EOSC Future

D5.2a

EOSC Front-Office Requirements Analysis

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D5.2a / EOSC Front-Office Requirements Analysis

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Abstract

This deliverable describes a part of the wider EOSC co-creation engagement programme outlined in the EOSC Future project general objectives 3 ('Scale up Capabilities and Deliver an EOSC Execution Framework') and 7 ('Reach Out and Engage with EOSC Communities and End Users'). The user engagement programme is implemented in collaboration with similar activities in Work Package 4, as well as jointly with Work Packages 6 and 9. The user engagement, requirements gathering and analysis is a contiguous process - it draws upon the results of the EOSC-hub and EOSC Enhance projects, evaluates their outputs and introduces modifications to the processes they developed in order to advance the existing knowledge of users' requirements and therefore the value proposition of EOSC.

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Glossary

EOSC Future project Glossary is incorporated by reference: https://wiki.eoscfuture.eu/x/JQCK

List of Abbreviations

Acronym	Definition
ADT	Analysis and Design Team member
API	Application Programming Interface
DT	Development Team member
HLR	High-Level Roadmap
IDI	In-depth Interview
PT	Product Team member
REP	Requirements Engineering Process
RET	Requirements Elicitation team member
RS	Recommender System
UX	User Experience

1 Executive Summary

This deliverable describes a part of the wider EOSC co-creation engagement programme outlined in the EOSC Future project general objectives 3 ('Scale up Capabilities and Deliver an EOSC Execution Framework') and 7 ('Reach Out and Engage with EOSC Communities and End Users'). The user engagement programme is implemented in collaboration with similar activities in Work Package 4, as well as jointly with Work Packages 6 and 9. The user engagement, requirement gathering, and analysis is a contiguous process - it draws upon the results of the EOSC-hub[1] and EOSC Enhance[2] projects, evaluates their outputs and introduces modifications to the processes they developed in order to advance the existing knowledge of users' requirements and therefore the value proposition of EOSC.

One of the contributions of this deliverable is the definition of the Requirements Engineering Process (described in detail in Section 4) which will be used to harmonise requirements gathering across Work Packages 4, 5, 7, and 9. By making it available as a standalone FitSM process definition, it is also expected to have utility beyond the EOSC Future project.

Deliverable D5.1a [4] contains a gap analysis that identifies the User Panel, Knowledge Hub, Learning Platform and Recommender System as being four(4) key components that will make a substantial contribution to addressing objective 3 ('Scale up Capabilities and Deliver an EOSC Execution Framework'), within the scope of this Work Package. Whilst that deliverable contains an initial functional specification for each component, further work is required to refine and validate the various requirements. This deliverable (D5.2a) sets out how to do that, whilst at the same time addresses objective 7 ('Reach Out and Engage with EOSC Communities and End Users') through an engagement and co-creation programme. This includes consultation of users through dedicated surveys and questionnaires (to advance the knowledge of needs by user type), formation of dedicated user groups (to test user journeys), collecting feedback from groups already present in the EOSC ecosystem, plus interactive engagement, interviews, and testbed exercises (as set out in the user engagement plan).

The insights gained thus far are translated into user requirements and will guide the first phase of enhancement of existing, and development of new, Front-Office components, culminating in the software release due in M18. The relevant parts of the Requirements Engineering Process (REP) will be applied to these components in the run up to that release and the findings will contribute to the updated version of this deliverable (also due in M18). That document will be used to steer the second phase of development, via the updated version of the Front-Office Design, Functional and Technical Specification (due in M24) to the second software release in M30.

Section 3 Front-Office definition defines the EOSC Platform Front-Office, in terms of its constituent user-facing components (including their functions and features) and functional architecture.

Section 4 User modelling for the Front-Office platform provides an analysis of the main User types of the EOSC Front-Office. User Personas analysis answered the question 'Who is the product being designed for?'. By understanding the expectations, concerns and motivations of target users, it will be possible to adapt the Front-Office to better satisfy their needs. User feedback is an important element of the co-design approach, which will help to ensure improvements to existing Front-Office components are user-centric.

Section 5 EOSC Front-Office Requirements Engineering Process describes the Front-Office requirements gathering and structuring process. It begins by clarifying what is meant by the term 'process', with reference to the FitSM Service Management System (SMS), then goes on to describe the UX process in detail and the associated UX research methods and modelling tools. It goes on to outline the User Experience research and design cycle and shows how the process is applied in practice.

Section 6 EOSC Front-Office User Experience Process describes the journey from gathering insights to user needs and behaviours, to the user-centric design approach, via research methods and modelling tools.

Section 7 Results of the conducted UX research contains the User Persona survey results and details of the Front-Office requirement analysis.

[1] https://www.eosc-hub.eu/
[2] https://eosc-portal.eu/enhance

Section 8 Conclusions summarised the finding of the Front-Office requirements analysis work to date.

2 Introduction

This deliverable describes a part of the wider EOSC co-creation engagement programme outlined in the EOSC Future project general objectives 3 ('Scale up Capabilities and Deliver an EOSC Execution Framework') and 7 ('Reach Out and Engage with EOSC Communities and End Users'). The user engagement programme is implemented in collaboration with similar activities in Work Package 4, as well as jointly with Work Packages 6 and 9. The user engagement, requirement gathering and analysis is a contiguous process - it draws upon the results of the EOSC-hub and EOSC Enhance projects, evaluates their outputs and introduces modifications to the processes they developed in order to advance the existing knowledge of users' requirements and therefore the value proposition of EOSC.

One of the contributions of this deliverable is the definition of the Requirements Engineering Process (described in detail in Section 4) which will be used to harmonise requirements gathering across Work Packages 4, 5, 7, and 9. By making it available as a standalone FitSM process definition, it is also expected to have utility beyond the EOSC Future project.

3 Front-Office definition

The Front-Office scope has been already discussed in Deliverable D5.1a [4]. The ongoing process of collecting insights, transforming them into requirements, which are further discussed, refined, analysed and validated led to shedding new light into the functionality that should be delivered by the Front-Office components. The progress that has been made in understanding the users' needs is outlined below and report the major differences between the scope presented in [4].

The definition of Front-Office has been updated based on the results of the User Persona Survey, which was conducted through August and September 2021 [12] to better understand the day-to-day challenges of current and potential users. The 142 survey respondents came from 26 countries, of which four (4) were non-European and seven (7) Eastern European. The results of the survey indicate that 70% of the respondents were researchers, while the other 30% was divided among other lines of work. 44% of the researchers were senior scientists while the other 56% was distributed among the PhD Students (16%), Post Docs (19%) and Chief Scientists (21%). While basic platforms for storing and sharing data were found to be used in all domains, researchers working in the humanities mainly focused on those services and infrequently mentioned other solutions. In Natural Sciences or Engineering and Technology domains, researchers also used tools for data processing and analysis. The complete overview of collected results is presented in Section 6.

Another important update concerned the Knowledge Hub implementation, which is one of the core components of the future User Portal. The analysis revealed the need for preparing a thorough business analysis to understand the rationale behind creating the User Portal, and to identify the benefits and costs related to delivering its specific functional items. In order to complete that step, the analysis of estimated effort is needed as well.

The analysis of requirements led to the identification of functional and technical components that constitute parts of the User Portal. They have been presented along with brief description of their scope in sub section 3.1.

3.1 Functional components

Functional components define the identified groups of closely related functionalities that address one objective or purpose. In Table 3-1 the functions are listed and their corresponding features are described.

Table 3-1: Front-Office functional components

Function	Features
Navigate the Front-Office	
Discover, access and compose resources	• Smart search user interface • Personalised resource suggestions • Resource comparison • Provider/resource details and access pages • Resource ordering and order management

	• User space for resource composition
Interact with the Front-Office using a personalised dashboard	• User profile • User settings • Personalised content • User space access • Feedback mechanisms
Access and contribute to EOSC knowledge	• Landing page for knowledge access • Training and learning materials access • Training and learning materials authoring
Access Open Science statistics	• Open Science metrics • Graphical metric analysis tools
Obtain support	• Open Science helpdesk/messaging access • *EOSC-Core* Helpdesk reporting access

The diagram presented in Figure 3.1 shows the functional architecture of the EOSC Front-Office. It maps individual functions to features and emphasises their assignment to higher level groups of functions.

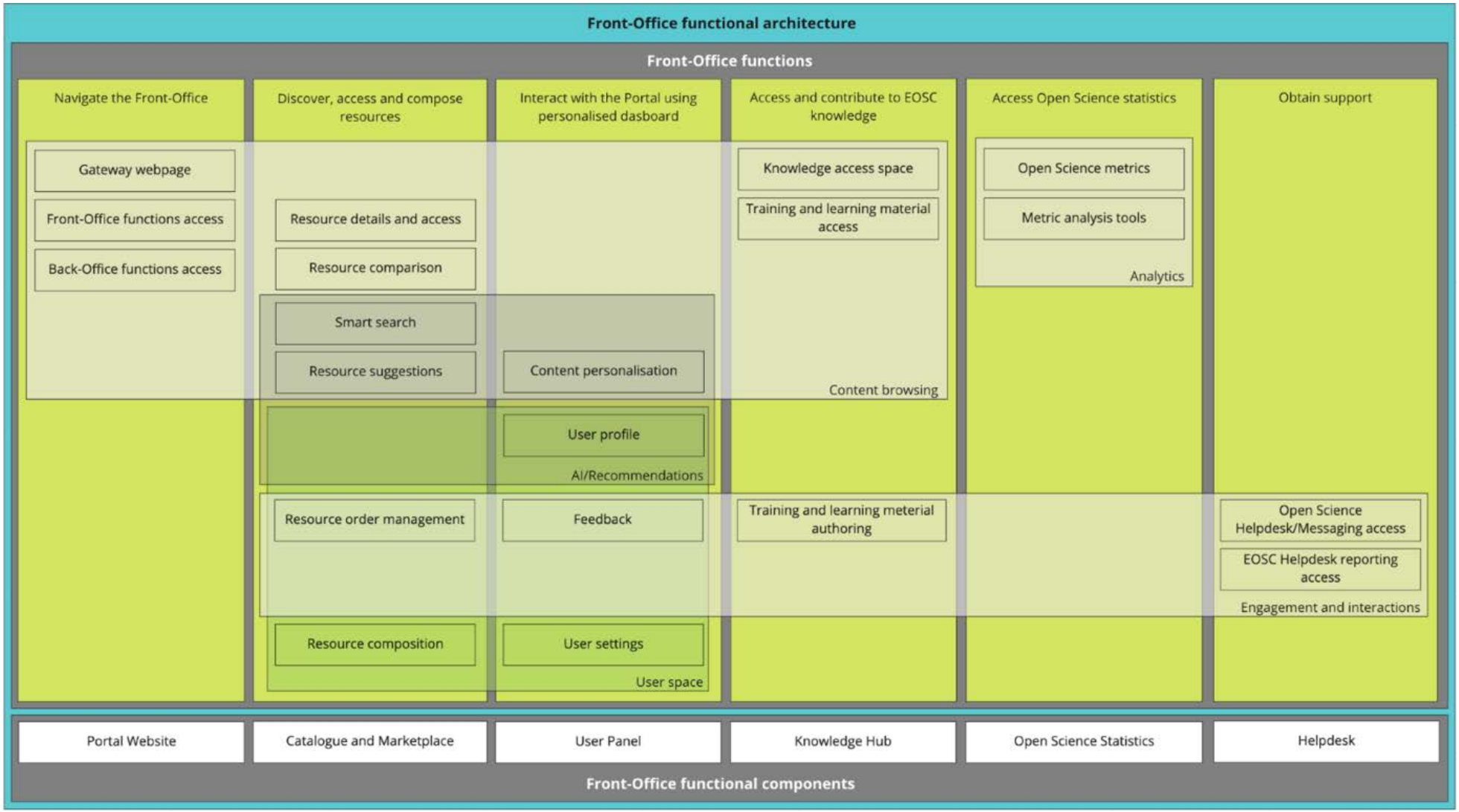

Figure 3.1: Front-Office functional architecture

4 User modelling for the Front-Office platform

The initial group of users for the Front-Office has been identified and presented in [4]. It included three main user groups, differing in their interest and involvement in specific research activities:

- Consumers;
- Providers;
- Facilitators.

The largest, the most complex and the most relevant group for the system are Consumers, who are interested in using the items available in the EOSC Marketplace and offered by the *EOSC Portal*. Consumers encompass users both from the public and private sectors, which includes a variety of individuals, groups and organisations, e.g. individual researchers/research communities, citizen scientists, and research support staff. The full categorisation of the user types for the acknowledged Front-Office as well as the User Personas documented later in the text as a result of the EOSC User Personas research are presented in this section.

4.1 User Types

In general, there are two main categories of consumers, depending on their direct involvement in research-related activities. The non-research users represent public administration, citizen scientists (non-professionals who voluntarily contribute to various research activities) or just citizens interested in science. They express some interest in research or its outcomes, but it is not at the core of their business. Therefore, while this group completes the overview of users and makes it holistic, it is the other group, called research users, who are the main target of EOSC-offered services, and shall play the dominant role in the *EOSC Portal* design process Therefore, the requirements analysis is focused on researchers, research groups and research organisations.

Researchers can be further categorised with respect to various attributes and properties, e.g, the collaboration structures and connections, research domain and discipline, the research methods used by them, and the level of seniority. All these attributes play a role in providing adequate functions in the Front-Office to address the user needs and expectations.

- **Research cooperation structure**

Researchers work in groups of diverse complexity. Based on the group structure (including its diversity), the cooperation and coordination of its research activities differ. It is likely that that the platform requirements supporting research-performing activities will differ too. This observation led to the introduction of this specific branch in the Front-Office typology. The categories defined within the research cooperation structure branch are often correlated with the types of workflows relevant in the Front-Office's operations (like resource ordering, resource access) and bring different types of policy rules that will shape both the operations and the Front-Office itself.

- **Scientific disciplines**

Requirements for the Front-Office might differ depending on the scientific discipline, as a connection between the scientific discipline, its dominant research methods and the types of resources used (in particular the workflows) to support the research carried out in that particular discipline exists. Further analysis needs to be conducted to unambiguously correlate the scientific disciplines with the resources most used. Nevertheless, the connection has been recognised and is considered.

- **Level of seniority**

Level of seniority of a researcher is another aspect that is relevant when describing the Front-Office user type. Requirements of the senior researchers might be different from those of their less experienced colleagues, due to the different goals that come with advancement in a scientific career. This assumption will be verified using the UX techniques that identify the User Personas, followed by analysis of whether there is a correlation between scientific career seniority and expectations of the functionality offered by the Front-Office.

The current Front-Office user typology is presented in Figure 4.1 (Consumers) and Figure 4.2 (Facilitators and Providers) below.

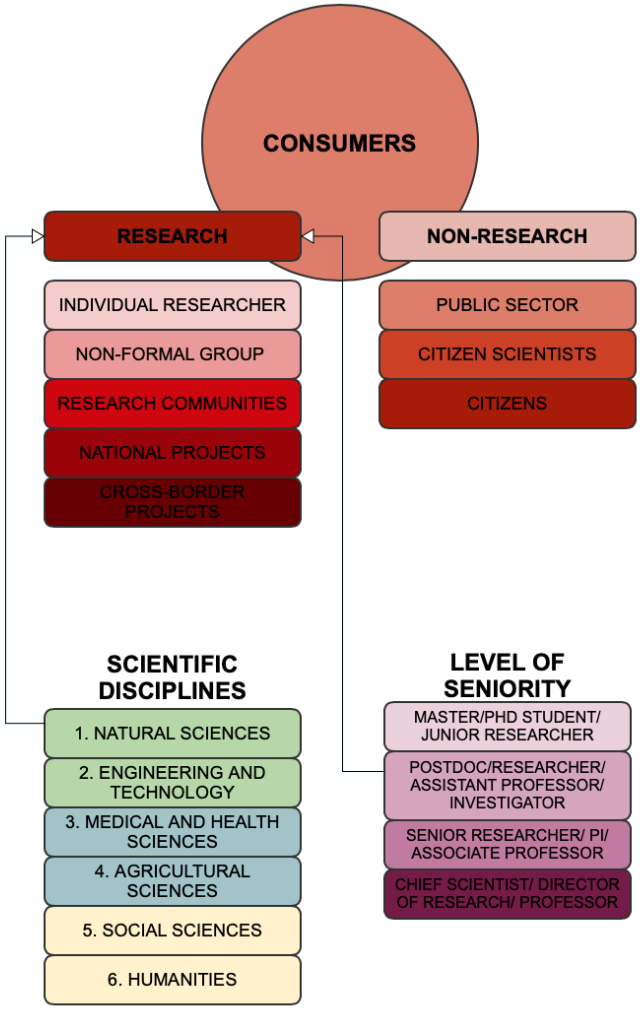

Figure 4.1: Front Front-Office user typology – Consumers

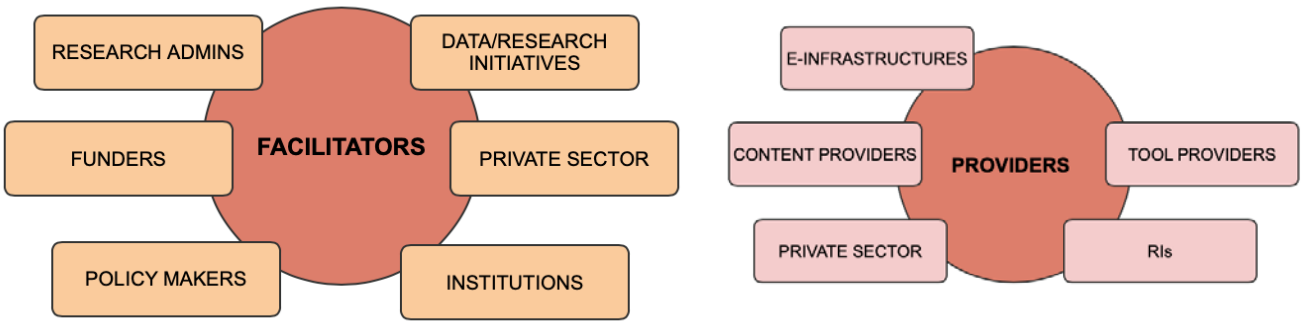

Figure 4.2: Front-Office user typology - Facilitators and Providers

4.2 User Personas

A User Persona is a concept used for identifying, describing and analysing various user perspectives for the subject software system, instantiated by an imaginary person with specific professional background, interests and objectives. Although a User Persona is presented as a specific individual, it is synthesised from observations of many users and enables the designer to focus on a manageable and memorable cast of characters. In EOSC,

User Personas help to uncover how different users search for and use a given product and are particularly useful for setting up a process for improving the experience for real users and their use cases. See section 6.2.2.1 for further details.

5 EOSC Front-Office Requirements Engineering Process

Requirements Engineering Process (REP) describes the way the requirement flow is modelled from the first insight to the reporting. REP is subsidiary to the High-Level Roadmap (HLR) planning process and assumes that the implementation schedule and direction is linked with the timeline of the HLR by performing appropriate analysis and design. It allows to glue the high-level planning with the collection of insights needed to correctly address solutions for bridging identified technical or functional gaps. The process definition doesn't start from scratch and is based on the experiences gained through the implementation of the EOSC Enhance project. The process documented in the EOSC Enhance deliverable *D2.3 EOSC Processes Development and Consensus (update)*[3] has been revised and adapted to the scope of the EOSC Future environment. The elaborated consensus on the process makes it usable for all other EOSC- Core platform components and allows to align the requirement gathering activities of the project WP4 and WP5 regardless the different nature of requirements, different target groups and vastly different approaches to requirement gathering and analysis.

The primary goal of this process is to organise requirements engineering from insights elicitation to the reporting.

The process covers the following objectives:

- Gathering and structuring requirements for the EOSC-Core platform;
- Analysis of requirements and identification of technical gaps;
- Design of the solutions bridging identified technical gaps and responding to elicited requirements;
- Linking the processing of collected user requirements with the High-Level Roadmap planning.

The process does not cover:

- Related stakeholder consultation activity based on the Stakeholder Engagement Plan;
- Related UX Process;
- Related HLR Planning Process.

The process is described in the two diagrams presented below; one (Figure 5.1) focusing on the various process phases and the second (Figure 5.2) focusing on the activities required to be implemented at the various phases.

Figure 5.1 below focuses on the states of the requirements and briefly describes the actions linked with the state transitions. It is helpful when trying to understand the scope of each action, as well as the accompanying implementation with the use of an issue tracking system of choice.

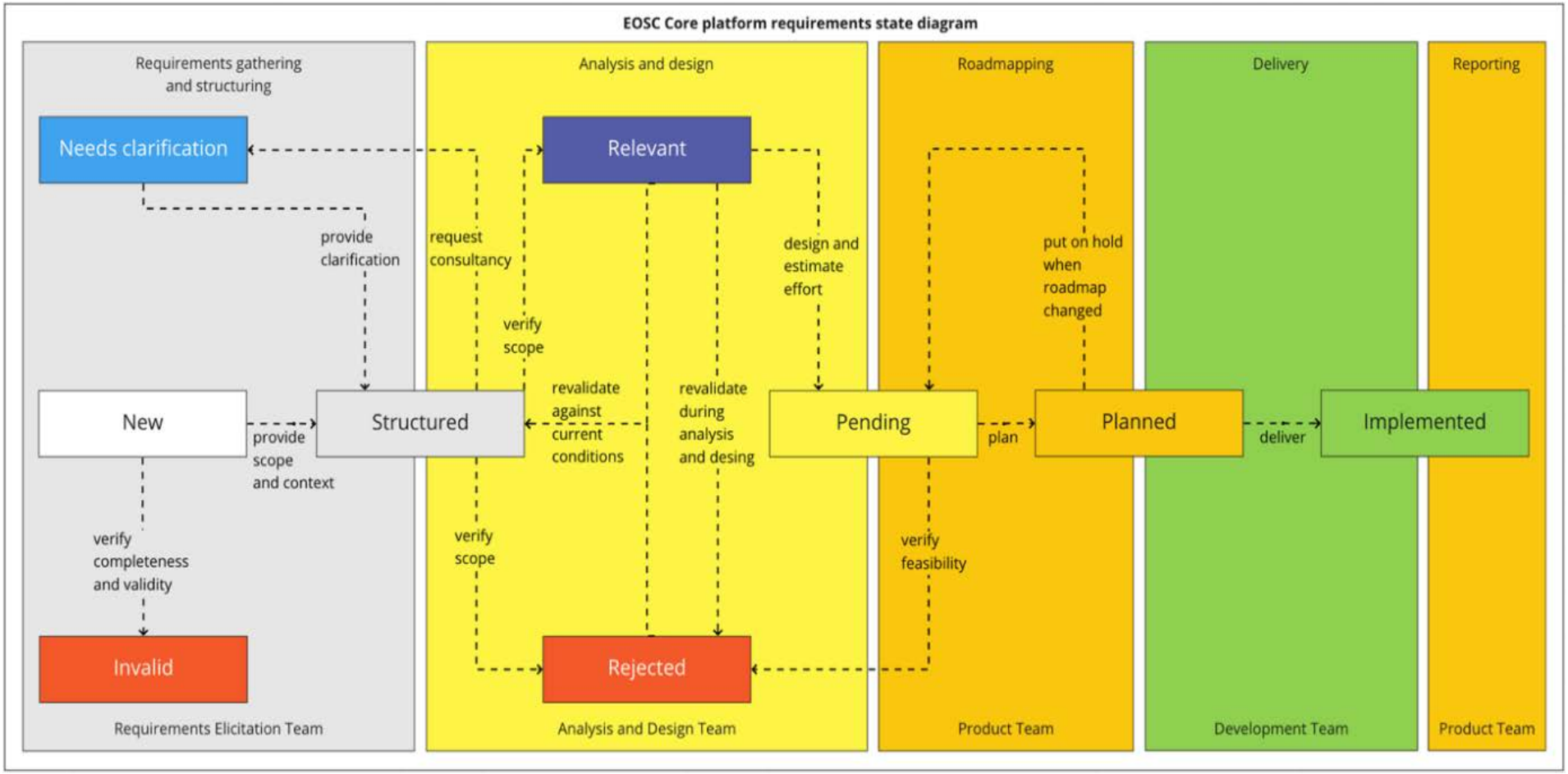

Figure 5.1: EOSC Front-Office platform requirements state diagram

The states documented in Figure 5.1 have been divided into activity groups and associated teams. Relevant information is passed between the teams via the issue tracking system – specifically comments made against an issue (i.e. requirement) as it transitions between the states. The roles of the groups are representing by the following semantics:

Requirement gathering and structuring

- New – insight collected;
- Invalid – insight definition is incomplete or misleading;
- Need clarification – requirement previously structured needs a clarification from the author or other relevant stakeholder.

