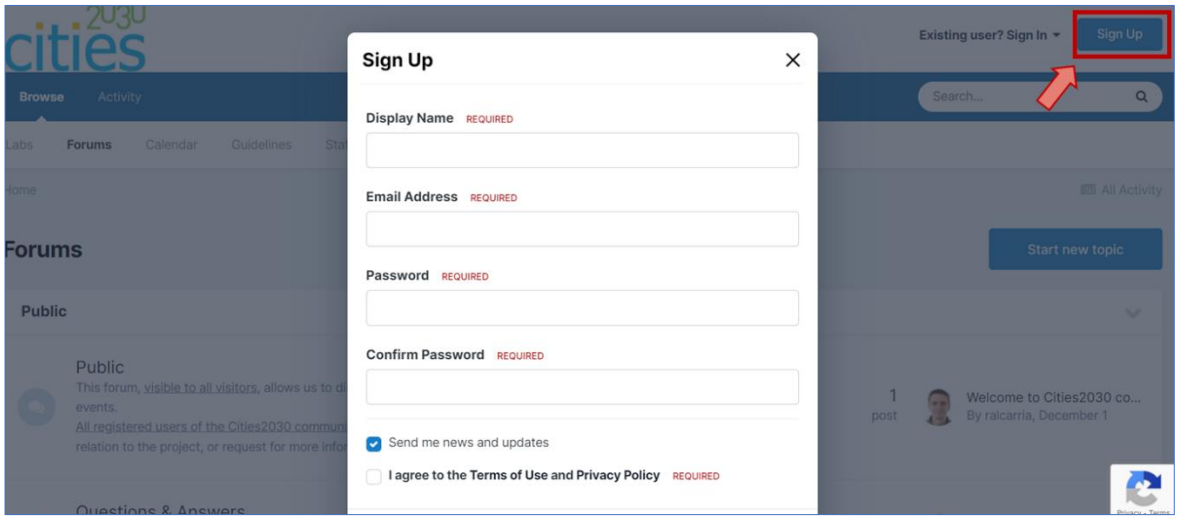


Figure 47. Sign up process in Cities2030 Community

At least one member from each partner participating in the lab must sign up. After that, please confirm your email (go to your inbox) and configure your profile.

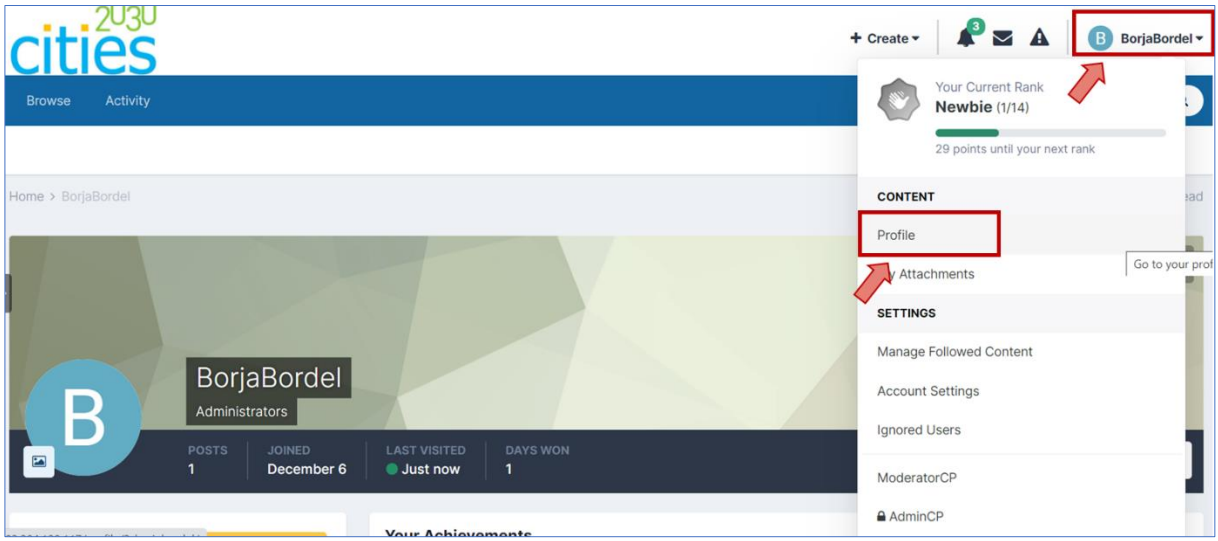


Figure 48. Location of user profile in Cities2030 Community

Three questions must be answered:

a) Partner's company name
b) If you are a member of the Cities2030 consortium
c) Select one or more labs in which you are participating

Optionally, you may also upload a photo, a banner for your personal profile, and some extra information, using the "profile" tab in your personal menu.

2. Lab creation

Lab creation is part of the phase 1.1 of the Extended Innovation Pattern (WP5) methodology, describing how labs can provide information about their creation process.

Create your lab (if not already created) using the blue button "Start a Lab" within the "Labs" section (use the top menu to move to this section)

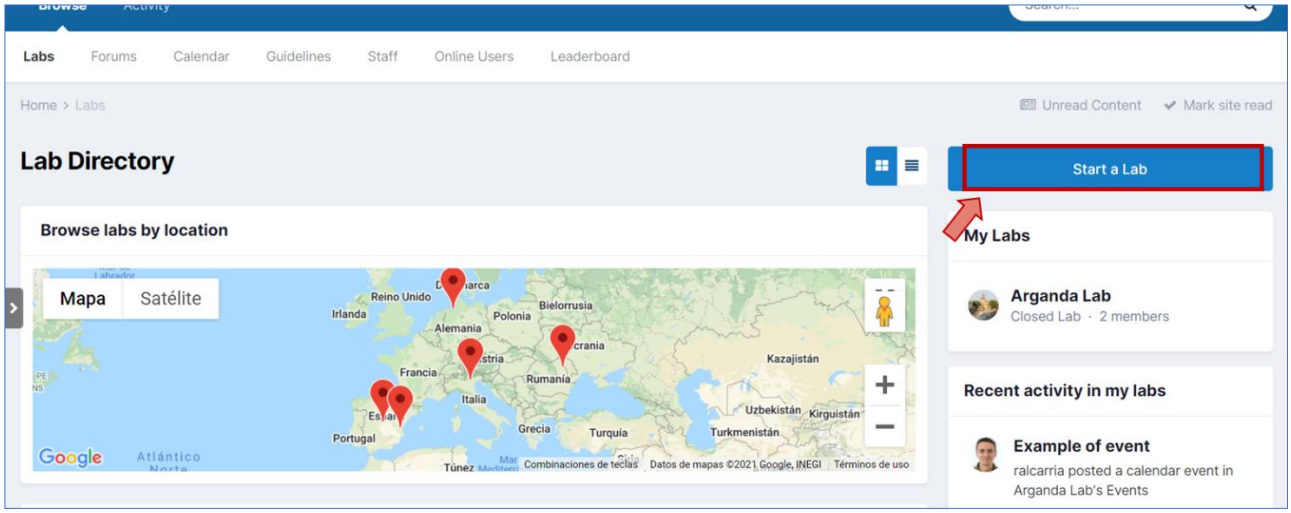


Figure 49. Create a new lab in Cities2030 Community

Regarding permissions, at this stage all labs must be "Closed"

- Public labs: Everyone can see the lab and its posts and can participate without joining.
- Open labs: Everyone can see the lab and its posts, but only members can participate. Everyone can join
- Closed labs: Everyone can see the lab and who's in it, but only members can see posts and participate. Users need to ask a leader to join.
- Private labs: Only members can find the lab and see its posts. Users need to be invited by a leader to join.

When all the information is ready to be disseminated, it will be possible to review this policy.

The next step will be to upload the main photos for your lab. Two photos are needed: (i) a square photo and (ii) a banner photo. You can see some examples in the repository and in the Arganda lab space (all sections are opened for review). Upload the profile photo of your lab using the "Lab Icon" button.

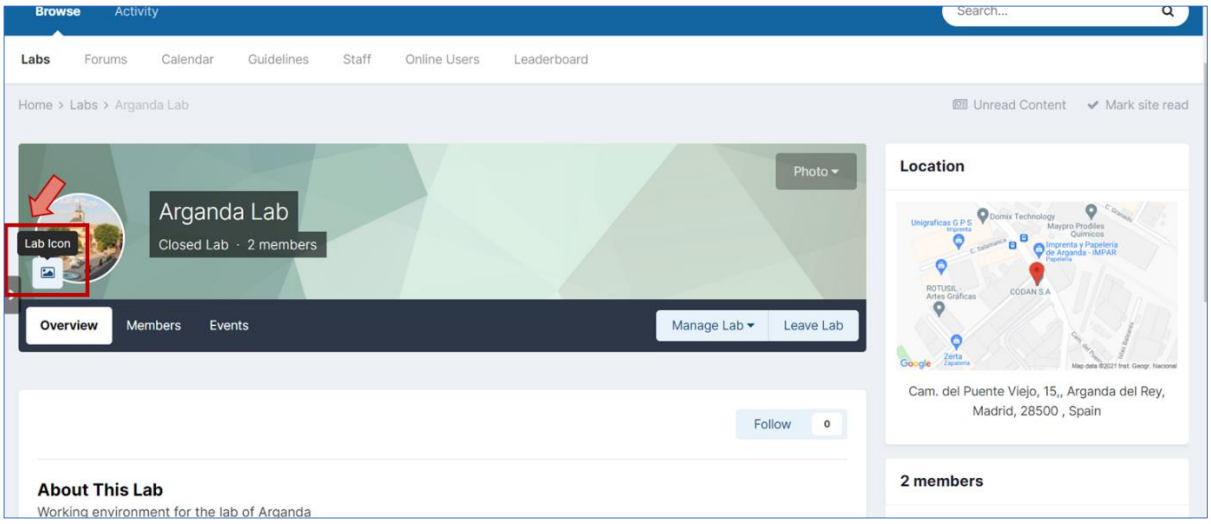


Figure 50. Upload the profile photo of your lab in Cities2030 Community

Also, you can upload the banner photo using the "Photo" menu:

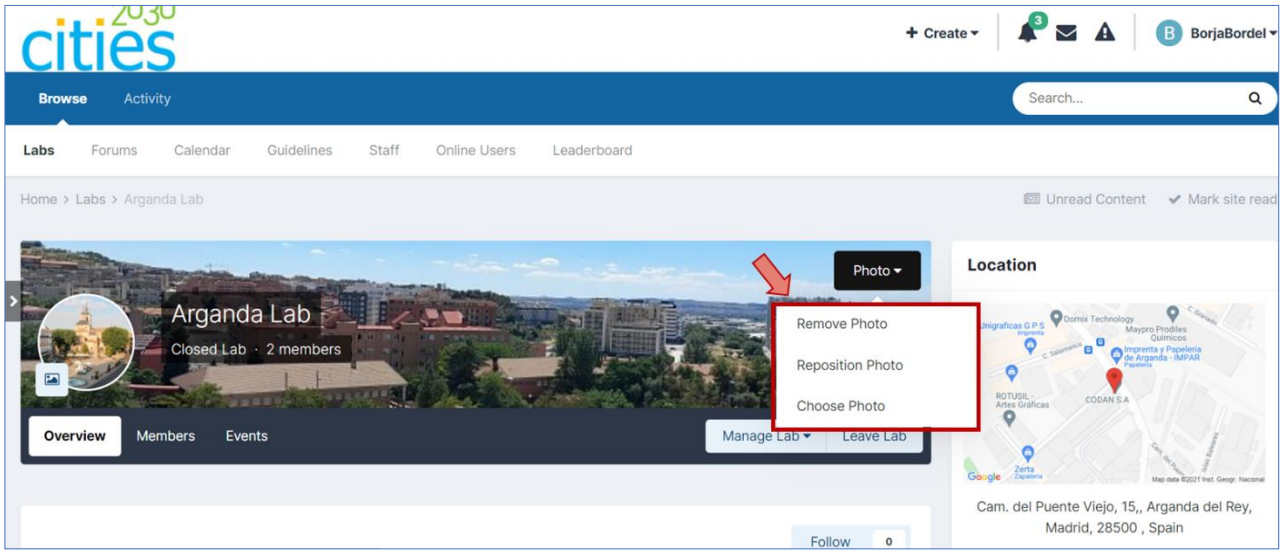


Figure 51. Upload the banner photo of your lab in Cities2030 Community

Please, provide the location of your lab and a short description about your lab. You can specify of you are a living lab, a policy lab or both. For example: "Working environment for the Living Lab of Arganda". You can do this using the following route: "Manage lab" > "Edit lab settings":

