R-Map
MAPPING THE EFFECTS OF REMOTE WORKING ARRANGEMENTS IN URBAN AND RURAL AREAS

D3.1

The R-Map platform (v2)

Arx.Net

31/05/2025

Funded by the European Union

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EXECUTIVE SUMMARY

The R-Map project, funded by the European Union's Horizon Europe program, aims to analyze the impacts of remote working arrangements (RWAs) on urban and rural regions in Europe. With remote work becoming a significant element of the labor market, the project seeks to provide policymakers, businesses, and communities with data-driven insights to understand and address the socio-economic, environmental, and spatial effects of RWAs.

To achieve this, the R-Map project will develop an Integrated Impact Assessment Framework, powered by the R-Map platform. The platform will serve as a decision-support tool, offering two core services:

- The R-Map Platform Prediction Model, which will analyze and forecast the potential effects of remote work over time under different scenarios and policy interventions.
- The Dataset Observatory, which will aggregate and visualize data from a large-scale survey of 20,000 individuals and various other sources, providing regional and national insights into remote work trends.

Work Package 3 (WP3) focuses on the design, development, and deployment of the R-Map platform, ensuring it is scalable, modular, and user-friendly. WP3 encompasses the architectural design, integration of diverse datasets, and implementation of visualization and forecasting tools that cater to the needs of policymakers, researchers, and other stakeholders.

This deliverable, D3.1: The R-Map Platform v1, outlines the platform's system architecture, detailing its core components, technical specifications, and data processing workflows. The document provides a comprehensive overview of the methodologies used in developing the platform, including the selection of technologies and visualization strategies based on an extensive review of existing European platforms.

Furthermore, the deliverable highlights key stakeholder engagement activities, such as workshops with project partners and advisory board members, which provided valuable input into the platform's design. Feedback from these sessions has informed the development of interactive dashboards, geospatial mapping features, and analytical tools to support evidence-based policy formulation.

Moving forward, the insights derived from the R-Map platform will contribute to the formulation of policy recommendations that facilitate balanced and sustainable remote work environments across both urban and rural areas in Europe.

1. INTRODUCTION

1.1 Background and Project Context

The R-Map project, funded under the Horizon Europe research and innovation program, aims to analyze the impacts of remote working arrangements (RWAs) on urban and rural regions across Europe. With remote work becoming a significant and permanent feature of the labor market, its effects on spatial, social, economic, and environmental dimensions are complex and multifaceted. Understanding these impacts is crucial for policymakers, businesses, and communities to make informed decisions that can bridge urban-rural disparities and foster sustainable regional development.

The project recognizes that RWAs have the potential to influence where people live and work, alter commuting patterns, reshape local economies, and impact the environment. However, the extent and nature of these changes vary widely across different regions, depending on factors such as digital infrastructure, socioeconomic conditions, and local policies. To address these challenges, R-Map will develop an Integrated Impact Assessment Framework, supported by the R-Map platform, which will provide stakeholders with data-driven insights to monitor and assess the consequences of remote work.

The R-Map platform is designed to serve as a decision-support tool for policymakers, regional planners, and researchers, offering two core services:

- The R-Map Platform Prediction Model, which will forecast the potential effects of RWAs over time, considering different scenarios and policy interventions.
- The Dataset Observatory, which will collect, process, and visualize key datasets related to social, economic, and environmental aspects of remote work.

By leveraging data from various sources, including a large-scale survey of 20,000 individuals and other relevant datasets, the platform will enable users to explore trends and predict the future of remote work under different conditions.

The R-Map Platform prediction model, the what-if scenario visualization and interactive visuals of the R-Map platform serve as dynamic representations of the findings from WP1 and WP2, translating complex data into accessible and actionable formats. Furthermore, these tools are essential for WP4, where they may be used as prompts to facilitate the co-creation of exploratory (descriptive) scenarios.

The development of the R-Map platform is being conducted within Work Package 3 (WP3), which focuses on designing the system architecture, integrating datasets, and implementing visualization and forecasting tools. WP3 plays a critical role in ensuring that the platform is scalable, user-friendly, and aligned with the needs of diverse stakeholders. The deliverable D3.1, which this document presents, provides a comprehensive description of the platform’s architecture, including its technical components, data processing workflows, visualization strategy, and user interaction features.

The insights derived from the R-Map platform will ultimately contribute to the formulation of evidence-based policy recommendations, ensuring that remote work can be leveraged to create balanced development opportunities across both urban and rural areas in Europe.

1.2 Objectives and Scope of Work Package 3 and Task 3.1

The objective of Work Package 3 (WP3) is to design, develop, and implement the R-Map platform to assess the current and future impacts of remote working arrangements (RWAs) on urban and rural areas across Europe. The platform will serve as a decision-support tool that integrates diverse datasets, analytical models, and visualization tools to provide actionable insights for policymakers, researchers, and other stakeholders. WP3 aims to create a scalable and modular system that can assess the social, economic, environmental, and spatial effects of remote work. The platform will provide two main services: (i) an interactive visualization of the R-Map model values for each EU region, including their corresponding typologies. This feature will enable users to explore how changes in the R-Map model factors influence the spatial, social, and economic dimensions of the urban-rural divide within a region and its typology; and (ii) a user-friendly, one-stop visualization observatory focused on remote working arrangements and their spatial, social, and economic effects. This observatory will present data through dashboards, maps, graphs, and charts, utilizing datasets collected in Task 3.2 and the EU-level survey conducted in Task 1.5, and visualizing factors and indicators from Task 2.1, providing valuable insights for policymakers. WP3 will also focus on usability, ensuring the platform meets the needs of diverse users by offering interactive dashboards, scenario-building tools, and customizable reporting features. A critical aspect of WP3 is to ensure the platform's compliance with data protection regulations, such as GDPR, and to develop strategies for long-term scalability and interoperability.

Task 3.1 focuses on designing the technical architecture of the R-Map platform by defining its core components, system functionalities, and technical requirements. This includes outlining how data will be collected, processed, and visualized to provide meaningful insights. The task will establish the overall system design, detailing key architectural layers such as data ingestion, analytical processing, visualization, and user interaction. It will also specify functional requirements, such as the ability to analyze regional disparities and forecast remote work trends, and non-functional requirements, including performance, security, and scalability considerations. Additionally, Task 3.1 will define the platform's deployment strategy, evaluating cloud-based and on-premises options to ensure efficient performance and accessibility. The visualization approach will focus on interactive tools such as geospatial maps, comparative charts, and scenario-based simulations to support evidence-based decision-making. Task 3.1 will ensure that the platform architecture aligns with findings from other work packages, particularly WP1 and WP2, and will provide a solid foundation for subsequent development and testing phases.

1.3 Project Partners and Contributors to the Report

The co-design of the R-Map platform architecture is a collaborative effort led by Arx.Net, bringing together the collective expertise of all technical partners within the project consortium and members of the R-Map Advisory Board. This inclusive approach ensures that the platform's design aligns with the diverse technical requirements and strategic objectives of the project. The co-design process was initiated through a technical workshop, where technical experts from partner organizations actively contributed their insights on system architecture and visualization requirements. This workshop served as a foundation for refining the platform's design and stakeholder needs. Following the initial co-design session, a validation workshop was conducted with members of the Advisory Board to gather critical feedback and assess the proposed architectural solutions against real-world use cases and policy-making requirements. These collaborative sessions accompanied by Feedback forms on the features of the platform provided valuable input that shaped the platform's development roadmap, ensuring its robustness, scalability, and usability. Further details regarding the workshops, including a list of participants and key discussion points, can be found in Sections 2.3.2 and 2.3.3, with additional participant details provided in Annex Tables 1 and 2.

1.4 Outline of the Report

This report is organized into eight sections, beginning with an Introduction (Section 1) that describes the R-Map project's background, the objectives of Work Package 3 and Task 3.1, an overview of project partners, and a summary of the report structure. Section 2 (Methodology) outlines the system's architecture approach—such as layered and service-oriented models—and explains the design process, which included desk research and stakeholder workshops. Section 3 (R-Map Platform Architecture) introduces the platform's core components, system architecture, functional requirements, and data flow processes, while also addressing scalability and deployment considerations.

Moving on to Section 4 (Technical Specifications), the report details front-end and back-end development choices, focusing on technology selection and their integration within the platform. Section 5 (Data Sources and Integration) highlights key data inputs, data cleaning and preprocessing approaches, and data management practices to ensure efficiency and compliance. Section 6 (Visualization Strategy) then examines dashboard design principles, visualization types, and user interaction features that enhance the platform's usability. Section 7, added in v2 of the deliverable focuses on Datasets to be visualized and their respective format along with analysis of their visualization potential.

In Section 8 (Reflections), the platform's strengths, challenges, and areas for improvement are discussed, along with suggestions for future enhancements to facilitate continued development. Finally, Section 9 (Conclusions and Next Steps) outlines the project's future direction and is supplemented by Annexes, which provide additional supporting materials.

1.5 Key Terminology

Term	Description
NUTS Levels	A geographic classification system for analyzing regional data (e.g., NUTS-2 and NUTS-3)
RWAs	Remote Working Arrangements.
Integrated Impact Assessment Framework	A tool to assess the effects of remote work on various factors.
Time Range Slider	A user interface component to filter data by specific time periods.
API (Application Programming Interface)	A set of protocols for enabling interaction between software components.

Dashboard	An interactive interface that visually represents key metrics and insights for users.
Data Pipeline	The system or process through which raw data is collected, processed, and transformed for analysis.
GDPR	General Data Protection Regulation, outlining compliance standards for handling personal data.
JSON schema	A JSON Schema functions as an agreed-upon blueprint for a data file. It specifies every field that must appear, the type of information each field must contain (for example, text, number, or date), and which fields are mandatory. By establishing these rules in advance, the schema ensures that any system exchanging the data can validate it immediately, preventing omissions or formatting errors from propagating downstream
Endpoint	The specific web address (URL) where a system makes data available or accepts requests
RESTful	Follows the widely adopted "REST" conventions for web communication, meaning standard HTTP verbs (GET, POST, etc.) are used in predictable ways
File ingestor	Software that reads an external file and loads its contents into a database or other internal system
Raster tile	A small square image (like a JPEG or PNG) that represents part of a map when your screen is zoomed to a particular level
Vector tile	A compact data packet containing drawing instructions (points, lines, polygons) for that same small map square; it renders crisply at any zoom level
OGC (Open Geospatial Consortium)	An international standards body that defines how geospatial data should be formatted and served so different systems remain interoperable
WMS (Web Map Service)	An OGC standard for delivering map images (rasters) on demand
WMTS (Web Map Tile Service)	An OGC standard for delivering pre-generated map tiles (raster or vector) in a grid, improving speed and scalability

2. METHODOLOGY

2.1 R-Map System Architecture Design Approach

2.1.1 Layered Architecture Model

2.1.1.1 Overview

The R-Map platform's architecture is designed to organize its functionality into separate layers. This approach ensures that the system is easy to understand, maintain, and scale, even for those without a technical background. Each layer focuses on a specific part of the platform's responsibilities, enabling a smooth flow of data and clear communication between components.

2.1.1.2 Layers of the Architecture

The platform's architecture is divided into four main layers, each addressing specific tasks. Figure 1 below illustrates these four layers, Frontend, Backend, Data Processing and Security.

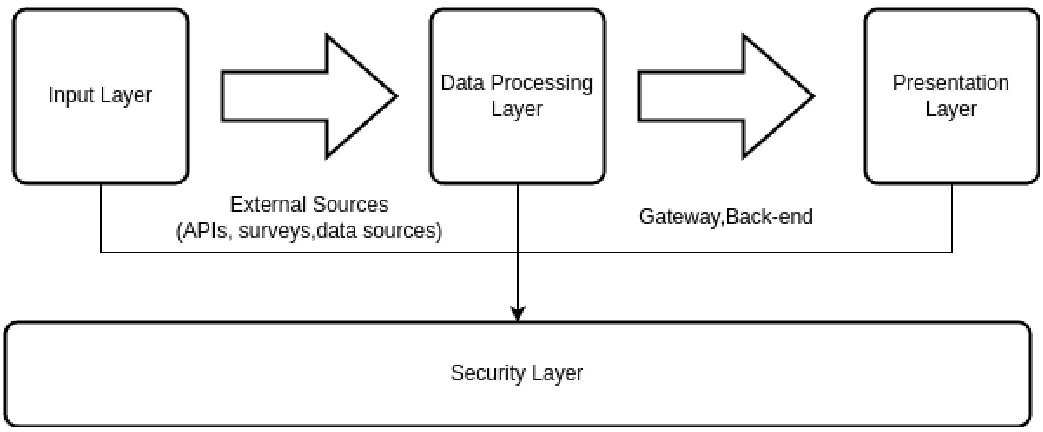

Figure 1: R-Map Platform System Architecture

1. Data Acquisition Layer

This layer is responsible for gathering all the input data needed by the R-Map platform.

- **Survey Input Handling**:
  - Collects responses from the large-scale survey of 20,000 participants as well as other various sources.
  - Ensures the data is prepared and organized for further use.
- **User Feedback Collection**:
  - Captures user opinions and feedback as they interact with the platform.