Analysis and design

- Structured – structuring completed with all the mandatory insight attributes provided. The insight becomes a requirement;
- Relevant – relevant for an ongoing analysis and design or awaiting planned analysis;
- Rejected – rejected in analysis and design process;
- Pending – analysis and design completed. Requirement is awaiting planning.

Roadmapping

- Planned – requirement scheduled for implementation.

Delivery

- Implemented – solution has been provided and deployed in production.

Reporting

- Implemented – report reasons for any deviation from estimated delivery date.

The second diagram (Figure 5.2) describing the process focuses on the actions needed to execute the process and presents the needed decisions, action causes and their consequences. Phases of the process and the corresponding roles have been indicated in both diagrams. The colour codes for the respective phases are matching in both diagrams for the reader's convenience.

Figure 5.2: Requirements engineering process for EOSC-Core platform

5.1 Requirement template

A requirement template represents a set of attributes of an insight or requirement that correspond to the respective roles in the process and cover the respective phases of the REP. For each phase the requirement template offers a set of attributes allowing to gather the relevant information introduced in this phase. The following specification, supplemented with the definition of the system's functional and technical components, is mapped to an issue tracking system ticket structure.

Table 5-1: Requirement template

Phase	Requirement template field	Example field values
Requirements gathering	ID	System-generated identifier
	Channel	E-mail, online survey, interview, HLR etc.
	Title	Short description of the proposed requirement
	Problem to be solved / user need	What problem is the user trying to solve? What does the user need and want? What will the user achieve when the requirement is met?
	Related use cases, real life scenarios	Example: I'm a climate scientist. I'm looking for a specific set of data from Africa about the temp distribution in

		Kenia. I have no idea where to find such data.
	Where did user find the problem / expect solutions to be found?	Link, picture, place in the Portal etc.
	User importance factor	Prioritisation assigned by user: Not important, Important, Crucial
	Known constraints and considerations (provided by user)	Rules and limitations (e.g., time, resource, funding) that may dictate how the requirement is carried out
	User group(s) benefited	Who will benefit from the result of the implementation? • Researchers • Service Providers • Content Providers • Research communities • Research projects • Private companies • Founders
	Author(s) affiliation	Who proposed the requirement? Organisation name
	Contact point	Who should be contacted to provide the details/ verify results? e-mail, other preferable contact channel
Requirements structuring	Affected functional components	Part of the functionality affected by the desired requirement (i.e. one or more EOSC services)
	Affected processes	Processes affected by the potential solution (i.e. one or more EOSC processes)
	Prioritisation	Assigned prioritisation (MoSCoW): must have, should have, could have, won't have.
	Other known constraints and considerations	Rules and limitations (e.g., time, resource, funding) that may dictate how the requirement is carried out.
	Identified target group(s)	• Researchers • Service Providers • Content Providers • Research communities • Research projects • Private companies • Founders
	Other parties potentially involved	Who will also be affected / take part in the process defined by the desired functionality/ requirement? (stakeholders/ infrastructures)

Analysis and design	Analysis and estimated effort	Link to the specification of the design and estimated effort analysis. Specification defines estimated effort to implement the overarching design concept with a feature set including the requirement.
Planning	Estimated delivery	Estimated delivery date for the overarching functionality planned.

5.2 REP roles and artefacts

The following roles are relevant in the context of this process and need to be assigned to persons or teams/ groups involved in the process.

Table 5-2: Requirement Engineering Process roles

Role	Tasks
Requirements Elicitation Team member **RET**	• Elicit insights / requirements • Provide scope and context for the new insights • Verify completeness and validity of the new insights • Consult authors / stakeholder to provide clarification for insights / requirements when needed
Analysis and Design Team member **ADT**	• Verify scope of the structured requirements • Revalidate relevant requirements against current conditions • Perform analysis and design for the overarching functionality for which requirements are relevant
Product Team member **PT**	• Based on a design concept specifications and estimated effort analysis prepare the tasks planning for the High-Level Technical Roadmap (HLR) • Verify HLR tasks feasibility • Periodically verify the status of the HLR tasks implementation • Report the HLR implementation progress based on the statuses of the roadmap tasks • Report deviations from the estimated delivery dates
Development Team member **DT**	• Based on the HLR schedule deliver functionalities needed to complete design concepts implementation • Report requirements implementation status • Report reasons for deviations from the estimated delivery date

Process artefacts are 'things' that are required, produced or processed by the process or one of its activities. The following objects are relevant:

Table 5-3: Requirement Engineering Process artefacts

Process artefact	Description
Insight	A set of user needs identified during requirements elicitation. Structure of an insight is defined be the Requirement Template.
Requirement	An insight structured by the Requirement Elicitation Team by refining problem descriptions, assigning known *functional* and *technical components*, *processes potentially affected by implementation*, *identifying constraints for the solution*, *target groups* and *parties potentially involved*, applying initial *priority*. Structure of a requirement is an extension of an insight structure. Both follow the specification of the Requirement Template.

High Level (Technical) Roadmap (HLR)	The main high-level roadmap defining high level areas of implementation, milestones, and technical tasks (HLR tasks).
HLR task	High level technical task describing a solution / design concept related to an identified technical gap and a set of requirements. Relevant requirements are referenced in the HLR task through the design of the specification.
Design concept	A specification for product improvement bridging the identified functional or technical gap and responding to a set of relevant requirements.
Functionality	A named solution for an identified problem elaborated in the design concept specification e.g Recommended Publications in the User Panel. May be modelled as an Epic.
Functional component	A named functional part of the system e.g. User Panel.

5.3 REP activities

Requirement Engineering Process is defined based on four interrelated activities: **Requirements gathering and structuring, Analysis and design, Road mapping and reporting**, and **Delivery**. These activities are performed one by one by the teams identified as groups of people with a corresponding role described in Roles and artefacts paragraph. The paragraph documents the tasks needed to perform each of these activities as well as the influence on the requirement state they might have.

5.3.1 Requirements gathering and structuring

To be able to identify the needs of EOSC users, the EOSC Enhance project-initiated requirements gathering activities. The REP described above both refines and codifies that approach, providing clear guidance on how to proceed within the EOSC Future project. The purpose of these activities is to identify, collect, refine, analyse, and prioritise functional and non-functional requirements coming from all stakeholders, e.g., users, providers and European Open Science Cloud implementation projects, to improve the EOSC Front-Office functionalities and value proposition continuously, reveal insights on the needs of future EOSC users and increase the EOSC user base by guiding user-focused implementations.

The first *EOSC Portal* document regarding functional and non-functional requirements was released in March 2020 and included a set of requirements to be further analysed. Since then, EOSC Enhance continued the work on the *EOSC Portal* development which together with the complete analysis of the remaining user requirements have been handed over to EOSC Future at the end of November 2021. EOSC Future work on enhancements has been ongoing and the updated set of requirements following the REP with the accompanying requirement structure and workflow will be documented in the successive deliverables.

From the REP point of view, the requirements gathering activity may be defined as either documenting insights gathered with stakeholder/user consultations or by conducting consultations to revisit requirements that have been classified as requiring clarification:

- **New** – collected insight.
- **Need clarification** – requirement previously structured needs a clarification from the author or other relevant stakeholder.

Requirement structuring in turn should be considered as a process that leads either to reducing the noise coming from incomplete or misleading insights, or providing additional information as described by the Requirement template:

- **Invalid** – insight definition is incomplete or misleading.
- **Structured** – structuring completed, with all the mandatory insight attributes provided. The insight becomes a requirement.

Figure 5.3 documents the channels through which the requirements flow, the required steps needed to gather insights and the actions that are needed to structure gathered insights.

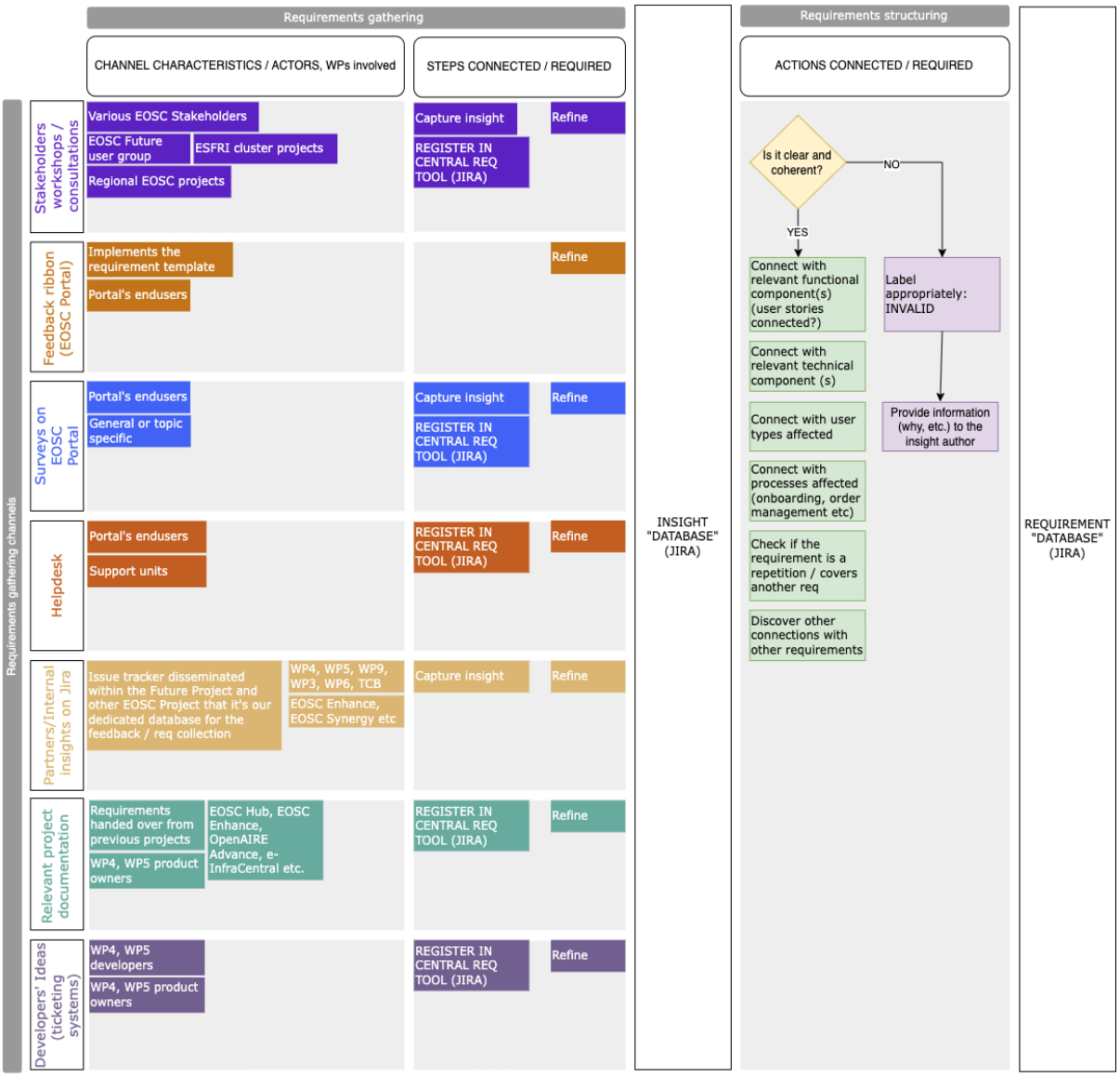

Figure 5.3: Requirements gathering and structuring

The following table presents the full list of actions in the scope of the Requirement gathering and structuring activity.

Table 5-4: Requirement gathering and structuring

Inputs, required information	• Requirements needing clarification
Roles involved	• RET
Outputs	• Structured requirements • Invalid insights
Actions	• Elicit New insights based on the activities following Stakeholder Engagement Plan • Verify completeness and validity of the new insights • Provide the scope and the context for the new insights • Based on the consultation with authors or relevant stakeholders restructure requirements that Need clarification.

5.3.2 Analysis and design

Analysis and design are the activity starting from reviewing the structured requirements and verifying their scope. The scope of the Front-Office platform constitutes the set of functional and technical components together with the set of the topics undergoing analysis and design conducted in scope of the EOSC Front-Office User Experience Process. From the REP point of view the status of the analysis and design is represented by the four states in the requirement state diagram:

- **Structured** – structuring completed with all the mandatory insight attributes provided. The insight becomes a requirement.
- **Relevant** – relevant for an ongoing analysis and design or awaiting planned analysis.
- **Rejected** – rejected in analysis and design process.
- **Pending** – analysis and design completed. Requirement awaits implementation planning.

Following table documents the inputs, REP roles involved, outputs and actions that need to be performed to link the REP and the undergoing analysis in the UX process.

Table 5-5: Analysis and design

Inputs, required information	• Structured requirements • Rejected requirements
Roles involved	• ADT
Outputs	• Design concept specifications • Pending requirements • Rejected requirements • Requirements needing clarification • Structured requirements
Actions	• Periodically verify scope of the Structured requirements • Based on a relevant process (e.g. Front-Office UX process) perform needed analysis and design for the overarching functionality with Relevant requirements. • Mark analysed requirements Pending or Rejected. • Periodically revalidate Rejected requirements against current conditions.

5.3.3 Road mapping and reporting

To frame the requirements engineering in the project that needs to ensure delivery of the main project goals there is a need to properly identify interfaces between the process of the High-Level Roadmap Planning and the Requirement Engineering Process.

From the REP point of view, it may be seen as the work focused on planning the implementation of the requirements for which the analysis and design has been completed. The implementation planning is performed based on the estimated effort analysis underpinned in the design concept that has been prepared. Based on the HLR changes requirements already planned may return to the pending state. The requirement states relevant in this activity:

- **Pending** – Requirement analysed and awaiting planning.
- **Planned** – Requirement scheduled for implementation.

The Road mapping and reporting activity respond to this need with the following set of actions:

Table 5-6: Road mapping and reporting

Inputs, required information	• HLR • Design concept specifications • Pending requirements • Implemented requirements

Roles involved	• PT
Outputs	• HLR tasks • Planned requirements • Pending requirements • Rejected requirements • Implementation reports
Actions	• Periodically check for the HLR updates and reflect changes / requirement status updates during the design and analysis activity • Periodically check for the need to update the HLR tasks definitions with the changes in the Planned requirements / analysis and design findings. Propose the HLR changes • Periodically verify the status of Planned requirements connected to HLR tasks against estimated delivery date. • Report the HLR task progress based on the Implemented requirements.

5.3.4 Delivery

Delivery is the activity that maps the status of the development to the status of the source requirement. Considering that all the developed software solutions are mature and work with the use of their own issue tracking systems this part of the process is simplified to the bare minimum of states and transitions. The requirement already planned need to be implemented, which finalises the delivery. The following states are considered relevant for this activity:

- Planned – requirement scheduled for implementation
- Implemented – solution has been provided and deployed in production.

Table 5-7: Delivery

Inputs, required information	• Planned requirements
Roles involved	• DT
Outputs	• Implemented requirements
Actions	• Deliver functionalities needed to complete a design concept implementation.

5.4 Requirements gathering in practice

'Take a human desire, preferably one that has been around for a really long time… Identify that desire and use modern technology to take out steps' (Evan Williams).

The practical implementation consists of the alignment of the EOSC User Interface (UI) with what the Consumers wish to find in EOSC as, for example, enabling researchers to perform open science in their daily workflows and getting access in a central manner to data resources. The unmet need identified is to find a single access to perform open science resources as FAIR (findable, accessible, interoperable, and reusable) as possible. The practical implementation will shape the EOSC UI in co-creation with the Target Groups listed in Table 5-8.

The main questions to answer are: what are the EOSC users requiring? Is the Platform able to meet the users' expectations and fulfil these requirements with the resources accessible in the EOSC marketplace? Can the User experience be improved on?

In the practical implementation, the Front-Office will be evolved through the thorough engagement and co-creation programme:

- consultation of users through the dedicated surveys and questionnaires to advance the knowledge of processed and needs by the user classification,

- formation of dedicated user groups to test user journeys, and collecting feedback with groups already present in target groups in the EOSC ecosystem,
- collecting feedback from the *EOSC Portal* on functionality and proposed roadmap,
- Interactive engagement, interviews, testbed exercises, as listed in Table 5-9.

Table 5-8: Description of Target Groups identified in EOSC Future and correlated projects as INFRAEOSC-07

Target groups	Descriptions
Project Partners	The members of the Project Partners gather all the relevant experts around a specific topic: • By research domain in Science Clusters (WP6) • By business in commercial world (WP8) • By education in training and knowledge sharing (WP9) • By relevant stakeholders in WP3 • By cross activities in Cross Working Packages (XWPs) groups and INFRAEOSC projects.
EOSC Future User Group	This group constitutes a team of 'EOSC champions', composed by representatives from different user groups across the EU to help test and refine functionalities of the *EOSC Portal*.
INFRAEOSC-07 projects	Within the collaboration between EOSC Future and INFRAEOSC-07 projects, the project partners develop pilots to demonstrate how EOSC services and resources can be composed. These pilots foresee the combined usage of services from multiple providers with an automation level expected to increase during the project lifetime, when more services and resources will adhere to the EOSC interoperability framework and its guidelines.

In the practical implementation a special focus is going to be dedicated to the EOSC Future User Group with the aim of onboarding the users and implementing the portal based on the consumers' behaviour. Case scenarios will be included in guidelines and training to take the best of the use of EOSC to implement the users experience in the portal. The above-mentioned users' personas will be further validated with the EOSC User Group researchers prospective and feedback, collected through interviews, surveys, and exercises.

Members of the EOSC User Group will be divided into smaller groups based on the consultation purposes, their profiling, and their interests, or selected by randomisation to gather feedback about and validate the proposals for the UI and functionalities of the *EOSC Portal*. The engagement plan activities are described in Table 5-9.

Table 5-9: WP5's plan for engaging the EOSC User Group

	Activities description	Timeline
1	**Wishlist of EOSC functionality:** EOSC User Group answered in webinars on what services they use in the research workflows and on identifying a wishlist of the functionalities they are expecting in EOSC	October-November 2021 (Onboarding of User Group)
2	**Virtual tour:** In the *EOSC Portal*, there is a virtual tour to guide users in the portal. Further implementation will be done by asking the EOSC user group to test the virtual tour and provide feedback	Autumn 2021 - onward
3	**EOSC User Persona Survey modified:** The group will be asked to answer in a modified version of the User Persona Survey with more feedback questions. The full description of it will be mentioned in the next paragraphs	January 2022
4	**Users profiling groups categorisation:**	January/February 2022

	The EOSC User Board will be split in scientific areas matching the cluster projects to implement the users experience based on the different research areas to be implemented.	
5	**Front-Office requirement analysis:** The users' group will be asked to provide feedback on D5.2a Front-Office Requirement Analysis	January/February 2022 onward for documents consultations
6	**User interface exercises on research areas:** Suggestions and implementation will be collected, based on the different use cases that researchers in different areas may be interest to run through EOSC.	Spring/Summer 2022 onward
7	**Categorisation and super categorisation in the portal:** User Group will be consulted to suggest a better categorisation and its level of granularity in the *EOSC Portal* to improve the user navigation.	Spring/Summer 2022
8	**Use cases with the user board:** The aim is collecting use cases on EOSC, test the cases that have been identified, ask the users other case scenarios they consider relevant.	Autumn 2022 onward
9	**Test the knowledge hub:** A training platform will be ready by September 2022 and work will take place in collaboration with other platform to improve the UI connected to this EOSC resource.	Autumn 2022 onward
10	**Collection of user stories:** Practical examples from researchers would be helpful for any other end users to make the best of their research by utilising EOSC in their research activities.	Late Autumn 2022 onward

6 EOSC Front-Office User Experience Process

User Experience (UX) research and feedback is an essential part of the human-centred design process and a crucial activity in creating solutions that meet user expectations and provide valuable results for the corresponding target group of users. To correctly identify problems, define objectives, prepare design concepts and validate decisions, UX-based product development may benefit from the state-of-the art practices of the UX research and modelling methods. Among the wealth of UX research modelling methods, the team of EOSC Future project partners involved in the T5.1 (EOSC Front-Office: Requirement Analysis) selected a set of practices that may be particularly useful during the EOSC Front-Office development. The work described in this paragraph builds on the foundation of the EOSC Enhance project. The selected approach to the UX research and design should be considered as an immediate aftermath of the process described in the EOSC Enhance deliverable D4.2 - UX model and verification (update)[7], that was defined, executed, and reviewed based on the analysis of various research, modelling and design activities performed throughout the way. The chosen direction builds upon the lessons learned during the EOSC-hub and EOSC Enhance projects and constitute the next step on the path to the ultimate excellence in the field of *EOSC Portal* usability.