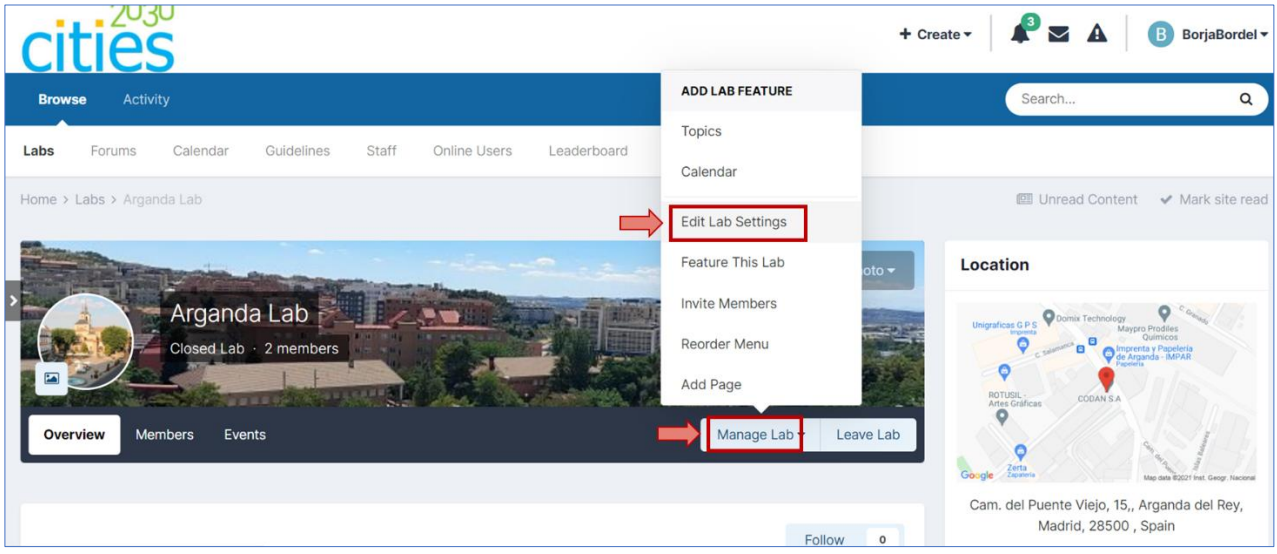


Figure 52. Edit lab settings (1) in Cities2030 Community

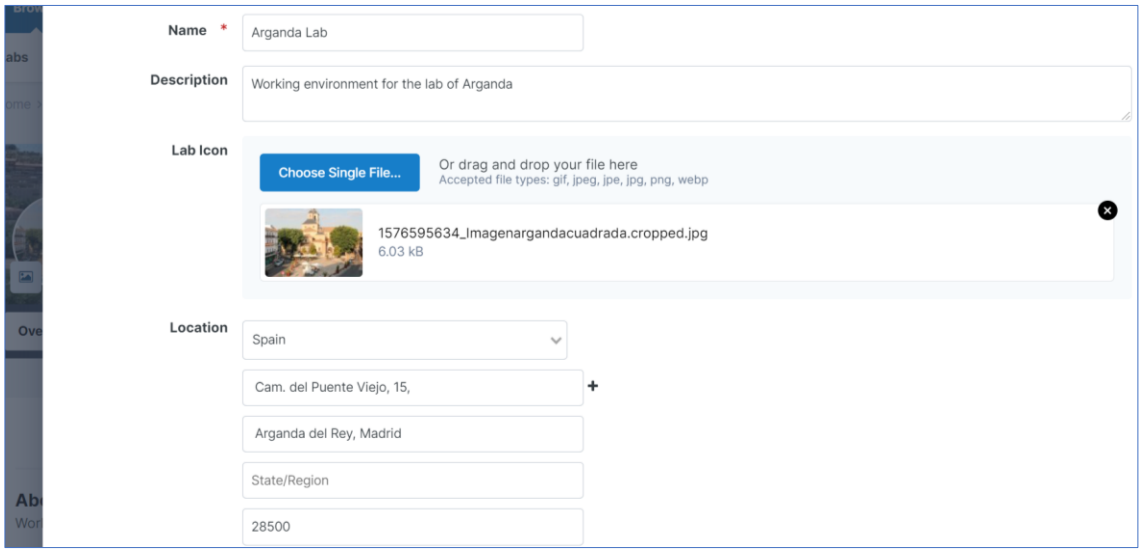


Figure 53. Edit lab settings (2) in Cities2030 Community

3. Welcome page creation

In order to create the welcome page, first of all, we have to publish and provide all stakeholders and other members in Cities2030 project with a general and holistic view about the lab. To create the "welcome page", you can use the "Manage lab" > "Add page" tab

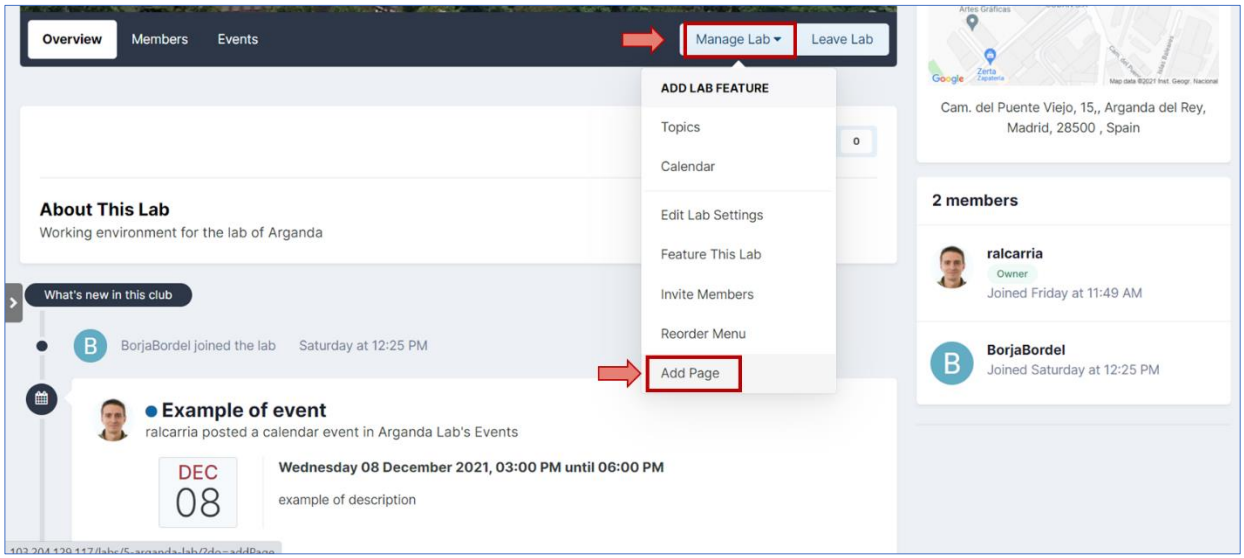


Figure 54. Add page section in Cities2030 Community

As page title you can use "Welcome page" and as page content you can put any initial message, as can be seen below:

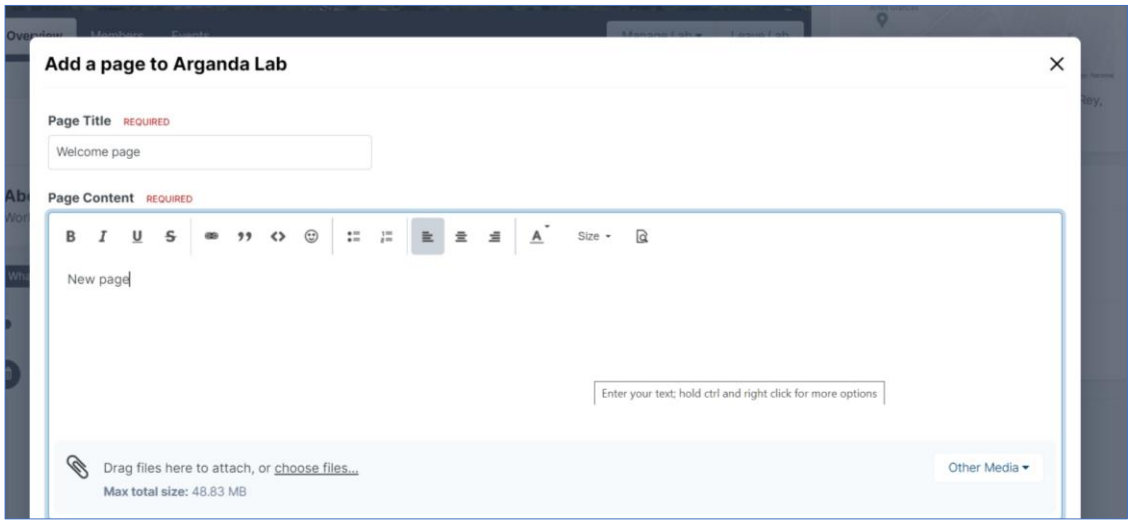


Figure 55. Add page to Lab in Cities2030 Community

After that, you can reorder the menu to move the "welcome page" to the first position on the left:

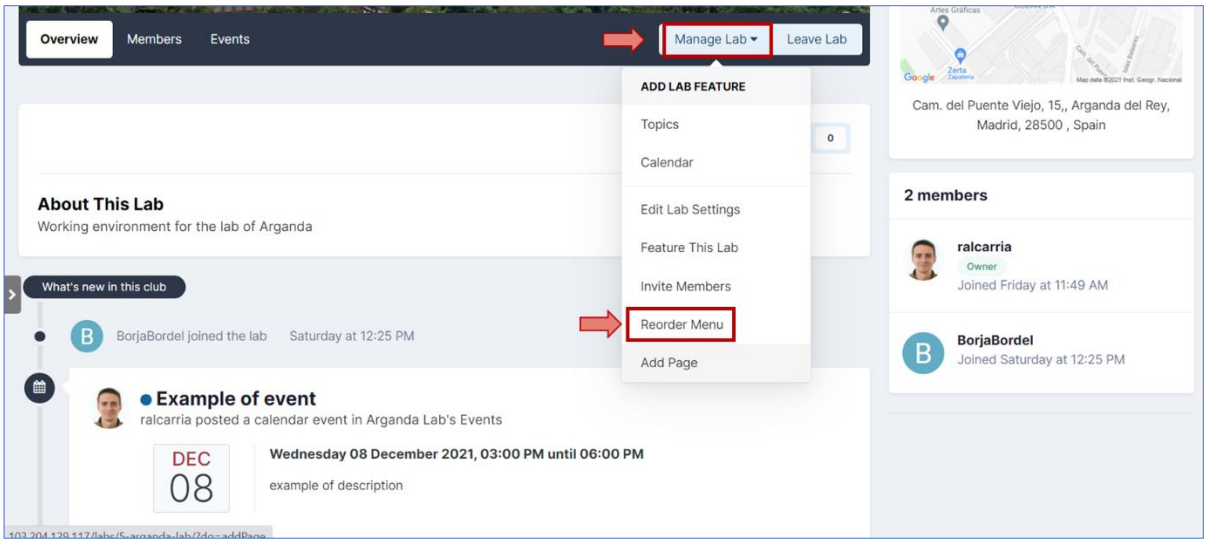


Figure 56. Reordering Lab menu in Cities2030 Community

This page must be a general and holistic description of your city and the CRFS. You can edit this page using the "manage page" option.

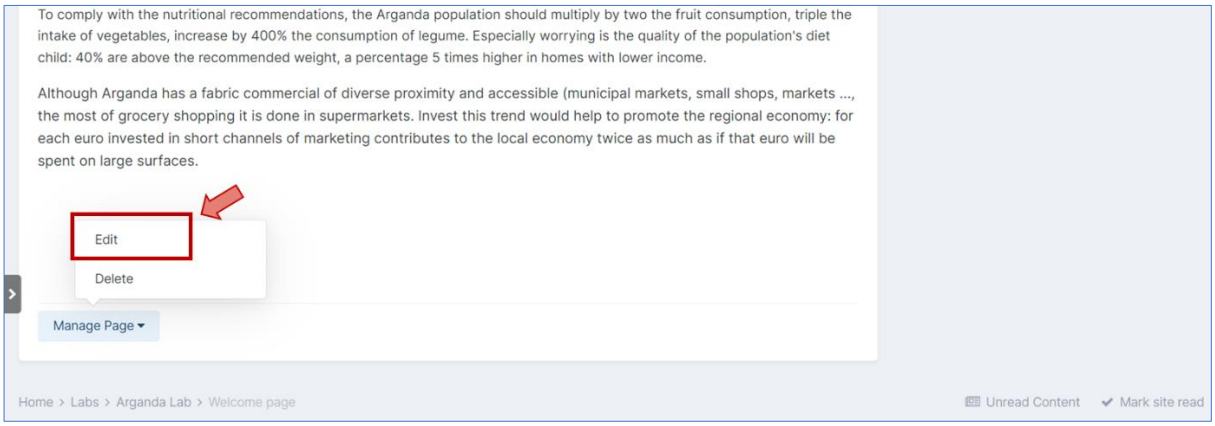


Figure 57. Edit page in Lab profile in Cities2030 Community

In the page we should provide:

- General introduction of city/region and/or add links to an external source
- Provide pictures of the region

You can use as an example the information provided in the Arganda lab. Please be aware that only partial data about CRFS is present in Arganda Lab. Please create a more extensive and detailed "welcome page" for your Lab.

This information is requested in WP4 and WP5 innovation methodologies. For living labs: This content is required in phase 1.1 in the EIP methodology. For policy labs: This information is the initial step (problem definition) in the co-creation process with the stakeholders

You can add photos about your city using the bottom menu. To insert them into the text, put the cursor where you want to insert the photo and press the "insert" link. Doble click on the photo to modify its size.

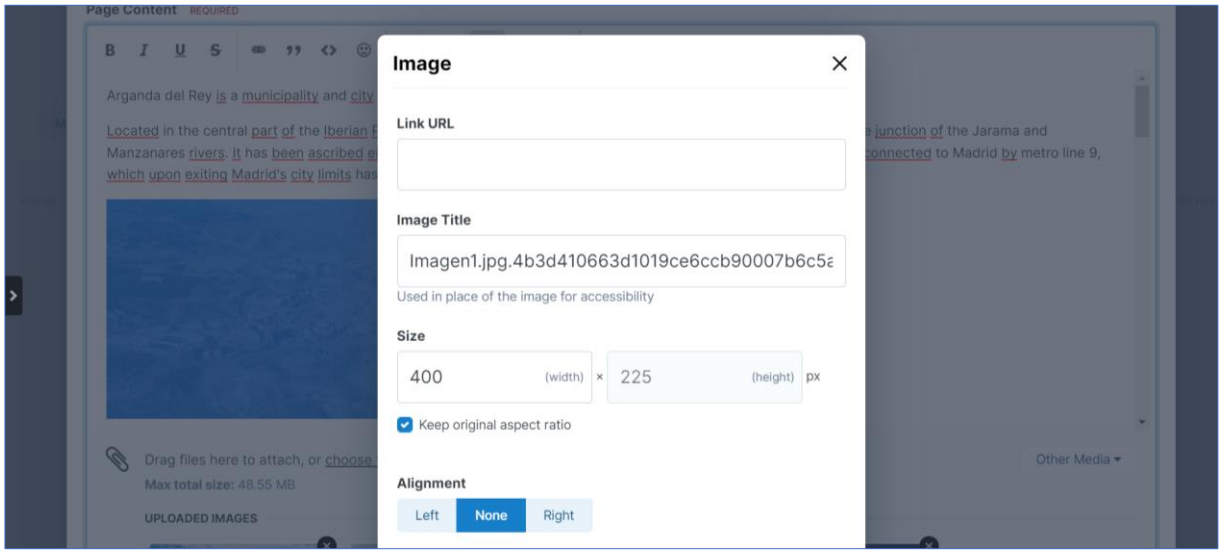


Figure 58. Adding photos of your Lab in Cities2030 Community

In the "welcome page", add a subsection to describe the objective of your living and/or policy lab. You should, besides, answer four important questions: why, what, where, who. For living labs: This content is required in

phase 0.2 in the EIP methodology. For policy labs: This information is the initial step (problem definition) in the co-creation process with the stakeholders (iterative process).