  - Supports updates based on real-time interactions.
- **External Dataset Integration**:
  - Gather additional data from external sources dynamically, such as regional statistics and environmental information
  - Make sure the data is accurate and ready for processing.

2. Data Processing Layer

This layer takes care of analysing the data collected in the first layer and preparing it for display.

- **Purpose**: To process the data, run analyses, and calculate predictions.
- **How It Works**:
  - Uses methods provided by the .NET framework to break tasks into smaller, manageable pieces.
  - Processes tasks individually to ensure flexibility and accuracy.

Main Components:

1. **Data Handlers**:
   - Connects with the database to store and retrieve information.
2. **Geospatial Data Processor**:
   - Prepares map-related information, such as showing how data varies by region (NUTS-2, NUTS-3 level).
   - Enables complex operations like zooming in on specific areas to see detailed insights.

3. Presentation Layer

This layer manages the user experience, making the platform intuitive and visually appealing.

- **Purpose**: To present the results of the data analysis in a way that is clear and actionable.
- **Main Features**:
  1. **Interactive Maps**:
     - Displays dynamic maps that allow users to explore data by clicking on regions or adjusting views.
  2. **Filters and Controls**:
     - Helps users focus on specific time periods, areas, or types of data they're interested in.
  3. **Data Dashboards**:
     - Uses charts, graphs, and cards to summarize key findings.
  4. **Device Compatibility**:
     - Designed to work seamlessly on computers, tablets, and smartphones.

4. Security Layer

This layer ensures that all interactions within the platform are safe and compliant with data protection regulations.

- **Main Responsibilities**:
  - Keeps user data secure through advanced encryption.
  - Controls access to sensitive areas of the platform to authorized users only.
  - Monitors activities to ensure compliance with data privacy laws like GDPR.

2.1.1.3 Benefits of the Layered Approach

1. **Clarity**: By organizing tasks into layers, each part of the system becomes easier to understand.
2. **Flexibility**: Changes or improvements in one layer don't affect the others, making updates smoother.
3. **Scalability**: The system can grow to handle more users or data without requiring a complete overhaul.
4. **Ease of Use**: The design ensures that even non-technical users can navigate and benefit from the platform.

2.1.2 Service-Oriented Architecture (SOA)

2.1.2.1 Overview

Service-Oriented Architecture (SOA) is a design approach where the system is divided into smaller, reusable components called services. Each service is focused on a specific function and interacts with others through clear and standardized interfaces.

2.1.2.2 Application in R-Map

In the R-Map platform, SOA principles are used to create a modular and flexible system. This setup allows the platform to integrate different features and adapt to changes efficiently.

Key Features:

1. **Reusability**:
   - Services are crafted to be used across multiple areas of the platform.
   - For example, a service for processing map data can be reused by both forecasting tools and visualization modules.
2. **Interoperability**:
   - Services communicate through universally accepted protocols like REST APIs, ensuring seamless integration.
3. **Flexibility**:
   - Adding or updating services is straightforward and doesn't disrupt the rest of the system.

2.1.2.3 Benefits:

- Simplifies system maintenance by separating functions into smaller, manageable parts.
- Improves scalability as services can grow independently based on demand.

Diagram in Figure 2 illustrates a star-shaped system architecture with a central “Core” (Back-End/API Gateway) that serves as the primary hub for all communication and data flow. Each surrounding component—Front End, External Sources, Data Processing Layer, and Storage Layer—connects directly to the Core.The Core orchestrates requests, handles data exchanges among the various layers, and ensures that each part of the system communicates efficiently and securely.

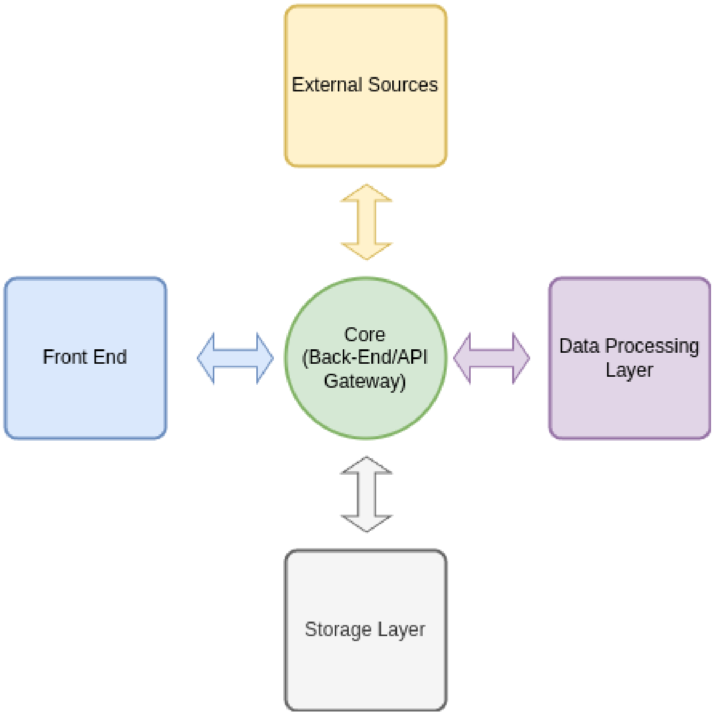

Figure 2: Back-End Core Architecture Design

2.1.3 Microservices Architecture

2.1.3.1 Overview

Microservices Architecture takes the principles of SOA further by breaking the system into highly specific and independently functioning units. Each microservice addresses one task, making the platform more robust and adaptable.

2.1.3.2 Application in R-Map

R-Map employs microservices to manage key functions like data collection, analysis, and visualization, ensuring a clear separation of responsibilities.

Key Characteristics:

1. **Independent Operations**:
   - Microservices can be individually updated or replaced without impacting other parts of the platform.
2. **Error Containment**:
   - If one microservice fails, it doesn't disrupt the entire system.
3. **Technology Flexibility**:
   - Teams can choose the most suitable tools for each microservice, rather than being confined to one technology stack.

2.1.3.3 Example:

A dedicated microservice for handling survey submissions ensures that updates or issues with this function operate independently, preventing any disruptions to data visualization or other features. This separation ensures that background processes do not impact the user experience on the platform's front-end.

2.1.4 Data-Driven Architectural Design

2.1.4.1 Overview

Data-driven design centers the system around the data it processes. This ensures that data collection, transformation, and analysis are at the core of the platform's operation.

2.1.4.2 Application in R-Map

The R-Map platform prioritizes efficient handling of large datasets to deliver meaningful insights and decision-making support.

Key Elements:

1. **Centralized Data Storage**:
   - Houses survey responses, regional statistics, and other vital datasets in one place.
2. **Dynamic Data Processing**:
   - Updates visualizations and analysis in real-time based on user interactions and incoming data.
3. **Insight Generation**:
   - Powers tools like prediction models and dashboards to provide actionable information.

2.1.4.3 Benefits:

- Ensures accurate and consistent data handling.
- Supports evidence-based decisions for stakeholders.

2.2 Methodological Approach and Terminology

2.2.1 Methodological Approach

The development of the R-Map platform, as depicted on Figure3, follows an incremental approach, allowing for continuous feedback and iterative improvements by breaking down the process into small, manageable phases. This method enables the team to address unforeseen challenges early, dynamically incorporate user feedback, and deliver functional prototypes at regular intervals for validation.

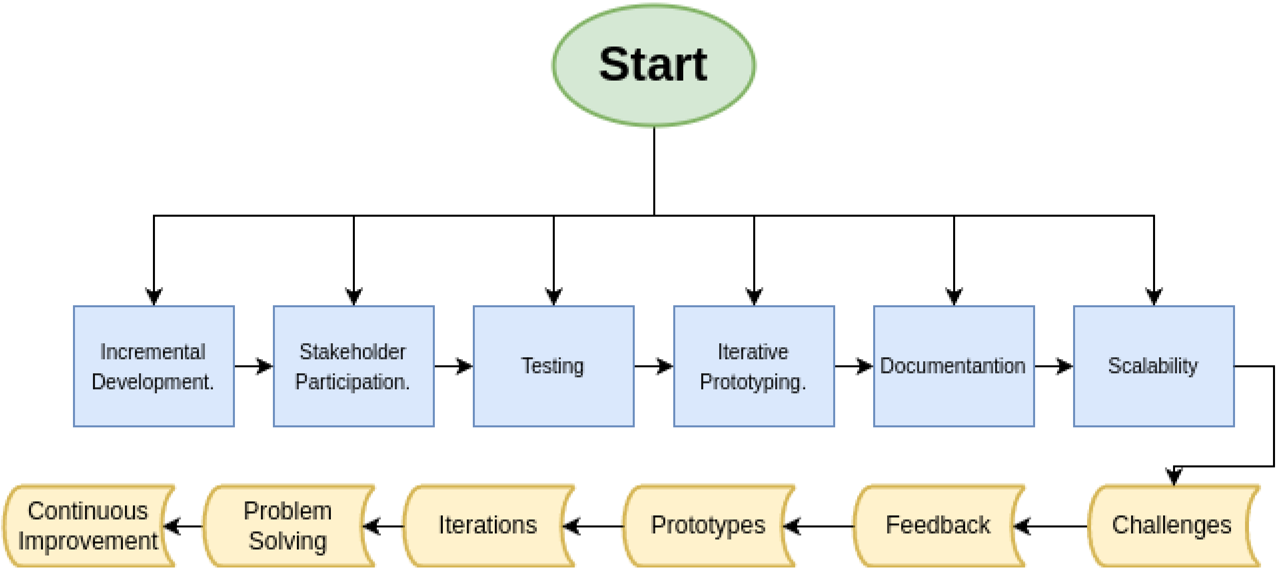

Figure 3: Methodological approach

Ensuring active participation from stakeholders is a key aspect of the development process. Regular consultations are conducted to align the platform with user expectations and project goals. Stakeholder engagement includes workshops and interviews with policymakers to refine platform features, feedback loops to identify areas for improvement, and input from the R-Map Advisory Board to validate technical and strategic decisions.

A comprehensive testing strategy is implemented to guarantee the platform's reliability and performance. Each component undergoes rigorous testing, including unit testing to verify functionality at the component level, integration testing to ensure seamless interaction between modules, user acceptance testing (UAT) to confirm the platform meets end-user needs, and performance testing to assess the system's capability to handle large datasets and concurrent users under various conditions.

The development process also incorporates iterative prototyping, where key features and functionalities are regularly developed and shared with stakeholders. This approach helps identify usability challenges early and ensures the platform evolves in alignment with user expectations before full-scale deployment.

To support long-term usability and maintainability, comprehensive documentation is maintained throughout the development process. This includes detailed technical specifications for each module and user guides and training materials to assist stakeholders in effectively utilizing the platform.

2.3 The R-Map Platform Design Process

2.3.1 Desk Research on Data Visualization Tools Used in European Union Websites

During the initial phase of Task 3.1, we conducted an in-depth analysis of various EU organizations' websites that utilize interactive maps for data visualization and is summarized in Table 1 below. This research aimed to identify best practices, tools, and methodologies employed by these platforms to present complex spatial data in an intuitive and accessible manner. The study examined the types of visualization tools and technologies used to create interactive maps, evaluating their effectiveness in helping users comprehend trends, patterns, and region-specific insights related to social, economic, and environmental factors.

The analysis focused on key aspects such as the user interface design, data layering techniques, interactivity features (e.g., filtering, zooming, and timeline controls), and the integration of multiple datasets to provide comprehensive insights. Additionally, we explored the underlying technical frameworks, such as GIS-based solutions, web mapping libraries (e.g., Leaflet, Mapbox, and OpenLayers), and data processing pipelines that support real-time and batch data visualization.

Furthermore, the study assessed how these platforms ensure usability and accessibility, considering factors such as compliance with accessibility standards (e.g., WCAG), mobile responsiveness, and multilingual support. Insights gained from this research have been instrumental in shaping the visualization strategy for the R-Map platform, ensuring that it meets the diverse needs of stakeholders and provides a seamless, informative experience for policymakers, researchers, and the general public.

The table below depicts the Most Common Visualization Tools and the relevant organization's page.

Table 1: Most Common VIsualization Tools

Organization	Page/Project	Visualization Tool Used
Eurofound	European Working Conditions Telephone Survey 2021	PowerBI
Eurostat	Regions and Cities Illustrated (RCI)	Leaflet
European Food Safety Authority (EFSA)	European Animal Diseases Visualization per Region	Leaflet
European Commission	Data viewer — Copernicus Land Monitoring Service	ArcGIS
European Environment Agency	Water Framework Directive - River Basin Management Plans	ArcGIS

European Geological Data Infrastructure (EGDI)	European Geology Data map	OpenLayers
EuroGeoGraphics	Explore Map	OpenLayers
En-ROADS	Global Scenario of Climate Action	Chart.js

Most Common Visualization Tools:

- **Leaflet** has become a favored option in many organizations, particularly in projects where interactive maps are needed to display geographical data by region. It is of a light weight and is commonly employed in open-source projects.
- **ArcGIS** is utilized in more advanced mapping and geographical information systems, favored by organizations such as the European Commission and the European Environment Agency.
- **OpenLayers** is also commonly used, especially for geological and spatial data, offering strong features for displaying extensive datasets.