Delivering excellent user experience in a complicated project environment while building a system for a diverse population of users, seeking a coherent solution in a distributed architecture of services, performing the development in the given circumstance of collaboration between different product teams, poses several organisational and practical challenges. To successfully deliver the expected result several assumptions have been made to apply state-of-the art principles of UX in the project environment.

A very important guiding principle throughout the UX process definition is the assumption that it is superior to the Requirement Engineering Process (REP). As it is described in various parts of this document, the activities performed in scope of the UX research (focus groups, IDI, surveys etc.), often lead to collecting insights that are in the field of the REP interest. All the described methods of the requirements collection mentioned in the REP produce in turn a valuable set of insights for the UX research. Moreover, the REP makes use of the design concepts, which in the incarnation of the REP part relevant for the Front-Office, map directly to the results of the UX process Design phase. These circumstances make the two processes interdependent and coexisting and taking advantage of the mutual benefits. However, prioritising added value for the users over meaningless changes leads to the necessity of making the UX process responsible for defining design concept, used to implement the solutions benefiting the users. This assumption makes the UX process superior to the REP. In practice this means that the solutions for the identified problems may or may not respond to the collected insights/requirement. The REP process has been aligned accordingly to allow for correct identification of a requirement that are either relevant to the undergoing analysis or may be rejected.

The second important assumption in the UX process definition is the acknowledgement for the collaborative work of all the partners involved, to support the main goals of the T5.1. In practice this means that an adequate organisation model for the task T5.1 has been prepared and adopted to properly structure the work. To address the challenge, several theme-oriented teams as well as the respective leadership structure have been established. During the first year of the project, theme-oriented teams have been working to deliver results of the analyses documented in section 5.3 - which describes the full cycle of the EOSC Front-Office UX research, analysis, design and validation activities and the corresponding methods/tools used to support respective parts of the process.

6.1 User Experience - from insights to successful solutions

In the heart of the User Experience design lays the definition of the design concepts that describe solutions enabling a added value product, ensuring the right balance between user needs, organisational objectives and the constraints defined by the product environment.

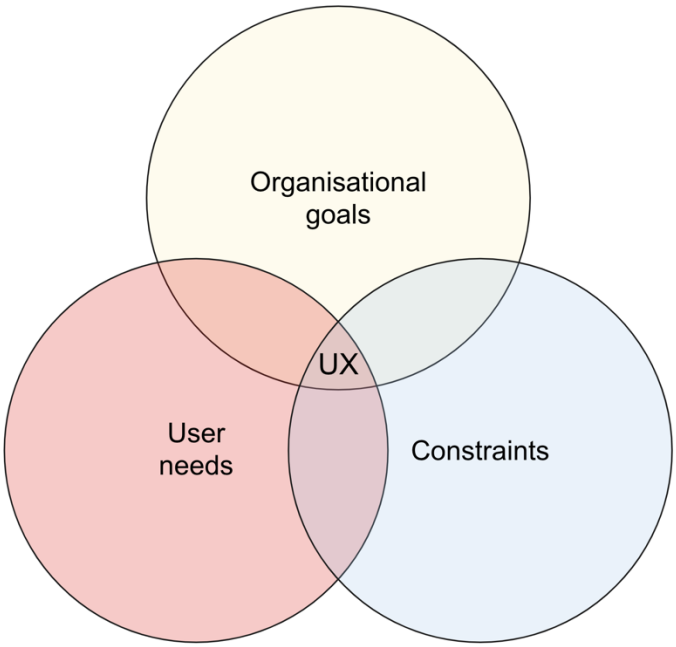

Figure 6.1: Fields of the User Experience process applicability

Among the other detailed objectives that can be mentioned to define the means to deliver an excellent User Experience the following fields of the UX process applicability can be mentioned:

- Understanding the product;
- Defining the target group;
- Examining the needs of the users and the organisation;
- Understanding how users are to achieve their goals;
- Defining the constraints / boundaries;
- Making technological decisions;
- Designing a solution;
- Testing the solution;
- Monitoring and improvement based on research.

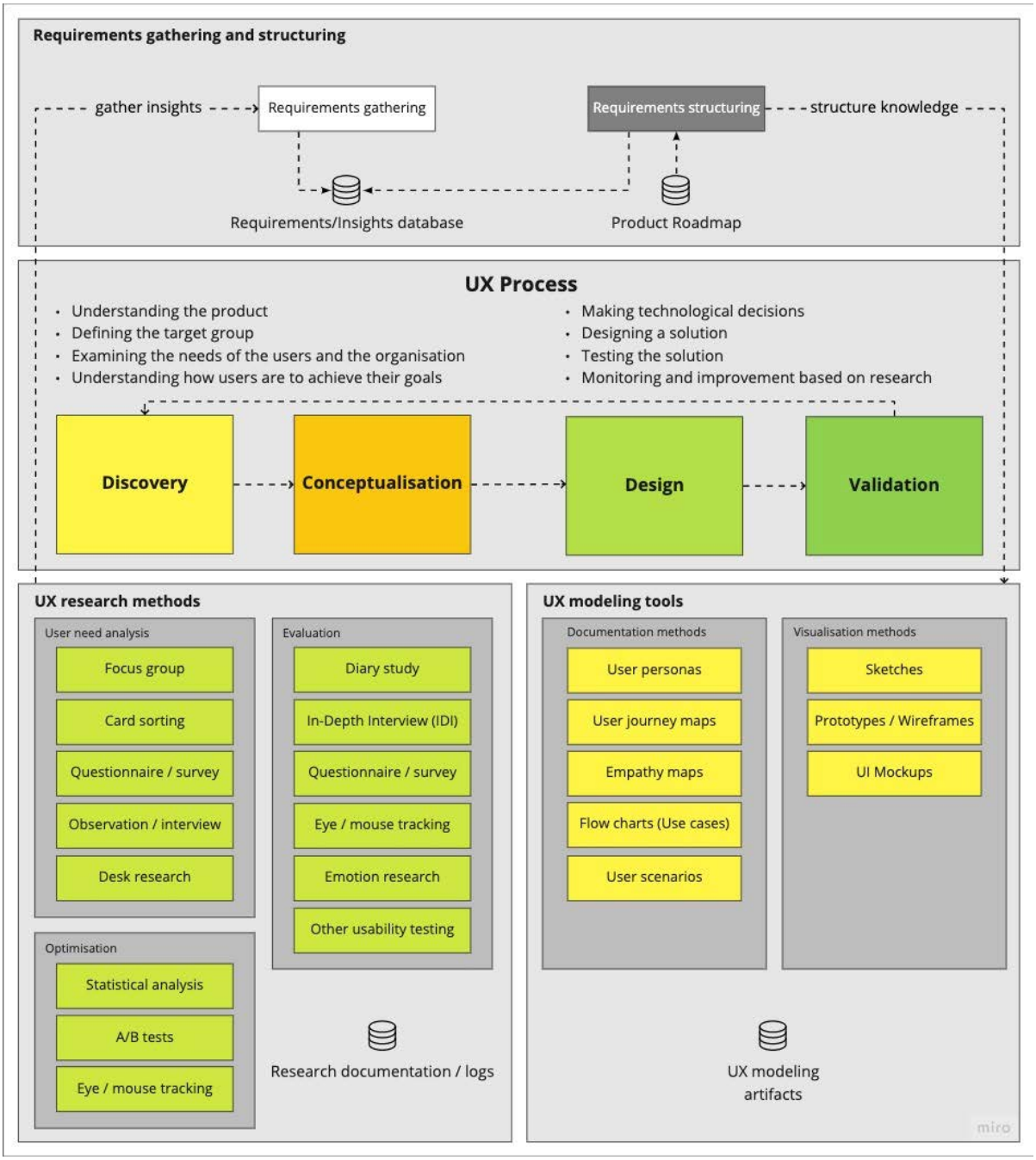

Figure 6.2: UX process building blocks, research methods and tools overview

When it comes to practice, each of these objectives may be supported by specific activities that bring the needed knowledge, allow boundaries to be identified, help in design preparation, and enable design concepts to be validated. This section describes the four steps of the established UX process, the selection of UX research methods and modelling tools supporting research and design of the EOSC Front-Office. The four steps in the process, the research methods and modelling tools are also described in Figure 6.2. Cycle starting from the discovery phase leads through the conceptualisation, design and ends with the verification of the selected design assumptions. The entire cycle brings not only the proper understanding of the identified problems and verification of the created design, but also determines the entry point to the next cycle, which starts the process again with the better knowledge provided and the intention to enable the next series of optimisations.

6.2 User Experience research methods and modelling tools

In this section user experience research methods and modelling tools are presented.

6.2.1 Finding insights with UX research

UX research is the base for all the analysis activities throughout the UX cycle. In the next sections the methods described in this paragraph will be mentioned accordingly to the phase in which they are essential or fit the most. This doesn't mean that the application of the research methods is by any means limited to a specific phase. In the very nature of the UX process lays the assumption that a research method needs to be fitted for purpose in order to gather required knowledge. As mentioned earlier each of the research activities may bring requirements that are to be modelled using the process described as REP.

For the EOSC Future T5.1 partners this list may be a guide through the research methods available for use during the theme-based analysis. At the current project stage most of the theme-based studies are either in Discovery or Conceptualisation phase. Each team was made responsible for running all research and analysis activities before entering the Design phase. Collecting the initial knowledge and validating the hypotheses with the use of UX research methods will remove the indispensable cognitive bias before the final shape of the design concept is elaborated.

The following summary presents a set of well-known UX research methods selected based on the prior experiences of the UX research team members and the method's general utility. As such, they are the prime candidates for use within the Front-Office requirements gathering process.

1. **Focus group**

A focus group is a qualitative research method that focuses on gathering user insights from a variety of people in a short period of time.

Focus groups are designed to gain an understanding of customer opinions and perceptions of new concepts or ideas. They are commonly used during the design and during early stages of the research phase to achieve consensus on user perception. After the product has been implemented, focus groups can also be helpful for gathering insights into how well the product is working.

As many participants as possible are invited to a focus group in order to gain as many perspectives as possible. However, too many participants may make it difficult for everyone to contribute to a discussion. 8-10 participants have been found to be the ideal number for a focus group. In addition, it is also recommended to facilitate three or four different focus groups to ensure a good mix of perspectives and ideas.

2. **Card sorting**

Card sorting is a UX research method used to help design or evaluate information architecture, which involves participants organising topics into categories that make sense to them and grouping them accordingly. Card sorting can be conducted in many ways using actual cards, post-it notes or one of the several online card-sorting tools

3. **Survey**

A UX research Survey is a research tool comprising in a set of questions sent to a targeted group of users in order to collect their preferences and attitudes.

Surveys can include both closed-ended and open-ended questions:

- A closed-ended question is one with a predefined set of answers, such as rating scales, rankings, multiple choices, etc.
- In an open-ended question, the test participants give their responses in a free-form style.

4. **User Interview**

A user interview is a research method for gathering information through direct conversations with the users.

A user interview typically involves asking a set of questions on a specific topic and analysing the answers provided. The quality of the results depends on how well the questions were formulated, but also on the participants willingness to provide insightful answers.

5. **In-Depth Interview (IDI)**

The in-depth interview is a qualitative data collection method that enables the collection of a considerable quantity of information regarding the behaviour, attitude and perception of the interviewees. The IDI is a meeting between two research activity participants – the researcher and the interviewee.

During in-depth interviews, researchers and participants can investigate new points and adjust the direction of the process as needed. It is an independent research method that can adopt multiple strategies according to the needs of the research.

6. **Diary study**

A diary study is a longitudinal research method used to uncover user behaviours, activities, and experiences that take place over a lengthy period.

This research method includes getting users to keep logs or diaries, take photos, explain their activities, and highlight things that stood out to them. A diary study allows telling the story of how products and services integrate into people's daily lives, as well as the touchpoints and channels they use to execute the tasks.

7. **Eye / mouse tracking**

Eye tracking, as used by top enterprises such as Google, uses cameras and specialised software to track where the eyes of user land on a webpage. Mouse tracking analytics follows the mouse movements of a user to simulate eye movement on a webpage. Website heatmaps use colours on a range of red to blue to depict the most popular (hot) and unpopular (cold) elements of a webpage. Heatmaps help identify trends and optimise for further engagement by aggregating user behaviour and providing an at-a-glance understanding of how people interact with an individual website page-what they click on, scroll through, or ignore.

8. **A/B tests**

A/B testing (or split testing) is a method for comparing two versions of a product or service to evaluate which is more successful.

A/B tests are made up of two variants, A and B, in a randomised experiment. It includes the use of statistical hypothesis testing, also known as 'two-sample hypothesis testing' in the field of statistics.

9. **Statistical analysis**

Statistical analysis is a data-driven research based on the product database, user-traffic tracking tools (Google Analytics, Matomo), various application monitoring, surveys data, other relevant datasets (e.g. documented in the web publications or scientific papers)

6.2.2 Mapping the needs with UX models

User Experience research introduces a lot of new information to the general product understanding. To ensure the focus remains on the users during the research and design activities, several modelling methods are used to properly maintain the essence of this information. The methods described in this paragraph form the basis for user-centric (or human-centric) product design within the Front-Office REP and are also helpful in various other activities along the way to ensure an excellent user experience.

6.2.2.1 User Personas

In user-centred design and marketing, a persona (also known as a User Persona, customer persona, or buyer persona) is a fictional character created to represent a user type who might use a site, brand, or product in a similar way. Personas are commonly used in online and technology applications, as well as in advertising, where other terms such as pen portraits may also be used.

The main purpose of User Personas is to answer the question 'Who are we designing the product for?'. By understanding the expectations, concerns and motivations of target users, it is possible to design a product that will satisfy the users' needs and therefore be successful.

User Personas is one of the artifacts chosen initially for the Front-Office UX design process. Typical attributes used for describing User Personas are:

- demographics: name, age, location;
- professional background: objectives, areas of expertise;
- view on the product: needs, constraints;
- personal traits: motivations, personal goals.

Based on the work done in previous projects and current investigations (including the User Personas surveys - see Section 3.2, desk research and user interviews) four personas have been identified:

- **Nicole, Henry (ESCAPE):** a young or mid-aged (25-65) researcher working within a single scientific discipline, applying scientific method in conducting research. The person needs a well-documented, reliable working environment with all necessary tooling, easy to set up, deploy and scale. The environment should fit and exceed the currently identified needs. They also want to communicate with other researchers easily, to foster the collaboration.
- **Lorenzo (SSHOC)**: a young researcher working in the humanities (Italian literature and philosophy), enthusiast of new methods, computer-supported data analysis and programming. His primary research-related need is a customisable, flexible search capability, allowing for finding specific concepts in the correspondence and to digitally annotate the corpus of texts. He wants to use a combination of network analysis and spatial analysis, so data collection, analysis and visualisation are his basic need
- **John (EUDAT)**: a skilled researcher with a strong programming-related background and initial knowledge of computer system administration. He wants to focus on conducting his research using the available tools and environments, but he wants to be spared the managerial and administrative tasks. He knows only a little about EOSC and its offerings.
- **Alice (EUDAT)**: a mid-aged (42) data manager, with very good skills in programming and computer system administration. Experienced in metadata and data management workflows and database technologies. She wants to work in collaboration with other researchers in a goal-oriented manner, helping them in conducting their research objectives.

User Personas are further described in 1 or 2-page summaries that include behavioural patterns, goals, skills, and attitudes, as well as a few fictional personal details to make the persona a realistic character. An example is shown below.

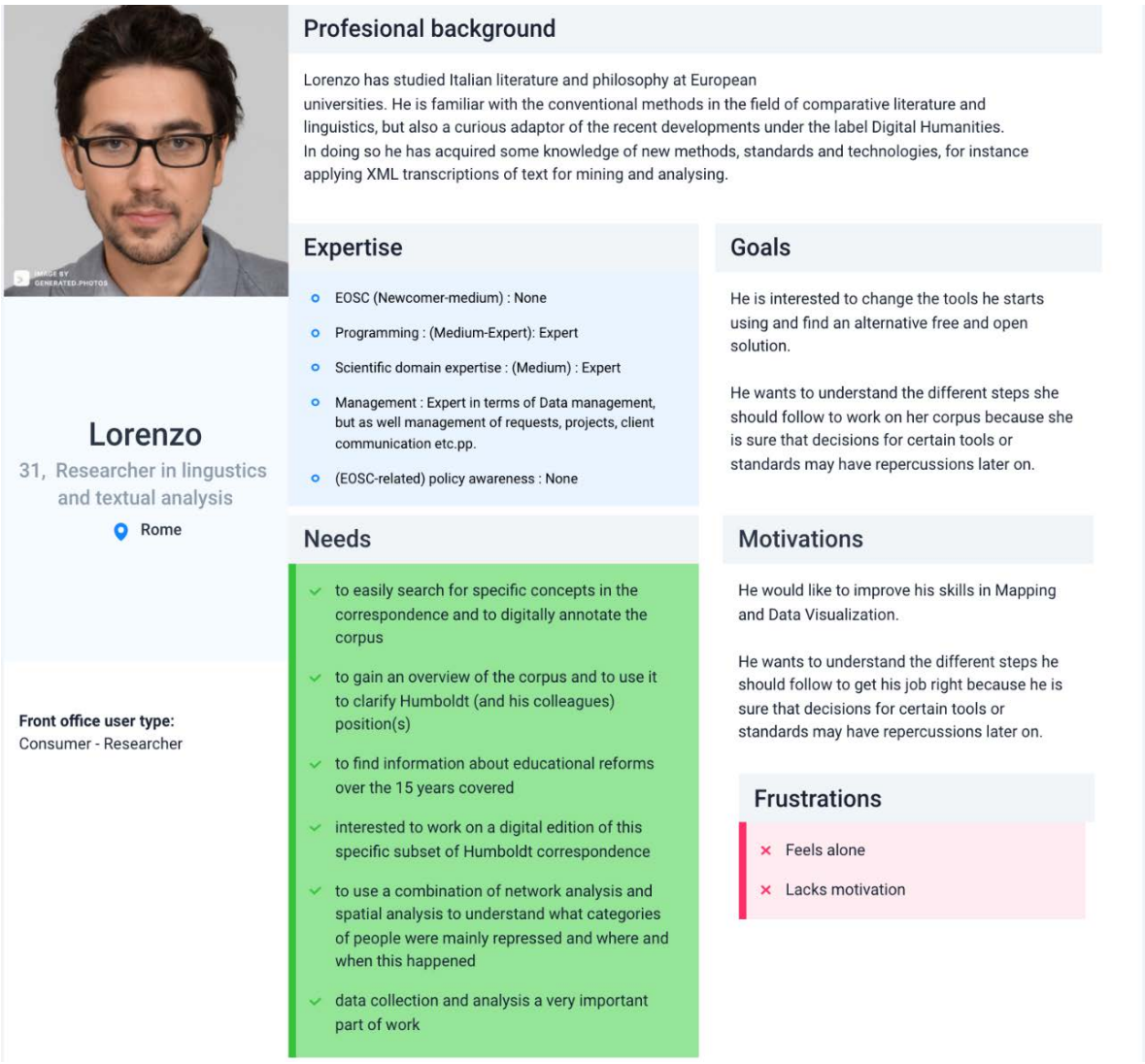

Figure 6.3: User Persona example details (1)

The User Personas presented within this document are defined with rigour as a by-product of our requirement investigation process based on the User Persona survey described in Subsection 6.1.

6.2.2.2 User journey maps

A journey map is a visualisation of the process that a person goes through to accomplish a goal.

Journey mapping, in its most basic form, begins by compiling a series of user actions into a timeline. The timeline is then fleshed out with user thoughts and emotions to create a narrative. This narrative is condensed and polished, culminating in a visualisation.

Most journey maps have a similar structure: at the top, a specific user, a specific scenario, and corresponding expectations or goals in the middle, high-level phases that include user actions, thoughts, and emotions, at the bottom, the takeaways: opportunities, insights, and internal ownership.

The terms 'user journey map' and 'customer journey map' can be used interchangeably. Both make use of a visual representation of a person using the product or service but depending on the context it may be more appropriate to refer to the user as a customer.

Journey maps come in a variety of shapes and sizes. Journey maps, no matter how they appear, share the five key elements listed below:

1. **Actor**

The actor is the persona or user who experiences the journey. The journey map is about the actor — a point of view. Actors are typically aligned with personas, and their actions on the map are rooted in data.

To create a strong, clear narrative, one point of view per map should be provided. A university, for example, could select either a student or a faculty member as an actor, resulting in different journeys (In order to capture both points of view, the university will need to create two separate maps, one for each of the two user types).

2. **Scenario + Expectations**

The scenario describes the situation addressed by the journey map and is associated with an actor's goal or need as well as specific expectations. Scenarios can be real (for existing products and services) or anticipated (for products still in the design stage).

Journey maps are best suited for scenarios that involve a series of events (such as shopping or going on a trip), describe a process (and thus involve a series of transitions over time), or may involve multiple channels.

3. **Journey Phases**

The journey phases are the various high-level stages of the journey. They organise the rest of the information in the journey map (actions, thoughts, and emotions). The stages will differ depending on the scenario; typically, each organisation will have data to help it determine what these phases are for a given scenario.

4. **Actions, Mindsets, and Emotions**

These are behaviours, thoughts, and feelings the actor has throughout the journey and that are mapped within each of the journey phases.

- Users' actions are their actual behaviours and steps. This component is not intended to be a fine-grained step-by-step log of every discrete interaction. Rather, it is a narrative of the actor's actions during that phase.
- At various stages of the journey, mindsets correspond to users' thoughts, questions, motivations, and information needs. Ideally, these are direct quotes from customers based on research.
- Emotions are represented as a single line across the journey phases, indicating the emotional 'ups' and 'downs' of the experience. This line should be considered a contextual layer of emotion, indicating where the user is delighted versus frustrated.

5. **Opportunities**

Opportunities (along with additional context such as ownership and metrics) are mapping insights that speak to how the user experience can be improved. Insights and opportunities assist the team in extracting knowledge from the map:

- What should be done with this information?
- Who owns what kind of change?
- Where can you find the best opportunities?