4. Dissemination of initial ideas on the CRFS

To disseminate the initial reflections on our CRFS and Cities2030 project we can create a new page (as described before). A possible title for this page is "Initial reflections", the Arganda Lab site can be used as example. Depending on the nature of the Lab (living lab or policy lab) this step varies:

Living labs

1. Upload as page content your reflection about the applicability of the living lab methodology. This initial reflection fulfill phase 0.1 of the EIP methodology
2. Upload your insights on the Design Thinking methodology. This initial reflection fulfill phase 1.2 of the EIP methodology
3. Analyze and describe the innovation landscape of your city, region and country. This initial reflection fulfill phase 1.4 of the EIP methodology

Policy labs

1. Analyze and describe the innovation landscape of your city, region and country. This is important to evaluate and identify relevant agents that may help and improve your co-creation process

Create a private forum for discussions with your lab member and stakeholders. You can do it using the "Manage lab" > "Topics" functionality. We propose a title for this forum "Private discussions".

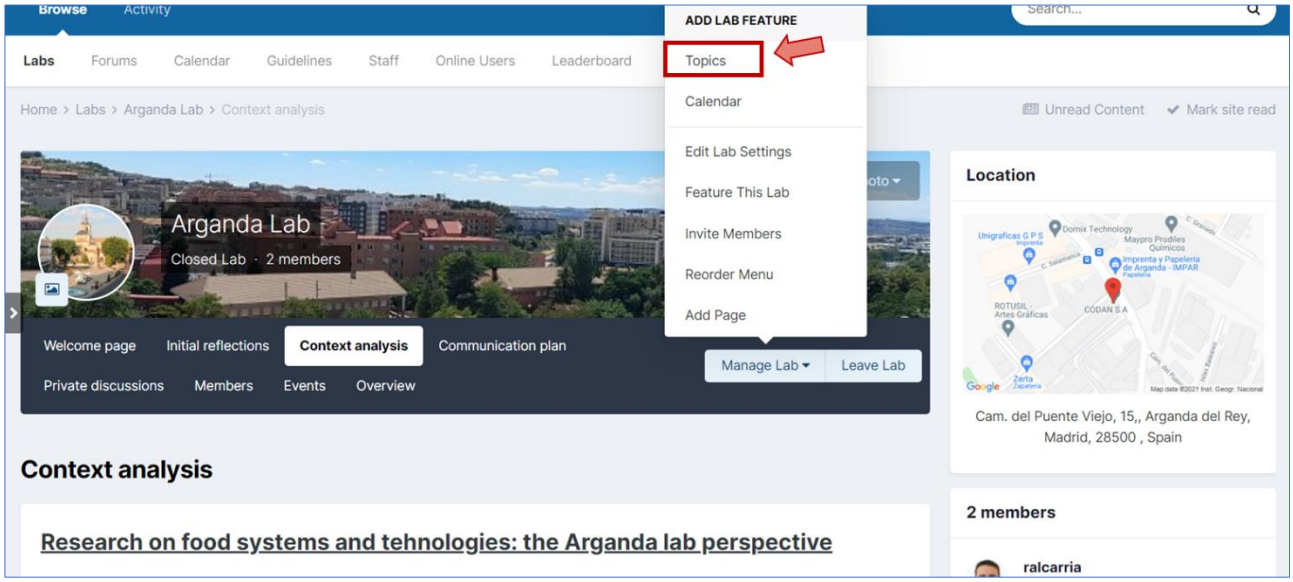


Figure 59. Creation of a forum in Lab space (Cities2030 Community)

Open a discussion in the private forum regarding these initial reflections to gather their opinions and discuss among all the partners within the lab (evidence for the EC). At least five interventions are expected. The next figure is an example of initial reflection opened in Arganda Lab.

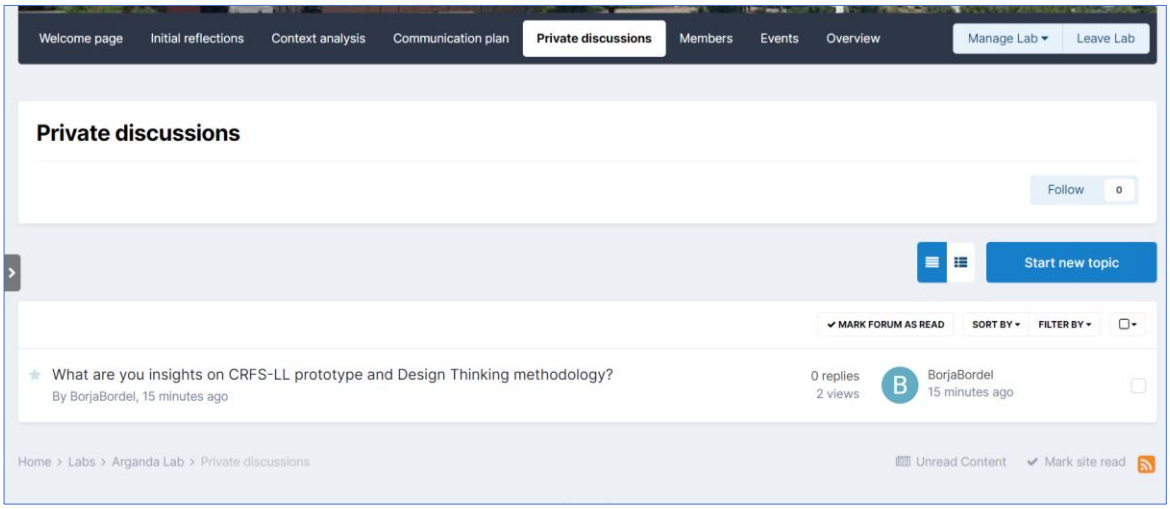


Figure 60. Opening a initial reflection discussion in the private forum (Cities2030 Community)

5. Identification and engagement of members and stakeholders

Ask all Cities2030 partners participating in your labs to join the communication space (at least one person from each organization). You can use the "Manage labs" > "Invite members" functionality.

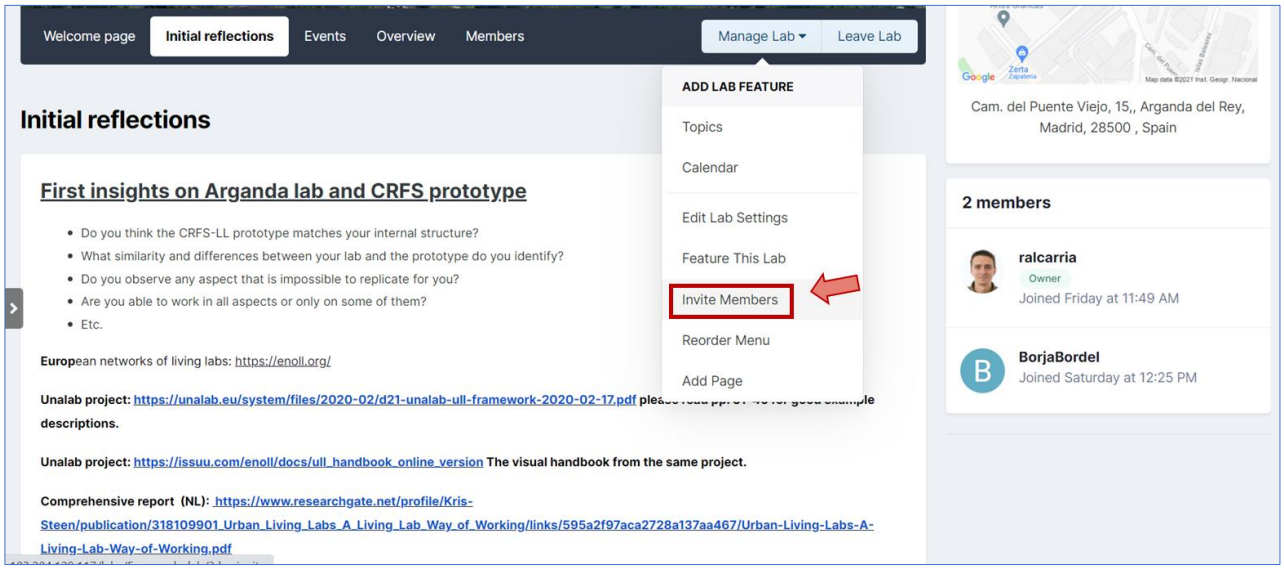


Figure 61. Invite members in Lab page (Cities2030 Community)

Please, be aware of the number of expected stakeholders (at least 5 of them from each lab). You can use the "Manage labs" > "Invite members" functionality. For **living labs**: This content is required in phase 0.3 in the EIP methodology. For **policy labs**: This information is essential for the co-creation methodology. All agents must be together to discuss and analyze the proposals, ideas, data, etc.

6. Creation of communication plan

Create a new page (as described before) to disseminate your communication plan. A possible title for this page is "communication plan". This content is required in phase 0.5 in the EIP methodology.

7. Context analysis

Create a new page (as described before) to disseminate your context analysis. A possible title for this page is "Context analysis". Depending on the nature of the Lab (living lab or policy lab) this step varies:

Living labs

1. Analyze the state of the art on food research and CRFS. Specially regarding your region. This content is required in phase 1.3 in the EIP methodology.
2. Analyze the political, cultural, etc. obstacles and vulnerabilities of your lab to implement any innovation (like the ones analyzed before) in your lab. This content is required in phase 1.6 in the EIP methodology.
3. Provide a SWOT analysis of your lab, regarding the innovations you would like to implement. This content is required in phase 1.7 in the EIP methodology.
4. Describe how would you like to improve your lab for the 2030 objective and vision. What are the This content is required in phase 1.15 in the EIP methodology.

Policy labs

1. Provide a SWOT analysis of your lab, regarding the possibility of proposing and implementing new policies. This analysis will be enriched in an iterative process. When data will be available, you can enrich this analysis with quantitative metrics and observations.

Open a discussion in the private forum regarding the SWOT analysis (evidence for the EC). At least five interventions are expected. The stakeholders must participate as well

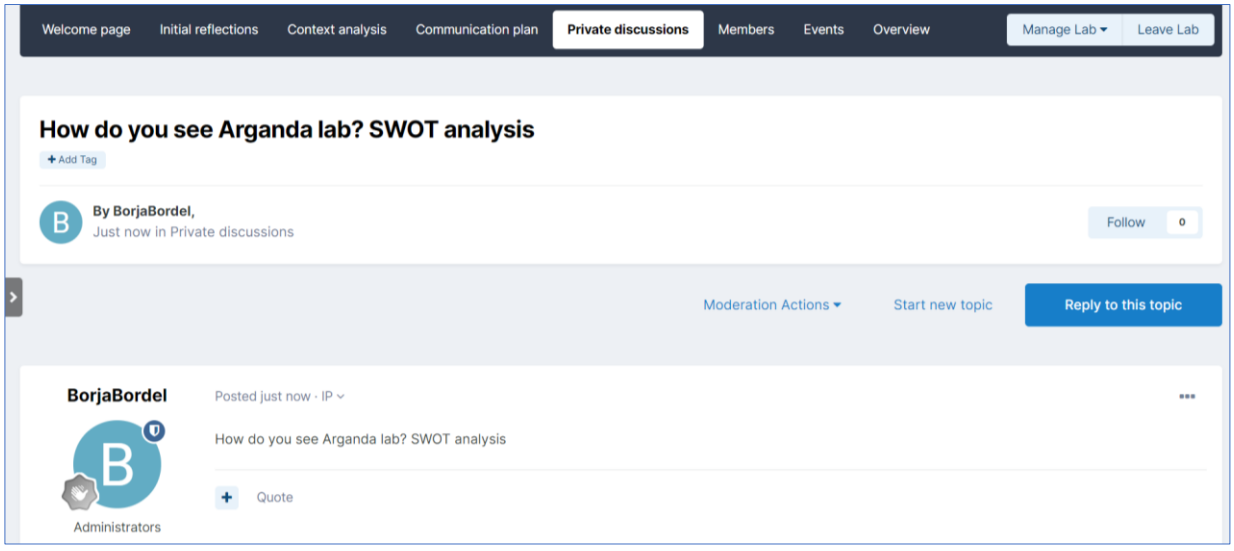


Figure 62. Opening a SWOT analysis discussion in the private forum (Cities2030 Community)

8. Creation of indicators list

Create a new page (as described before) to disseminate the indicators your lab is going to monitor and improve. A possible title for this page is "Indicators". Depending on the nature of the Lab (living lab or policy lab) this step varies:

Living labs

You can propose your customized indicators, according to the innovation actions you are carrying out and your objectives. However, we encourage you to review and select indicators (at least some of them) from the "Milan Urban Food Policy Pact Monitoring Framework"[15]. This content is required in phase 1.14 in the EIP methodology.

Policy labs

From the "Milan Urban Food Policy Pact Monitoring Framework", select the indicators your lab is going to develop. The co-creation process needs clear objectives as first step.