2. **Tailored Options:**
    - **CEWEP** and similar organizations are choosing to use personalized mapping tools to address their specific visualization requirements, showcasing a considerable level of customization.
3. **Other Tools**:
    - Software such as **PowerBI**, **MapBox**, and **D3.js** are utilized for particular scenarios where data presentation merges geospatial display with analytics or intricate visualizations.
4. **Wider Adoption**:
    - The variety of tools reflects the adaptability in selecting a technology that suits the organization's requirements, based on factors like scalability, data type, and interactivity.

Our research provided important information on the utilization of map-oriented data visualization tools in the European Union, aiding in technology choices for comparable projects needing geographic data display.

Below is a collection of the data visualization pages explored during this research, complete with screenshots and detailed descriptions. These examples showcase how various organizations utilize mapping tools to represent data, highlighting their approaches to visualizing trends, patterns, and regional insights. Section 4.4 provides detailed justification for the selection of tools used in the development of the R-Map platform, carefully chosen from those analyzed during the research phase.

1. **[Eurofound: European Working Conditions Telephone Survey 2021]**

Tool Used: PowerBI

This page displays an interactive dashboard created using PowerBI, allowing users to explore data on working conditions across Europe. The interface is highly customizable, offering dynamic data filtering and various chart types for better data interpretation. As we can see in figure 4 it also provides a mouse-hover detailed description of the data

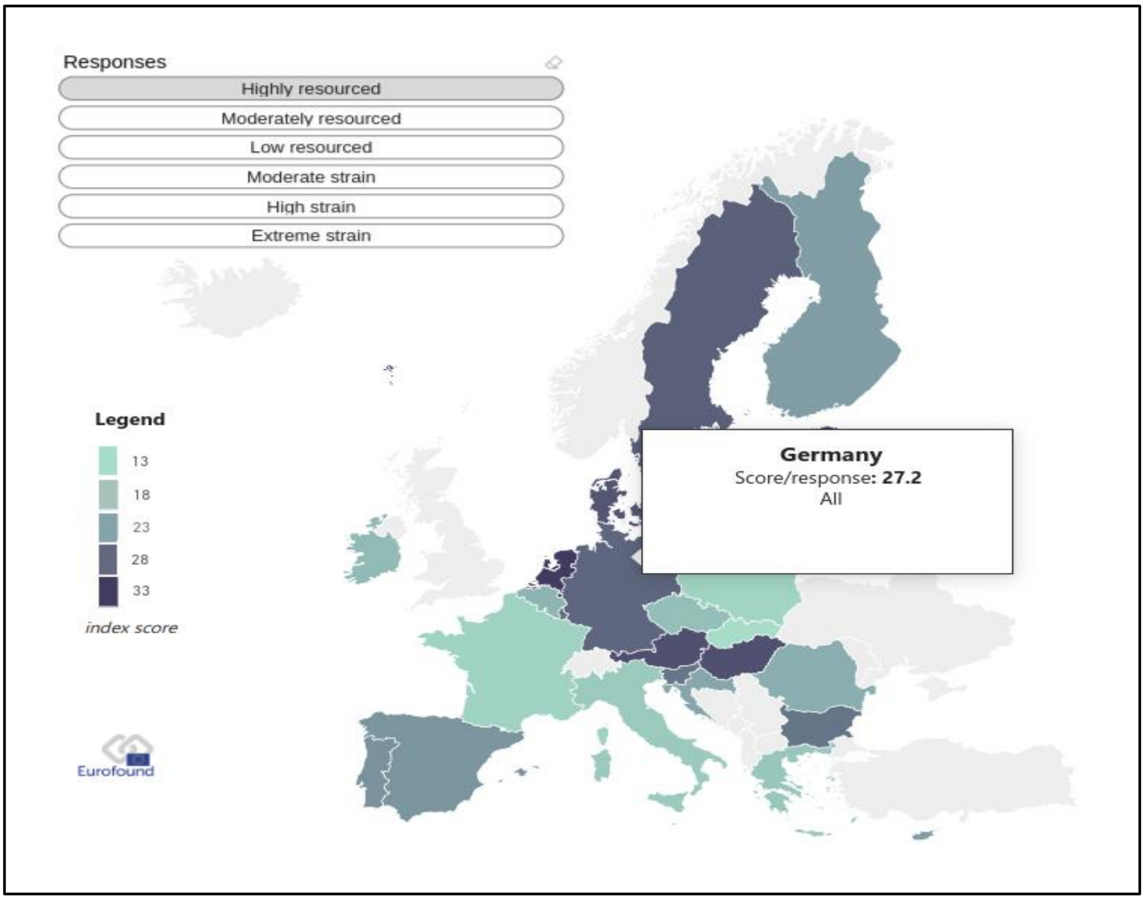

Figure 4: Eurofound

.**2. Eurostat: Regions and Cities Illustrated (RCI)**

Tool Used: Leaflet

This webpage, as depicted in Figures 5 and 6, offers visual mapping data representation and statistical data in a Gantt Chart format, along with detailed descriptions for each country through mouse-hover.

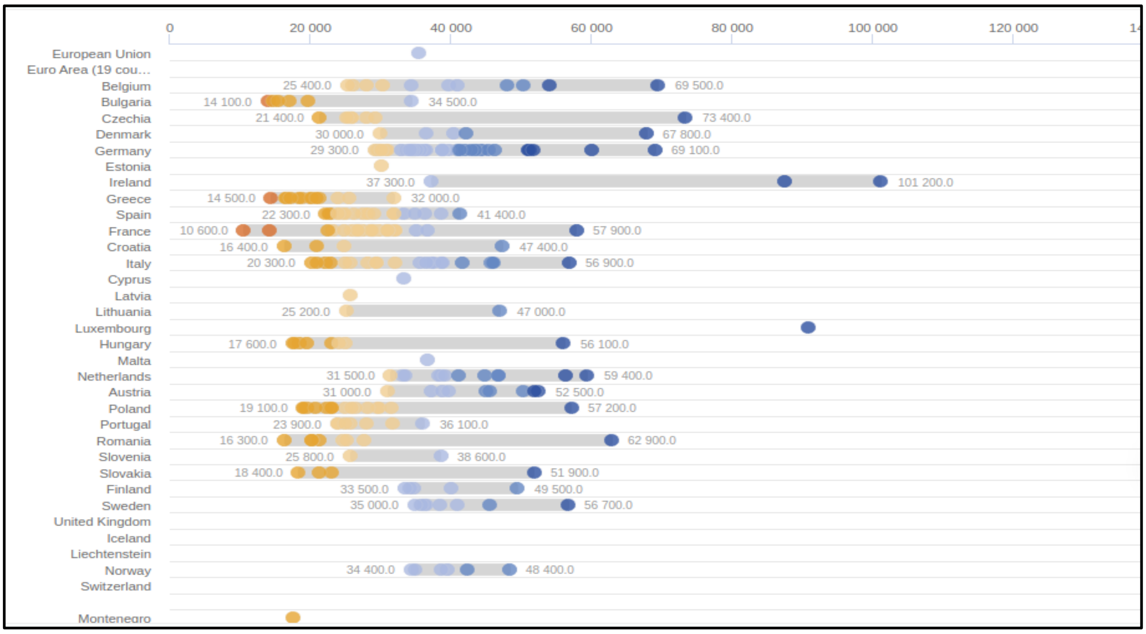

Figure 5: Eurostat-1

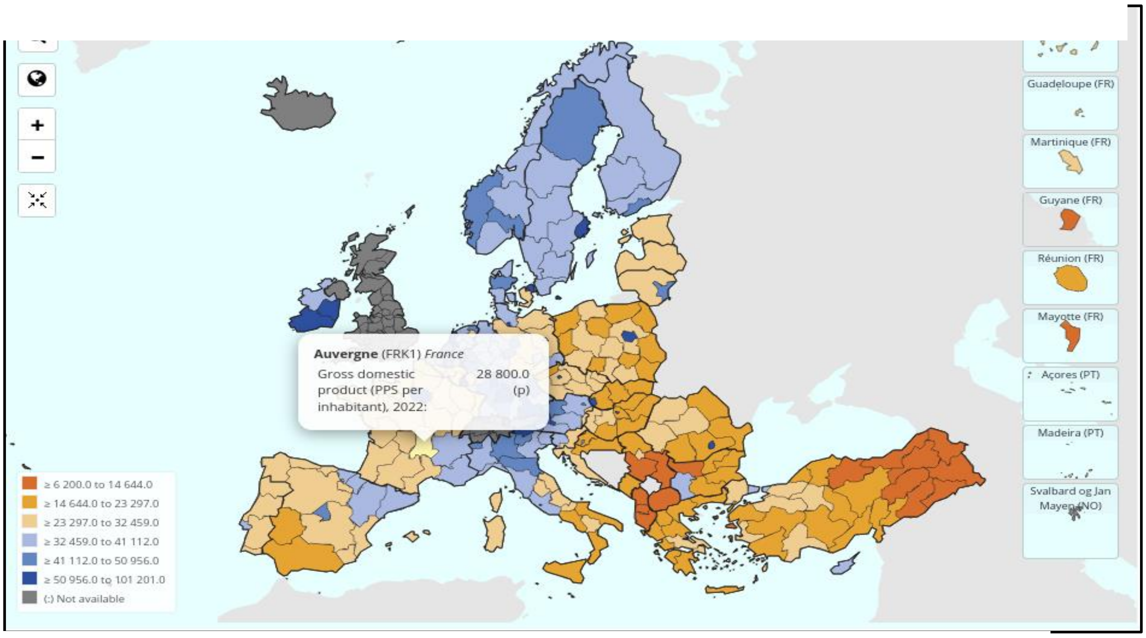

Figure 6: Eurostat-2

3. European Food Safety Authority (EFSA): Animal Diseases Visualization per Region

Tool Used: Leaflet

This page enables the user to adjust the date range using a slider to display the data and also offers detailed events per region in a map-bulleted format for the countries.

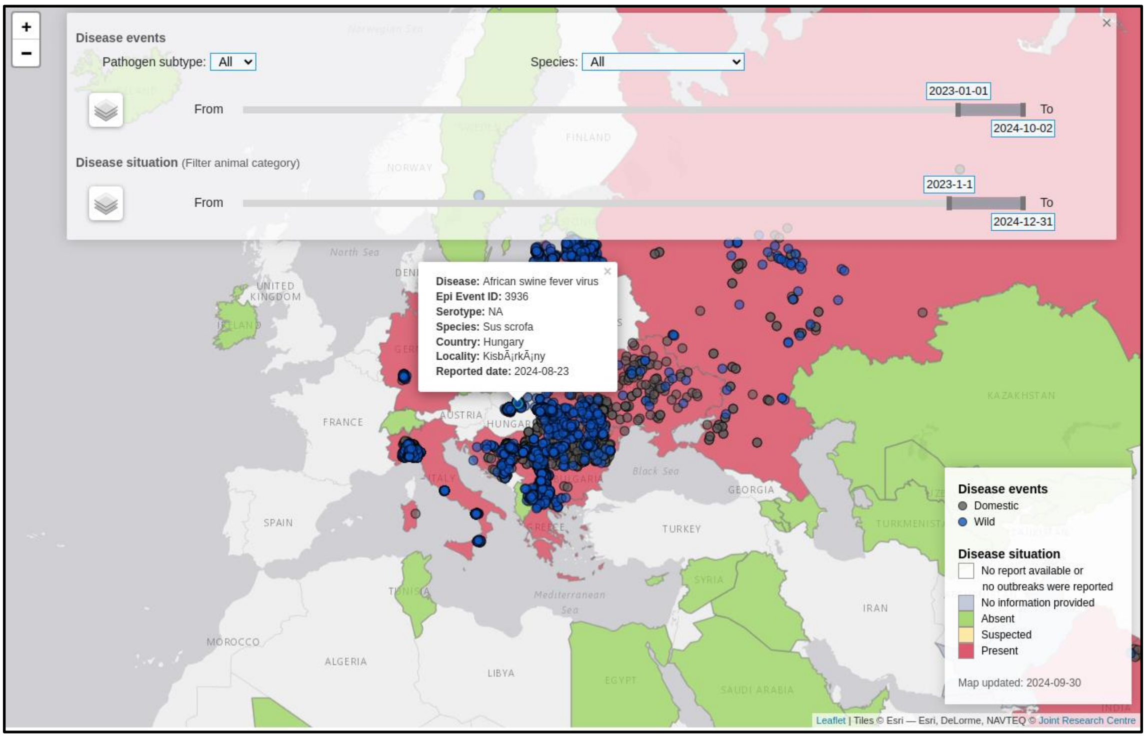

Figure 7: EFSA

4. **European Commission: Copernicus Land Monitoring Service**

Tool Used: ArcGIS

This webpage offers Heatmap-style as well as Satellite imagery of the map showcasing only the visual display of the data without the detailed information for each individual country.