John (PhD St, newbies)

	Step 1	Step 2	Step 3
Description	Discover and re-use data and tools needed as base for your own studies and research work The hope that she finds the right data/service or at least contact persons for the request. She is searching the EOSC portal because she has heard that this would be the right place	In most cases she knows from their experienced colleagues which archives/aggregators are suitable for climate data.	Go productive and refine workflow
Thinking and motivations	The hope that she finds the right data/service or at least contact persons for the request. She is searching the EOSC portal because she has heard that this would be the right place	In most cases she knows from their experienced colleagues which archives/aggregators are suitable for climate data.	
Points of contacts	I don't know - I never have and don't know anyone who has used the EOSC portal to search for points of contact. As far as I know, people get to the contacts via other channels (private comm., directly via EUDAT ...). *Similar to the previous one? I am not sure they will actually use it but the natural idea would be to make a search in the portal but I am not sure which type of search would be relevant in this case.*	Not at all, see above	
Feeling	Not at all, see above	Since they do not use the EOSC portal : no Enjoyability, no relevance and no help	
Pain points	She will not find what she is searching for, e.g. : she is looking for a output of IPCC climate scenarios in https://marketplace.eosc-portal.eu/services# , first she recognized you can NOT directly search for data in this portal. Then she filters → Natural Sciences → Earth and Environm. Sciences : 10 services found, but nothing related to 'climate data' … she leaves the EOSC-portal for ever ...		
Key insights & opportunities	Hmm, don't know. Likely EOSC-portal is not appropriate for searching of domain specific data, but more for tools, like 'A climate scientist looks for a tools which allows analysing climate data - at least she will find the ECAS service .		

Figure 6.4: User Persona example details (2)

6.2.2.3 Empathy maps

An empathy map is a straightforward, easy-to-understand visual that captures information about a user's behaviours and attitudes. An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to help teams better understand their users. Empathy mapping is a simple workshop activity that can be done with stakeholders, marketing and sales, product development, or creative teams to build empathy for end users. For teams involved in the design and engineering of products, services, or experiences, an empathy mapping session is a great exercise for groups to 'get inside the heads' of users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Empathy maps are most effective at the start of the design process, following user research but before requirements and concepting. The mapping process can assist in synthesising research findings and revealing deeper insights about a user's needs (the maps are most effective when based on research data, but they can also be built using knowledge from internal participants or existing personas, as with provisional personas). It can aid in the development of personas or act as a link between personas and concept deliverables.

When included in the early stages of a project, the exercise assists teams in entering the user's world and approaching things from his or her point of view before creating solutions - whether it's content ideas, a webpage design, an app prototype, or a new service offering. Among the advantages are:

- Improved user comprehension;
- Information distilled into one single visual reference;
- Highlights of key research findings;
- Quick and inexpensive;
- Simple to customise based on available information and goals;
- Common understanding among teams.

The maps can also be used throughout the design process and updated as new information becomes available. A sparsely populated map or a session that reveals more questions than answers indicate the need for additional user research.

6.2.2.4 User scenarios

User researchers create scenarios to aid communication with the design team. In agile development, project/product managers create user stories to define the requirements prior to a sprint. Use cases are created to assist developers with testing. Because of the differences in target audience, the structure and information contained in the approaches differ.

Scenarios are stories that capture the goals, motivations, and tasks of a persona in a specific context. A scenario will include pictures of the persona, the context, and anything else that contributes to the story. Scenarios are used to bring the persona to life so that designers can role play when making design decisions. An example of a scenario, minus the accompanying imagery, is shown below:

'Jim, a second-year internal medicine intern at Mount Pleasant Hospital, walks into the room of his patient, Andrew Ross. Since Andrew stayed the night in the hospital, Jim needs to review Andrew's medical records to see if the nurses on the night shift had checked in and recorded any changes in Andrew's condition'.

6.2.2.5 Use cases and user flow

A collection of instructions for achieving a goal is known as a use case. Each step in a user case should be able to be read by the audience, who should know what to do with the system and how it should respond. Use cases will also feature branching logic, which would allow users to skip steps based on their actions. A flow chart can be used to describe use cases. To add to the confusion, there are also usage scenarios which typically only follow one sequence of steps in the use case, and the actor is assigned a name, like in a scenario. The following is an example of a use case.

Use case: Review Records

Actor: Doctor

Steps:

- Doctor walks into room;
- Doctor sees patient in bed;
- Doctor identifies patient in bed;
- Doctor sees medical charts on foot of bed;
- Doctor gets medical charts from foot of bed;
- Doctor opens medical charts;
- Doctor reads medical charts;
- Doctor changes pages to continue reading;
- Doctor closes medical chart;

When a user scenario contains many choice points, a user flow diagram is a useful graphical depiction. A user flow diagram depicts each step a user takes when interacting with a product or service.

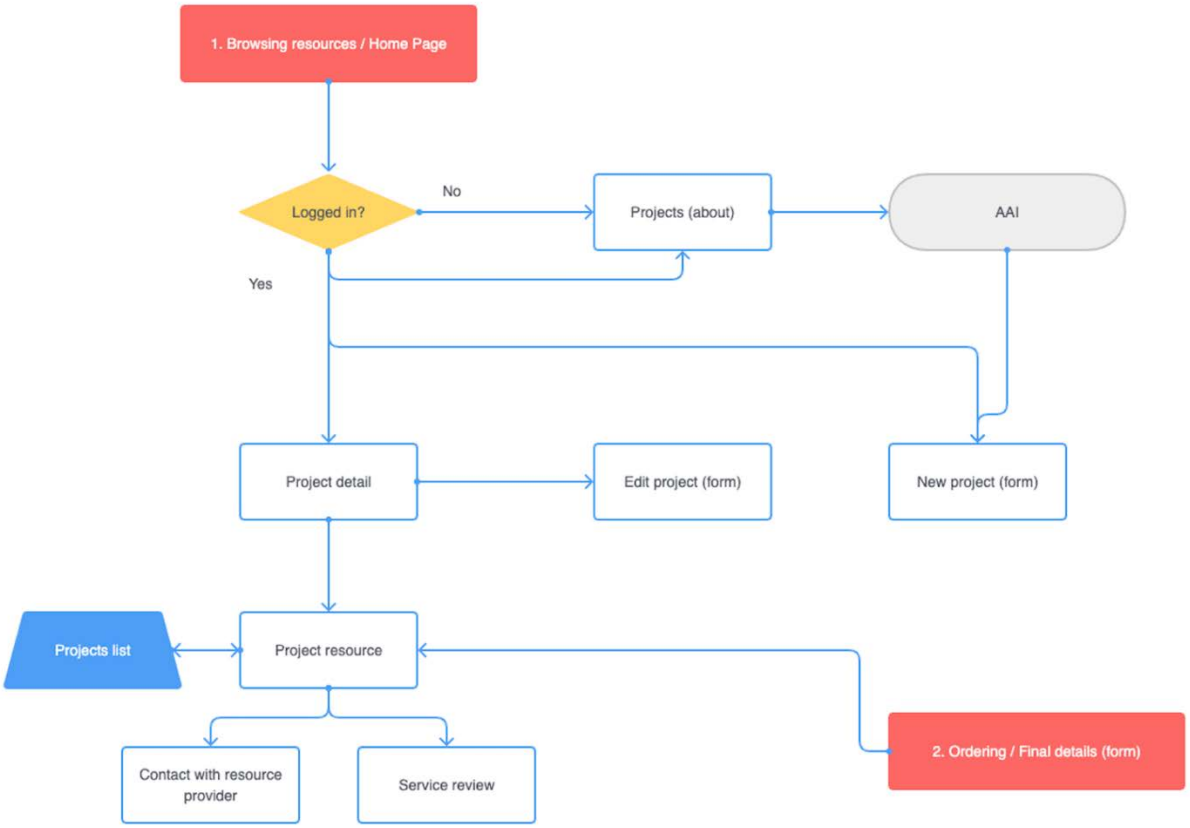

Figure 6.5: User flow example

6.2.3 Communicating design concepts

Effective communication of the design concepts involves several methods of visualisation, presenting different user perspectives. They not only help in presenting the concepts to end users, but also enable their validation by providing user experience close to reality. The primary advantage of the visualisation approaches is that they can be adopted and used early enough to collect the feedback from users and apply in the development phase. Four popular approaches that are reported in the literature and commonly used in practice are described below.

1. **Sketches**

Sketches are the simplest form of communication. They show in a static manner how the application looks like and the layout of controls in the user interface. The sketches could be supported by dedicated drawing tools

which use components nearly identical to the actual ones. While sketches cannot directly depict the dynamic dimension of the UI, they have been found to be effective enough in presenting the early concepts of the system. Sketches are used in the exploratory phase of the design to propose, explore, refine and communicate the design ideas, as they are quick, timely, minimalist and disposable.

2. **Wireframes**

Wireframes are low-fidelity design artifacts that depict only the most important aspects of a user interface. They serve as a skeleton for the design, illustrating the basic UI and serving as a blueprint for the product. Wireframes are most relevant in the initial stages of the design process as they serve in evaluating the structure of individual pages, how the related pages work together and for preparing a detailed project requirement document.

3. **UI Mock-ups**

UI Mock-ups are mid or high-fidelity visualisation approaches intended to deliver the visual look of the product design. They are most relevant during the visual design phase of the entire designing and conceptualisation process, when styles, visual consistency and accessibility must be evaluated and decided. In some cases, mock-ups can be used also for initial validation of user interactions by showing how the system should respond to basic user operations by imitating transitions between individual mock-up boards.

4. **Prototypes**

Prototyping is a common technique used for presenting a more advanced view of the system. They serve well in testing the user experience and collecting feedback in sessions involving end users. Prototypes simulate the final product not just in its outlook, but also in imitating the behaviour of controls and other elements of the UI. As such, they comprise and capture many more aspects of the final product than other methods, providing a nearly complete application interface. Additionally, prototypes can be delivered much earlier than the product itself, which facilitates shortening the feedback loop.

6.3 User Experience research and design cycle

Once it is decided which research methods and modelling tools will be used to understand the user needs, evaluate feedback and measure system usability, the next step is to introduce the process workflow. Figure 6.6 describes the steps in the process, goals, inputs and particularly valuable research methods and modelling tools that will be used in the respective phases to deliver expected results.

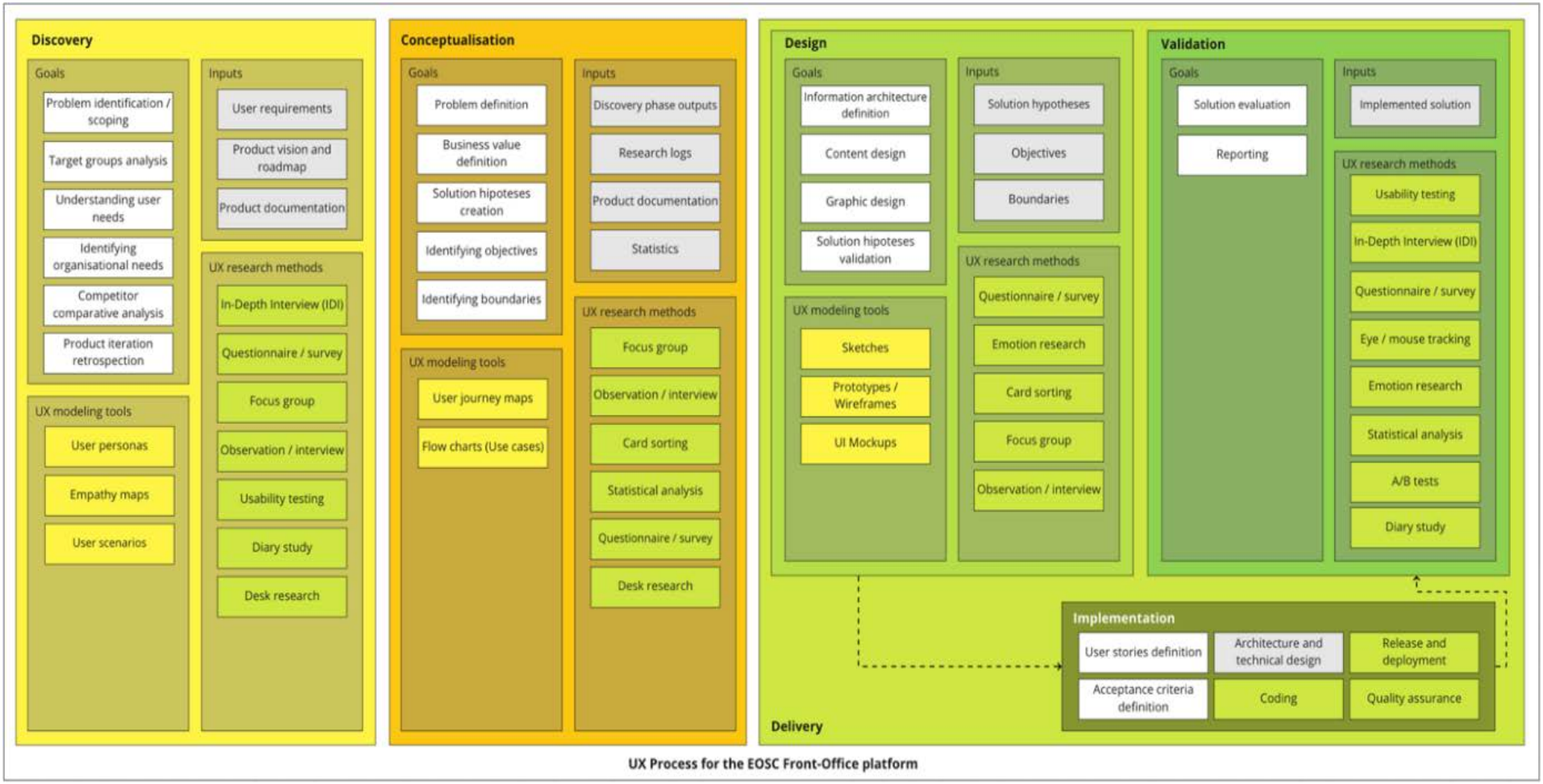

Figure 6.6: EOSC Front-Office platform UX Process

What?/Why?/How ?

The Front-Office UX process is divided into four logical steps – **Discovery**, **Conceptualisation**, **Design** and **Validation**. The two last steps (**Design** and **Validation**) are strictly connected with the process of design concept **Implementation**. As the implementation is described by a separate process and performed by another team (development team) it is not elaborated in this document.

- The **Discovery** phase lets us start the UX process with the focus on critical review of the current product functionality, preparing on all the available insights testifying user needs that are not fully covered with the value offered and organising information in a way that it can enable the following stages. Research and analysis on the user typology and their needs, identifying organisational goals and product vision/roadmap, defining the gaps that need to be bridged, analysing competitors lets us understand the missing or poorly design functionalities. The main output of this phase are the identified problem sketches and scoped themes for the later analysis. Various research methods may be helpful to gather needed input starting from desk research to organising In-Depth Interview. Product goals and the High-Level Roadmap need to be taken into consideration to set boundaries of the work in the Discovery phase.
- **Conceptualisation** is a set of research and analysis activities that enables problem definition and implies a series of next steps performed to identify objectives and boundaries for the problem solution proposals. Conducted business analysis leads to the intended added value identification. The main result of this process stage is the set of identified objectives, boundaries and solution hypotheses.
- **Design** - based on the prepared definitions of the solution hypotheses first design sketches are being prepared and the process of design validation begins. With the consecutive design approximations and accompanying research activities the information architecture becomes clearer and the work starts heading towards identifying right solution. The UI mock-ups are prepared to serve as specification for development.
- **Validation -** the scope of research methods usable in the Validation stage is very broad and not limited to the documented ones. It is the responsibility of the UX researcher to select a proper method to evaluate design concepts and delivered solutions.

6.3.1 Discovering the needs and problems to be solved

A User Experience oriented development starts from building the understanding of the target users characteristics, gathering information about their needs and motivations. Based on the collected documentation, requirements and the accompanying research conducted during the Discovery phase leads to scoping the work and the intended added value identification. The main result of this stage of the UX Process is the set of identified objectives, boundaries, and solution hypotheses.

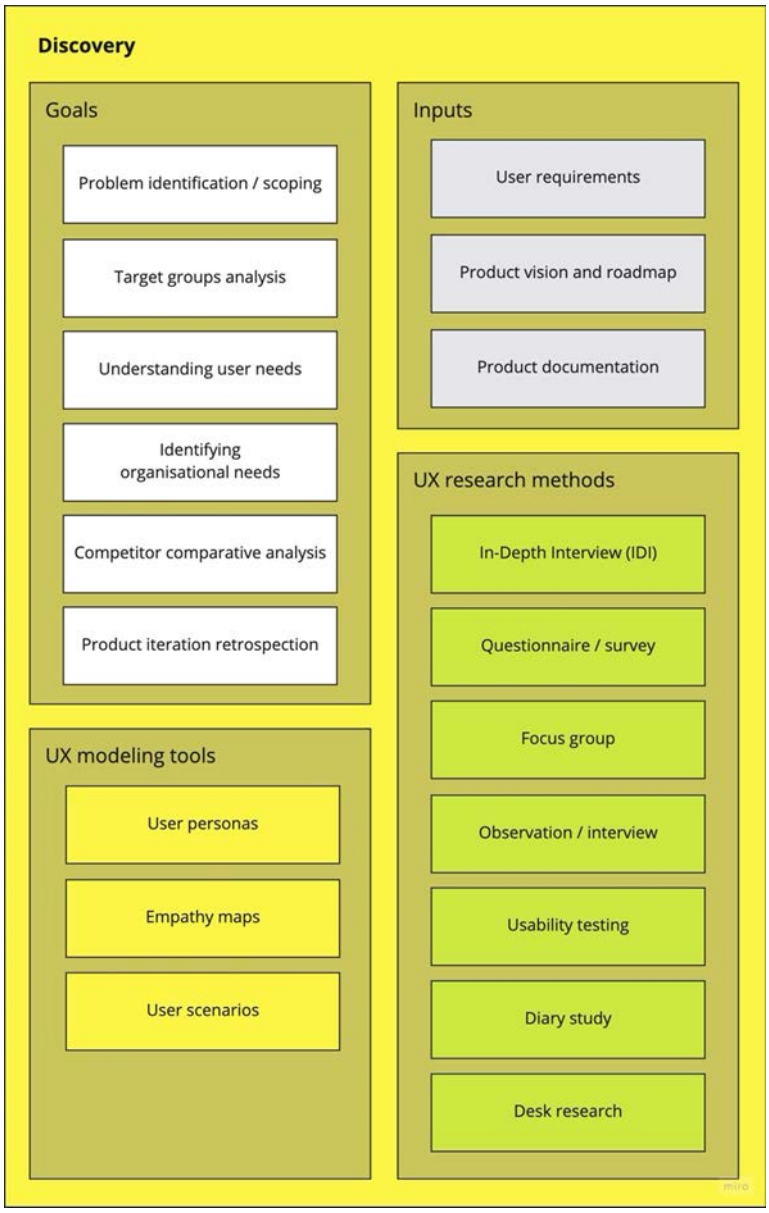

Figure 6.7: UX process – Discovery phase

User Types

The User Persona modelling (described earlier in Section 4.2 User Personas) represents a great UX researcher help in building the empathy with the users and understanding their demographics, professional background, expertise, motivations, goals, needs, and frustrations. The work on the personas for the *EOSC Portal* doesn't start from scratch but is based on a prior effort (particularly coming from EOSC Enhance project), be it stakeholder workshops, online surveys, or constant listening to the users' voice through various channels like conferences, tutorial sessions etc. In scope of the EOSC Future T5.1 a user survey dedicated to the User Persona identification has been conducted. The results of the analysis have been documented in the paragraph EOSC User Persona Survey and influenced updates in the User Persona modelling cards mentioned above.

In order to start the problem analysis, the user needs need to be mapped to the organisational needs as well as the overall direction taken in the definition of the product vision and product development areas. EOSC Future is a project with the set of high-level goals already defined in the proposal text, as well as the already established overarching High-Level Roadmap[1] built with the high-level User Experience vision in mind. These sources provided the background for the undergoing analysis carried out by the established theme-oriented research and analysis teams. The current findings from the conducted analysis have been documented in the section 7.2 EOSC Front-Office analysis.

An additional source of information will be the set of collected requirements coming through various requirement gathering channels, be it stakeholder workshops or online form. The REP implementation will be equipped with various tools to support the requirements collection such as a form introduced directly in the platform, to let the users pass their insights in the form that aligns with the structure of other insights collected. The important requirements handed over from previous projects (EOSC-hub, EOSC Enhance) were already taken into consideration when rolling out the Discovery phase for the Front-Office.

Besides the already mentioned activities, the state-of-the-art UX research practices provide a handful of methods that can be helpful in the Discovery phase. The ones that are particularly valuable in getting the initial understanding of the identified problems or functional gaps are listed in the above (Figure 6.7) diagram.

- **IDI** – the researcher and interviewee direct meeting dependant on the interview script can lead to identifying usability problems, understanding the user needs, understanding emotional reactions to the use of the product. It is often preceded by quantitative analysis of the user demographics or other important user characteristics to select the right interviewee and ask proper questions. In the discovery phase it might help modelling User Personas, identifying unknown constraints, verifying previous assumptions, or evaluating previously implemented solutions.
- **Focus group** – the study performed in the group of 6-9 properly selected research activity participants to discuss issues and concerns about the features can be a good opportunity for the UX researchers to quickly observe some patterns in the spontaneous reactions to the product or observe some group dynamics or organisational issues. However, being a group activity focus groups can only assess what the users say and not how they operate the product directly.
- **User Interview** - Interviews give insights into what users think about a product. They can point out what features are useful, what people feel is important in our strategy or what ideas for improvement they may have. This can help in defining personal, journey maps, scoping work on the feature ideas etc.
- **User Survey** – dependent on the survey questions they can help modelling personas, collecting feedback on the implemented solutions, assessing the priorities for the future development, or narrowing down the field of the research. Conducting surveys require a proper understanding of the communication medium used. Running a survey without a proper approach to dissemination or doing this too frequently for the potential respondents to react may lead to a poor number or poor quality of responses.
- **Usability testing reports analysis** – analysing heatmaps, session recordings, ratings results or feedback responses may lead to identifying barriers for the end users to reach their goals or indicate slight inconveniences in the use of the product. Most of the UI components of the *EOSC Portal* uses a HotJar [11] integration which on its own constitutes an endless source of system usability information. For the discovery phase it may bring additional context when trying to properly address the scope of the work that need to be performed.
- **Desk research / Observation** – the conceptualisation may start from researching comparable solutions or observing the trends in the user behaviour, statistics, self-study trying to replicate the path to reach personas goals and many other research activities driven by a common sense. Validating the current product state or trying to address needs collected with the new user / stakeholder requirements or analysis of the high-level goals for the new product milestone may help in scoping the Discovery work.