For both labs

Open a discussion in the private forum regarding the indicators (evidence for the EC). At least five interventions are expected. The stakeholders must participate as well

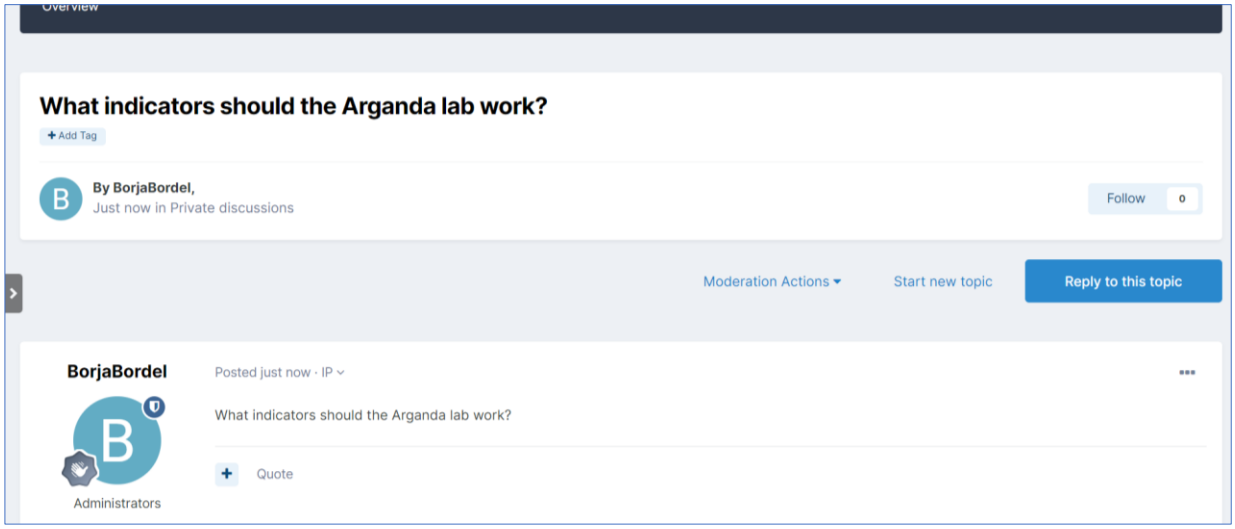


Figure 63. Opening an indicator discussion in the private forum (Cities2030 Community)

9. Integration of food events in Cities2030 and the lab

Create a public calendar to report and disseminate all your food events. You can do it using the "Manage lab" > "Calendar". We recommend using as title: "Lab calendar".

[15] Milan Urban Food Policy Pact Monitoring Framework: https://drive.google.com/file/d/10F9lxSbwGrJlyXsby2Ff_E59jMTxIlpD/view?usp=sharing

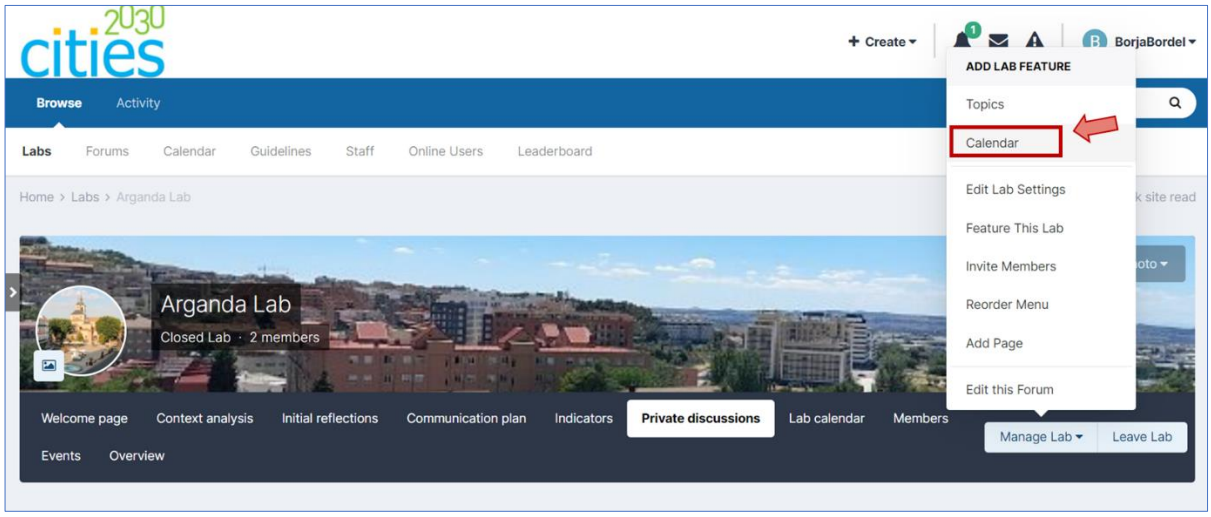


Figure 64. Accessing Lab calendar functionality in Cities2030 Community

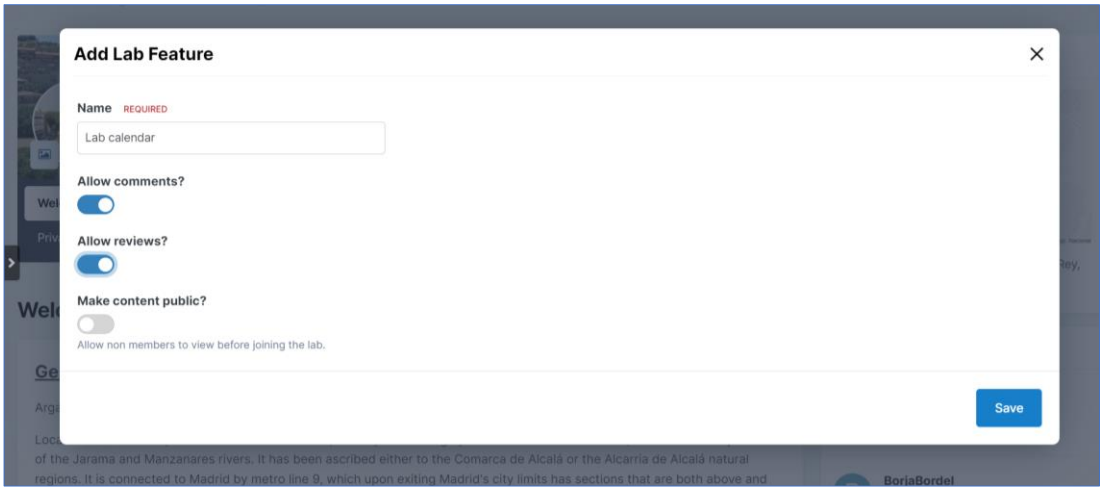


Figure 65. Creating Lab calendar in Cities2030 Community

Please, include in the calendar all the food events related to the Cities2030 and your lab. You can use the "Create event" blue button, or the (+) symbol located in every day in the calendar.

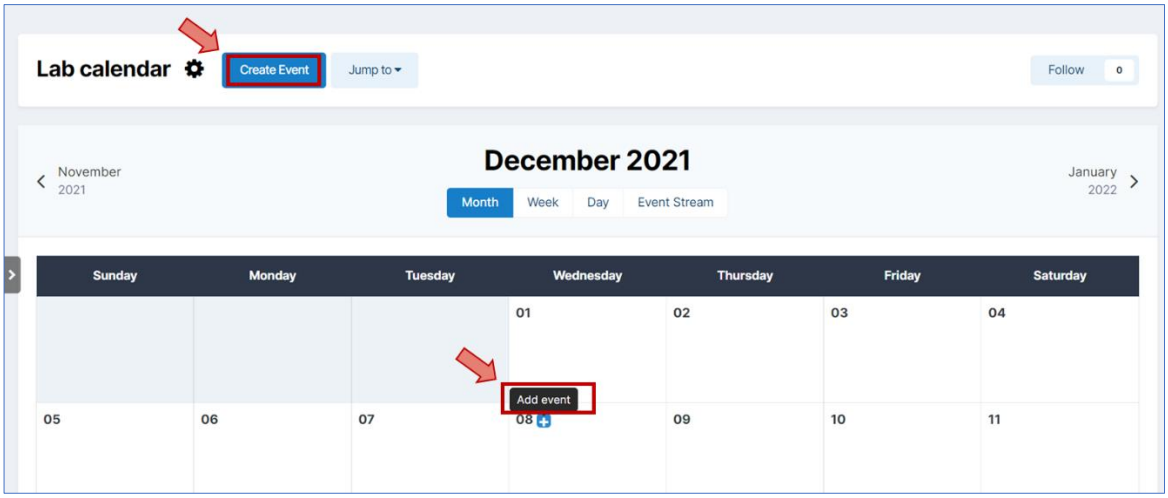


Figure 66. Adding Lab event in Cities2030 Community

For each event, you are encouraged to provide:

- A title for the event
- Use the description space to include the agenda, objectives, some photos, and conclusions about this event. Describe, besides, the relation of this event with Cities2030 (if possible)

Participants may include comments about the event. This may be interesting to so interaction among participants, stakeholders, etc.

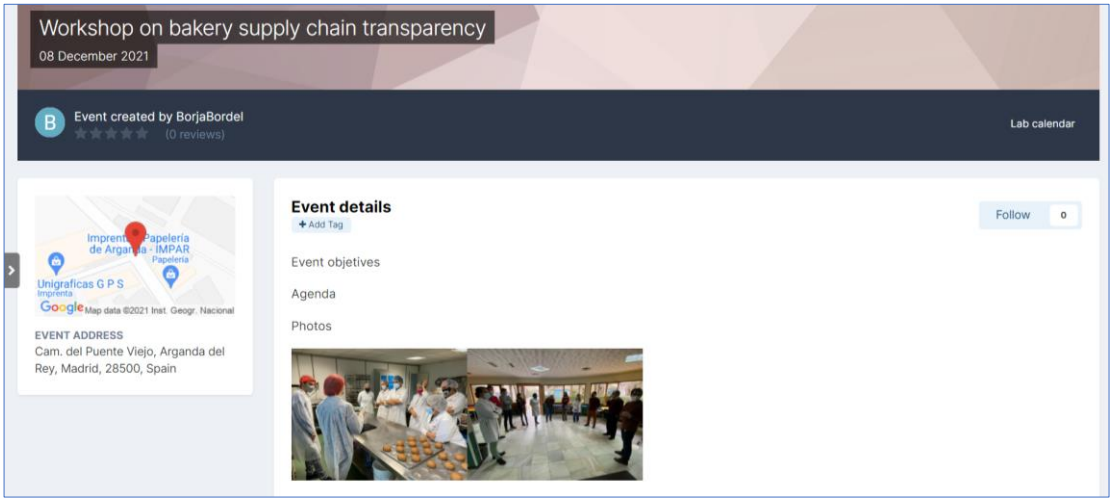


Figure 67. Example of event created in Arganda Lab (Cities2030 Community)

10. Contribution in Working groups and report results and good practices

Please, go to the "Forums" tab

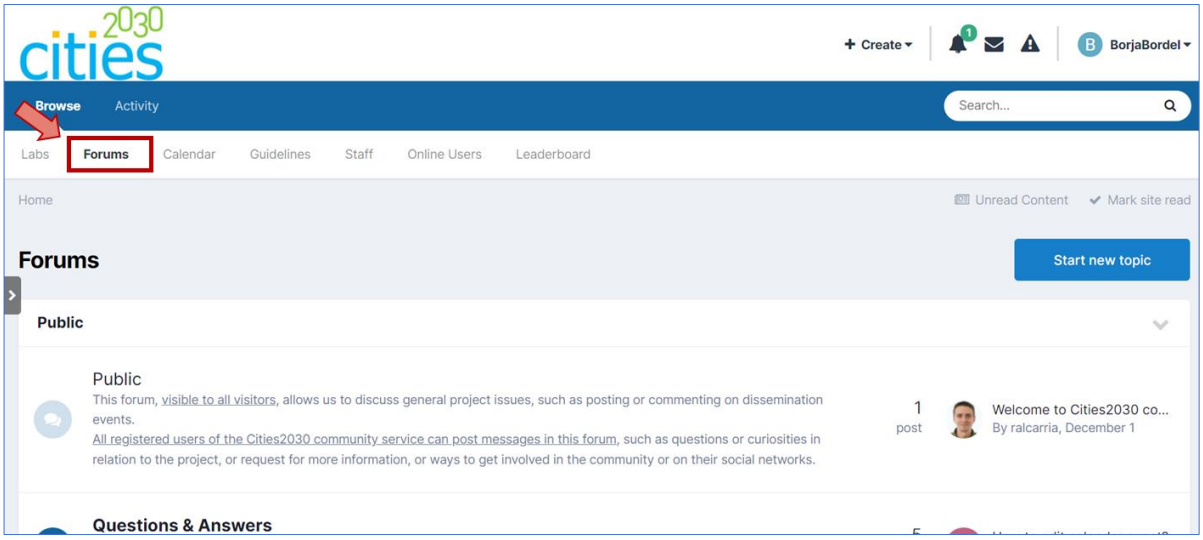


Figure 68. Forums tab in Cities2030 Community

Go to the end of the page, to locate the thematic forums for the working groups (FAO): CRFS Action

Figure 69. CRFS action section in Forums page (Cities2030 Community)

It is expected from all partners to participate in those working groups. Every lab should contribute to two different working group with two interventions.

For living labs: This action is part of the phase 0.4 of the EIP (WP5) methodology

For policy labs: This action has been presented to policy labs at the Policy Lab Fifth seminar session, June 21st, 2022, as part of Step 2 "Pathway to action" of the WP4 methodology, for the ultimate creation of the "Policy lab action plan".

For reporting results and good practices, please use the good practices tool, whose user manual is in Annex II.

Annex II: User manual for Good Practices

This section presents the user manual delivered to the Labs in the technology transfer process, regarding the Good Practices component. This manual is structured in a series of steps to cover the phases of:

1. User registration and login in CRFS Good Practices
2. Registering innovations
3. Visualizing all good practices in an atlas.

Below, each of them is detailed through specific instructions and screenshots.

1. User registration and login in CRFS Good Practices

Go to: https://cities2030.eu/single-click-crfs-platform/

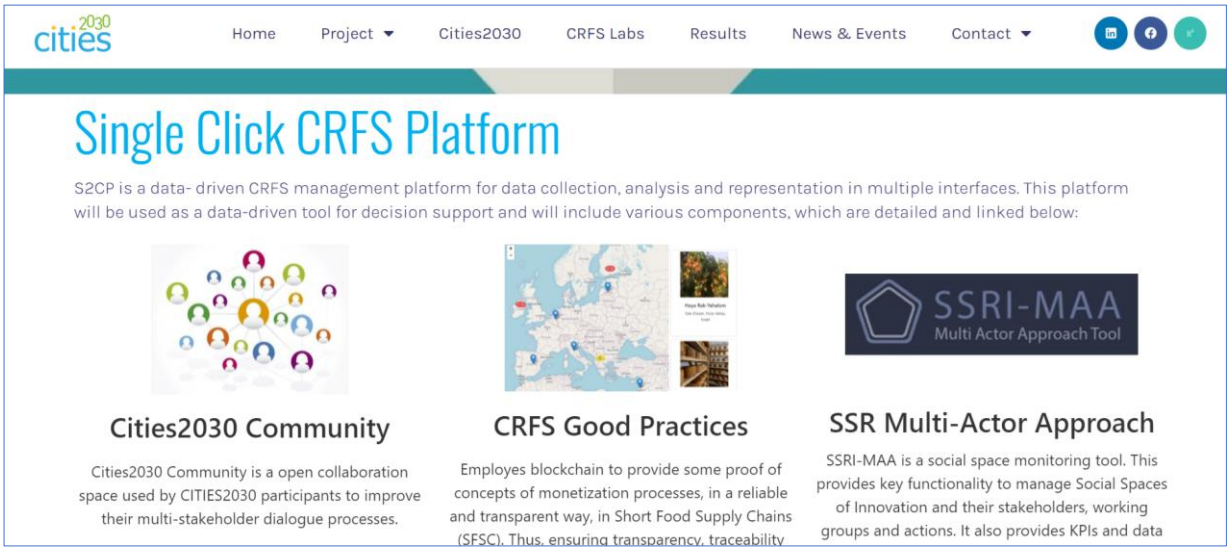


Figure 70. Link to CRFS Good Practices component

And click on the second component: CRFS Good Practices. In the Good practices component, use the "Register" menu in the top menu (right).