Figure 8: Copernicus-1

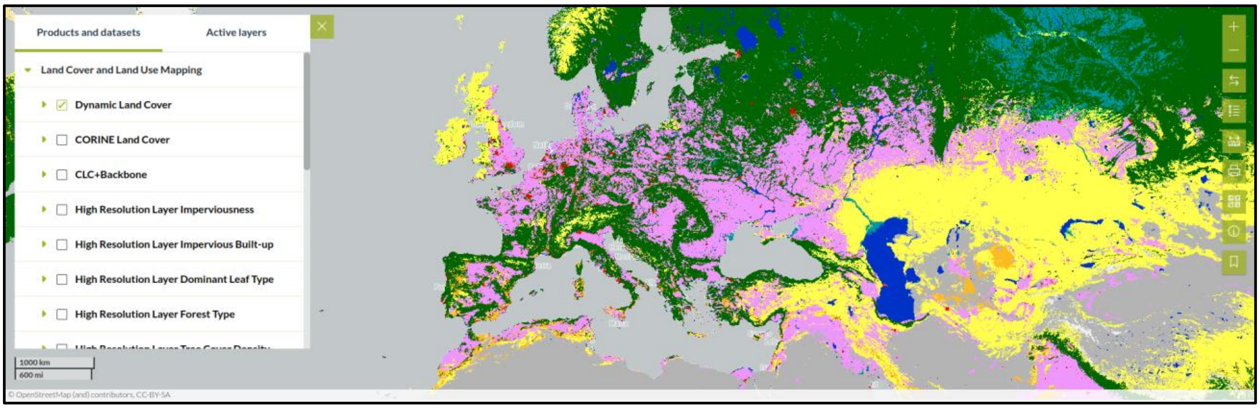

Figure 9: Copernicus-2

5. [European Environment Agency: Water Framework Directive]

Tool Used: ArcGIS

This page displays country-specific statistical information in a Heatmap format, providing additional details when a specific country is clicked. It also includes a Layer select Box to toggle between different filtered layers based on type.

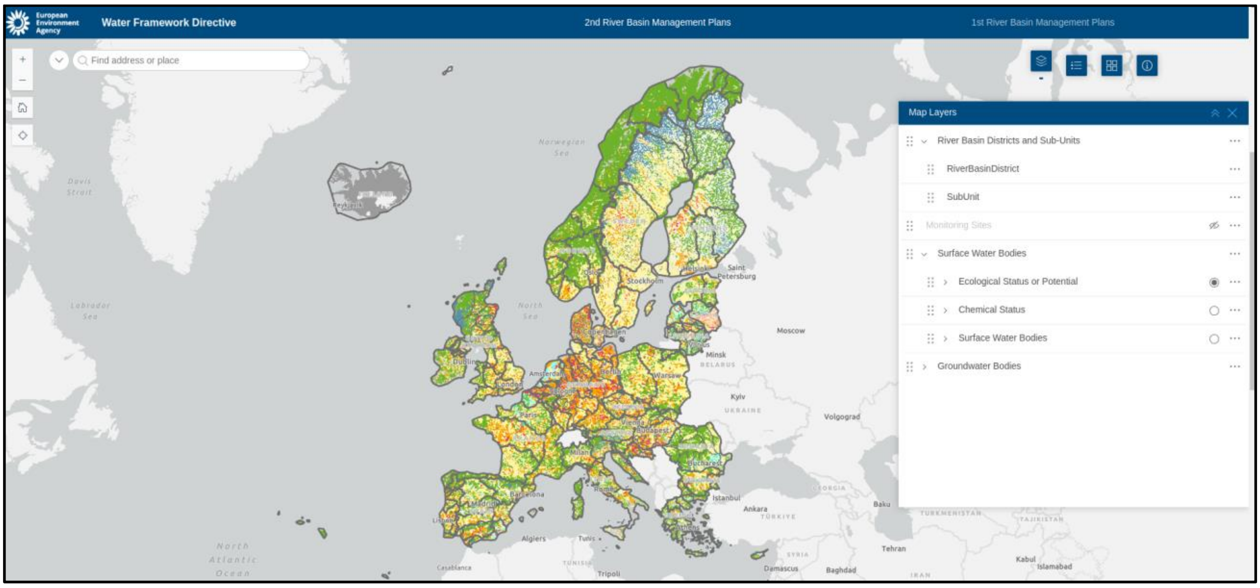

Figure 10: EEA

6. European Geological Data Infrastructure (EGDI) Map

Tool Used: OpenLayers

This page showcases the EGDI map, which is an online geospatial visualization tool showing different geological data products like basic geology, marine geology, mineral resources, and others. The map allows users to zoom, pan, and search the EGDI metadata catalog. It is compatible with various coordinate systems such as EPSG:3034 and EPSG:4326 and combines information from sources such as Eurostat and OpenStreetMap. Furthermore, users have the option to input their own data through WMS, improving its features. The map zooms in on the Pan-European region, using a 1:1,000,000 scale.

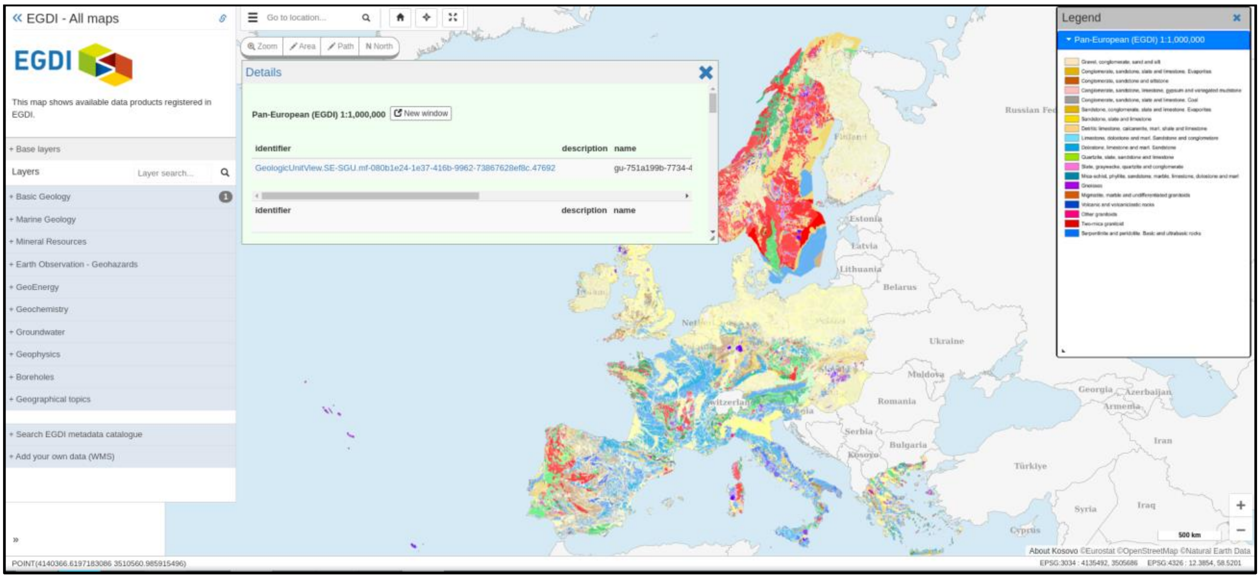

Figure 11: EGDA

7. EuroGeoGraphics: Explore Map

Tool Used: OpenLayers

This page demonstrates the usage of OpenLayers in creating an interactive map of Europe, enabling users to smoothly navigate geographical information. The setup consists of multiple interactive tools at the top of the map, including buttons for zooming in and out, a switcher for changing map layers, and a search feature for finding specific locations. Moreover, there are tools available for measuring distances and areas, as well as the ability to draw shapes directly on the map. These characteristics boost user involvement and offer a complete set of tools for examining and engaging with the presented geographic information.

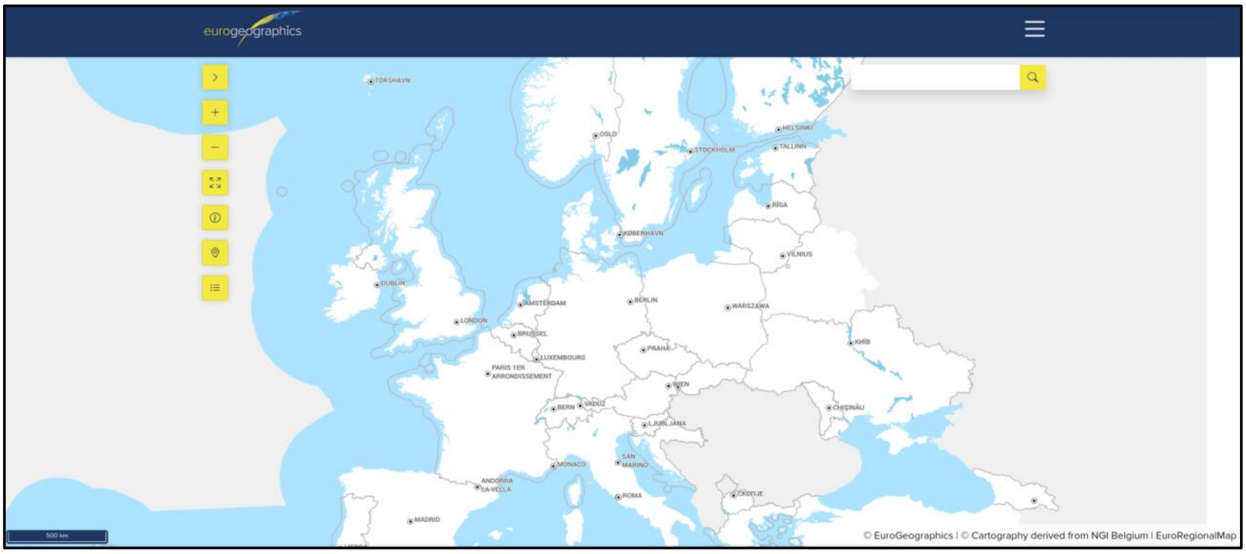

Figure 12: EuroGeoGraphics

8. En-ROADS: Live Chart visualization data

Tool Used: Chart.js

- This page displays how Chart.js is used to present intricate data sets, like worldwide primary energy sources like coal, oil, gas, renewables, bioenergy, and nuclear energy. Utilizing Chart.js enables the production of dynamic, interactive charts that improve user interaction and comprehension. The library provides different types of charts and includes features such as tooltips and animations, allowing for real-time updates and in-depth analysis. Its weightlessness and smooth blending with frameworks make it a great option for enhancing web applications while efficiently conveying complicated data in an approachable manner.

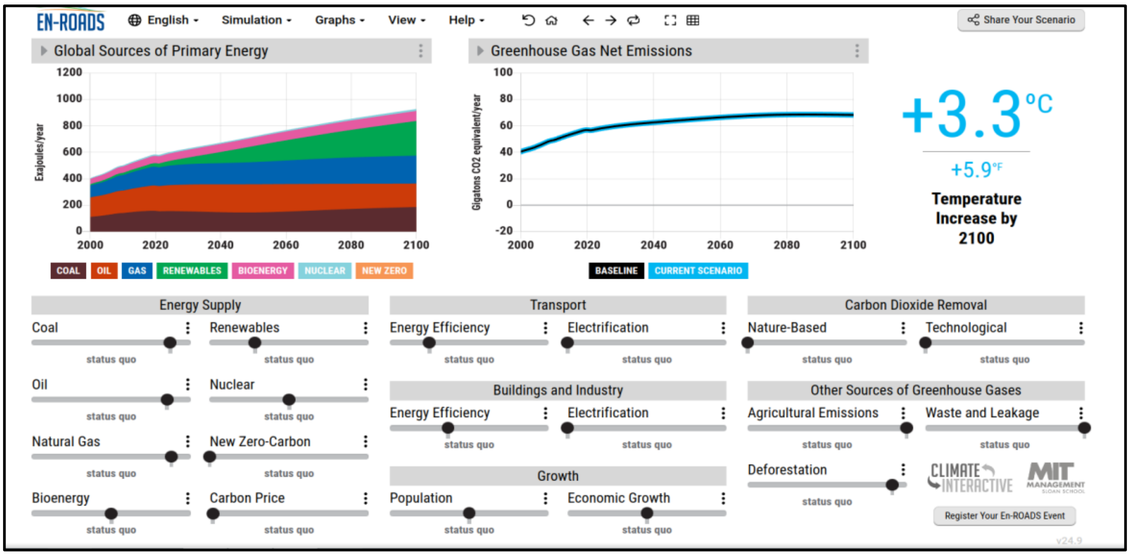

Figure 13: En-Roads

2.3.2 Initial Requirements Technical Workshop

A dedicated workshop was conducted with project partners (see details in Annex 1) to explore visualization tools used by various European organizations as described in 2.3.1 and assess their potential applicability to the R-Map platform. The objective of the session was to familiarize partners with best practices and existing solutions in data visualization, focusing on interactive maps, dashboards, and analytical tools commonly employed by institutions dealing with spatial and socio-economic data. The presentation featured a demonstration of several visualization platforms currently used by European organizations to display regional and demographic insights, showcasing functionalities such as geospatial mapping, data filtering, and trend analysis.

The workshop provided a valuable opportunity for participants to observe different approaches to data visualization and discuss how similar techniques could be adapted to meet the specific needs of the R-Map project. Attendees were encouraged to share their observations and initial thoughts on the presented tools, considering aspects such as usability, flexibility, and the ability to convey complex datasets effectively. However, no concrete decisions were made during the session regarding the selection of visualization tools for the R-Map platform, partly because it was still early in the process and additional alignment with the desired project outcomes was needed. Moreover, participants emphasized the importance of a co-design approach to better capture and address specific user needs before finalizing any visualization strategy.