The described research activities may help in gathering requirements, getting insights about the user voice, their needs and the pain points, enable the modelling of User Personas, building empathy maps or documenting typical user scenarios. Maintenance of the up to date UX modelling artifacts (with the use of the mentioned modelling tools) as well as utilising them throughout the UX cycle (starting from the Discovery phase) leads to the proper scoping of the problems, identifying gaps and understanding the structure of the priorities needed to deliver valuable product with excellent usability.

6.3.2 Defining objectives and concept hypotheses

Conceptualisation is the process where the solution hypotheses are generated. During this stage, the scope of reasoning defined in the Discovery is utilised to set the stage for the further analysis of the gathered knowledge (including user modelling, user feedback and insights etc.), to define the problems that need to be addressed.

Based on the problem definition scoped within the identified boundaries the business analysis leads to defining the objectives and the crucial element of the end user value proposition. At this stage it is also important to prepare or revisit the User Journey Maps to verify the background for the solutions that are drafted in this phase. User scenarios and the user flow diagrams may be helpful in defining the solution hypotheses by high-level modelling of the user paths that lead to reaching the identified user goals.

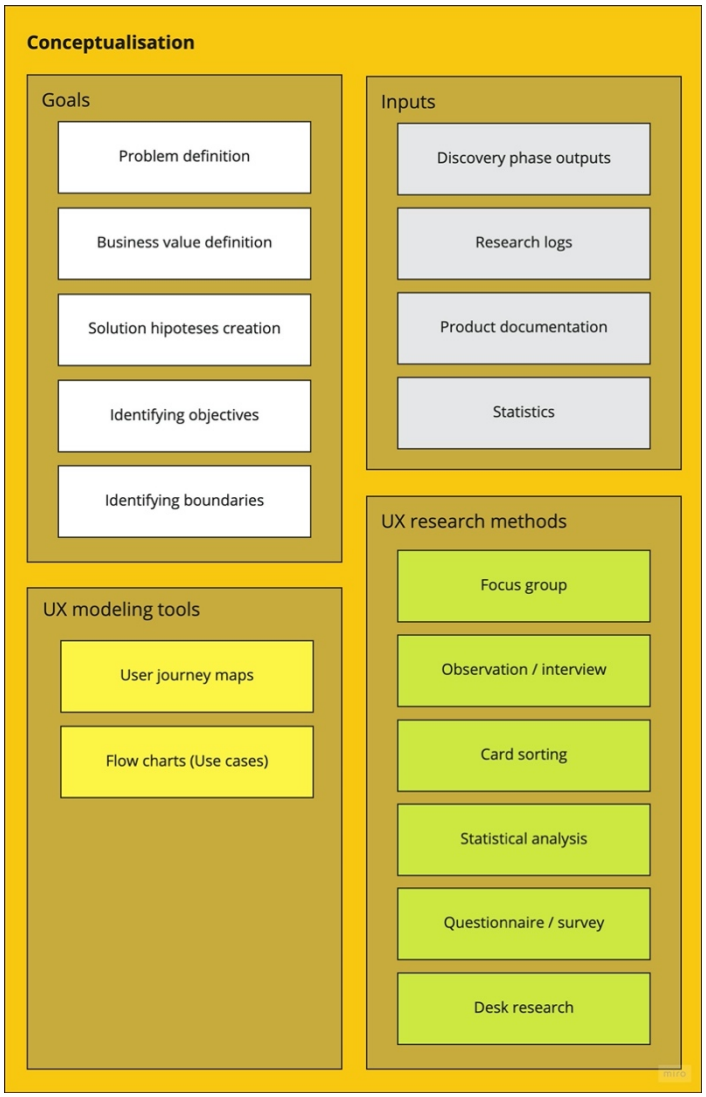

Figure 6.8: UX process – Conceptualisation phase

To validate the assumptions made in this phase several UX research methods may be found useful:

- **Focus group** - in the Conceptualisation phase focus group research can help in defining objectives and concept hypotheses. Validating the findings with the end users lead to the better definition of the goals. Solution hypotheses may also be validated once they are defined. The main challenge when preparing for focus group-based research is the definition of a research script.
- **User Interview** – user interview can help in verifying the problem statement, objectives and boundaries that are set in the Conceptualisation phase. Once the problem is defined the respondents may indicate additional needs that should be taken into consideration or provide information about specific corner cases that need to be indicated as boundaries. User consultation may be also useful to prioritise the objectives or narrow down selection of the hypotheses.
- **Card sorting** - once the solution hypotheses have been identified card sorting exercise may help in narrowing down the research field. Card sorting may be helpful in either objectives prioritisation or selection of the proper solution hypotheses.

- **Statistical analysis** – statistical analysis helps us in prioritisation and scoping the research field. Google Analytics and Matomo tracking introduced in the current version of the Front-office platform helps in understanding the user traffic characteristics. Apart from the traffic the analysis of various product databases lets us understand whether the requested features are corresponding to the current or expected characteristics of the user base and allows to validate the solutions against the realistic needs of the expected audience.
- **Questionnaire / survey** – similarly to the user interview once the problem is defined the respondents may indicate additional needs that should be taken into consideration or provide information about specific corner cases that need to be indicated as boundaries. User consultation may be also useful to prioritise the objectives or narrow down selection of the hypotheses.

6.3.3 Selecting design concepts that fit purpose

When the Conceptualisation phase is finished there is a time to create product designs. This part of the process may leverage from the help from the technical / development team to quickly identify technical constraints that may be heavily affecting design evaluation. It's worth noticing at the very beginning that some of the designs may be require considerably more effort to implement than the others. Elements of the concept design allow us to focus on the structure, functionalities and mode of operation. The design phase starts from sketches and defining the information architecture which make the later prototyping possible. Designing the solution with the focus on the functionality for the users as well as user interface prototyping allows for verifying if the key value proposition is correctly addressed by the design concept.

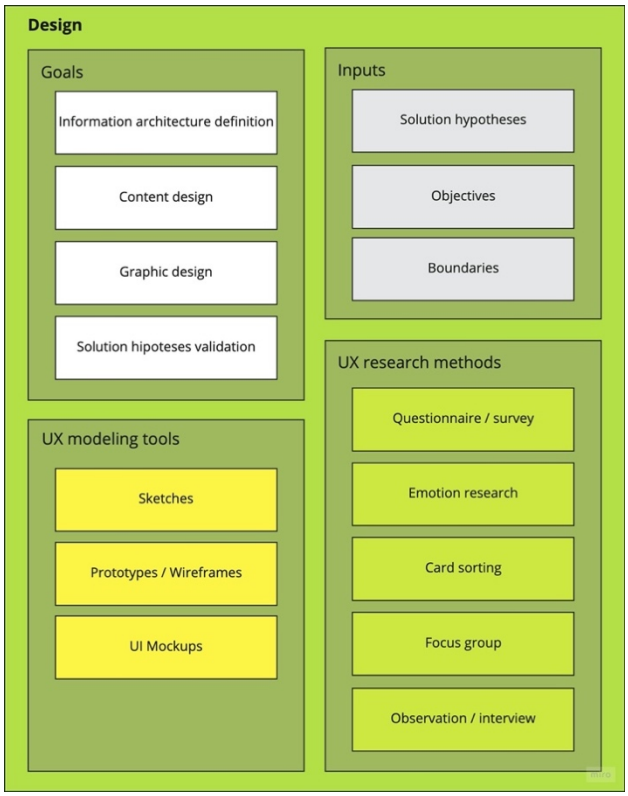

Figure 6.9: UX process – Design stage

In this phase user research leads to collecting particularly valuable feedback from the users. Planning the operational model, the location of new functionalities will significantly accelerate and rationalise design and programming work which in turn brings measurable effects to the process of the product development. This fact closely links the phases of Design, Implementation (implicit for UX process), and Validation, and is the reason for introducing overarching Delivery super-stage to the detailed UX Process diagram. Some of the research activities in the Validation stage require appropriate preparation in the Design phase as well as an adequate realisation in the Implementation phase (implicit for the UX Process). Based on the sketches,

prototypes, wireframes and UI mock-ups several research methods can be applied to validate the design concept:

- **Questionnaire/survey** – by asking the right question UX researcher may either verify information architecture design, validate graphical design assumptions, receive feedback about sketches/ prototypes or get more clarification about specific elements of design
- **Emotion research** – various types of emotion research at this stage can help in managing expectations and considerably improve the effectiveness of the solution delivery. When focusing on the design elements that bring most of the value verification can be started early in the delivery process. This in turn allows for higher convergence in the added value delivery.
- **Card sorting** – helps in the preferable prototype/wireframe selection. Together with similar methods like Tree research it can help also to verify the chosen approach for information architecture, bringing the most needed / expected information closer to the user (higher in the hierarchy of navigation, higher in the layout prepared based on the structured information architecture)
- **Focus group** – focus groups can be invaluable help in interactive preparation of the design sketches or verification of the prototypes. This is a type of a study that qualifies as emotion research so all the conditions mentioned in emotion research apply.
- **User interview** – user interview may be used to validate interactive prototype. Given that the product is not ready it is too early to run a proper IDI but interviewing the right audience can help in the design concept verification especially when even early sketches or other means of visualisation are prepared.

6.3.4 Challenging the decisions made with concept validation

Validation stage of a UX process is a set of activities very important for a product development. It closes the loop started with the Design and may refer to either productional or beta/demo deployment of the product instance prepared after implementation of a given design concept (as already mentioned, the implementation stage is implicit for the UX Process). Validation is the time to monitor how users use our service, how and what they communicate or if they can properly address their objectives. This process may and should run in parallel with the other stages – it brings invaluable help for the Discovery which is indicated in the diagram showing the process building blocks. After this step, the whole UX process will restart to fulfil new insights and users' needs as EOSC Front-Office is constantly evolving. The main principle for this stage is to focus the research on usability testing, collecting opinions and other feedback from interest groups to document ideas for improvement, identify conceptual errors or choose the right version of the proposed solution with A/B tests.

Figure 6.10: UX process – Validation

The scope of research methods usable in the Validation stage is very broad and not limited to the documented ones. It is the responsibility of the UX researcher to select a proper method to evaluate design concepts and delivered solutions.

- **Usability testing** – various methods of evaluating usability can be used. From analysis heatmaps, through the feedback in the online forms to the eye/mouse tracking. This class of methods is mentioned mainly to indicate that a lot of other research tools and methods not documented in this document may be also used to evaluate the implemented solutions.
- **IDI** – when a system version is ready it is a good opportunity to validate results of the iteration in either demo/beta environment or in the productional system (before the users are accustomed to the new version of the system). By conducting an in-depth interview, a researcher may observe usability issues, evidence of unintuitive information architecture as well collect general feedback about the added value offered.
- **Questionnaire / Survey** – post-production-deployment survey may bring some feedback about the newly introduced features, which may be considered in further reasoning. It should be also noted that users need to get familiar with the new added value to be able to rate the new development (this mean that it might be reasonable to keep some of the questions for the one of the next Discovery sessions).
- **Eye/mouse tracking** – heatmaps can bring valuable usability measures for the newly introduced user interfaces. It is a good opportunity to verify the layout or navigation. Implemented HotJar or Matomo integrations will be the place to search for such data.
- **Statistical analysis** – observing various statistics coming from the tracking of the newly developed features allows verify assumptions made during the Design phase. User demographics data, page views or similar statistics can be analysed using Google Analytics or Matomo service. Statistics coming from the product databases are a valuable source of product- specific information such as user activity with regard to the new functions.
- **A/B testing** – A/B testing experimentation need to be addressed earlier – in the Design and Implementation phase. Once the experiment is deployed in productional environment it can be used to evaluate user preferences in terms of the interface design. This is a valuable source of information for the usability testing. Researchers need to postpone their validation in order to let the system gather adequate number of data (similarly to user familiarisation needed for other research methods).

- **Diary study** – diary study focused on the feature can bring various information about the validity of the design concept. The long-term observation of user work can measure long term impact on the usability or dynamics of the changing user needs that should evolve due to the added value provided.

7 Results of the conducted UX research

The main goals for the T5.1 execution are the preparation of a proper analysis for the problem space defined in the project and making sure that the vision described there matches the needs of the Front-Office platform users. Apart from the user modelling described above, two major activities have been conducted in scope of the task. EOSC User Persona Survey describes the assumptions made to conduct a survey with the goal of the User Persona validation in mind. The thorough analysis, as well as the set of conclusions drawn from them, have been documented below. EOSC Front-Office analysis provides in turn a set of conclusions derived from the findings discovered during the work carried out in scope of the UX Process Discovery and Conceptualisation. The T5.1 partners collaborative effort, devoted to the work in theme oriented T5.1 teams, made this analysis possible. Each of the theme-based analysis was concluded after a series of research and brainstorming meetings dedicated to the theme analysis.

7.1 EOSC User Persona Survey

The purpose of the survey was to develop an accurate and possibly complete picture of the EOSC Portal user and to build appropriate personas based on reliable feedback.

The construction of the survey was guided by three main categories: 1) who are the users, 2) what they are trying to achieve and the barriers they face, and 3) what are their expectations from the EOSC. The survey contained 22 qualitative and quantitative questions covering aspects related to these categories. For the first category, the survey respondents were asked to provide information about their location, age, affiliation, profession/job function, research domain and their current knowledge of research infrastructures, e-Infrastructures and EOSC. The second part of the questionnaire, containing both open and closed-end questions, was designed to acquire information on challenges, successes, collaboration and tools that are already used or are needed to conduct research. For the third category, the respondents were asked to give a qualitative review of the current portal functionalities and future functionality preferences.

To recruit participants, the survey was distributed in August 2021, with a closing date in late October 2021: online via both the *EOSC Portal* and the EOSC Future websites, and via personal connections of EOSC Future participants. The aim was to gather enough responses to satisfy the target sample size. This assumed that the size of the population (1.7 million researchers + other categories) is roughly two million. The sample size was calculated with a 95% confidence level and ±10% allowable errors, giving a target sample size of about 100. The collected responses were analysed based on profession, location (Eastern vs Western Europe) and, in case of researchers, field of science and by level of seniority, as our initial thinking was that the needs and challenges might differ with the authority gradient. The open-ended questions were analysed using Grounded Theory, while the responses to closed questions were analysed quantitatively.

The number of received valid responses was 142, which reduced the margin of error to 8%. Although the response rate for the entire sample satisfied the assumed size, some of the categories did not reach the required ratio. Nonetheless, the entire dataset was used to explore the potential usefulness of the survey.

An overview and summary of key analytical points of the survey follow:

- Most of the respondents (70%) were researchers from 26 countries, covering all major fields of science and levels of seniority. The rest of 30% was divided among eight other lines of work;
- The great majority of the respondents are not involved with any EOSC related projects;
- The respondents considered discovery and limited access to data as the main obstructive issue in their work, followed by the lack of time and computing resources;
- The number of publications remains the primary measure of scientific achievement while research quality, ranked second, increases in importance with the level of seniority;
- When collaborating with others, the main challenge was found to be time management, followed by data sharing, communication, difference in expertise and incompatible tools;
- The main differences among fields of science were found to be in the tools and platforms used to support everyday work but also to store, share or analyse research data. Free tools are preferred, but custom solutions and commercial products are also in use;

- Several functions were found to be missing from the tools and platforms the respondents are using in their work. The most frequently mentioned feature was the ability of easily exchanging data;
- Data collection and analysis is recognised as a very important aspect in the researchers' present and future scientific work;
- The EOSC Portal should also offer additional features, such as a proper and user-friendly data search engine and information about the sources; links to available training and tutorials, recommendations, a platform to store, process and analyse data for cross-institution/cross-borders research groups;
- Out of the participants who visited and used the EOSC Marketplace, 47.5% are happy with the functionalities offered, while 25% reported there are too many functionalities and that key functionalities are missing.

7.1.1 Respondents

The 142 survey respondents come from 26 countries, of which four (4) are non-European and seven (7) Eastern European. The results of the survey indicate that 70% of the respondents were researchers, while the rest of 30% was divided among other lines of work (see Figure 7.1). 44% of the researchers are senior scientists while the other 56% is distributed among the PhD Students (16%), Post Docs (19%) and Chief Scientists (21%).

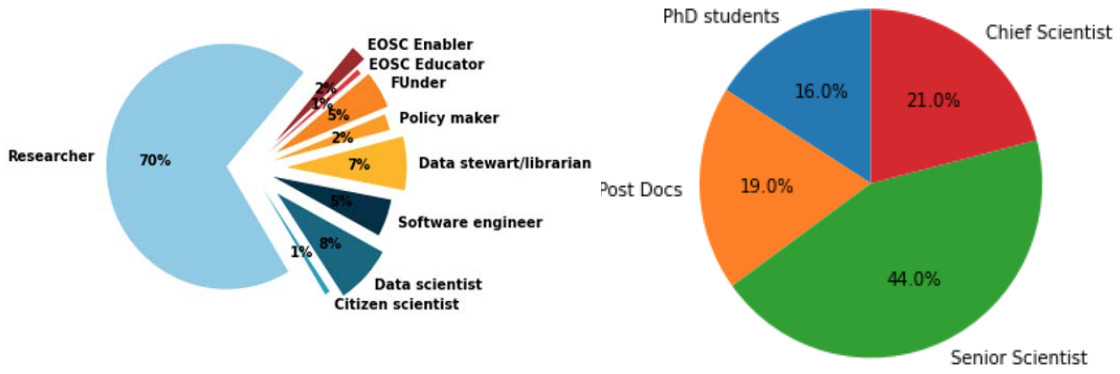

Figure 7.1: Breakdown by occupation of the respondents (left) and level of seniority (right)

In terms of field of science distribution, nearly half of the researchers belong to Natural Sciences, followed by Social Sciences, Engineering and Technology, Medical and Health Sciences and a very small portion from Humanities and Arts (see Figure 7.2).

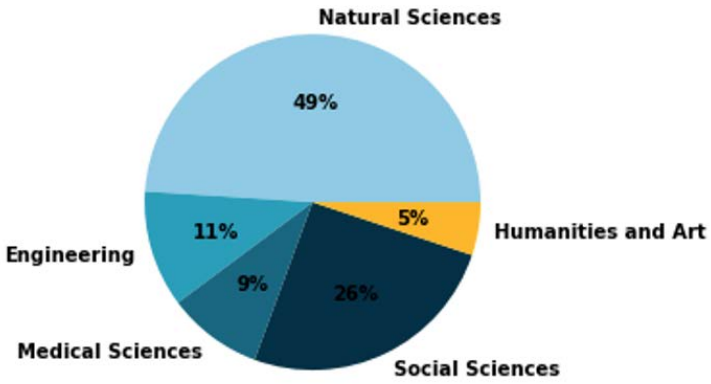

Figure 7.2: Survey respondent breakdown by field of science

With respect to the involvement of respondents in European research infrastructures or e-Infrastructures, the results were balanced, with a ratio of YES/NO of 1.1. On the other hand, only 17.6% of the answers were positive in connection to the respondents' involvement in EOSC related projects.

7.1.2 Research behaviour

7.1.2.1 Day to day challenges

Coding was used to analyse the open questions. For the question '*What are the three biggest challenges in your day-to-day work*', the following coding categories have been assigned: data access (including e.g., discovery, access, dispersion), lack of time, computing resources, data storage, access to publications, funding (lack of or difficulty to obtain), tools (either too many or too few) and difficulties in orchestrating them into a working environment.

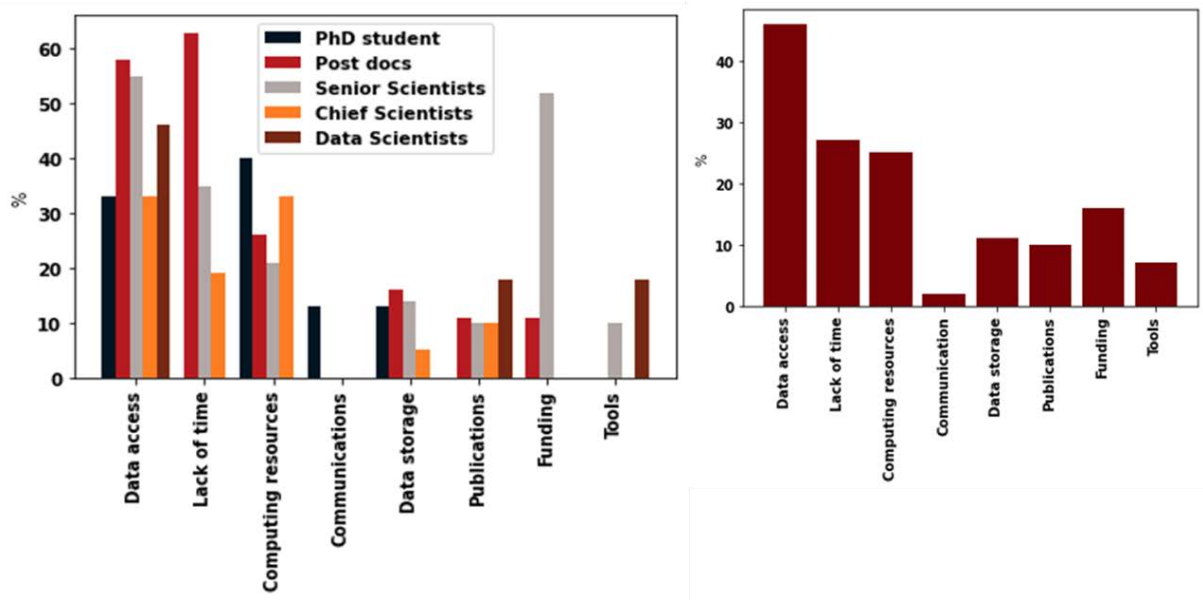

Figure 7.3: Day to day challenges, by survey respondent type

The answers were analysed based on the description of the respondents' occupation and level of seniority, as listed in Figure 7.3 (left hand chart). The respondents considered the limited access to data as the main obstructive issue in their work, outranking all the other coding categories except for the case of Post Docs and PhD students, who recognised the lack of time and, respectively, computing resources as the most problematic. Senior scientists and chief scientists ranked funding and respectively computing resources as their second highest challenge.

Only three (3) answers from policy makers were received and therefore cannot be considered representative. However, their responses were aligned around the non-prioritisation of data management in universities and the lack of incentives for sharing data and making them publicly available. The answers received from Data Steward/librarians revolved around the lack of proper, mature and seamless services for open science.

The cumulative answers in Figure 7.3 (right hand chart), show the data discovery and access to it to be by far the main challenge researchers face in their work, followed by lack of time and computing resources.

Some of the answers could not be easily categorised, but they are nonetheless worth mentioning. PhD Students feel alone in their work, lack motivation, skills and understanding, while both postdocs and senior scientists seem to be overworked, stressed, either because of lack of funding and time or lack of career perspective, pressure to excel on all fronts, disagreements with superiors, politics and bureaucracy.