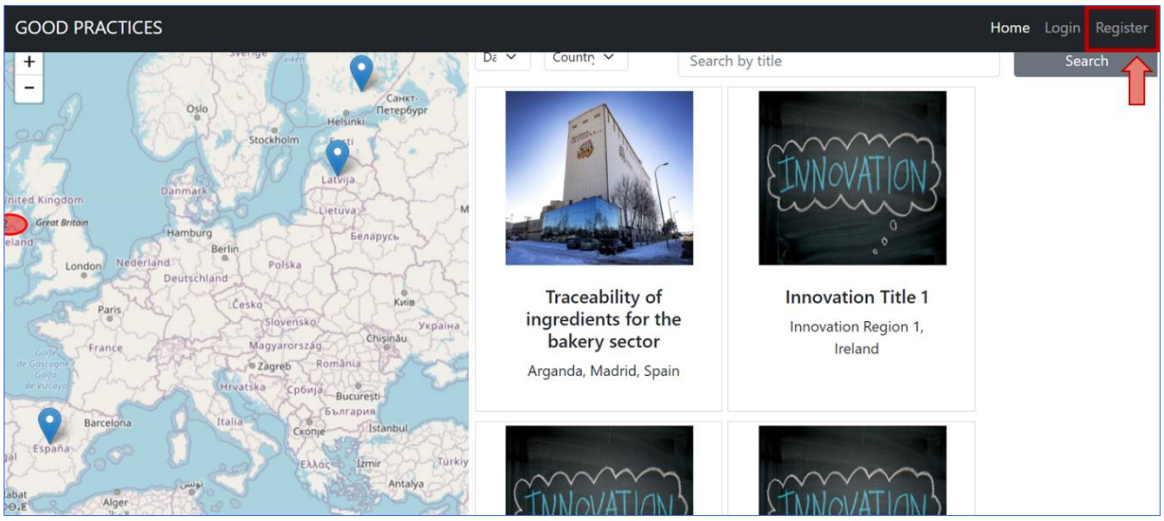


Figure 71. Register user in CRFS Good Practices component

Once the registration is done (by entering email and password) we can proceed to log in in the application:

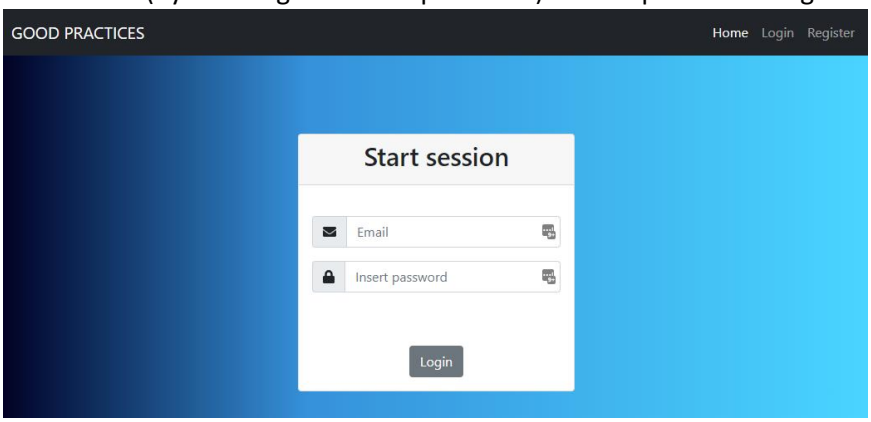


Figure 72. Login in CRFS Good Practices component

2. Registering innovations

In the component main web page any partner can add all the innovations, policies, or good practices generated by labs and also found in the Food Systems landscape across Europe. The information registered through this component is public. It is expected at least one good practice per cities2030 partner.
For every good practice we should provide[16]:

- Title
- Region (lab)
- Country
- Short description
- The link to the official or institutional page where the policy or innovation is described with details
- Use the map on the left to select the specific location of your lab and/or where the innovation has been deployed

[16] All fields are mandatory, a warning will be displayed in a field is empty. In this case, please add N/A or other similar statement.

- A profile picture for this good practice

Next figure shows the forms available to introduce this information:

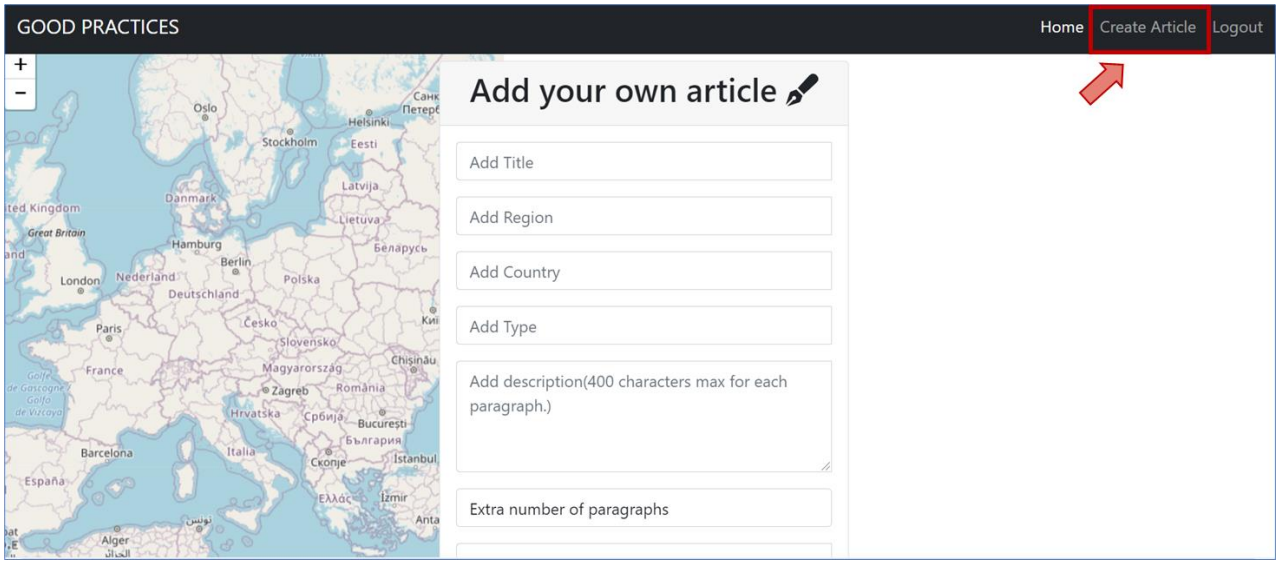


Figure 73. Article creation in CRFS good practices

3. Visualizing all good practices in an atlas

Once the good practice has been registered, and validated by the administrators, it will appear on the main page of the Good Practices component:

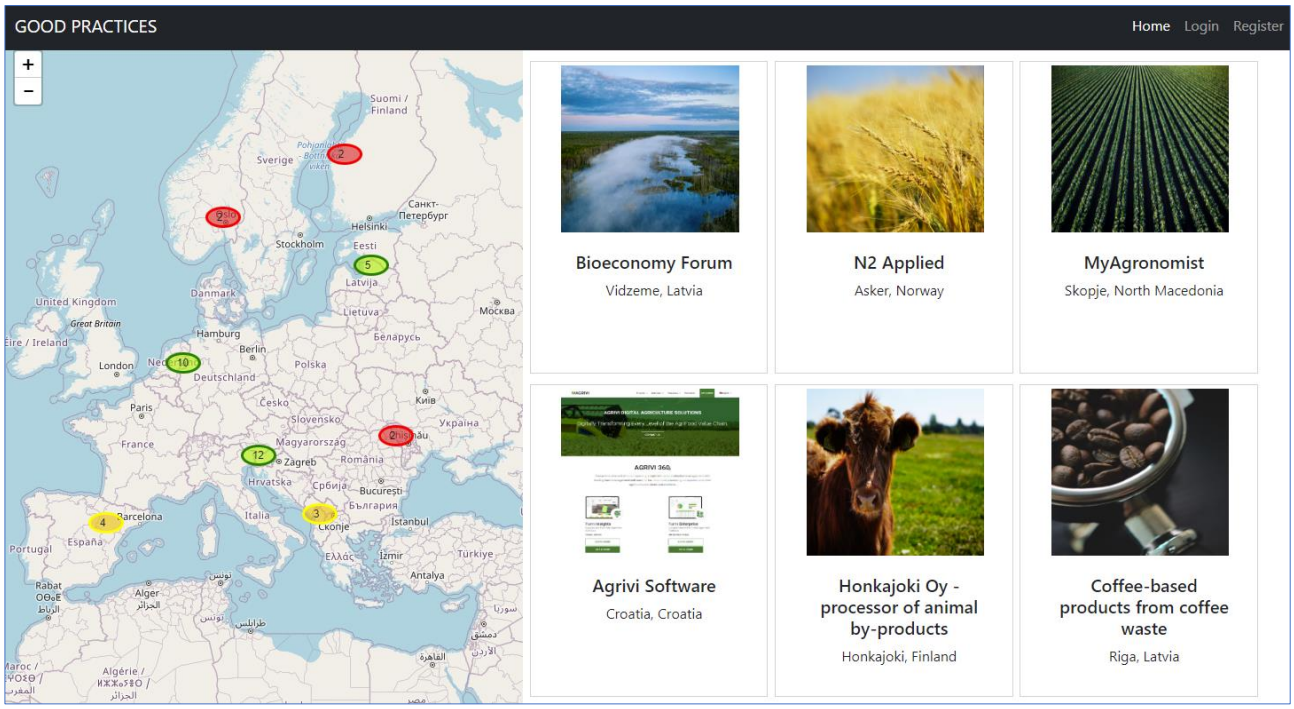


Figure 74. CRFS Good practices main page

If we click on this article, or on the corresponding point on the map. We will go to a detail page where we can see all the information provided:

Figure 75. Detail of article in CRFS Good practices

Annex III: User manual for SSRI-MAA tool

1. Introduction

SSRI-MAA is a Web-based tool that aims to register and monitor the innovation at a well-defined Social Space. The main objectives of SSRI-MAA tool are:

- Catalog and monitoring of SSRI actions and action plans.
- Catalog and monitoring of stakeholders and their representativeness.
- Monitoring of SSRI maturity levels and progress.
- Context, Policy & Performance indicators catalog and monitoring (KPIs).

Also, it is important to highlight that SSRI-MAA tool is not intended to be a networking nor collaborative platform. The entities and forms that manages are the following:

- Social Space definition and stakeholders.
- Objectives and actions.
- Catalog of stakeholders and its representativeness in the SSI.
- Catalog of actions and outcomes.
- SSI KPIs monitoring & impact.
- Actions monitoring & impact.
- DSS and Dashboards.
- Catalogs, (Type of actions, KPIs, etc.).

2. Functionalities

In this section we will cover the different sections and functionalities that SSRI MAAT implements in order to cover the objectives previously mentioned.

2.1 User login

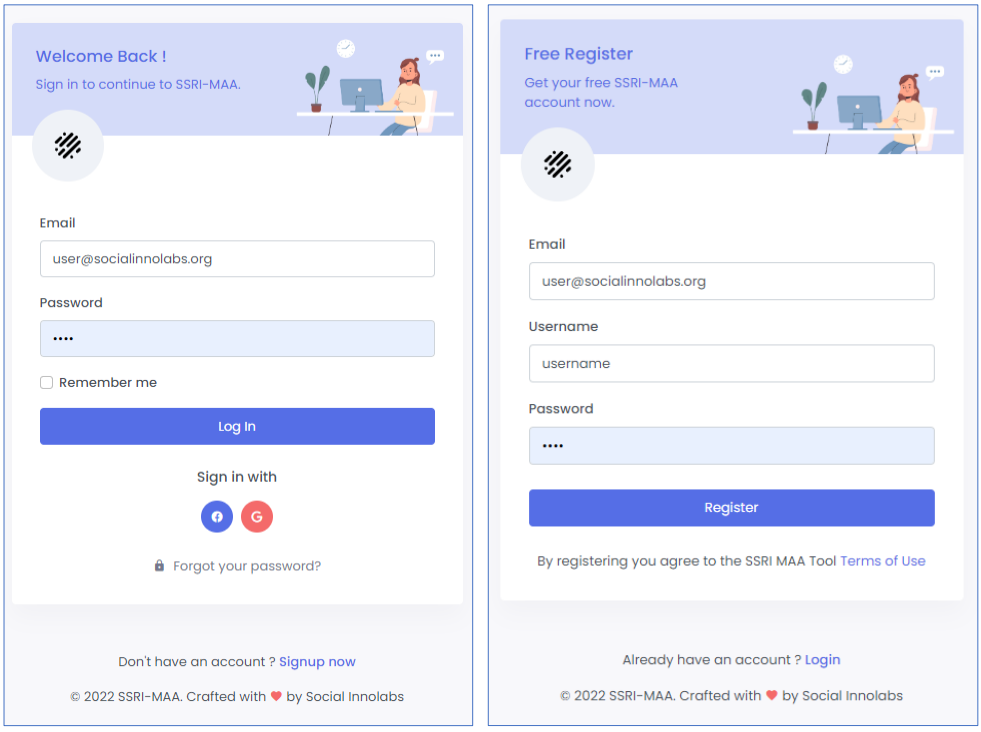


Figure 76. SSRI MAA Tool login page (left) and registration page (right)

In the image above users can introduce their credentials in order to login into the platform. Also, they will be able to create a new account in MAAT by clicking the "Signup now" link.