Following the workshop, a feedback form was distributed via email to collect participants' detailed input on the features to be included in the visualization platform. The form aimed to capture their perspectives on which features and functionalities could best support the visualization goals of the R-Map platform. The feedback collected will contribute to shaping the next phases of development, ensuring that the visualization components align with user expectations and project objectives. Among the insights gathered, participants emphasized the importance of data visualization on maps and the need to identify policymakers' specific requirements to guide design decisions.

2.3.3 Technical Validation Meeting with members of the Advisory Board

A validation meeting was held with members of the R-Map Advisory Board (see details in Annex 2) to present and discuss the platform's visualization modules, gather expert feedback, and assess their alignment with stakeholder expectations. The session provided an overview of the platform's two core modules: the Interactive Data Visualization Module, which focuses on leveraging existing EU datasets and predictive modelling tools, and the One-Stop Visualization Observatory, designed to provide access to visualized responses from the R-Map survey, alongside other EU datasets related to remote work trends and their potential effects across different regions and countries.

During the meeting, early-stage designs (Figures 14 to 16) for both modules were presented, illustrating key functionalities and interactive features. The Observatory Module demonstration showcased essential tools such as a time-range slider for selecting specific periods of data, an interactive map offering hover-based insights, and various filtering options tailored to user preferences. Similarly, the R-Map Survey presentation included time-range selection, filtering tools, and dynamic charts to effectively visualize survey results. Participants were encouraged to provide feedback, acknowledging that these presentations represented an initial conceptualization and would be refined based on their input. The Advisory Board members recognized the preliminary nature of the visualizations but affirmed that the core functionalities aligned well with policymakers' needs.

Feedback on the user experience (UX) and user interface (UI) design was largely positive, with participants praising the visually appealing layout and intuitive navigation. However, they recommended the inclusion of contextual information within the interface to minimize clutter and assist users in understanding the data. Additionally, they highlighted the necessity of refining the classification of remote workers to reflect the diverse nature of remote work arrangements, such as distinguishing between employees, freelancers, and entrepreneurs.

The discussion also touched upon the platform's ability to adapt to evolving user needs, with participants emphasizing the importance of balancing functionality with usability. Some participants expressed support for adding further layers of complexity with more filters, given that the platform is intended for a specialized audience. However, they also noted that streamlining features will be essential to avoid overwhelming users.

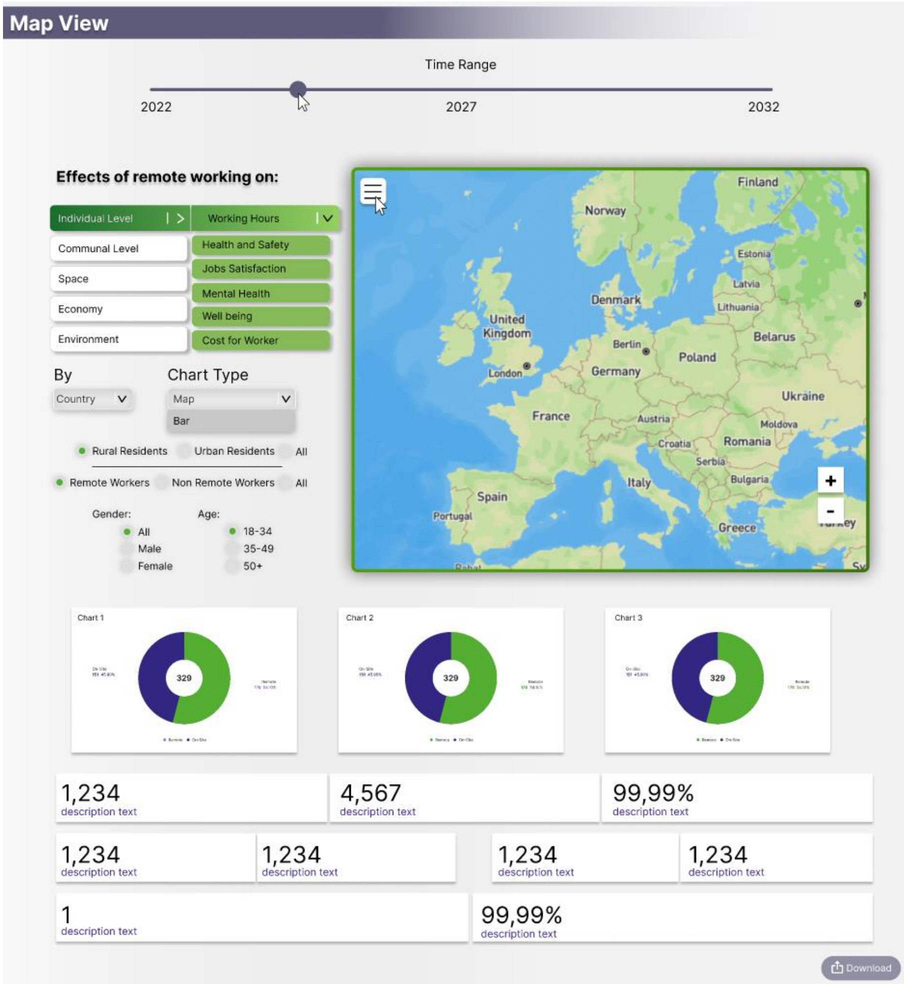

Figure 14: Early stage designs 1 – Data observatory

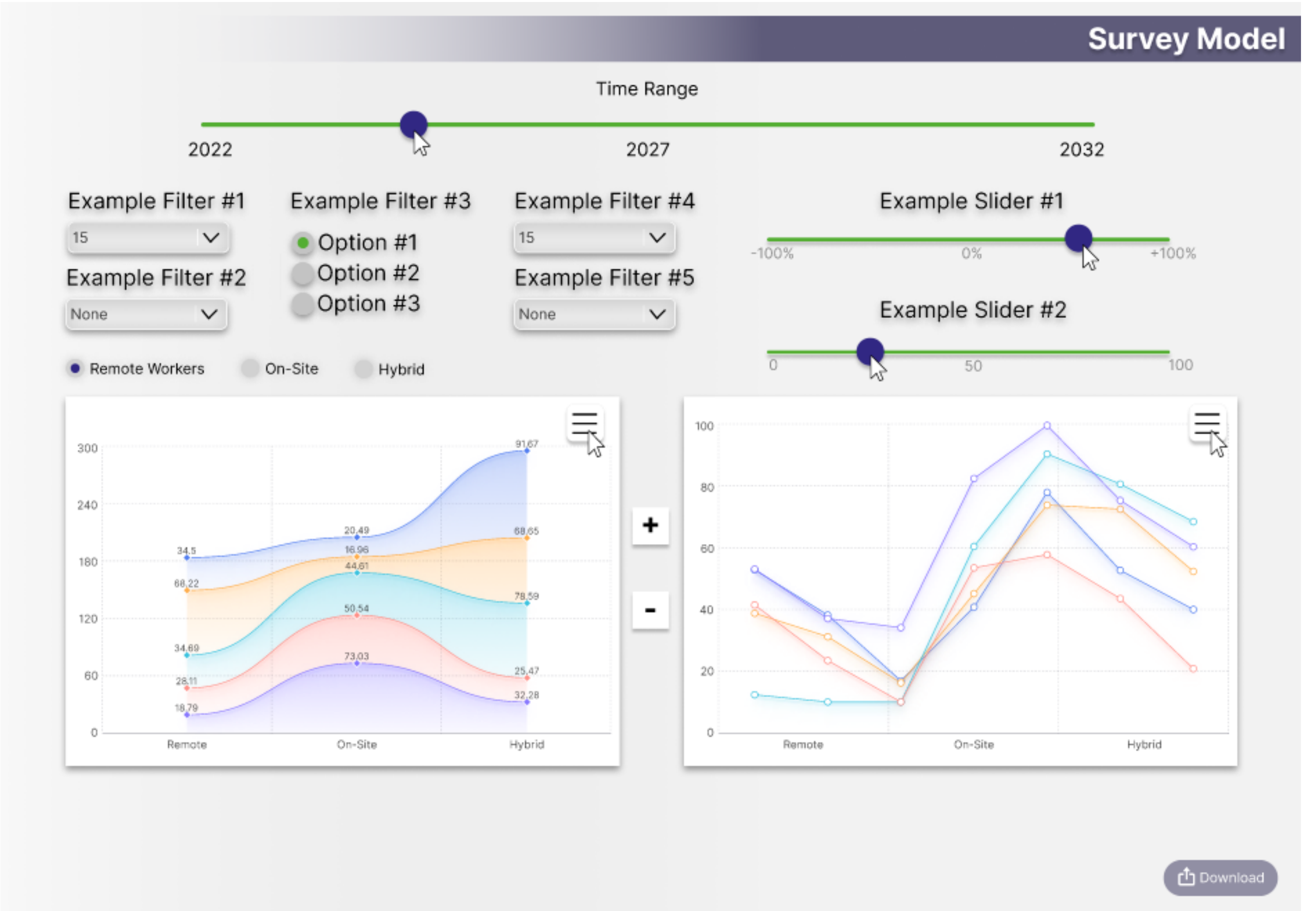

Figure 15: Early stage designs 2 – Prediction model

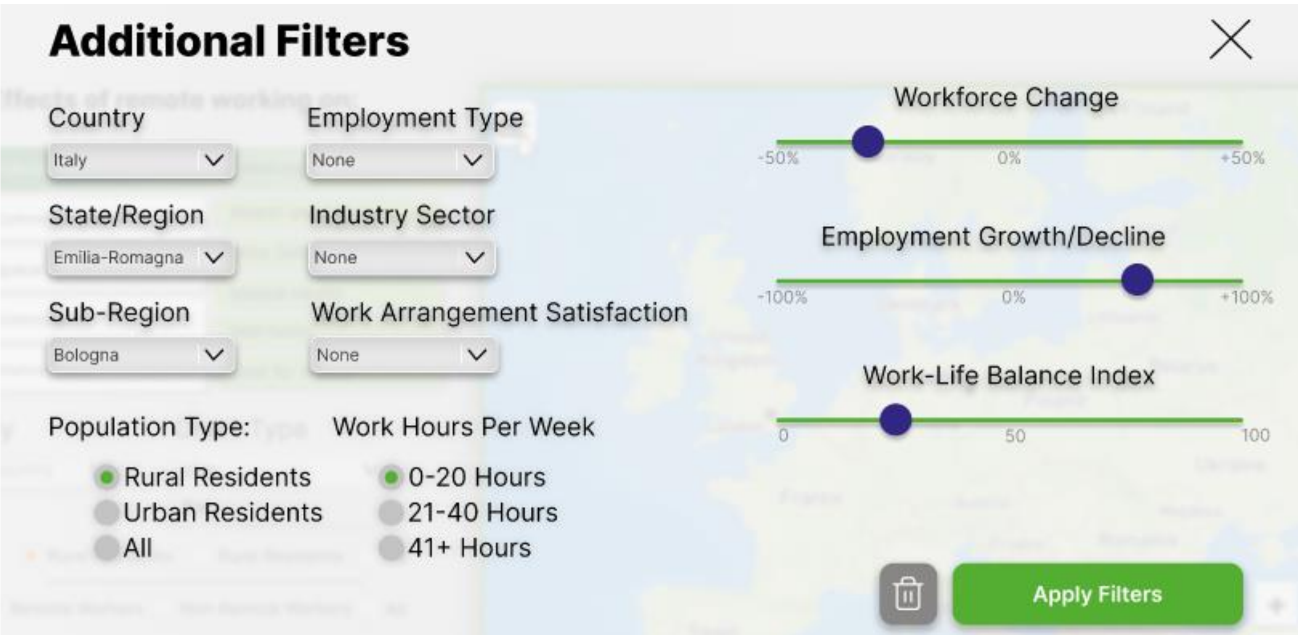

Figure 16: Early stage designs 3 - Data observatory

3. R-Map PLATFORM ARCHITECTURE

3.1 Core Components of the R-Map Platform

3.1.1 R-Map Platform Prediction Model

The R-Map Platform Prediction Model is a key analytical tool designed to provide policymakers with valuable insights into the impacts of remote working arrangements (RWAs) across multiple dimensions, including migration patterns, economic shifts, and environmental effects. Developed through a co-design process involving experts and stakeholders, the model builds on a multidisciplinary framework to analyze the cause-effect relationships underlying remote work dynamics. Rather than independently forecasting future trends, the Prediction Model leverages the R-Map model developed in WP2, which is designed to assess impacts based on available data. By utilizing validated project-specific datasets, the platform ensures that analyses remain grounded in empirical evidence, enhancing accuracy and relevance while streamlining data utilization to support evidence-based decision-making.

The R-Map Platform Prediction Model operates through a systematic and dynamic process that involves data retrieval, integration, and visualization. It communicates directly with the R-Map model via API to request insights on how specific metrics—such as workforce distribution, infrastructure readiness, and environmental sustainability—change over time under different scenarios. Once the requested data is retrieved, it undergoes a structured integration process, where it is formatted and validated to align with the R-Map platform's structure, ensuring consistency and usability. The platform then presents these predictions through intuitive, interactive visualizations, allowing users to explore and filter data by geographic regions, time ranges, and other relevant parameters. These visualization capabilities empower policymakers to simulate various policy scenarios, assess their potential impacts at both regional and national levels, and make informed decisions based on real-time and forecasted data generated within the project framework.