In general, lack of access to scientific knowledge and publications, bureaucracy and rigidity of the academic system seems to be common trend in the Eastern European research environment.

Data availability, data storage and computing are recurring issues for the Natural Sciences, Engineering and Social Sciences and to a lesser extent for the Medical and Health Sciences.

7.1.2.2 Definition of success

For the question '*How do you define success in your role*', the following categories have been identified: number of outputs (mostly scientific articles), research quality, mentoring/teaching/coaching, efficiency, accuracy, learning and funding (number of successful research grants received).

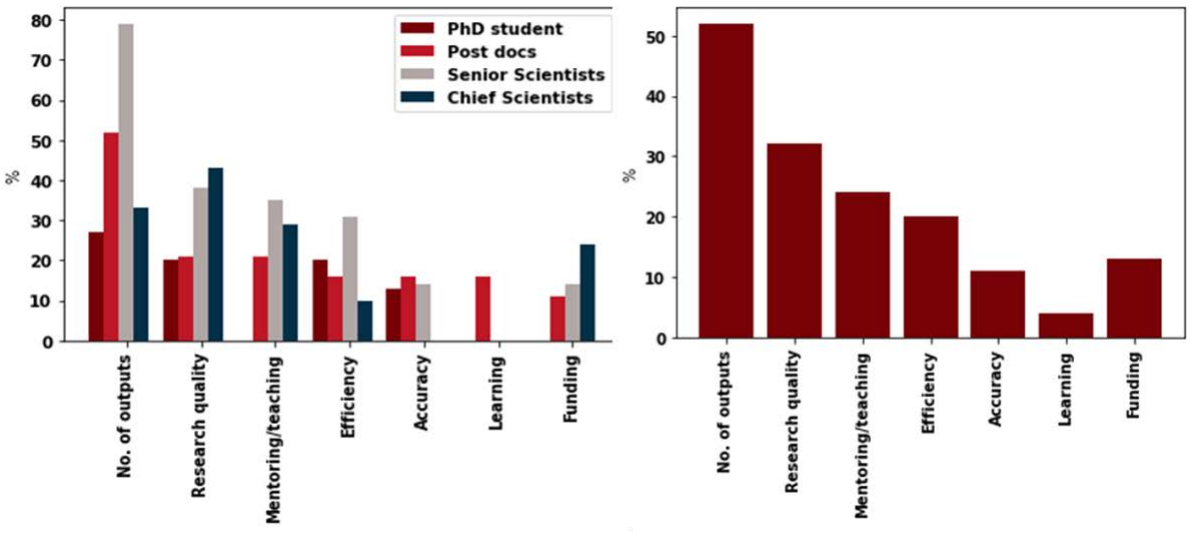

Figure 7.4: Number of research outputs, by survey respondent type

The number of publications remains the primary measure of scientific achievement, of productivity and self-worth for scientist, predominantly for Post Docs and Senior scientists (see Figure 7.4). The runner up (research quality) increases in importance with the level of seniority.

Mentoring/teaching/coaching and efficiency are mostly prevalent in the senior scientists' category, while funding is a stronger factor for the chief scientist/professor group.

No difference has been found between Eastern and Western Europe, nor between the fields of science.

7.1.2.3 Collaboration challenges

The question 'What are the biggest challenges you face when working with others' revealed the following coding categories: data sharing, communication, time (either lack of or time difference), cultural differences, incompatible tools, teamwork, funding, politics and weak coordination.

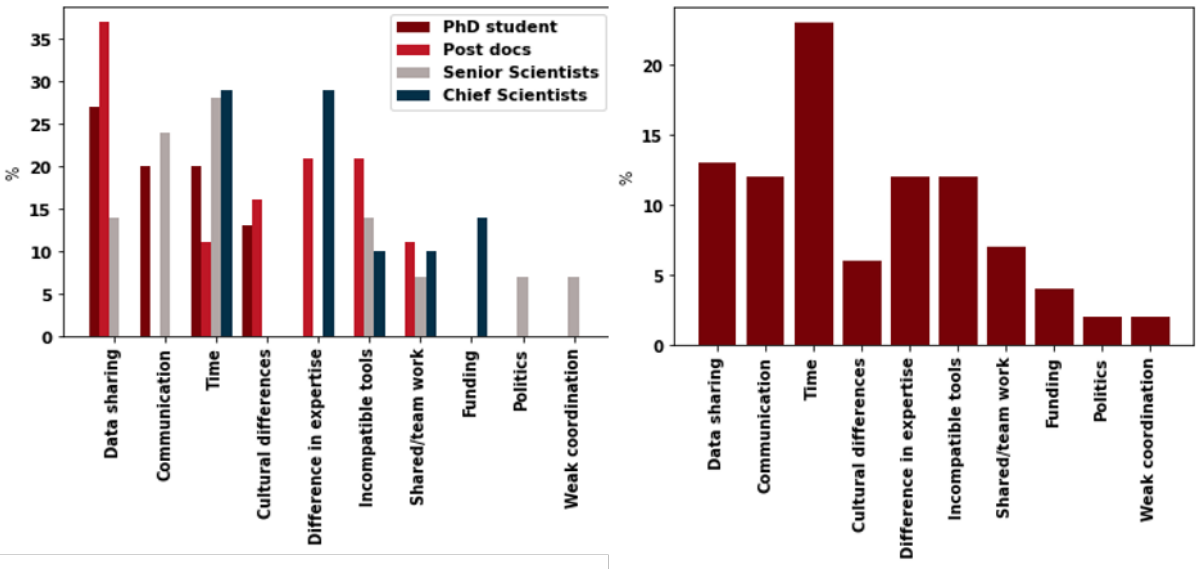

Figure 7.5: Factors that affect collaboration, by survey respondent type

The majority of the respondents (128 out of 142) usually collaborate with colleagues when conducting research. The main challenge was found to be time management, followed by data sharing (especially for PhD students and Post Docs), communication, difference in expertise and incompatible tools (see Figure 7.5). Because of the small number of answers, data scientists, librarians and software engineers are not presented separately. However, their answers mostly follow the pattern found in the researchers' groups. The research facilitators underlined the problems coming from differences in policies at national and disciplinary levels. No obvious differences in responses were found when analysing the discipline or country of origin.

7.1.2.4 Use of tools and platforms

For the question 'What tools and platforms do you use to support your everyday work routine?' the respondents enumerated the tools and platforms in an open way, which in many cases resulted in general answers that included various tools serving different purposes. The results indicate that there are several categories of tools and platforms:

- General-purpose, freely-available tools provided in the cloud by large vendors. These tools are not directly related to pursuing research activities, and could be used by all users to collect, manage and analyse any data, but also to create documents. They include: Google suite (Drive, Docs, Spreadsheets, Forms, Calendar), Office 365, GitHub, GitLab, Overleaf, Trac, Trello, Doodle, Dropbox, WeTransfer and Instant Messaging applications;
- Proprietary, paid tools dedicated to research-related activities, e.g., SPSS, Matlab, Stata, ESA/NASA-originated tools dedicated to astronomy, ASDC, AstroCOLIBRI, GCN, Astronomers Telegram, FAVA; proprietary software of MAGIC, IceCube and CTA;
- Free tools closely related to research activities, e.g., R Studio, Zendon;
- Programming tools, e.g. Python, C, C++;
- Freely-available and/or paid tools for communicating with other researchers, e.g., Zoom, MS Teams, Slack, Gmail;
- Freely-available computer system- and application software, e.g., Knime, Gimp, Linux.

Some answers also indicated the use of own-developed tools and solutions.

There are some differences concerning tooling used by researchers working in various domains. Researchers working in the humanities mentioned mainly public tools for storing the data, file sharing and communication (Google Drive-related, MS Office, IMs). They expressed no or only a little interest in analytical tools.

Researchers in other domains, in addition to the commonly mentioned public tools, also mentioned an interest in analysis tools, programming environments and HPC services. In particular, in the Engineering and Technology domain there were more responses concerning C++, Python and R Studio than in other domains.

One interpretation of the results is that the choice of specific tools depends primarily on the domain, but also on the direct and immediate availability of the tool for the researcher. If the tool is offered by their organisation, then it is used; otherwise, researchers tend to use publicly available services and products. Free tools are preferred, but custom solutions and commercial products are also in use.

7.1.2.5 Storing, sharing and analysing data

For the question '*What tools or platforms do you use to store, share or analyse any research data*?' several dominant categories of tools and platforms were identified, differing in their purpose, availability and the way of providing support to the end users. Below is the list of categories of tools with labels indicating their purpose.

- Local storage: individual computers, disks or tools provided by the organisation, to which researchers are affiliated to, e.g., NAS drives, private clouds, secure servers localised in the organisation's premises, institutional data repositories, grids, git;
- Free, general-purpose tools and platforms, usually offered in the clouds by large vendors (but not only), e.g. Google Drive, Dropbox, jupyter notebooks, SharePoint, WeTransfer, OneDrive, CernVM-FS, GitHub, GitLab;
- Paid storage platforms, e.g., Amazon s3, MS Azure;
- Dedicated software to statistical data analysis and processing: SPSS, DataOn, R Studio, GrADS, Stata, own developed scripts;
- Dedicated platforms to process data: Atlas.ti, proprietary software of MAGIC, IceCube and CTA, CASA, AIPS, BIMS;
- Free tools for storing and publishing datasets or research publications: Zotero, Zenodo.org, FigShare, Mendeley.

The distribution of responses slightly varies with respect to the research domain.

While basic platforms for storing and sharing data are used in all domains, researchers working in the humanities mainly focus on these services and infrequently mentioned other solutions. In Natural sciences or Engineering and Technology domains, researchers also use tools for data processing and analysis. In some research areas, researchers mostly use dedicated tools, customised to their specific needs (e.g. astronomers mentioned platforms that are not used in any other domain).

In all groups there is a preference for using tools and platforms that are commonly available, also for free. Unfortunately, the collected data does not indicate whether they use free or paid services based on those tools.

7.1.2.6 Functional gasps

The following question in the survey enquired about the tools and platforms the respondents are missing in their work. The answers varied greatly but revealed several functions that the respondents consider to be missing in the tools they use. While some functions missing from certain tools are provided by other solutions, they all cannot be easily integrated into a functional environment. Therefore, the inability to integrate several tools into environments or pipelines that can collaborate and exchange data was the most frequently mentioned feature that is missing.

Specifically, the commonly mentioned missing functions include the following:

- integration of tools in pipelines, integration with external platforms, interoperability, standardisation of interfaces, transparency of policies;
- storage for large data that would allow for collaboration and sharing datasets and data items with other researchers;
- sharing the data outside the existing ecosystem or beyond a tenant;
- communicating online (video/chat) with others researchers directly in the tool;
- efficient and scalable tools for analysis of large datasets;

- scalability of the computational power offered by a platform;
- data security;
- ensuring compliance to GDPR concerning data residency;
- improved UX, usability; providing friendly user documentation;
- proper user support by humans.

Analysis of the missing features in various research domains did not capture significant differences.

7.1.2.7 Aspects of research life

For the following three questions, the respondents were asked to grade the importance of several aspects of their research life on a scale from 0 (does not apply), 1 (not at all) to 5 (very much).

Data collection and analysis is recognised as a very important aspect in the researchers' scientific work. The mean value for all responses was 4.12 (std=1.23) and mode 5. This is also reinforced by the detailed analysis for individual research domains where the dominant answer was 5 (see Figure 7.6).

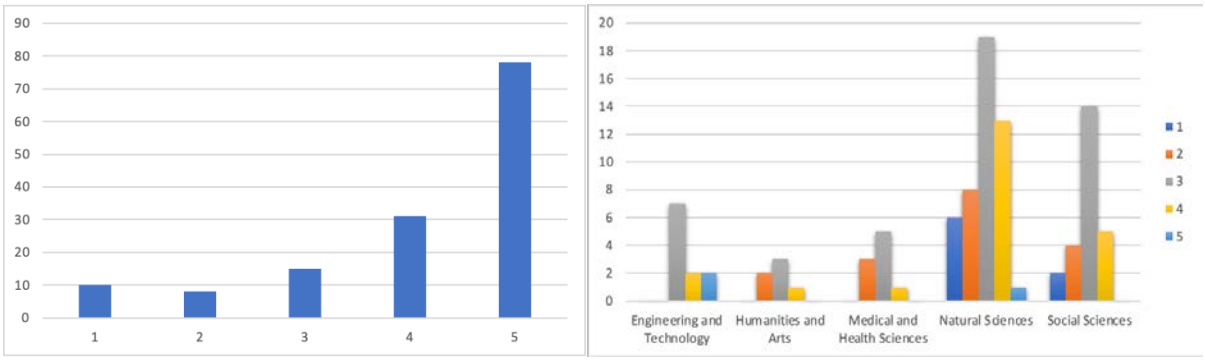

Figure 7.6: Importance of aspects of research life, by respondents' research domains (right) and cumulative (left)

A similar trend to the one above was found for the statement 'I think data will play a more important role in my job in the coming years'. An even larger number of respondents answered positively (5) when asked about the future role of data in their work. The mean value for responses was 4.24 (std=1.1, mode=5), indicating that researchers expect the importance of data and data analysis to increase in the future.

The results for the next statement 'My current data collection, storage and analysis practices are efficient' revealed a different status for storage and data analysis. The mean value for responses was 3.02 (std=0.96, mode=3), indicating that researchers are mostly neutral with their practices, but also a great potential for improvement.

7.1.3 EOSC Portal

Most of the respondents (91 vs 51) had not visited the EOSC Portal. Those using the *EOSC Portal* were mostly visiting the Catalogue and Marketplace, followed by services and resources, the policy section, the information for providers, and the use cases, which is the least visited section of the portal. The 'Other' refers to users checking information about the EOSC projects.

7.1.3.1 Suggested improvements

According to the survey respondents, the EOSC Portal should also offer additional features, such as the ability to search datasets and related information about their sources; links to available training and tutorials for each service and the chance to get recommendations (e.g. '*users who checked this service also used…*'); a platform to store, process and analyse data for cross-institution research groups; in the marketplace, the chance to select the services first and then to narrow them down by discipline, or, along the same line, the chance to have pathways to guide researchers to the resources more interesting for them; stronger links with re3data, perhaps about the data sources. Finally, there's an interesting point about the need for the EOSC to become a seamless part of the institutional infrastructure for researchers to really make use of it.

Among the **suggestions on how to improve the portal**, some are particularly worth mentioning.

- Service monitoring - to assess their usage or quality;
- Providing use cases to help researchers to achieve their goals;
- Clearer explanations on what each component of the Front-Office is intended for;
- Putting consumers rather than providers at the centre (leading to a more user-friendly interface);
- Providing tips on how to use the portal.

These are the more outstanding suggestions resulting from the survey.

Users participating in the survey that were already familiar with the EOSC Portal found about it from social media, following colleagues' recommendations, or at events where the EOSC was mentioned. Mailing lists from projects and institutions also prove to be a source of information about the EOSC Portal.

The vast majority (72%) of the respondents have never visited the EOSC Marketplace; out of those who have, some (5.59%) found it useful, others used it but report that it did not serve their needs (10.48%), while some others used it more than once or on regular basis (11.18%).

Out of the 40 participants who visited and used the EOSC Marketplace, 47.5% are happy with the functionalities offered. On the other hand, 25% reports there are too many functionalities and that key functionalities are missing.

About the functionalities to be added, those refer to the possibility of instantiating useful software, to improve access through the AAI, to refine the filters to search for services based on the country where the provider is based, and direct access to the service, not to the provider's main page.

Users answering the survey would be interested in the following additional offering from the EOSC (answers are on a scale 1 to 5, where 1 represents no interest and 5 high interest).


Discovering new tools and resources tailored to my needs
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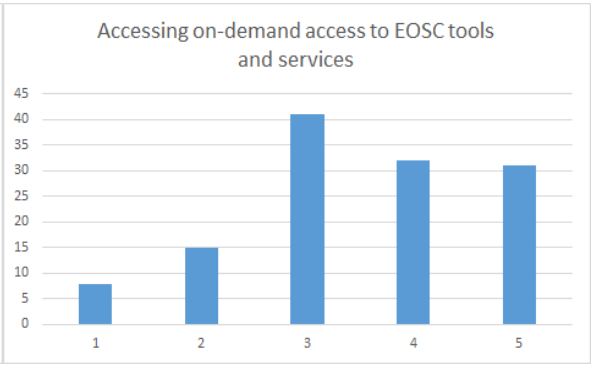
Accessing on-demand access to EOSC tools and services
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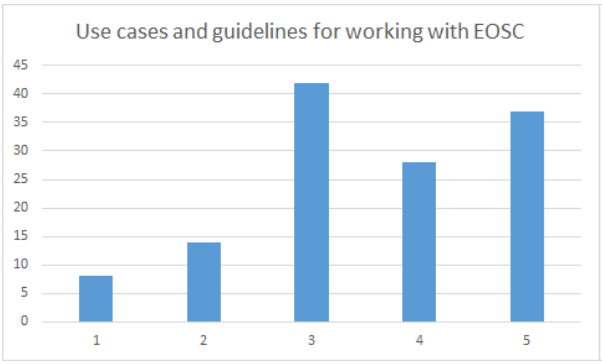
Use cases and guidelines for working with EOSC
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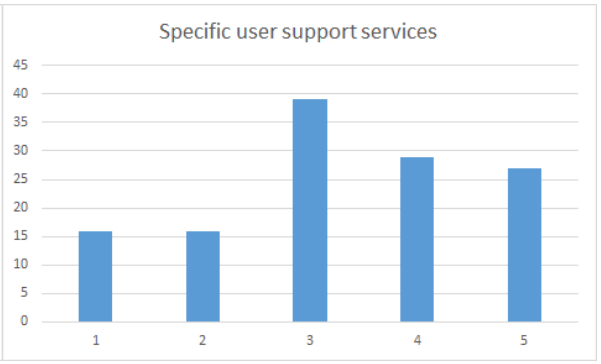
Specific user support services
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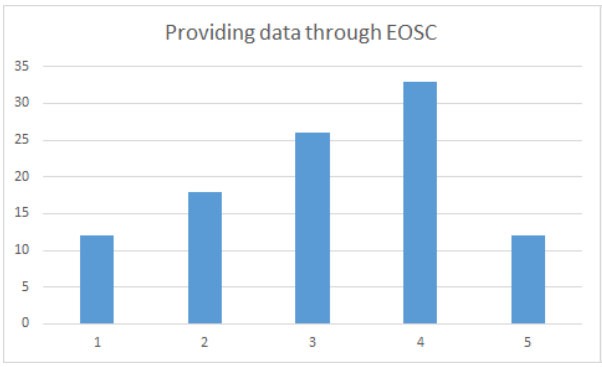
Providing data through EOSC
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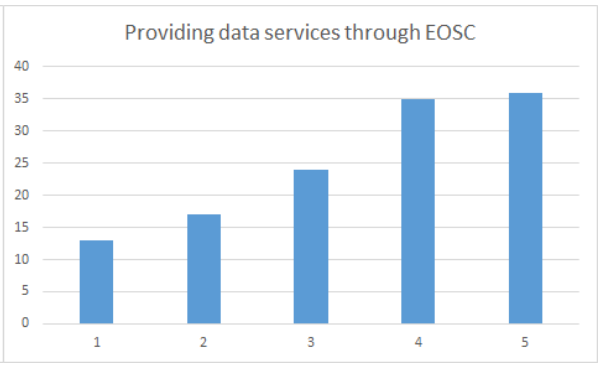
Providing data services through EOSC
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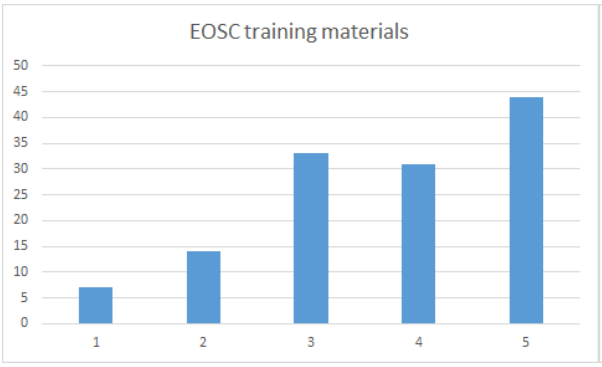
EOSC training materials
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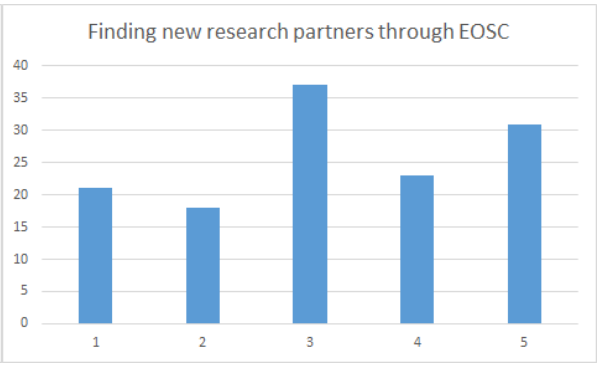
Finding new research partners through EOSC
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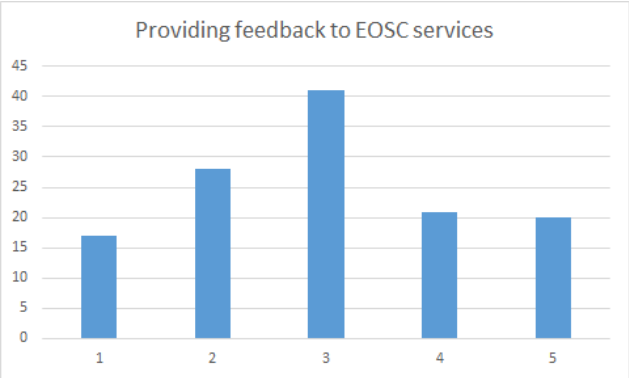

Figure 7.7: Importance of other possible EOSC services

7.2 EOSC Front-Office analysis

During the first months of the EOSC Future the T5.1 established the structure for the research and analysis work needed to address the upcoming Front-Office development activities. Most of the project partners involved in the T5.1 joined the theme-oriented teams to prepare the analysis needed for the Discovery and Conceptualisation stages of the UX Process. Each of the theme-based analysis documented in this paragraph was concluded after a series of research and brainstorming meetings dedicated to the theme analysis. The following months of the project will bring more results in scope of the analysis, user group consultations etc.

The template used to drive the analysis is presented in Appendix A, while the following subsections present the themes and their respective analysis.

7.2.1 Data inclusion in the EOSC Front-Office

The EOSC Front-Office is the access point to the research outputs in the EOSC.