The required fields to create a new account are email, username and password. Once the user has completed this process, it will receive a confirmation email. It will be able to follow a link provided in this email to complete the registration process.

2.2 User Dashboard

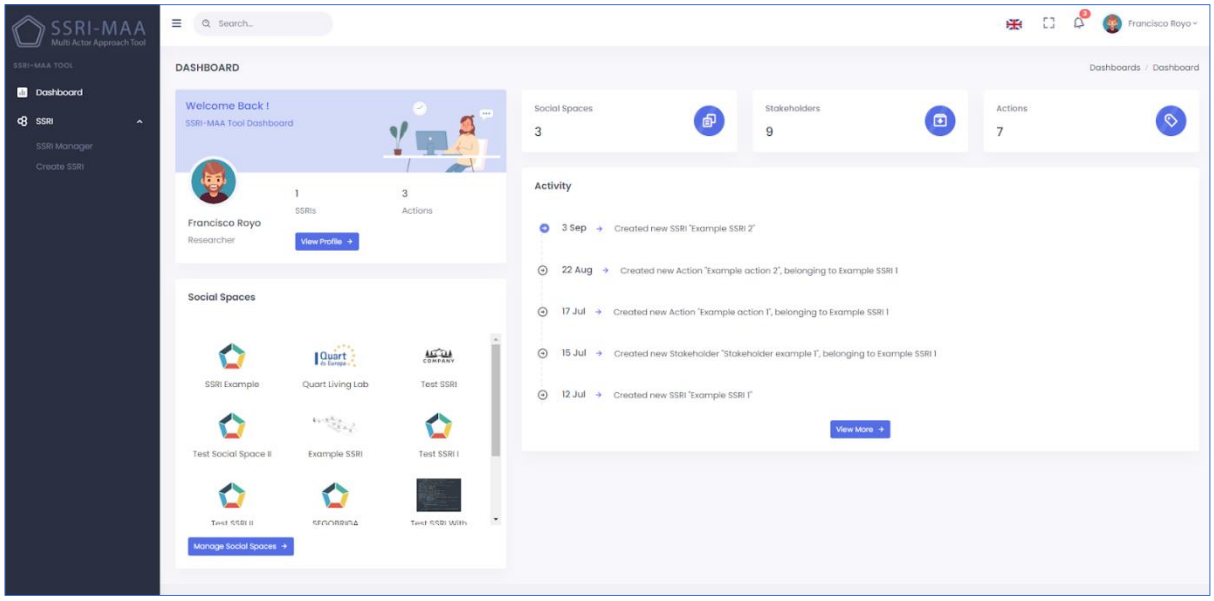


Figure 77. SSRI MAA Tool user dashboard

The image above shows the first section the user can see once it is logged in. There are different tools in this section that lets the user see a brief overview of social spaces and their activity.

- Welcome block, in which the user can see the number of social spaces owned or involved in and its actions. This block also shows the complete name of the user, its position and a link to a more detailed version of its profile.
- Social Spaces. This block shows a list of social spaces in which the user participates. Each icon links with the social space page that shows a detailed view of the content.
- Upper summary blocks. Shows the number of social spaces in which the user participates and their stakeholders and actions.
- Activity. Shows the actions performed by the user in the platform, ie: Create a new social space, setting up a new action, etc.

2.3 Top bar

This part of the interface is located at the very top of the screen and is always visible on every section of the tool.

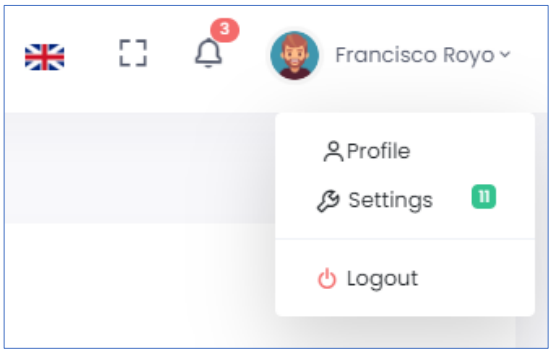


Figure 78. SSRI MAA Tool top bar

This bar contains buttons to show/hide the left menu, change language, toggle full screen mode, see the notifications and a dropdown menu that lets the user see its profile, settings and close its session.

2.4 Left side menu

Figure 79. SSRI MAA Tool left menu

Through this menu users can access and manage the main functionalities of MAAT. By now, this menu lets users access to the following sections:

- Dashboard. The section mentioned previously, shows the user's dashboard.
- SSRI
    - SSRI Manager. Section that shows a detailed view of the social spaces the user owns or it is involved in. It also lets the user create, edit or delete each social space.
    - Create SSRI. Direct link to social space creation tool.

2.5 SSRI Manager

This section shows a detailed view of the social spaces the user owns or is involved in. It also lets the user create, edit or delete each social space.

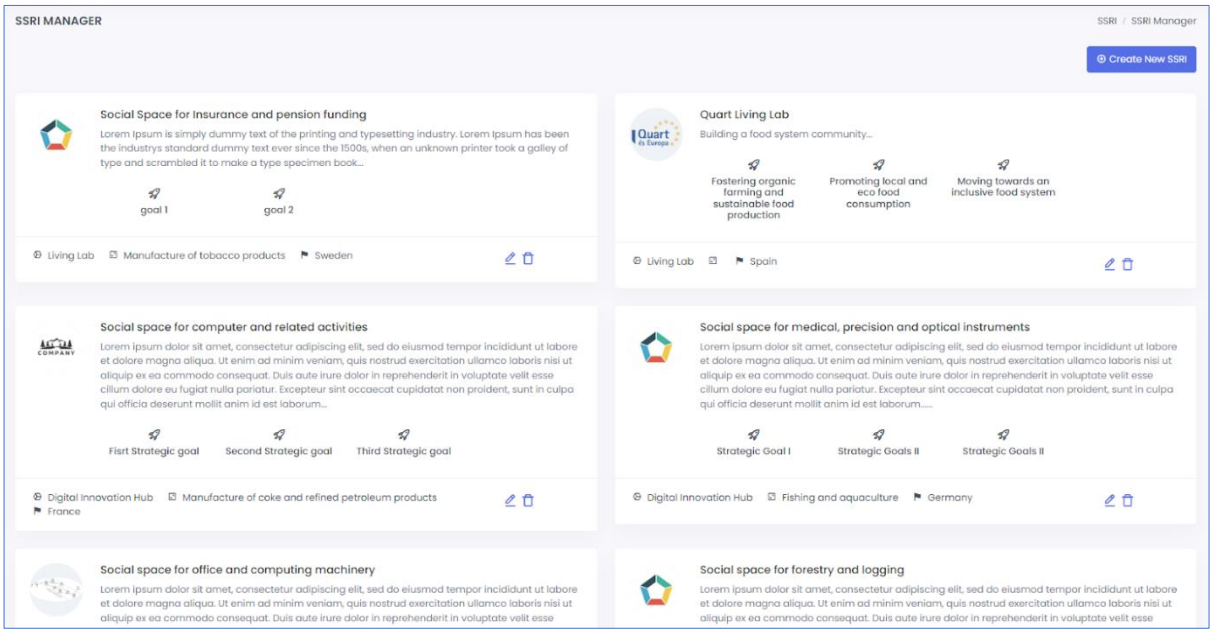
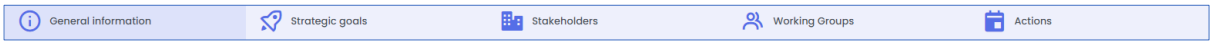


Figure 80. SSRI MAA Tool social space manager

Each item in this list shows the name, main goal, list of strategic goals, type of social space, type of activity and country of the social space. It also lets the user edit or delete each social space. Users can access the detailed view of each social space by clicking on its name. This section allows the user to create a new social space by pressing the button "Create new SSRI" located in the right upper corner of this view.

2.6 SSRI Creation/Edition tool

Social spaces can be created or edited though the same form. Due to the size and complexity of this form, it has been divided into five different sections: general information, strategic goals, stakeholders, working groups and actions. Each one of these options can be accessed through the tab bar located at the top of the form.



2.6.1 General information

In this form users can enter general information of the social space like name, image, main goal, context description, problems addressed, and area covered. It also includes more specific fields like type of activity, keywords, context indicators, country and region. Note that some fields also have an information icon next to them. When the user clicks on these icons additional information of the field is shown in order to clarify the scope of the field.

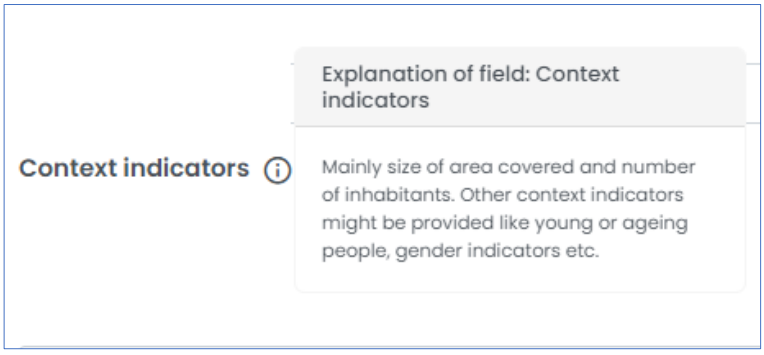


Figure 81. SSRI MAA Tool field explanation helper

There are complex fields in this form like context indicators that require the user to introduce more than one field and more than one time. For this purpose, this tool allows the user to add more than one item (collection of fields) to the list so it can be defined with more than one context indicator.

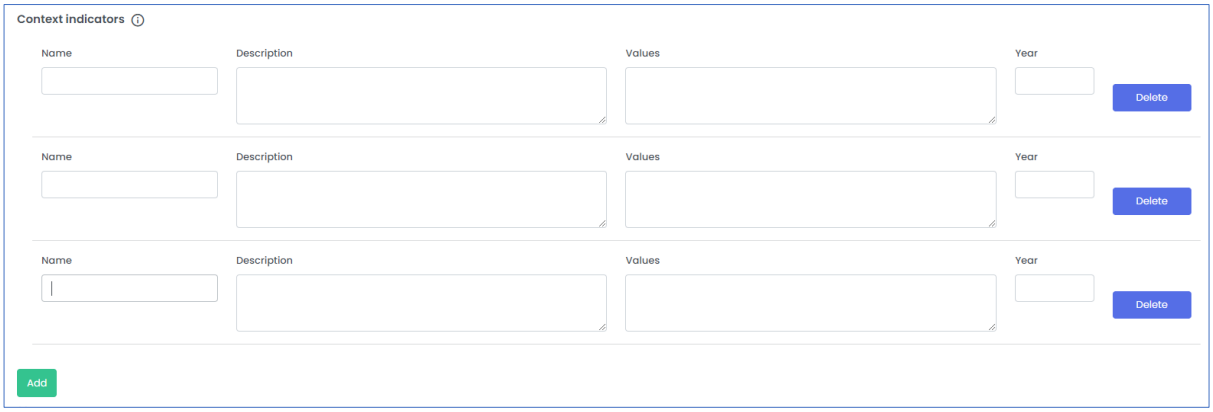


Figure 82. SSRI MAA Tool context indicator field

Once the user has completed all mandatory fields, it can save the social space by clicking the button "Save SSRI and exit" located at the bottom of the form. It can also navigate through the different sections of the form by using the 'previous' and 'next' buttons located next to the save button.

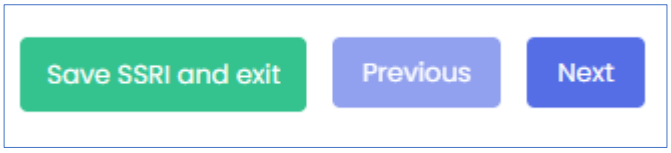


Figure 83. SSRI MAA Tool save SSRI and navigation buttons

2.6.2 Strategic goals

This section of the form allows users to define the strategic goals of the social space. Note that this is very important information due to the actions of the social space will be linked with one or more goals of this list. The purpose of most actions of a social space is to achieve one or more strategic goals of the social space.

As shown in the previous context indicators field, the strategic goals are managed as a list of fields and this tool lets the users add, edit or delete each one.

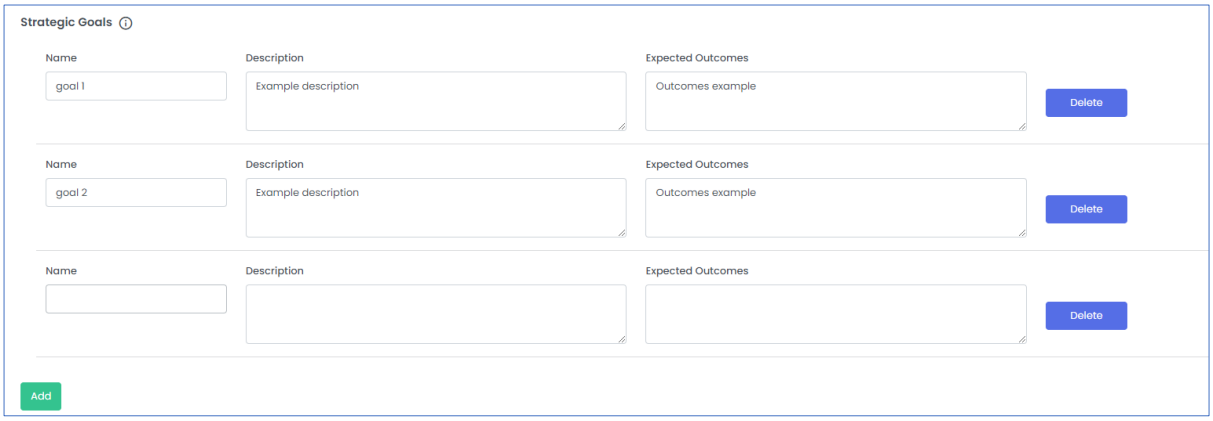


Figure 84. SSRI MAA Tool strategic goals field

For each strategic goal, the user must provide a name, description and expected outcomes.

2.6.3 Stakeholders

In this section users can add, edit or delete a collection of stakeholders involved in the social space. This list shows the name, type, address, social networks and options of each stakeholder.