We need to clarify here that the R-Map Platform prediction model, the what-if scenario visualisations and interactive visuals of the R-Map platform are the visual representation of WP1 and WP2 results and may be used as a prompt to facilitate the discussions for building exploratory (descriptive) scenarios in WP4.

3.1.2 Dataset Observatory

The Dataset Observatory is a central feature of the R-Map platform, designed to provide stakeholders with comprehensive access to a wide range of datasets that support the analysis and evaluation of remote working arrangements (RWAs) across Europe. The Observatory will integrate over 10 EU-level datasets and at least 18 regional datasets, providing a broad, multi-dimensional perspective on various geographic, socio-economic, and environmental factors that can influence remote working arrangements (RWAs). While most of these datasets are not explicitly related to RWAs, they offer valuable contextual information on employment trends, digital infrastructure, economic conditions, environmental factors, and quality of life indicators. By bringing together diverse data sources, the Observatory enables policymakers and researchers to explore the broader conditions shaping remote work adoption and assess its potential impacts with greater depth and accuracy, supporting more informed, evidence-based decision-making. The EU-level datasets are sourced from reputable organizations such as Eurostat, Eurofound, and the ESPON Data Portal, providing harmonized and comparable statistics across countries and regions. Meanwhile, the regional datasets capture localized nuances, offering granular insights into the specific conditions, opportunities, and challenges of remote work within different territories. The Dataset Observatory enables users to explore these datasets through an intuitive interface that includes interactive visualizations, filtering options, and analytical tools that allow for cross-regional comparisons and trend analysis over time. Through the integration of both EU-level and regional data, the observatory facilitates a comprehensive understanding of how remote work is shaping urban and rural regions differently, providing stakeholders with the ability to tailor policies to specific needs. Moreover, the observatory ensures data reliability and consistency by incorporating validation processes that align with the platform's high standards, making it a trustworthy resource for policymakers.

3.1.3 Visualization and Reporting Modules

The Visualization and Reporting Modules of the R-Map platform are designed to provide policymakers and stakeholders with an intuitive and comprehensive way to analyse remote working arrangements (RWAs) across different regions. These modules consist of key components that enhance data exploration and communication, including interactive maps, which allow users to visually explore regional data with features such as zooming, filtering, and layering to identify spatial trends and disparities. Additionally, charts and dashboards summarize key trends and findings, presenting complex data through easily interpretable graphs and visual indicators that highlight patterns over time and across different demographic and economic factors. To support informed decision-making and collaboration, the platform also offers exportable reports, enabling users to generate reports in PDF and other formats to share insights with colleagues and stakeholders efficiently. The entire visualization and reporting system is designed with a user-friendly approach, ensuring accessibility for both technical and non-technical users. The platform’s intuitive interface, clear data representations, and interactive elements allow users to effortlessly navigate and interpret information, empowering them to make data-driven policy decisions without requiring specialized technical skills.

3.2 System Architecture Overview

Figure 17 below illustrates the logical flow of the R-Map platform. The system starts with two key inputs: the Frontend Layer, which includes user interaction and visualization tools, and External Data Sources & APIs, providing third-party data and survey inputs. Both feed into the API Gateway, which acts as a bridge to the Backend Layer responsible for business logic and microservices. The Backend Layer connects to three core components—Data Processing, Data Storage, and Monitoring & Logging—which collectively support the Infrastructure Layer, forming the foundation of the platform.

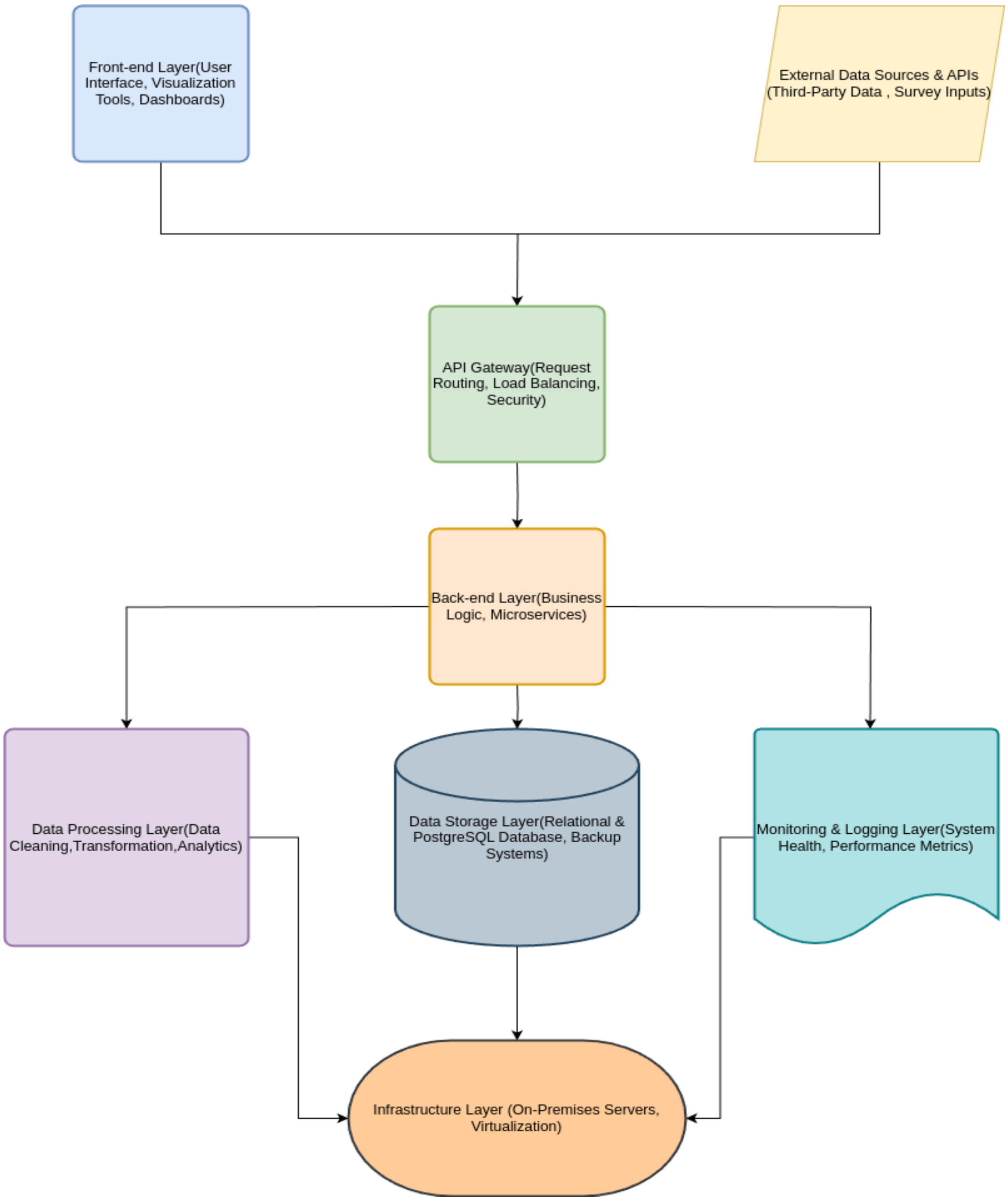

Figure 17: R-Map Platform System Architecture

3.2.1 Data Ingestion and Processing Layer

The Data Ingestion and Processing Layer is the foundation for collecting and preparing data for analysis. This layer ensures that raw data from multiple sources is transformed into a consistent and enriched format, ready for further analysis.

Responsibilities

- Data Collection: Aggregates data from diverse sources, including external APIs, large-scale surveys, public repositories, and user-generated inputs.
- Data Cleaning: Removes noise, inconsistencies, and redundant entries, ensuring the data's accuracy and reliability.
- Data Standardization: Converts data into consistent formats like CSV or JSON, applying uniform conventions for units, date formats, and naming conventions.
- Data Validation: Verifies completeness and integrity, flagging any gaps or anomalies that require attention.

Tools and Technologies

- Batch Processing Pipelines: Handle large datasets in bulk, enabling efficient processing of historical data.
- Real-Time Processing Frameworks: Tools like Apache Kafka or similar are integrated to manage and process streaming data in real-time.
- ETL Pipelines: (Extract, Transform, Load) automate the data ingestion workflow, ensuring seamless integration with the platform's storage layer.
- Data Orchestration Tools: Manage dependencies and schedule processing jobs, ensuring timely delivery of enriched datasets.

3.2.2 Analytical and Modeling Layer

The Analytical and Modelling Layer is responsible for transforming processed data into actionable insights. It employs a combination of statistical and machine learning tools to uncover patterns, generate predictions, and provide a deeper understanding of trends.

Components:

1. Statistical Analysis Tools
    - Facilitate descriptive and inferential analyses to summarize data and establish correlations.
    - Employ techniques such as regression, clustering, and hypothesis testing for in-depth examination.
2. Data Aggregation Engines:
    - Aggregate data into meaningful formats for higher-level analysis, summarizing metrics across dimensions such as time, geography, and demographics.
3. Integration:

- Seamless Connectivity: Collaborates with the Data Ingestion Layer to process pre-cleaned data efficiently.
- Visualization Modules: Directly feeds insights into the Visualization Layer, ensuring real-time updates for end-users.

3.2.3 Visualization and User Interface Layer

The Visualization and User Interface Layer acts as the primary interaction point for end-users, transforming complex data into accessible and actionable formats.

Key Features

1. Interactive Dashboards:
    - Provide a user-friendly interface for exploring data through visualizations like charts, graphs, and maps.
    - Allow users to drill down into specific metrics or filter data based on their preferences.
2. Advanced Filtering Tools:
    - Include sliders, dropdown menus, and multi-select filters to refine visualizations by parameters such as time range, region, or demographic group.
3. Device Compatibility:
    - Designed with responsive layouts to ensure seamless functionality on desktops, tablets, and mobile devices.
4. Export Options:
    - Enable users to download visualizations and reports in formats such as PDF or CSV for offline analysis and sharing.

3.3 Functional and Non-Functional Requirements

3.3.1 Functional Requirements

The R-Map platform is designed to cater to two primary types of users: policy makers and administrators. Policy makers are the primary end-users who will utilize the platform to analyze remote work trends, assess socio-economic impacts, and make data-driven decisions to shape policies that address regional disparities. They will interact with the platform through intuitive dashboards, geospatial visualizations, and scenario analysis tools to support strategic planning. Administrators, on the other hand, are responsible for managing the platform's functionality, ensuring data accuracy, and maintaining system security. They oversee user access, data integration, and compliance with regulations to guarantee that the platform operates smoothly and effectively serves the needs of policy makers.

The user stories presented in Tables 2 and 3 below stem from informed assumptions and commonly observed policymaking and administrative needs. They serve a practical purpose: guiding the design of the platform to ensure it meets typical user expectations and supports decision-makers and administrators effectively. By framing these user stories prominently in the development process, we clarify how the platform's functionalities align with real-world scenarios—even if they are not drawn from a formalized stakeholder session. In this sense, they do not necessarily represent questions explicitly asked by policymakers and administrators but rather illustrate likely use cases based on domain knowledge and project objectives.

The scenario prediction functionalities described here are subject to the current capabilities of the R-Map model, which only supports certain causal chains and impact factors based on available data. Consequently, any scenario projections or forecasts generated by the platform must be interpreted within these constraints, as broader or more complex relationships may not be accurately captured with the existing data.

Table 2: User stories for Policy makers

Title	User Story	Acceptance Criteria
Interactive Geospatial Maps	As a policy maker, I want to view interactive geospatial maps so that I can analyze remote work trends across different regions.	The map should allow zooming, panning, and data overlays with clear region-specific data visualization.
Time-Based Data Filtering	As a policy maker, I want to filter data by specific time periods so that I can observe changes and trends over time.	The platform should offer an interactive time slider and date range filter with accurate data updates.
Data Overlay Comparison	As a policy maker, I want to overlay multiple datasets so that I can compare the impact of different factors on remote work.	The dashboard should support multiple layers with toggle functionality to compare datasets side by side.

Regional Data Comparison	As a policy maker, I want to compare data across regions so that I can identify disparities in remote work adoption.	A comparative visualization tool should provide side-by-side charts and maps with regional breakdowns.
Demographic Insights	As a policy maker, I want to analyze demographic breakdowns so that I can tailor policies to specific population groups.	Filters should allow breakdowns by age, gender, and employment sector, with corresponding visualizations.
Scenario-Based Analysis	As a policy maker, I want to create and compare different scenarios so that I can evaluate the potential impacts of remote work policies.	The platform should allow input of different parameters and generate comparative scenario visualizations.
Socio-Economic Impact Analysis	As a policy maker, I want to assess the socio-economic impacts of remote work so that I can better allocate resources and funding.	The platform should provide economic indicators linked to remote work data, such as GDP impact and job shifts.
Environmental Impact Assessment	As a policy maker, I want to analyze the environmental effects of remote work so that I can develop sustainable policies.	The platform should include CO2 emissions data, transportation patterns, and energy consumption trends.
Infrastructure Readiness	As a policy maker, I want to evaluate digital infrastructure readiness so that I can plan improvements for remote work expansion.	The dashboard should display broadband availability, digital literacy rates, and telecommunication coverage.
Workforce Productivity Insights	As a policy maker, I want to analyze remote work productivity trends so that I can measure the effectiveness of existing policies.	Reports should provide productivity metrics such as output rates, engagement levels, and industry comparisons.
Social Inclusion Metrics	As a policy maker, I want to track remote work accessibility for disadvantaged groups so that I can promote inclusivity.	The platform should provide insights on accessibility for disabled workers, low-income groups, and rural areas.
Policy Effectiveness Tracking	As a policy maker, I want to monitor the impact of my policies so that I can make informed adjustments over time.	Key policy performance indicators (KPIs) should be tracked and visualized for evaluation purposes.