The analysis about what kind of information to include in the Front-Office started from the hypothesis that researchers would best benefit from the *EOSC Portal* if they could find and discover research data of interest, and re-use it for their research. It then addressed issues related to discovery versus access, to the potentially different access policies across countries, and to the level of granularity of the description of the resources presented through the Front-Office.

The EOSC Front-Office platform should provide seamless access to research outputs (starting with datasets) to allow researchers to discover and find information that could be useful in their research activities. The search engine behind the *EOSC Portal* should have a dedicated view on the OpenAIRE Research Graph (known as the EOSC Research Graph), that will enable search, browse and recommendation on content. There might be an integration with OpenAIRE Explore with additional sources for enhanced user experience. Data providers would not need to be registered with OpenAIRE, though, to ensure content visibility on the *EOSC Portal*. However, this parallel inclusion path will need specific requirements to be defined in accordance with WP4. However, some details must be clarified, including the minimum requirements that data sources and information providers should align with, and if EOSC Future foresees technical support to those that do not have the technical infrastructure or development capacities to prepare specific integration mechanisms. It is foreseen that both authenticated and non-authenticated users can access and use the Portal to its full potential; however, authenticated users should benefit from additional services, e.g. the possibility to save searches, access to workspaces, collaborate with colleagues, and so on.

A minimum set of searchable metadata should be available to enable information search and retrieval through the Portal. Some considerations concern the fact that searchable attributes need to be exposed in the User Interface to present perfect matches. However, a trade-off between speed and quality of the search is unavoidable to limit the need for computing resources to execute the search.

The Front-Office (as well as the data) should comply with the FAIR principles. In particular:

- **F**: making content findable, not just the data sources/content providers. Foresee an alert system based on the selected filters to which the user can subscribe for future notifications;

- **A**: identifying the access type, both at the metadata level and at the content provider level (in case authentication is required);
- **I**: provide details on the data format and maybe usage guidelines (possibly linked to training?);
- **R**: provide information on the license type and any relevant legal information.

The implemented solutions will take into account the results of the persona survey and the feedback received by the EOSC User Group, that ideally guides the implementation from the usability (and usefulness) point of view.

Guidelines for content providers on how to make their content searchable through the Front-Office will align with the technical requirements specified in WP4.

7.2.2 Enhances/improved Discovery capabilities

'Discoverability, in the context of product and interface design, is the degree of ease with which the user can find all the elements and features of something new when they first encounter it. That ability is an important consideration in user interface and user experience design… Discoverability is also one component of learnability, a measure of how easily someone can find, access and make use of the components and features of a new system. Learnability, in turn, is an element of usability, which is an assessment of a product's potential to accomplish the goals of the user'[8].

Discoverability may be referred to as:

- the quality of being easy to find a resource via search;
- the need for something to be effectively searched for and located.

The Marketplace supports a few ways to present information to the user. It has several 'trends' about the resources based on the data received by the Service Providers and many features supported by the data themselves. The Resource search, the Resource filtering and sorting, the Resource Presentation Page, the Provider Presentation, the Page Resource comparison and the Favourite resources are some of the main features that the Marketplace supports.

At the same time the features based on the data received by the Service Providers are:

- **Popular resources**: This is a list displayed in the first page of the Marketplace and it depends on a combination of the number of orders and the number of visits;
- **Suggested compatible resources**. The Service Providers provide this information;
- **Related compatible resources**. The Service Providers provide this information;
- **Required compatible resources.** The Service Providers provide this information.

This type of information could be considered as a first version of discoverability and is useful for the visitor of the Marketplace. In order to augment the ease of the discoverability, some new ideas should be taken into consideration.

Notify guest/unauthenticated users:

Notify guest/unauthenticated users that they should log-in and create a profile to receive better recommendations and results, as shown in Figure 7.8.

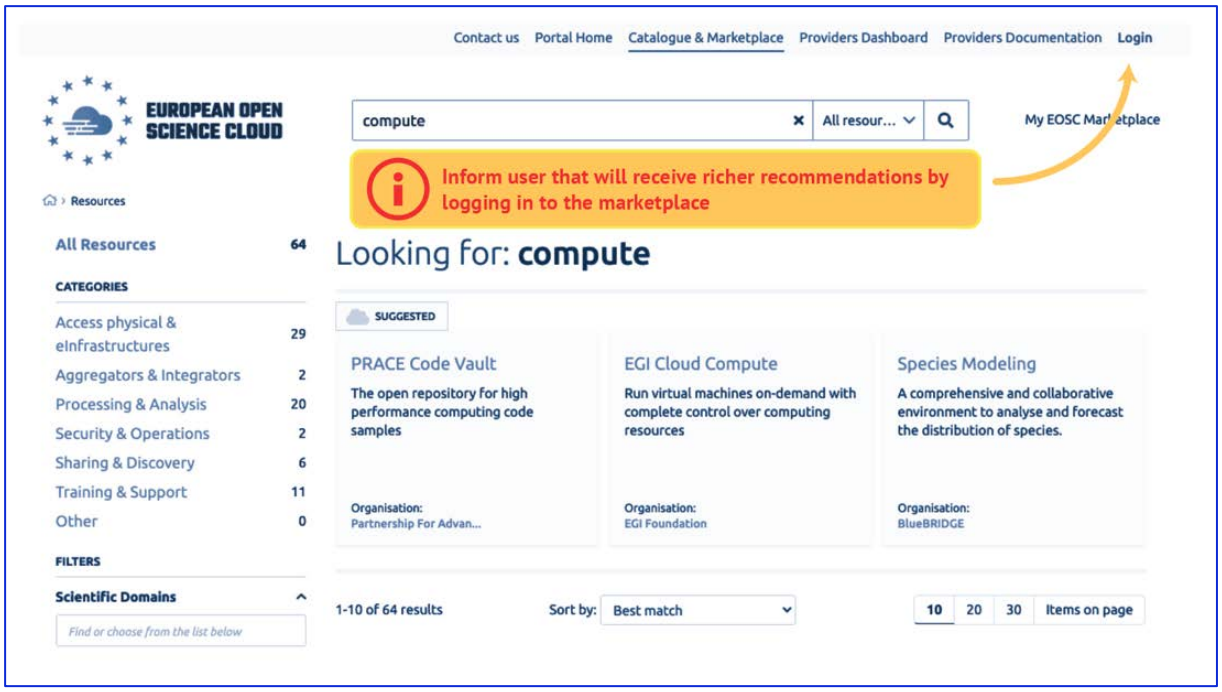

Figure 7.8: Notification for anonymous users regarding personalised recommendations

Explain to the user the criteria that the search algorithm uses to display results

Discovery requires a means of consistently communicating information about resources (meta information) that are made available for discovery. The Marketplace should present to the user the criteria used to display the results in every search. This can make it easier to understand the relevance of the results to the search criteria and/or the user profile and at the same time create a feeling of trust. See Figure 7.9 for an example of how this could be done.

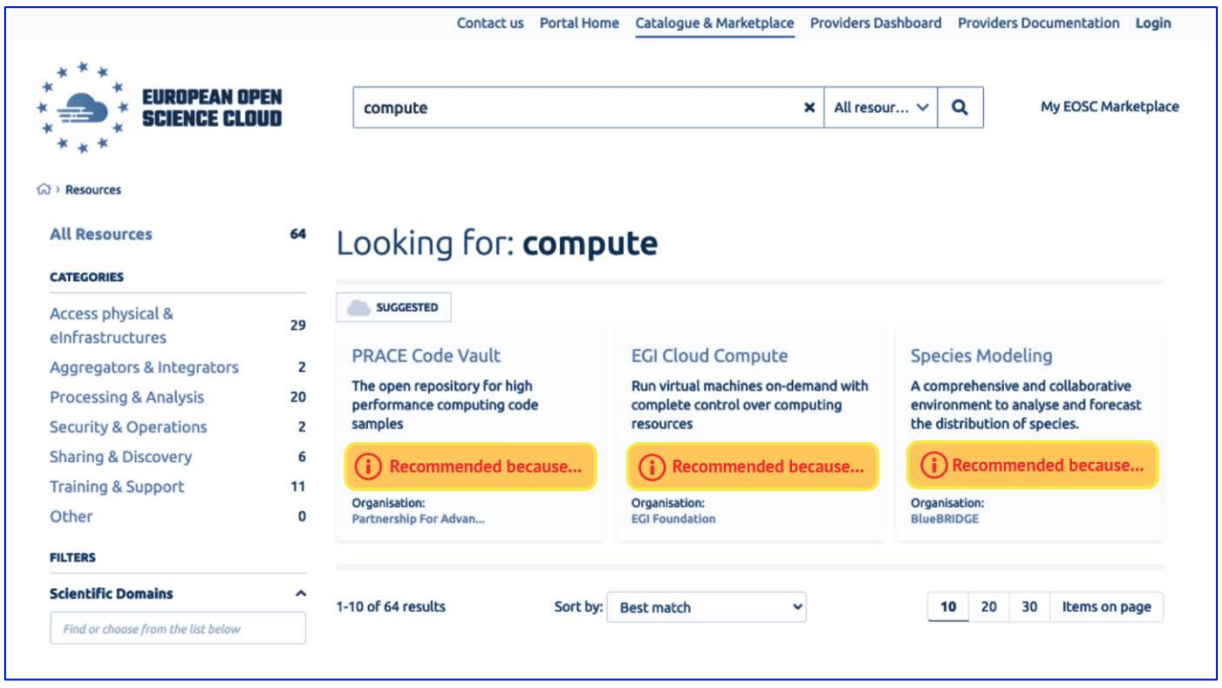

Figure 7.9: Explanation of criteria used to display search result recommendations

Optimise No Results Pages with Resources

When researchers are looking for very specific resources on the Marketplace, they might come across no results or the 'null-results page'. This can be due to the unavailability of relevant resources or due to meta tags that lack essential attributes and descriptions that enable better product discovery. The Marketplace should recommend similar or partial matches to the search criteria, helping the researcher follow a path of similar resources.

Use AI-Generated Tags for Insights on Trends

The depth and granularity of extracted tags pave the way for volumes of data on a catalogue and the way in which users interact with the Marketplace. Better decisions can be made by understanding the split between categories versus how they are performing. Tags can be used by analysing trends, styles and users' behaviour.

Support for User Curated Content

Allow experienced users to display - if they want - their public profiles so other users with similar interests can see a human curated list of service and resource recipes that may help them accomplish similar research goals.

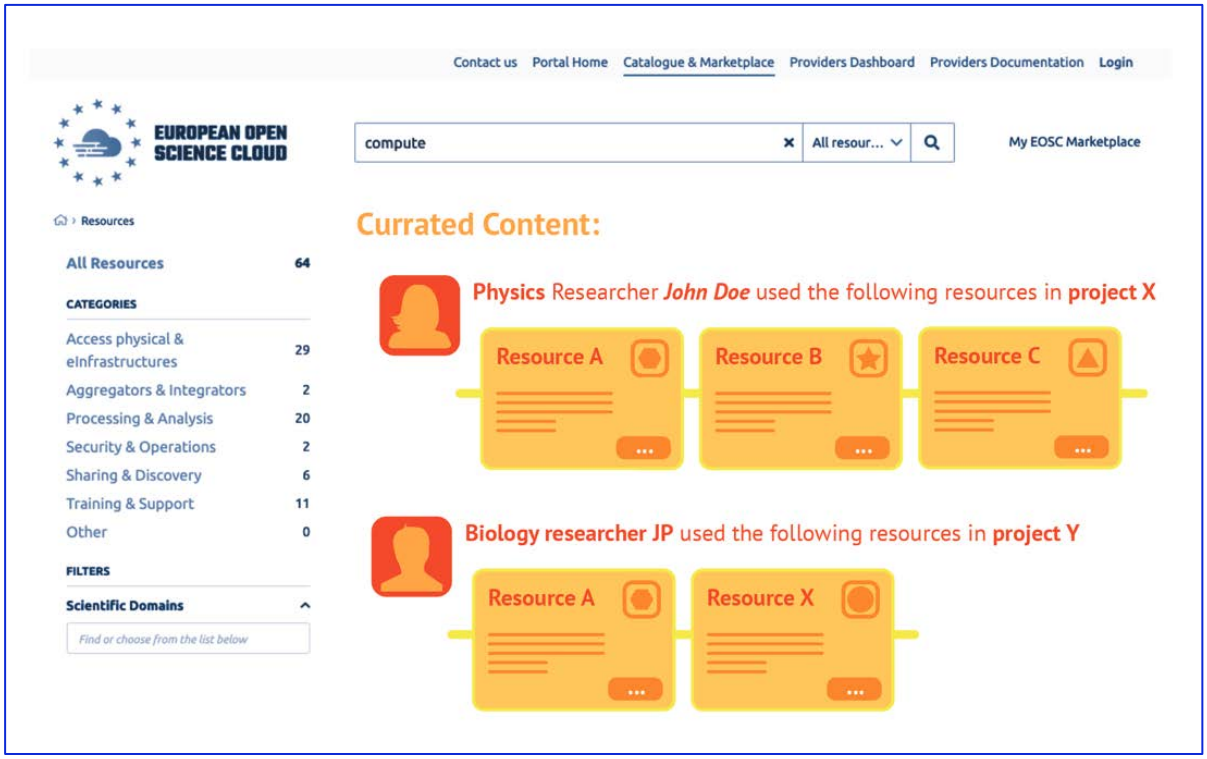

Figure 7.10: User curated content view

Provide in parallel other ways to categorise resources

Apart from the main categorisation provided, it can be useful to have additional mappings of items in categories that reflect different approaches/perspectives such as a data-oriented categorisation of resources or a more technically oriented one etc. Those can be provided as additional ways to explore the catalogue without disrupting the main categorisation scheme.

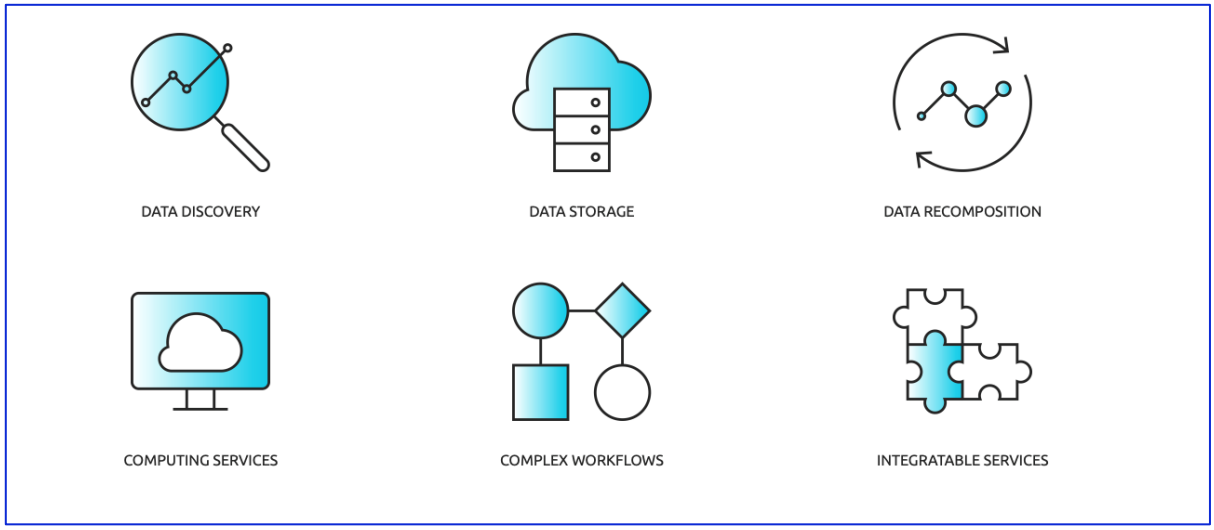

Figure 7.11: Resource categories

Explain technical terms to non-technical users

In a cloud and service-oriented world, some technical (terms such as resource, service, application etc.) become increasingly more mainstream. However, to support more traditional users, such cornerstone terms that appear in the UI should be thoroughly explained both by a dedicated page and an information pop-up (like the way that Wikipedia explains terms in lemmas).

7.2.3 Integration of regional/thematic catalogues/marketplaces

A wide variety of regional and thematic catalogues have been developed in the last decade, and many have associated services which are also intended to be included in the *EOSC Portal*. Due to their number, the EOSC Future WP5 initially concentrates on the data and service catalogues created by the Horizon2020 or Horizon Europe EOSC projects, who have their own internal development process and resources for their thematic catalogues. The most important ones are probably the science cluster project catalogues and other EOSC-related thematic and regional projects.

The EOSC Milestone MS25, entitled 'Researchers can see services and reach thematic and regional portals from the EOC Portal', was achieved because the five thematic and five regional projects are indeed referenced [10]. However, when looking more closely at these ten 'project' portals, one can easily see that the levels of integration with EOSC are very different, reaching from static web pages to truly 'on-boarded' catalogues (as is the case for NI4OS).

This section explains the additional steps required to have the catalogues from the ten regional and thematic EOSC projects fully onboarded. This may require qualifying the term 'onboarding' to make sure the reader understands that onboarding does not mean to simply collect web links.

The concept of onboarding includes service metadata and may also include research data metadata from the aforementioned catalogues, if these catalogues are to be fully federated and become searchable. This process includes several challenges such as:

- **Technological challenges**, related to interfaces, formats, accessibility (e.g., authorisation), and exposure of the services provided. At the current stage, a set of small discussion workshops is being planned between the cluster project portal developers to clarify the technologies used and needed interfaces from the portal side. For other projects and initiatives, this approach is needed later on in the project;
- **Inventory of resources** initially intended for exposure, and their types. This can be combined with the workshops above, but is much more involved with the actual service offering and the policy considerations (below);
- **Policy consideration**, on how to properly document the origin (provenance) of the provided resources, considering the potentially challenging complex origin of e.g., data products from the original data

producer to research infrastructure, cluster portal and finally EOSC Portal. This issue is to be discussed together with cluster coordinators in early 2022.

Overall, the aim is to include key aspects of the science cluster and thematic/regional cluster catalogues in the EOSC Portal, providing a minimum level of discovery (i.e., the user is directed to the resource provided by those catalogues, but in some cases, directly to the underlying resources (e.g., dataset, training material, services)).

The onboarding process, as described during the conference 'Realising the European Open Science Cloud'[3] implies creating an account for the provider, describing the provider profile, checking and approving the provider, describing the resource to be onboarded (in this case the catalogue), submitting the description (which is then audited with respect to rules of participation), and if approved, publishing the catalogue in the EOSC registry. Attention has to be paid that the rules of participation and the onboarding procedure are sufficiently light weight to avoid creating a barrier which otherwise might scare away resource providers.

7.2.3.1 Knowledge Hub - Training Catalogue and Training Platform

Following the initial specifications for the training catalogue, the training platform, and the knowledge hub described in D5.1 and D9.1, discussion have taken place between WP5 and WP9 to align the respective visions for the functions and services described in the deliverables. These discussions will continue until the beginning of 2022 with the aim to have an implementation roadmap for the remainder of the EOSC Future project duration. Although there is broad agreement on how and when core functions for the training catalogue and the training platform shall be implemented, a detailed analysis is still needed to detail the requirements and validate the implementation roadmap with respect to the available resources in WP5.

Another discussion between WP5 and WP9 is planned to brainstorm on a significantly more ambitious version of the Knowledge Hub where users would find a rich collaborative platform allowing them to share knowledge and experience before, during, and after training sessions. Although such an environment may be out of reach during the lifetime of the EOSC Future project a shared vision should lead to a blueprint for a 'next generation' Knowledge Hub as part of a future release of the EOSC Portal.

The Front-Office functions of the training catalogue will be implemented in successive releases allowing for corrections and user feedback to be integrated over the project duration. Extensive feedback must also be collected from the Science Clusters, regional clusters, and other major training content providers to ensure large uptake and inclusiveness during the successive releases of the Knowledge Hub.

Pending further discussion with WP9, the first release of the training catalogue and training platform will be made available in month 15 (July 2022), followed by a minor release in month 17 addressing issues and adding some additional functions. Month 20 will see another major release followed by two minor releases in months 24 and 28 respectively. The envisaged feature rollouts are:

Release 1.0 – Month 15

- Definition and management of a metadata set for learning resources, courses and/or curricula for search and browsing;
- Search/browse training resources;
- Display of landing pages of external training catalogues;
- Registration and login to access metadata records;
- Manual content creation and onboarding;
- PID schema;
- User and platform administration of the Learning Management System (LMS) and the associated administration dashboard;
- User feedback workflow;
- Technical specification of the e-learning authoring tool;
- Technical specification for e-learning object packages.

Release 1.1 – Month 17, will feature in addition:

[3] https://www.eosc-hub.eu/events/realising-european-open-science-cloud/how-can-i-onboard-my-resource-eosc#

- User profile management;
- Help desk.

Release 2.0 – Month 20, will feature in addition:

- Aggregation mechanism;
- Review process workflow;
- Versioning;
- Training/Learning workflow management;
- Feedback mechanisms;
- Support for different languages;
- Security specifications.

Release 2.1 – Month 24

- Extended search capabilities.

Release 2.2 – Month 28

- Security implementation;
- Trainer directory.

7.2.4 Recommender System and UI

The Recommender System (RS) is a novel component of the *EOSC Portal*. It will provide the EOSC users with recommendations concerning the items (resources, services, training, projects and publications) that could be of their interest, based on a multi-focal perspective of the users. RS is meant to improve user experience (UX) by guiding the users and supporting them by suggesting the items that would attract their attention. RS should also improve the overall user satisfaction with *EOSC Portal*, which should prompt the users to use the system in the future. For the Provider end, the recommendations could provide more comprehensive insights into the needs of users and help customising the user experience even more.

The engine of the EOSC RS will utilise **records** of **users** (**researchers)** and records of **usage of resources (**such as historical data of previous orders or searches)**.** Records of a researcher will include various attributes related to an EOSC researcher (such as personal data, research interests, similarities with other users, affiliation etc.). Currently, elements of Researcher's data are spread across EOSC applications and services such as EOSC Portal (basic personal information, organisation, community profile, related interests) or OpenAIRE graph (research background including affiliation and interests). EOSC RS will combine this data into a set of coherent records that aim to stand as a base for profiling the users and assisting them in constructing virtual environments supporting experiments and research.