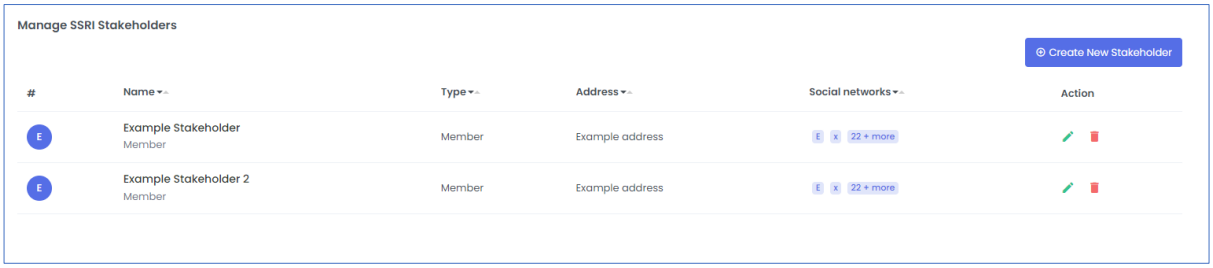


Figure 85. SSRI MAA Tool stakeholders tool

It is also possible to add a new stakeholder by clicking on the right upper button. When the user clicks on this button a new overlay form will appear.

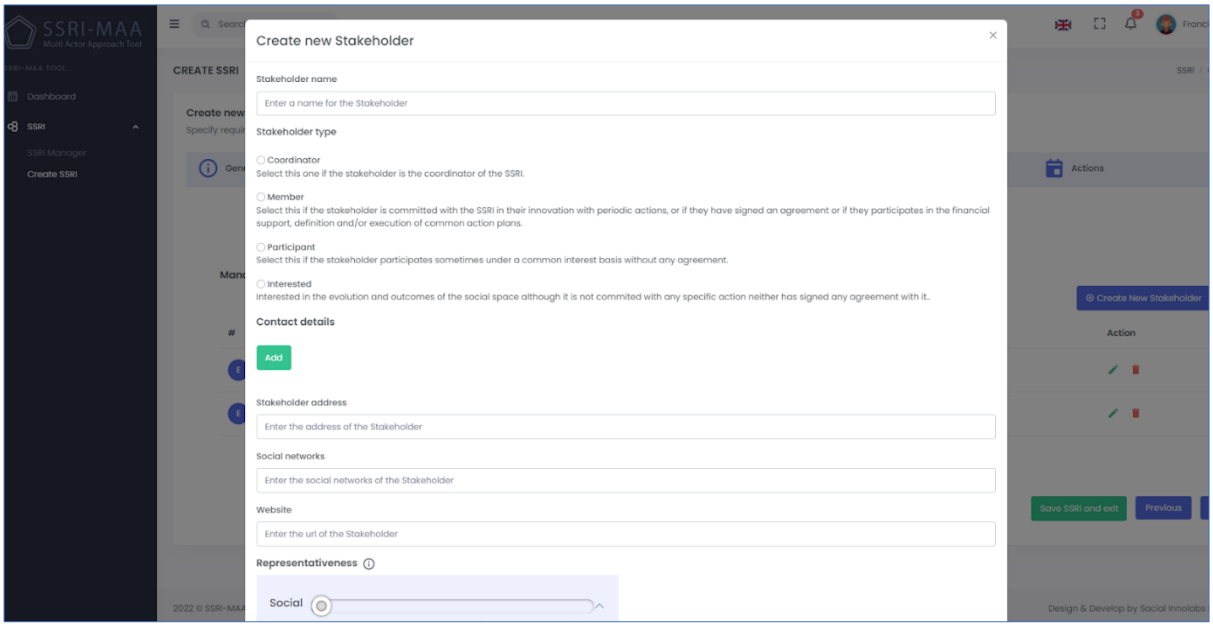


Figure 86. SSRI MAA Tool stakeholder form

The stakeholder creation/edition form allows to specify name, contact of members, address, social networks, website of the stakeholder. It also allows the user to specify the type of the stakeholder. There are four different types of stakeholders and each one is presented with a brief description of the role so the user can identify the right position for each stakeholder.

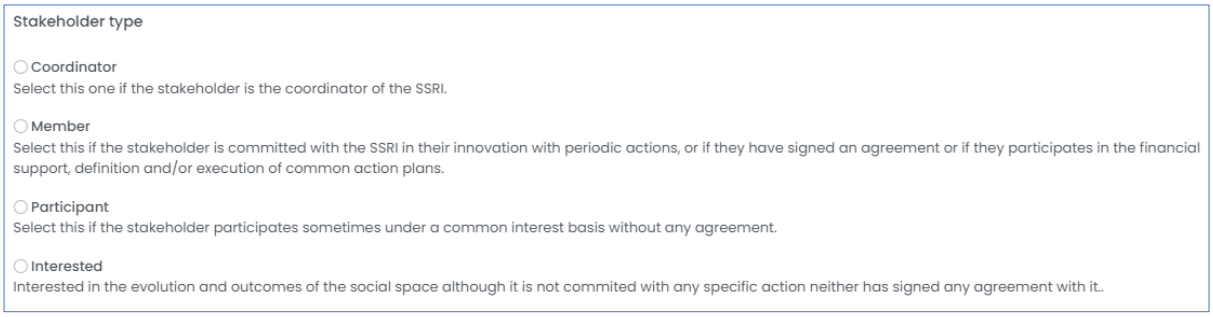


Figure 87. SSRI MAA Tool stakeholder type selector field

Finally, users can define the representativeness of the stakeholder. This defines how strong the stakeholder is in the next five areas: social, policy-government, ICT and infrastructures, training and education and market-economic. Users can define the weight of each one of these areas by sliding the point over the bar associated with it. The graph located next to the bars will show a polygon representing the weights in the five areas.

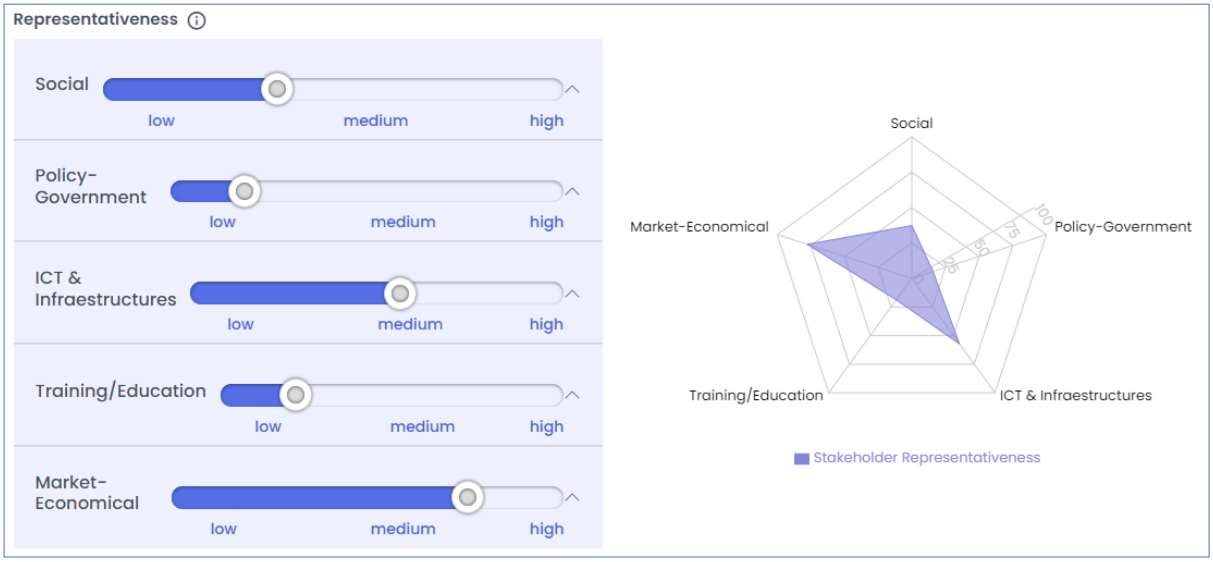


Figure 88. SSRI MAA Tool representativeness tool

Inside one of the areas, users must define the weight of the stakeholder for four additional subareas. The weight of an area is based on the media of the weights of its sub-areas.

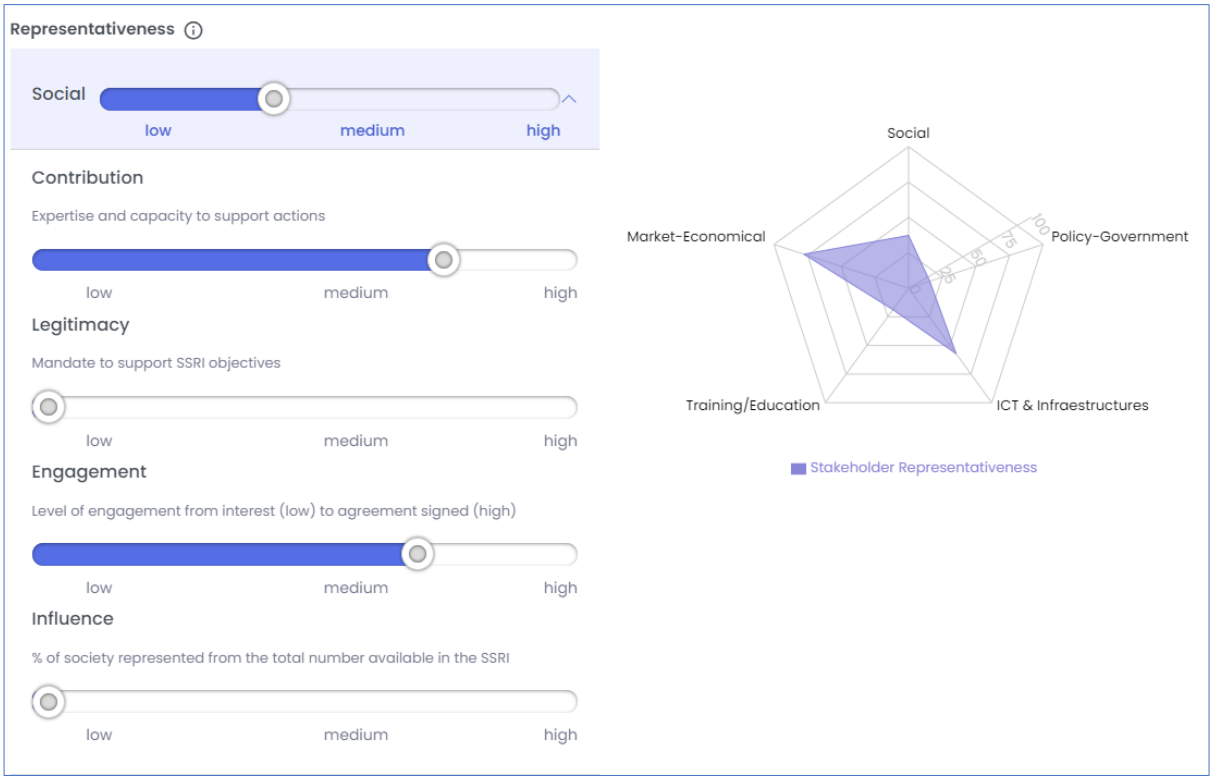


Figure 89. SSRI MAA Tool representativeness tool with sub-areas

Once the user has completed all mandatory fields, it must click on 'save' button and the new stakeholder will show on the list.

2.6.4 Working groups

This section allows the user to define the teams that work in for the different goals and activities defined in the social space. They also are presented in a list and can be created, edited or deleted.

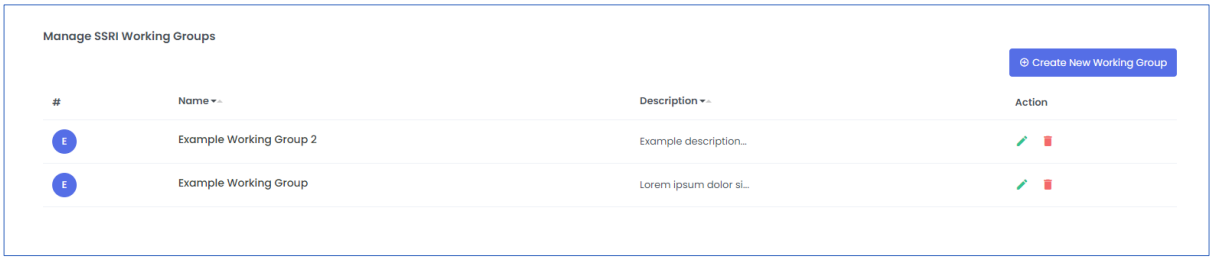


Figure 90. SSRI MAA Tool working groups

By clicking on the creation button located in the right upper corner, users can access the overlay creation form.

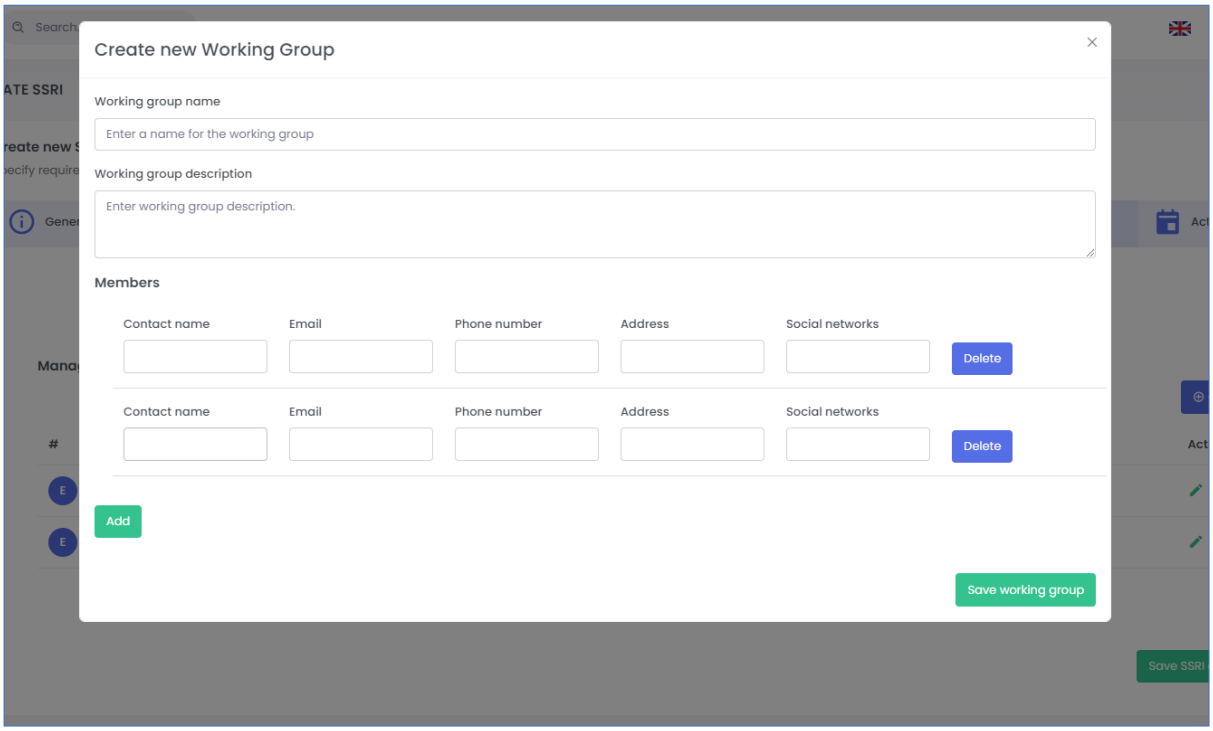


Figure 91. SSRI MAA Tool working group form

This form allows users to define name, description and a list of members of the working group. Note that the members defined here will be able to be linked in the actions as responsible staff as it will be shown in the next section.