Mobility and Commuting Trends	As a policy maker, I want to analyze remote work effects on commuting so that I can optimize public transportation planning.	The platform should display trends in commuting reduction and modal shifts (e.g., car, public transport).
Regional Disparities Overview	As a policy maker, I want to identify inequalities between urban and rural areas so that I can create balanced development strategies.	The system should highlight differences in employment, wages, and digital access between regions.
Emergency Preparedness	As a policy maker, I want to assess remote work's role in emergency planning so that I can build resilient work policies.	The platform should provide insights into remote work adaptability during crises such as pandemics or disasters.
Benchmarking Against Other Countries	As a policy maker, I want to compare remote work trends with other EU countries so that I can align national policies with best practices.	The platform should allow cross-country comparisons using standardized metrics and visualizations.
Job Market Trends	As a policy maker, I want to monitor changes in job market dynamics so that I can provide targeted employment support programs.	The platform should include job demand trends, skills requirements, and remote job distribution data.
Data Download and Export	As a policy maker, I want to download data in different formats so that I can analyze it offline.	The system should support downloads in CSV, Excel, and PDF formats for selected datasets.
Cross-Sectoral Analysis	As a policy maker, I want to compare remote work impacts across industries so that I can create sector-specific interventions.	The platform should provide industry-specific dashboards for sectors such as healthcare, IT, and education.
Future Policy Planning	As a policy maker, I want to forecast remote work adoption trends so that I can proactively design future policies.	The system should include forecasting models based on historical data and policy simulations.
Stakeholder Collaboration	As a policy maker, I want to collaborate with other government departments so that we can coordinate policy efforts more effectively.	The platform should include features for sharing insights and communication between different stakeholders.

Table 3: User Stories for Administrators

Title	User Story	Acceptance Criteria
User Account Management	As an administrator, I want to create and manage user accounts so that I can control access to the platform.	The system should allow admins to add, modify, deactivate, and delete user accounts with role assignments.
Role-Based Access Control	As an administrator, I want to assign roles and permissions so that users can access only relevant data and features.	Users should have role-based access with restricted permissions depending on their assigned roles.
Data Source Integration	As an administrator, I want to integrate new data sources so that the platform stays up to date with the latest information.	The system should support manual and automated data ingestion with validation checks.
Data Validation	As an administrator, I want to validate incoming data so that I can ensure accuracy and consistency.	The platform should provide automated data validation processes and error reports for inconsistencies.
Security Compliance	As an administrator, I want to enforce security policies so that the platform complies with GDPR and other regulations.	The system should provide encryption, access logging, and compliance reports for audits.
Backup and Recovery	As an administrator, I want to perform regular backups so that data is protected in case of failure.	Automatic backup schedules should be configurable, with restore options available.
System Logging and Audits	As an administrator, I want to review activity logs so that I can monitor system usage and security breaches.	Audit logs should capture user actions, system changes, and unauthorized access attempts.

3.3.2 Non-Functional Requirements (Scalability, Security, Usability)

The non-functional requirements of the R-Map platform define the critical performance, security, usability, and scalability aspects that ensure the system operates efficiently and meets stakeholder expectations. **Scalability** is a key consideration, allowing the platform to handle increasing volumes of data from diverse sources, including large-scale surveys, open data repositories without compromising performance. The system must support both horizontal and vertical scaling to accommodate future growth and evolving user demands.

Performance efficiency is another essential requirement, ensuring that the platform delivers fast response times for data queries, visualization rendering, and user interactions, even under heavy workloads. To achieve this, optimized data processing pipelines, caching mechanisms, and asynchronous processing techniques will be implemented. **Security** and data privacy are fundamental to the platform, with stringent measures such as encryption, access control, and compliance with data protection regulations (e.g., GDPR) to safeguard sensitive information**. Usability and accessibility** are also prioritized to provide an intuitive and inclusive experience for with varying levels of technical expertise. The platform will adhere to accessibility standards such as WCAG, ensuring compatibility with assistive technologies and responsive design across multiple devices. Additionally, **maintainability and reliability** are crucial for the long-term sustainability of the platform, with modular design principles that allow for seamless updates, bug fixes, and enhancements without disrupting core functionalities

3.4 Data Flow and Integration

3.4.1 Internal Data Processing and Storage

Internal data processing and storage in the R-Map platform are foundational to ensuring data integrity, consistency, and accessibility. This component of the architecture manages the transformation of raw data into enriched, structured formats, enabling effective analysis and visualization.

Processes

Data processing begins with the ingestion of raw datasets from various sources, including surveys, external APIs. Once ingested, the data undergoes a series of cleaning and enrichment steps:

- Cleaning: Removes inconsistencies, duplicates, and errors to ensure accuracy and reliability.
- Enrichment: Augments datasets by integrating additional attributes, such as geographic identifiers or time stamps, to provide more context and analytical depth.
- Standardization: Formats data into consistent structures, enabling seamless integration across different layers of the platform.
- Validation: Applies checks to confirm data completeness and adherence to predefined quality standards.

The processed data is then funnelled into a centralized repository, where it is organized for efficient storage and retrieval.

Storage

The R-Map platform employs PostgreSQL as its relational database, connected to the .NET 8 framework, to manage structured data efficiently. This setup ensures high compatibility with the platform's architecture and enables reliable performance for analytics and reporting:

- Relational Database Management: PostgreSQL is used to store structured data, including survey responses, demographic statistics, and time-series data. It is optimized for complex queries and transactions, making it suitable for large-scale analytical operations.
- Integration with .NET 8 Framework: Provides seamless connectivity for data ingestion, retrieval, and processing, leveraging the latest features for performance and scalability.

- Data Backup Systems: Regular backups ensure data resilience, safeguarding against loss and supporting disaster recovery.
- Advanced Indexing: Supports efficient query execution by employing indexing techniques, ensuring rapid access to critical data.
- Scalability: PostgreSQL's robust architecture allows for scaling to accommodate the platform's growing data requirements, maintaining consistency and reliability.

3.5 Platform Deployment and Scalability

3.5.1 On Premises Infrastructure and Hosting Solutions

Hosting: The R-Map platform is deployed on an on-premises infrastructure, which offers organizations the ability to maintain full control over their computing environment. By hosting the platform within its own data centers, ARX.NET ensures complete authority over resources, data handling, and operational workflows, providing unparalleled data security and compliance with regulatory standards. This approach guarantees robust performance while supporting scalability and reliability for the platform.

Advantages

The following are the platform’s main advantages:

Data Sovereignty: All data remains within the organization's control, eliminating risks associated with third-party cloud service providers and ensuring compliance with local and international data protection laws, including GDPR.

Enhanced Security: On-premises infrastructure allows ARX.NET to implement customized security protocols, including advanced firewalls, intrusion detection systems, and physical security measures, significantly reducing vulnerabilities to cyber threats.

Performance Consistency: Hosting locally minimizes network latency and ensures consistent performance, even during peak usage periods.

System Specifications

The infrastructure supporting the R-Map platform is designed to handle demanding workloads and ensure seamless operation. ARX.NET employs a robust on-premises setup featuring high-performance KVM-based virtual machines (Kernel-based Virtual Machines) with the following specifications:

- Processor: 56 x Intel(R) Xeon(R) CPU E5-2680 v4 @ 2.40GHz (2 Sockets)
- Memory: 384 GB RAM per VM Host
- Storage: 14 TB available storage

This configuration ensures:

- High Processing Power: Capable of managing complex computations and data processing tasks efficiently.

- Ample Memory Capacity: Supporting multiple concurrent users and applications without performance degradation.
- Scalable Storage: Providing sufficient capacity for datasets, predictions, and future expansions.

3.5.2 Performance Considerations

Optimization: Regular performance testing ensures fast response times and efficient resource usage, allowing the platform to deliver a seamless user experience even under heavy workloads. These tests include monitoring and optimizing query execution, load balancing, and resource allocation to maintain system efficiency.

Key Strategies for Performance Optimization

Scalable Architecture:

- The platform is designed with a scalable architecture, enabling horizontal and vertical scaling to handle increasing data volumes, user interactions, and concurrent requests without compromising performance.

Efficient Data Processing Pipelines:

- Batch and real-time processing pipelines are optimized to handle large datasets with minimal latency.
- Caching mechanisms are employed to store frequently accessed data, reducing the load on databases and ensuring faster response times.

Asynchronous Processing:

- Tasks such as data ingestion, complex computations, and background analytics are handled asynchronously, ensuring the platform remains responsive during peak loads.

Database Optimization:

- Indexing is employed on key fields to accelerate query execution.
- Partitioning is used to distribute large tables, improving performance for data-intensive operations.
- Regular database maintenance, such as vacuuming and defragmentation, ensures efficient storage and query execution.

Front-End Optimization:

- Minification and compression of JavaScript, CSS, and images reduce page load times.
- Lazy loading ensures that only essential components are loaded initially, with additional elements loaded as needed.

User-Centric Performance Metrics:

- Response Time: Measures the speed at which users receive data visualizations or interact with the platform.
- Throughput: Evaluates the number of requests the system can handle per second.

- Uptime: Tracks system reliability and ensures high availability for users.

Energy Efficiency:

- Performance optimization includes energy-efficient resource utilization, reducing the platform's environmental impact while maintaining robust capabilities.

3.5.3 Data Security and Compliance (GDPR)

Data Security: The platform prioritizes robust data security measures to protect sensitive information and ensure compliance with legal and regulatory requirements. Security protocols are integrated at every layer of the platform to safeguard data during collection, processing, storage, and transmission.

Key Security Measures

Encryption

- Data at Rest: All stored data is encrypted using advanced encryption standards (AES-256), ensuring that sensitive information remains secure even in the event of unauthorized access to the storage systems.
- Data in Transit: Data is encrypted using Transport Layer Security (TLS) to prevent interception during transmission.

Access Control

- Role-based access control (RBAC) ensures that only authorized personnel can access sensitive data and system functionalities.
- Multi-factor authentication (MFA) is implemented for administrative and privileged access to enhance security.

Regular Security Audits:

- Comprehensive security audits and vulnerability assessments are conducted periodically to identify and mitigate potential threats.
- Penetration testing is performed to simulate cyberattacks and validate the effectiveness of security mechanisms.

Secure Data Deletion:

- Data that is no longer required is securely deleted following established protocols to prevent unauthorized recovery.

Monitoring and Logging:

- Continuous monitoring systems track all activities on the platform to detect anomalies and respond to potential security breaches promptly.
- Detailed logging ensures traceability and supports forensic investigations when needed.

Backup and Recovery:

- Regular backups are performed to safeguard data against loss or corruption, ensuring quick recovery in the event of a system failure or cyberattack.

The platform will be fully compliant with the General Data Protection Regulation (GDPR), ensuring the lawful, transparent, and secure handling of personal data.

4. TECHNICAL SPECIFICATIONS

4.1 Introduction

The R-Map platform is designed with a robust and scalable technical architecture to support the comprehensive analysis of remote working arrangements (RWAs) across urban and rural regions. The platform's development strategy focuses on creating a modular and adaptable system that ensures seamless data integration, efficient processing, and intuitive visualization. A multi-layered architecture is employed to facilitate smooth interaction between the user interface, data processing workflows, and backend services, ensuring a responsive and user-centric experience.

A key priority in the platform’s development is to provide an intuitive and accessible user interface that enables stakeholders to explore complex data effortlessly. Advanced visualization techniques will be incorporated to present geospatial, statistical, and temporal data in an interactive manner, allowing users to analyze trends, compare regions, and gain meaningful insights. The design will ensure responsiveness across various devices and accessibility for users with different technical expertise levels.

On the backend, the platform will be built to handle large volumes of data efficiently, integrating information from multiple sources to provide reliable and up-to-date insights. The system will incorporate optimized data processing techniques to deliver real-time or near-real-time results while maintaining data accuracy and consistency. Strong security measures will be implemented to protect sensitive data and ensure compliance with relevant data protection regulations and best practices.

Below is a comprehensive overview of the development tools and technologies utilized in the design and implementation of both the front-end and back-end components of the R-Map platform. These tools have been carefully selected to ensure optimal performance, scalability, and user experience, supporting the platform’s goal of delivering robust data analysis and visualization capabilities.