7.2.4.1 Functional Specification

Operational goals for the Recommender System

Recommender System will serve several purposes. Among others, these are the operational goals it should address:

- **Relevance:** Items recommended to the user should be relevant for them. Users are more likely to consume items they find interesting. However, although relevance is the primary operational goal of a recommender system, it is insufficient when considered in isolation;
- **Diversity**: The operational goal of a Recommender System is to select and order a set of k items such that the utility of the set (measured by relevance) is maximised. Recommender systems do this by providing ranking based on sorting quality scores;
- **Novelty**: Recommender systems can be particularly helpful if the recommended item is something that the user has not seen in the past. Repeated recommendation of popular items can also produce unwanted feedback loop and lead to reduction in sales diversity. As a result, most of the sales would include only a small set of very popular items;
- **Serendipity**: Serendipity is a related notion. As opposed to the obvious recommendations, the RS can include a modest element of lucky discovery. Serendipity is different from novelty in that the

recommendations can be surprising to the user, rather than simply something they did not know about before.

Types of users

From the Recommender System point of view, there are three types of users:

- An **authenticated EOSC user**, for whom a complete record of publications, interests, involvement and interactions is available;
- A **user authenticated using the federated login**, for whom only partial information (mainly concerning the user's interest and affiliation) can be extracted and gathered;
- An **anonymous user**, for whom there is no record of research-relevant data is available, and only their behaviour and interaction with the *EOSC Portal* could be tracked. It must be noted that these types of users are independent from the typology defined in section, as it focuses on the amount of information about the user that is available to the RS.

Recommendations provided by the RS are directed primarily towards Researchers, while Facilitators and Providers are covered only partially. In particular, recommendations for Providers indicate the types of offerings that are most likely to be used by other Users.

Types of recommendations

Recommendations can be served in three ways, depending on the time of their deliver:

- **Online**, generated by Recommender System in real time and immediately available to the user, delivered as a response from the *EOSC Portal*;
- **Nearline**, which require a more time-demanding analysis, including collecting additional data or performing complex computations, and are delivered in the *EOSC Portal* as a notification;
- **Offline**, which are the most complex, consume much longer time to produce and are delivered by other means, e.g., via email or asynchronous notifications.

The online recommendations (which includes the immediate and delayed ones) will be provided directly in the *EOSC Portal*, in response to the user's request; the offline recommendations are more accurate than online ones, but due to the time needed to generate them, they need to be sent to the user through a different channel than the portal, mainly via email.

7.2.4.2 Properties of recommendations

In addition to above, the recommendations created for the user need to have the following properties:

- **Be explainable:** the user should be able to understand how a given recommendation was created and which data source has been used for it;
- **Be evaluable:** the user should be able to provide feedback on the quality of recommendations, both on a per-list and per-item basis, positive and negative;
- **Be customisable:** the user should be able to switch on/off recommendations, both in general and for specific types of recommendations.

7.2.4.3 Sources of data for recommendations

There are diverse sources of data that could be used for generating recommendations for the user:

- History of items browsed, observed or used by the user in the past;
- User interests, either explicitly declared by them or extracted from the data associated with the user.
- Items that have been of an interest by former or current collaborators of the user;
- Items that are popular in the community, both general ones or limited to the researchers who are like the user or work in a similar domain;
- Factual data provided explicitly by the user, either directly or in an interaction with the Recommender System;
- The Recommender System manages and processes sensitive data about users, so they should be able to manage and explicitly restrict specific sources of data, to ensure compliance with GDPR.

7.2.4.4 Functional architecture of Recommender System

During functional decomposition of the Recommender System, a number of components have been identified. They have been depicted in Deliverable D5.1a [4].

The Recommender System interacts with the Marketplace using several endpoints in the RS Marketplace API and through the Data bus. Various subcomponents are responsible for providing and filtering recommendations online, nearline and offline. Generated recommendations are stored in the dedicated internal database (Database Recommendations). Due to the modular architecture, the Recommender System is scalable and can be extended to provide recommendations using different data sources.

7.2.5 User Panel

Analysis methodology used

The User Panel, as introduced in D5.1a, will be one of the newly developed functional components in the EOSC Front-Office. For that reason, the analysis conducted needed to be comprehensive and included a vast number of possibilities on what it might become.

The analysis started with a list of clear goals that should be achieved as it would be possible to lose focus due to the breadth of the topic:

- State the definition of the EOSC Front-Office User Panel;
- Define the user stories that the user panel should implement (in the end) and prepare a roadmap for their implementation;
- Functional and technical gap analysis for the proposed solution;
- Define the relations and dependencies with the recommender system;
- Define the relations and dependencies with the other Front-Office components;
- Define the set of parameters that the users should be able to define/manage in their connected profile;
- Explore possible integrations (ORCID etc);
- Proposition of the UI for the user panel.

For the first approach to define what the User Panel might become, the analysis team focused on depicting the comparable solutions available in the market and then contrast them with the user stories expected to be included in the User Panel. It considered comparable solutions included commercial and research services such as:

- Spotify;
- Netflix;
- Elsevier Pure;
- Scopus.

The list of user stories potentially adequate for the User Panel is long, so it needed to be narrowed down to focus on the main goals that the Front-Office should fulfil. In relation to that, three main groups of user stories have been recognised.

- User stories that are recommendations and content related, such as:
  - (User settings) As a Researcher, I want to define **my scientific profile and interests** in order to be offered services and scientific products that might support my research activities.
  - (User settings) As a Researcher, I want to **define my interests** so I am exposed to relevant scientific content that might apply to my research or interests.
  - (Availability) As a Researcher, I want to **see news and articles** that are related to my interests and activities (as in scientific articles? (User settings) As a Researcher, I want to define my **technical needs** in order to be offered resources that might support my research activities.
- User stories that are EOSC activities of the user related:

- (Availability) As a Consumer, I want to have a dedicated and intuitive space to **reach the services and scientific products of my interest**.
- (Availability) As a Consumer, I want to have a dedicated and intuitive space to **reach the services I'm using** (workflows I've defined).
- (Availability) As a Consumer, I want to have a dedicated and intuitive space to **reach the Marketplace projects** I have defined.

- User stories that include the social aspect and users' collaboration:

- (Collaboration) As a Consumer, I want to **be able to form user groups** in the Portal.
- (Collaboration) As a Consumer, I want to **relate a user group to a Marketplace research project.**
- (Collaboration) As a Consumer, I want to **be able to join a discussion of my interest** (forum functionality).

The user stories derived from the feedback gathered during the consultations conducted prior to the EOSC Future project, such as EOSC User Persona and User Journey activity hosted in EOSC Enhance project, and from the personal experience of the analysis team members.

The next step is to verify the list of the user stories with respective representatives of the EOSC Front-Office user groups, using the UX research and verification methods presented in section 6.2

The analysis conducted delivered the first understanding of the scope for the User Panel along with a User Panel prototype supporting this vision, its functional specification and foreseen connections and integrations to other EOSC Platform components.

User Panel definition

The User Panel is a single place where the user has access to all necessary information in the context of his history, engagements, behaviours and potential expectations towards EOSC Front-Office. It will be responsible for managing the interaction with the user and providing them with the resources offered by the *EOSC Portal*. In particular, it includes elements relevant or possibly relevant to the user activity in the Front-Office. The activities in EOSC can be scoped to:

- supporting the research-related activities of the user;
- supporting the EOSC-related activities (projects, task forces, communities etc.) of the user;
- managing User Profile and user settings.

In the User Panel users will find recommendations for services, publications and articles, generated by the Recommender System based on a variety of criteria. Functionalities such as informing about the resources owned (used) or viewed by the user and related changes are an equally important part.

The history of the user behaviours will be available (e.g. what questions the user asked the system, which items they viewed and how they interacted with the system) to ensure the continuity of the user's work in the system.

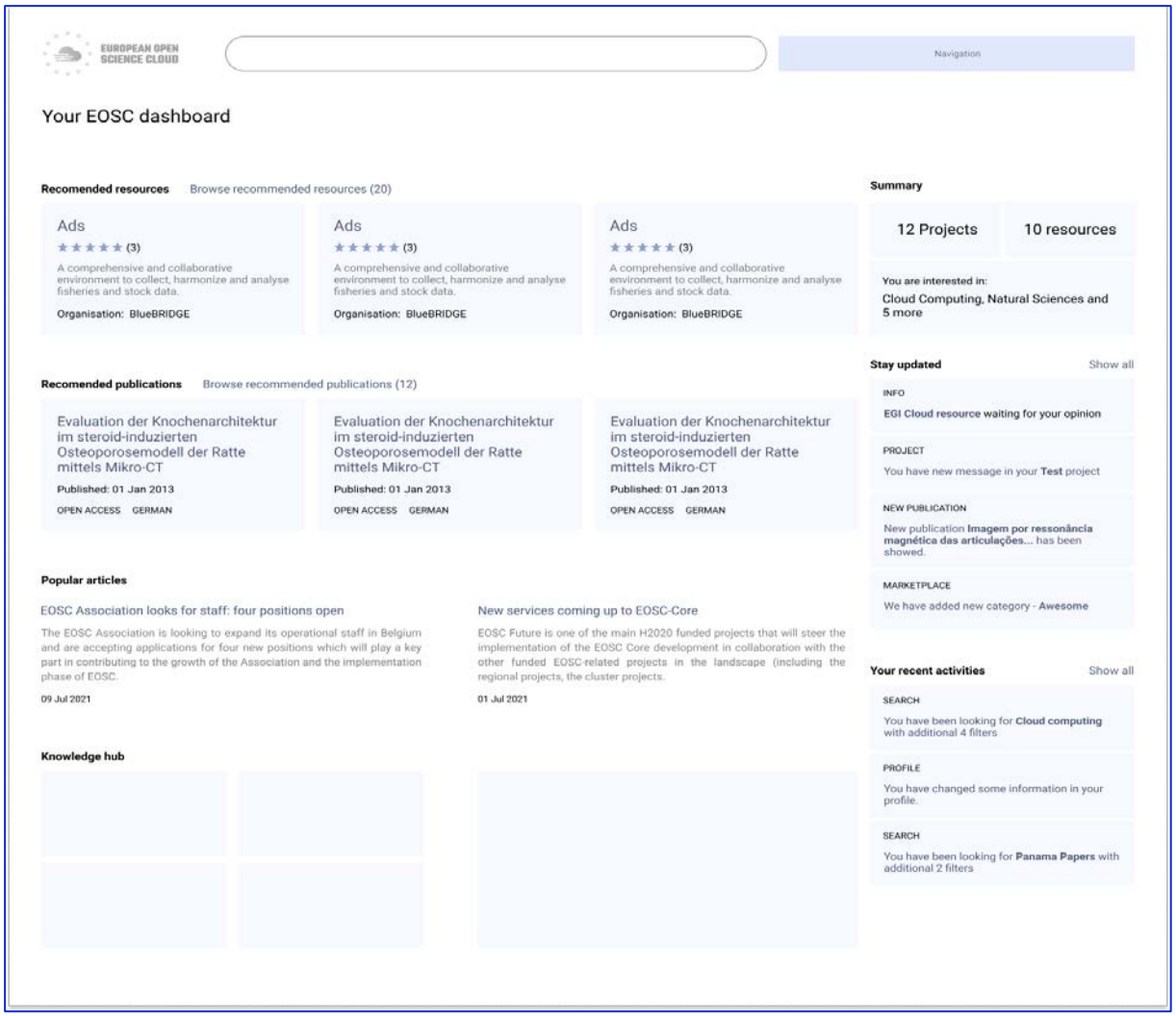

Figure 7.12: User Panel Prototype

Functional Specification

The User Panel is directed primarily to Consumers. Within them, Researchers play the key role as the users who want to access the items offered by *EOSC Portal* to support, foster and facilitate their research activities.

The User Panel provides the user with all information that could support them and conducting their research supported by the EOSC. There are five major functional areas covered by the Panel:

- **User Profile**, which covers the functions responsible for collecting, entering and managing data about the user stored in the EOSC. It includes the data about the user, its identifiers (e.g., ORCID), contact data, affiliations, involvements, history, publications, projects etc. The profile is currently identified with ORCID, but other supporting identifiers can be used as well;
- **User Settings**, which allow for customising the Panel to the user's needs;
- **Access to EOSC-managed items**, which helps the user to discover, learn, acquire, manage and compose items (i.e., resources, services, trainings etc) offered by *EOSC Portal*;
- **Feedback**, which allows the users to rate items (both positively and negatively); the ratings could be used by other users, resource providers or the recommendation system in *EOSC Portal*;
- **Collaboration** with other EOSC users, projects or research groups.

The following functions have been found most relevant for the users:

- accessing EOSC items, news or articles that could be relevant to them, based on their research domain or interests;

- defining technical needs, related with deploying, using and combining EOSC items to create research environments;
- discovering and creating new groups of interest, to foster collaboration with other researchers,
- providing feedback and rating the EOSC items that have been used by the user;
- creating a dedicated personal space to collect and visualise the relevant information about the research projects the user is involved in, to facilitate accessing the resources relate to them.

Proper implementation of these functional needs requires also addressing non-functional constraints or requirements.

- The Panel manages personal data, which makes it a sensitive module with respect to accessing data, securing them from unauthorised access and managing consents the user needs to grant;
- The Panel needs to be customisable and intuitive, to help users using it and preventing them from making mistakes.

Related functional components

As the User Panel is planned to be a central component of the Front-Office from the user perspective, it connects to, and will require integration with, several other Front-Office components:

- **Recommender System**
  - an AI-based service providing **lists** of personalised content (publications, software, services, etc.) for the end user;
  - direct interconnection between the RS and the User Panel;
  - service recommendations will be available in the EOSC Marketplace Recommender service – this forms the basis for the evolution of the RS in EOSC Future.
- ***EOSC Portal* Front-Office discovery functionalities**
  - the search bar:
    - currently there are separate search bars for the *EOSC Portal* website (articles), EOSC Marketplace (services/resources/providers);
    - other resource types to be included in the Front-Office (initial step - EOSC Enhance Data Sources, next step - EOSC Future OpenAIRE Research Graph);
    - discovery functions will be aligned during the course of the EOSC Future project;
    - historical search phrases:
      - possible source of information about users' needs;
      - displaying a user's search history may be a welcome feature.
- **EOSC Marketplace**
  - User Profile:
    - the main *EOSC Portal* functionalities configuration space for the end-user;
    - a place where users' interests are defined:
      - scientific disciplines;
      - resource categories;
      - other factors;
    - a place to sign up for e-mail notifications:
      - e.g. get alerts when new content of interest is added to the *EOSC Portal*;
    - Creation of User accounts based on the EOSC AAI service:
      - information of the IdP used by the end user may be a source of information for content personalisation;

- ORCID:
  - used as a basis for researcher / author recognition in the OpenAIRE Research Graph;
  - possible integration with the profile information (self-declared by the end-user).

- Favourite resources;
  - a source of information about the user's interests.
- User projects:
  - a place to define end-user Use Cases;
  - a place to manage end-user resource orders;
  - a place to collect services for a specific use case;
  - a place to rate services;
  - messages to/from Operations Team / resource Providers

- **EOSC Resource Catalogue** (OpenAIRE Research Graph)
  - source of many types of linked resources (publications, data sources, software, etc.).
- **Knowledge Hub**
  - the source of articles that may be of interest to the end-user.
- **Training Catalogue**
  - the source of training materials that may be of interest to the end-user.
- ***EOSC Portal* content component (Drupal)**
  - the source of news about the EOSC ecosystem (success stories, Use Cases etc.);
  - the place where news about the evolution of the *EOSC Portal* is published.
- ***EOSC Portal* Provider Dashboard**
  - provides information about services/resources owned by the various Providers;
  - recognises EOSC users as Providers - the source of this information is the EOSC Service Registry;
  - provides the possibility to leverage knowledge about the user's type via the User Panel;
    - content types specialised for end-users that are Providers (e.g. news about comparable services or new Knowledge Hub content relevant to their domain of expertise);
    - the User Panel may provide links to specialised information in the Provider Dashboard.
- **EOSC DIH (Digital Innovation Hub)**
  - an entry point / shared collaboration space for commercial Providers;
  - content may be relevant to end users.
- **EOSC Helpdesk**
  - communication with technical support and/or research domain experts.
- **OpenAIRE Explore**
  - a portal with end-user functionalities:
    - research discovery;
    - research annotation;
    - a potential source of information for *EOSC Portal*.

8 Conclusions

This deliverable describes a part of the wider EOSC co-creation engagement programme outlined in the EOSC Future project general objectives 3 ('Scale up Capabilities and Deliver an EOSC Execution Framework') and 7 ('Reach Out and Engage with EOSC Communities and End Users'). The user engagement programme is implemented in collaboration with similar activities in Work Package 4, as well as jointly with Work Packages 6 and 9. The user engagement, requirement gathering and analysis is a contiguous process - it draws upon the results of the EOSC hub and EOSC Enhance projects, evaluates their outputs and introduces modifications to the processes they developed in order to advance the existing knowledge of users' requirements and therefore the value proposition of EOSC.

This deliverable provides the overview of the evolution of the UX design process, based on the updated requirement engineering derived from the evaluation of the EOSC Enhance requirement process, in compliance with the FitSM guidelines [6]. The process will facilitate transition from the requirements to the implementation phase, whilst ensuring sufficient communication with the relevant stakeholders. This in turn should improve the transparency and overall trust in the EOSC ecosystem.

User Personas are the key concept adopted throughout the analysis of requirements and subsequent specification and implementation of the actual components/functionalities of the *EOSC Portal*. This deliverable describes the concept and classification used in the requirement analysis processes in Work Package 5. Examples of modelled User Personas, their requirements, user journeys and phases are presented to illustrate the actual processes of evaluation and design for the enhanced user experience.

An important part of this deliverable outlines previous user engagement and initial requirement analysis activities. Substantial work has been done in selecting the relevant representative group of users who will be engaged throughout the project to further interact in the process of requirement analysis, implementation, and validation. Results will be used for further work to derive the pain-points relevant to each user group by correlating different results as well as by further engaging with the identified specific user groups.

The descriptions of the existing user engagement results are complemented by the analysis of the user requirements for specific components of the portal: Front-Office, discovery capabilities, integration with regional/thematic catalogues, and EOSC Recommender System, including derived functional specifications.

The results of the user engagement and requirement analysis in this deliverable show the importance of co-creation of *EOSC Portal* to evolve the value proposition and meet the ambitious goals set out by the project. This deliverable is an important step to set out the requirement analysis framework in two directions: externally engaging with the users to attain deeper knowledge and refine initial set of requirements, and internally, to establish fully transparent and manageable process of requirement analysis and subsequent steps towards implementation.

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9 Appendix A: UX Analysis template

The template described below is a structure for a working document that will acts as the log during the implementation of the UX process activities. It is intended to capture blocks of well structure information and indicate the required next steps, rather than describing the various components of the UX process.

Analysis 101

Topic Definition - Initial, short description of the recognised issue to be analysed. Initially, might be a list the user stories or descriptions copied from the underpinned functional requirements. It includes first questions and remarks to be taken into further consideration. Ultimately, should include a 'bigger picture' emerging from the gathered requirements.

Main Goals - What are the expected outputs of the analysis.

Exploratory analysis

Knowledge structuring

1. *Relevant functional requirements* - A list of the functional requirements relevant to the theme analysed (a link to a dedicated google doc/a list of JIRA tickets).
2. *Relevant non-functional requirements* - A list of the non-functional requirements relevant to the theme analysed (a link to a dedicated google doc/a list of JIRA tickets).
3. *Recognised EOSC Front-Office user types connected* - Taken from the underpinned requirements. If the scope of the theme is broader than the underpinned requirements, supplemented with missing user types.
4. *Recognised functional components connected* - Taken from the underpinned requirements. If the scope of the theme is broader than the underpinned requirements, supplemented with missing functional components.
5. *Recognised technical components connected* - Taken from the underpinned requirements. If the scope of the theme is broader than the underpinned requirements, it must be supplemented with missing non-functional components.
6. *Recognised stakeholders for the brainstorming* - Sometimes it's evident who should be involved for the analysis or the consultations. The consultations should always include user types identified above. Additionally, there are EOSC stakeholders worth consulting earlier (during the brainstorming phase) due to their expertise and experience in a given subject. The same experts can be also consulted later in the consultations. All the potential stakeholders (Internal and external to the project) that can be essential for the analysis must be listed.
7. *Relevant documentation* - Links to the documents relevant to the analysis
8. *Comparable solutions* - Adequate functionalities / solutions that can be found among other EOSC/commercial tools

Defining the problem and solution hypotheses

1. *Remarks (brainstorming)* – Brainstorming conducted by the project partners (T5.1 and external if relevant).
2. *Problem statement* - Comparing to the Topic definition, it's a broader description of the theme under analysis, based on the analysis conducted so far.
3. *Important findings* - Important points from the analysis that cannot be omitted in the further analysis and design. The description and the comment fields are not required when defining the Finding.
4. *First ideas for the solutions (solution hypotheses)* - At this stage of the analysis there might be an intuition about the possible solutions for the posed problem. These must be listed as relevant guidelines for the design phase.

5. *Identified steps for the Business analysis* - Initial proposition of specific actions to be taken during the business analysis phase. Resulting from the outcomes of the exploratory analysis

User group research

Questions to be asked during the consultations (to the relevant stakeholders) - It is expected that consultations with the stakeholders will be conducted for every theme recognised. The consultations should take place several times in the REP. This section should contain sets of questions identified to be asked for each of the consultation round. The sets should be updated in case of new findings. It is assumed, that not all of the sets can be defined during the Exploratory phase but later in the process.

a. Questions after the Exploratory Phase;
b. Questions for the first design presentation;
c. Questions for the (first) prototype presentation;
d. Questions for the beta release;
e. Questions for the feedback after the productional deployment.

Business analysis

1. *Data analysis* – The essence of the statistical research. Aggregated data and conclusions.
2. *Identified business value* – Intended key value proposition for the identified target groups that will benefit from the solution.
3. *Identified objectives* – The key high-level assumptions made when identifying business value.
4. *Identified steps for the design phase* - Initial proposition of specific actions to be taken during the design phase. Resulting from the outcomes of the exploratory analysis and business analysis and a feedback loop from the design phase.

Design

1. *Related features* – Features that are available and related to the concept currently being designed.
2. *Solution proposal* – Definition of the assumptions for the design concept. Technical aspects also taken into consideration and documented.
3. *Feedback for solution proposal* – Feedback gathered from the UX research activities (e.g. focus group, survey).
4. *Minimal viable product definition* – Selected set of functionalities to be delivered in first iterations of the product development relevant to the current topic.
5. *Graphical design proposals* – Sketches, Prototypes, Wireframes or User Interface Mock-ups – the visualisation method based on the problem characteristics.
6. *Feedback for graphical design proposals* – Feedback gathered from the research team, project partners or results of the conducted UX research activities based on the graphical design proposals (e.g. focus group, survey).
7. *Other related ideas* – Ideas for other product development activities not related to the elaborated topic but worth documenting for future revision.