2.6.5 Actions

The last part of the social space creation form is the actions manager. It lets the user create, edit or delete actions in the scope of a social space.

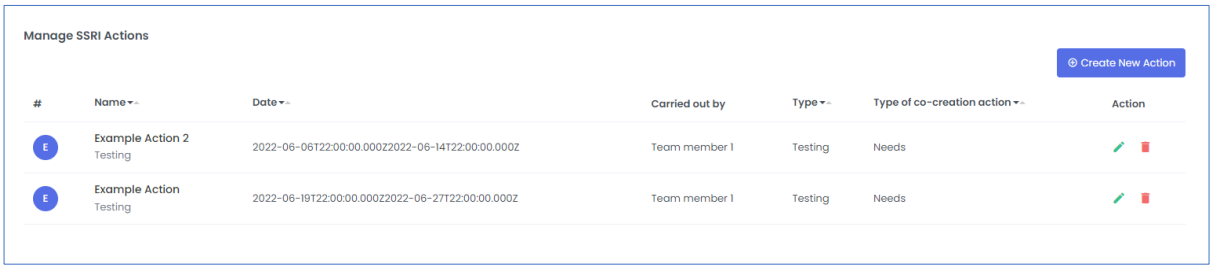


Figure 92. SSRI MAA Tool Actions

This list shows name, date, member that carries out the action, type, co-creation and options for each action registered. The creation button is located at the upper right-hand corner of the list. It deploys a new overlay form to create new actions.

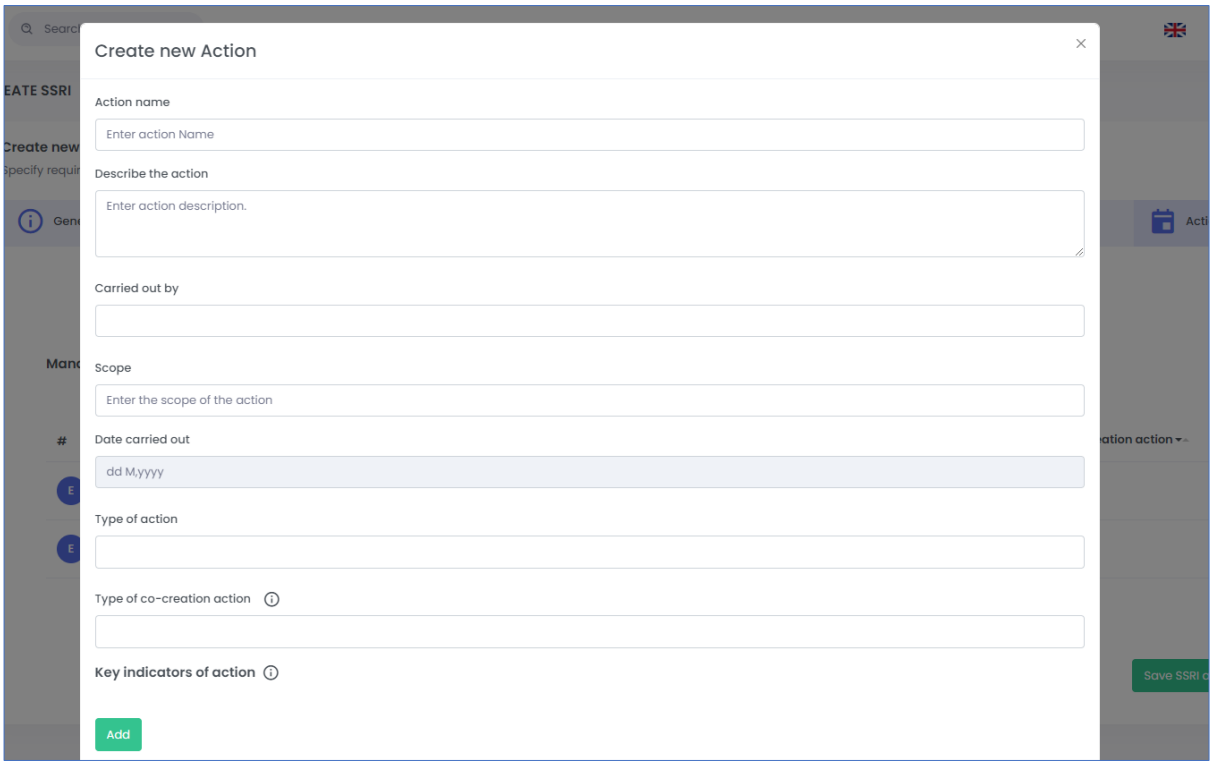


Figure 93. SSRI MAA Tool action form

The action is one of the complex entities of a social space. It includes general fields like name, description, scope, date, type and URL. In the field 'carried out by' the users must select a previously defined member in the working groups section. This member could belong to any working group. 'Type of co-creation action' lets users select from one of these options: Needs, validation or dissemination. Note that this field is conditional, so when a choice is selected, some fields will be shown, and others could be hide.

If 'Needs' is selected, the field needs will be shown, and the user will be able to add as many needs as it wants. if 'Validation' is selected, the fields outcomes and needs will be displayed. Finally, if 'Dissemination' is selected, only the field outcomes will be displayed.

Main participants field lets the user select the users involved in the action from previously defined working groups. It can also select a stakeholder that this member is representing in the action.

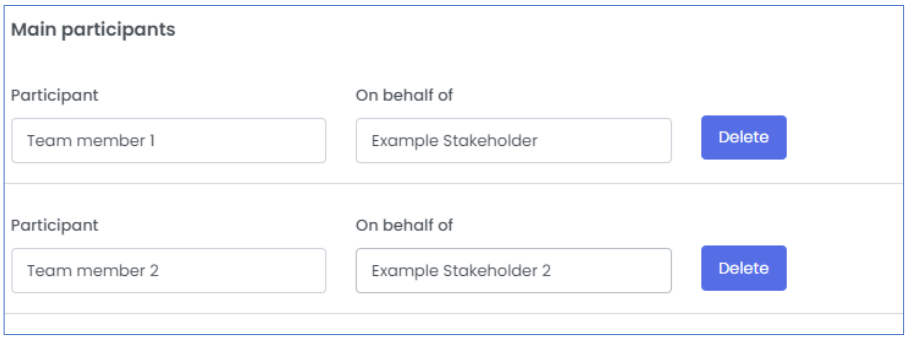


Figure 94. SSRI MAA Tool main participants in action

Related goals let the user link the action with previously defined strategic goals of the social space. It can also specify different goals for the scope of the activity.

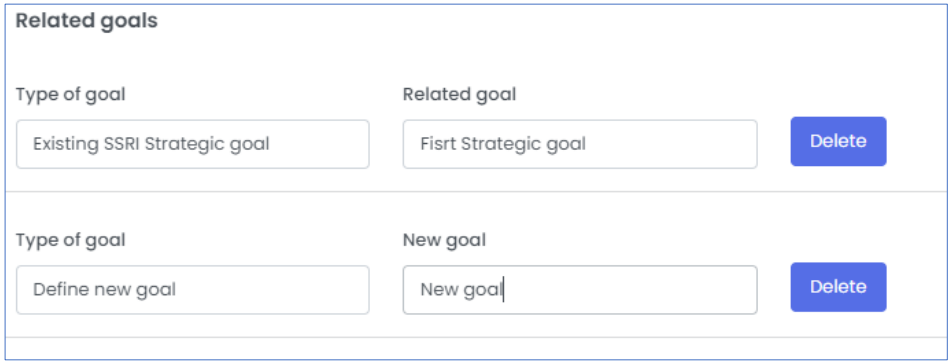


Figure 95. SSRI MAA Tool related goal in action

Annex IV: User manual for Blockchain-enabled marketplace for SFSC

This chapter describes the user manual or steps that are taken in order for the traceability system to work. Three actors are included over the lifespan of the activity. At first, the farmer enters data about his production, which is then received by the store or SFSC management. Finally, all this data is shown to the end-consumer at the final location (store or storage facility). The following steps have been introduced:

- Step 1: Producer takes pictures of his production phase over different period of time and uploads the pictures in the application, allowing the product's traceability at the end. Local producer receives digital identity and enters the data about his production (selected product) to the application; he also prepares the delivery docs (digital).
- Step 2: Local producer delivers product directly to the store / or the products are handed to internal transportation at the producer location, where they are being checked for quality and quantity inspection.
- Step 3: The store accepts the product from producer by scanning QR code from his mobile phone; it signs the transaction and data is directly transferred to store business management system.
- Step 4: Declaration for the product is prepared by the store and placed to packaging or shelf so customers can track the origin by scanning QR code with mobile phone. Details are presented on store's webpage.
- Step 5: Product information available for end-user by scanning the QR code in the store.

1. Producers enters data about his production -> creation of delivery docs

When a farmer harvests his production in the field, he prepares all the necessary documents in the application. He enters the following data: Type of the product, amount of the product and date of harvest. Afterwards, he creates the delivery docs in the application, where the final product is QR code, which is created and stored in the application system.

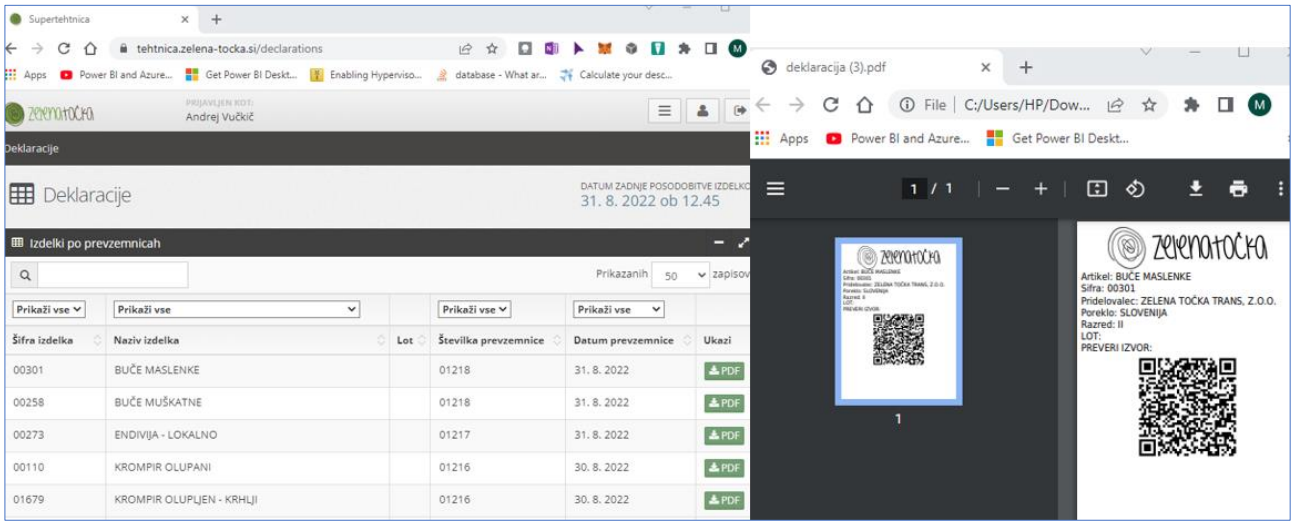


Figure 96. List of products and QR code of final product

2. Delivery and incoming quality and quantity inspection

Products are delivered to the store/storage facility by a local producer, where they are inspected on quality and quantity by the store manager or Quality control manager.

Figure 97. Product inspection by the Quality control manager

3. Accepting goods by the store by scanning QR code and digitally signing the transaction

If the store manager approves both quality and quantity, then products are accepted by the store by scanning the QR code.

Both the store manager and producer open up the application, where the producer opens up the delivery docs (QR code), while store managers opens up the request for scanning the delivery docs, which opens up the camera. Finally, store manager scans the QR code (delivery docs) from the producers, which allows the transfer of the data directly in the store management system.

Figure 98. Store manager and producer in a blockchain-enabled marketplace transaction

4. Product in store including generated traceability QR code

After the product is accepted and stored in the internal management system, the store manager needs to create a new QR code, which will be presented on the shelf in the store. Declaration with QR code is being printed and is set next to the product on the shelf. The printed declaration with QR code also shows data

about the product type, the producer's name, Quality type, country of origin and certificate (if it is available for the product).

Figure 99. QR code inclusion in store self

5. Customer scanning the QR code with mobile phone

The customer scans the QR code in the store with help of mobile phone. After scanning it, the system takes him to the store website, which allows customers to receive more product data.

Figure 100. Customer scanning the QR code with mobile phone

Final information received by customer from the store website.

- Farmer or producer name
- Production location
- Product certificate type if applicable (Integrated production, organic etc). Upgrade planned to present also the actual full farm certificate.
- Photos of planting/sowing, growth phases and other events (number depending on product type)
- Date of harvesting and delivery to warehouse/store

Figure 101. Information about origin received