4.2 Front-End Structure Using Angular

1. **Angular Framework**
   - **Component-Based Architecture**: The front-end will utilize Angular’s component-oriented structure to build a modular, maintainable, and scalable application. This approach facilitates prompt updates and smooth incorporation of new functionalities.
   - **State Management**: We will implement Angular's state management features to ensure fluid user experiences, particularly when handling large datasets and intricate visualizations.

2. **Integration with Mapping Libraries**
   - **Use of Leading Mapping Libraries**: The platform will integrate mapping libraries such as Leaflet or OpenLayers within the Angular framework. These libraries will enable:
     - **Geographical Visualization**: High-performance rendering of maps showing where people work remotely, with features like zooming, panning, and custom data layers.
     - **Interactive Data Layers**: Overlay statistical data, such as the percentage of remote workers by region, on geographical maps to provide detailed visual insights.

- **Custom Map Features**: Development of functionalities such as heatmaps, clustering, and region-specific analytics.

3. **Data Analytics Integration**
   - **Real-Time Data Visualization**: Integration of Angular-friendly analytics libraries, like [D3.js] or [Chart.js], to visualize remote work data trends, such as the growth of remote work over time or the demographic breakdown of remote workers.
   - **Interactive Dashboards**: Customizable dashboards will allow users to filter and analyze specific data sets, making it easier to draw insights from the remote work data.
   - **Data-Driven Decision Support**: The platform will include tools for comparing regions, tracking changes over time, and forecasting future trends based on historical data.

4. **Responsive User Interface (UI) Design**
   - **Adaptive Layouts**: The UI will be fully responsive, providing an optimal experience on desktops, tablets, and smartphones. This is critical for ensuring accessibility for all users, regardless of their device.
   - **User-Friendly Navigation**: A focus on intuitive navigation will make it easy for policy makers to access and interpret the data, even if they are not technically inclined.
   - **Dynamic Data Display**: Interactive elements will allow users to engage directly with the data, such as by selecting specific regions or demographic groups to display on the map.

4.3 Back-End Development with .NET

1. **Statistical Data Processing**
   a. **.NET Framework**: The back-end will be developed using the .NET framework, which is well-suited for handling large volumes of statistical data related to remote work patterns.
   b. **Data Integration and Management**: The back-end will process and integrate various data sources, ensuring that the front-end visualizations are up-to-date.
   c. **API Development**: RESTful APIs will be created to facilitate smooth communication between the Angular front-end and the .NET back-end, ensuring that data is delivered quickly and securely.
2. **Security and Performance**
   a. **Data Security**: Implementation of robust security protocols to protect sensitive data, particularly when dealing with potentially sensitive information about remote workers.
   b. **Optimized Performance**: Ensuring that data processing is efficient, with minimal latency, so that real-time data can be visualized without delays.

4.4 Exploration of Alternative Technologies and Choice of Angular

Before finalizing the decision to use Angular for the front-end development of the R-Map project, we explored various alternative technologies that are widely used, including those adopted by the official websites of the European Union as described in section 2.3.1. Our goal was to ensure that our final choice not only meets the technical requirements but also aligns with the standards and practices prevalent in Europe, including the use of open source software.

1. **Vue.js and React:**
    a. **Evaluation:** We considered Vue.js and React, both of which are highly popular options for front-end development. Vue.js is known for its simplicity and ease of integration, while React offers significant flexibility through its component-based architecture.
    b. **Usage in the EU**: We observed that main official websites of the European Union adopt these frameworks, particularly for smaller-scale projects or when flexibility and rapid development are priorities.
    c. **Decision**: Despite their strengths, we decided on Angular due to its comprehensive ecosystem, built-in state management, and its ability to support large-scale projects. Angular also offers increased security and stability, which are essential for developing a complex and demanding project like R-Map.
2. **Plugins and Libraries**:
    a. **Usage in the EU**: We noticed that many EU websites use specific plugins and libraries to enhance functionality and performance. This influenced our choices as well, as we selected plugins and libraries that have already proven reliable in European environments.
    b. **Decision**: We opted for a range of Angular-friendly plugins and libraries, such as D3.js for data visualization and Leaflet for geographical visualization, based on practices successfully implemented in other applications within the European Union.

5. DATA SOURCES AND INTEGRATION

5.1 Primary Data Sources

5.1.1 R-Map Large-Scale Survey

The R-Map Large-Scale Survey that ran under T1.5 served as a primary data source for the platform, providing valuable insights into the adoption, challenges, and impacts of remote working arrangements (RWAs) across urban and rural regions. The survey was conducted across a diverse sample of 20,000 respondents, capturing a wide range of socio-economic, demographic, and geographic variables. It offered a comprehensive understanding of remote work trends, workers' preferences, and the socio-economic factors influencing their choices. The data collected from the survey is being systematically processed and cleaned and is going to be integrated into the R-Map platform to support evidence-based analysis and decision-making. Through advanced data integration techniques, the survey findings will be combined with additional external datasets to provide a holistic view of remote work dynamics. This integration will allow policy makers to explore correlations between remote work patterns and factors such as regional infrastructure, economic development, and quality of life indicators.

5.1.2 Open Data Repositories

Open data repositories play a crucial role in providing publicly accessible and reliable datasets to inform the R-Map model and further be visualized in the R-Map platform. These repositories, typically maintained by governmental and international organizations, offer a wealth of data covering various socio-economic, environmental, and spatial indicators relevant to the project. Key sources include Eurostat, which provides harmonized statistical data across all EU countries at high spatial resolutions, and the European Foundation for the Improvement of Living and Working Conditions (Eurofound), offering comprehensive insights into working conditions and quality of life indicators across Europe. Other notable repositories include OpenStreetMap, which provides detailed geospatial data, the EU Social Progress Index (EU-SPI), offering region-specific socio-environmental data, and the ESPON Data and Knowledge Portal, which aggregates data related to territorial development across Europe. These open data sources enable the R-Map platform to analyze trends and patterns in remote working arrangements, ensuring comprehensive and informed assessments at varying spatial levels, such as NUTS2 and NUTS3 regions.

5.2 Data Cleaning and Preprocessing

Data cleaning and preprocessing will be critical steps in ensuring the accuracy, reliability, and consistency of the structured datasets used within the R-Map platform. These processes are already being conducted under Task 3.2, where raw data from various sources, including the R-Map Large-Scale Survey and official statistical databases, undergo rigorous validation and refinement procedures. The goal is to identify and correct inconsistencies, handle missing values, and standardize formats to ensure seamless integration and analysis within the platform. Preprocessing techniques such as data normalization, outlier detection, and duplicate removal will be applied to enhance data quality and usability.

The outcomes of the data cleaning and preprocessing phase will serve as valuable feedback for version 2 of Deliverable D3.1, enabling refinements to the platform's architecture and ensuring that the data processing pipelines are optimized for improved performance and accuracy. As part of this iterative process, best practices and lessons learned from Task 3.2 will be incorporated to enhance the data ingestion, storage, and analytical capabilities of the platform.

5.3 Data Storage and Management Strategies

The R-Map platform will employ a data storage and management strategy to ensure the efficient handling, retrieval, and analysis of critical datasets. Structured data, originating from sources such as the R-Map Large-Scale Survey and official statistical databases, will be stored in relational database management systems (RDBMS) that provide robust data integrity, consistency, and scalability. The storage framework will be designed to support complex queries, enabling stakeholders to access reliable insights with minimal latency. Data will be organized using well-defined schemas that facilitate efficient indexing, retrieval, and cross-referencing of key variables such as geographic, demographic, and economic indicators. Regular data validation and quality checks will be implemented to ensure accuracy and consistency across all datasets. The platform will also interact dynamically with the R-Map model by storing results generated by the model. When the platform queries the R-Map model to simulate specific scenarios or retrieve forecasted trends, the fetched results will be systematically stored within the database. This ensures that previously generated insights can be efficiently retrieved without requiring repeated model executions, optimizing system performance and reducing computational load. Additionally strict access control mechanisms will be set in place to regulate user permissions and protect sensitive information in compliance with data protection regulations, such as GDPR. Backup and recovery strategies will be established to prevent data loss and ensure business continuity.

6. VISUALIZATION STRATEGY

6.1 Dashboard Design Principles

The R-Map platform's dashboard is designed with a user-centric approach, ensuring that complex data related to remote working arrangements (RWAs) is presented in an intuitive, accessible, and actionable manner. The dashboard serves as the primary interface for policymakers offering interactive tools to explore spatial, social, and economic insights across urban and rural regions. To achieve this, the design follows key principles such as clarity, usability, responsiveness, and interactivity, ensuring that users can easily interpret data and make informed decisions based on reliable insights.

One of the core principles guiding the dashboard design is clarity and simplicity, where visual elements are carefully structured to avoid clutter and information overload. The dashboard presents data in an organized manner using well-defined layouts, color schemes, and typography to ensure readability. Essential information is prioritized through the use of visual hierarchy, making it easy for users to identify trends and patterns at a glance. The inclusion of contextual tooltips and explanatory notes further enhances clarity, providing users with additional context without overwhelming the interface.

Interactivity and customization are also critical components of the R-Map dashboard design. Users can engage with the platform through dynamic filters, time-range selectors, and drill-down options to refine their analysis according to specific geographic regions, demographic groups, or economic factors. This functionality allows stakeholders to compare different scenarios, track changes over time, and extract insights tailored to their unique needs. Additionally, customizable dashboards enable users to personalize their experience by selecting preferred visualization types, such as maps, charts, or tables, ensuring relevance to their policy focus.

Another fundamental principle is responsiveness and accessibility, ensuring that the dashboard is fully functional across multiple devices, including desktops, tablets, and smartphones. The platform’s adaptive design allows seamless interaction regardless of screen size, enabling stakeholders to access critical insights on the go. Compliance with Web Content Accessibility Guidelines (WCAG) ensures that the dashboard is accessible to users with disabilities, incorporating features such as keyboard navigation, screen reader compatibility, and high-contrast visual options to enhance inclusivity.

Data visualization best practices are at the core of the R-Map dashboard, leveraging various visualization techniques to present complex datasets in a meaningful way. Geospatial maps, time-series graphs, and comparative bar charts are utilized to highlight regional disparities, trends, and correlations. The dashboard is designed to accommodate large volumes of data without compromising performance, using optimized rendering techniques and efficient data querying to ensure smooth interactions even when handling complex visualizations.

In addition to visualization and interactivity, performance and security considerations are integrated into the dashboard design. The system is optimized to handle large datasets with minimal latency, ensuring that users receive real-time insights without delays. Robust security measures, such as role-based access control (RBAC) and data encryption, safeguard sensitive information, ensuring compliance with privacy regulations such as GDPR.

Finally, decision support and actionable insights are embedded within the dashboard design to provide stakeholders with meaningful outputs that guide policy formulation and strategic planning. The platform includes features such as automated reporting, scenario analysis, and predictive modeling, enabling users to make data-driven decisions confidently.

6.2 Visualization Types

6.2.1 Geospatial Maps

Geospatial maps in the R-Map platform are integral tools for understanding the geographic distribution and regional variations of remote work trends. These maps enable users to visually explore and analyze data across different locations, providing an intuitive way to grasp complex spatial patterns. With interactive features like panning and zooming, users can focus on specific areas of interest, from a macro view of entire countries to a micro-level view of individual regions.

Color-coded regions offer a straightforward representation of data intensity, making it easy to identify areas with high or low adoption rates of remote work. Additionally, the platform supports overlaying multiple datasets, such as broadband infrastructure, population density, or economic indicators, on the same map. This feature allows users to explore correlations and gain deeper insights into regional disparities.

Geospatial maps are particularly useful for identifying urban-rural differences, helping policymakers and stakeholders understand where interventions may be needed. For example, by analyzing regional readiness for remote work, the platform can highlight infrastructure gaps that need addressing to support equitable development.

Platform Features that will be implemented:

1. Interactive panning and zooming for detailed regional analysis.

2. Color-coded regions to highlight variations in metrics such as remote work adoption or economic impact.

3. Overlay options for displaying multiple datasets simultaneously, such as broadband access and population density.

4. Various Map implementations such as:

- Choropleth Map
- Dot Distribution Map
- Heat Map
- Cartogram

Indicative Use Cases:

1. Identifying urban-rural disparities in remote work adoption.
2. Analyzing regional infrastructure readiness for remote work.

6.2.2 Time-Series Analysis

Time-series visualizations in the R-Map platform are designed to uncover trends and patterns over time, providing a temporal perspective on the impacts of remote work. These visualizations are represented through line charts, area graphs, or bar charts, which dynamically update as users adjust the time range sliders. This interactivity allows for granular exploration of specific periods, enabling users to focus on short-term fluctuations or long-term trends.

Annotations within the time-series charts provide additional context by marking significant events, such as policy changes or external disruptions, that may influence remote work trends. These visualizations are particularly valuable for monitoring how remote work adoption evolves over months or years, offering stakeholders insights into the effectiveness of policies or market adjustments.

For instance, a time-series chart could show how remote work adoption surged during a specific year due to external factors, such as a global event or government initiative, and then stabilized or declined in subsequent periods. Such insights are crucial for planning future strategies and understanding temporal dynamics.

Platform Features that will be implemented:

1. Line charts, area graphs, and bar charts for tracking data changes over time.

2. Integration with a time range slider to dynamically filter data by specific periods.

3. Annotations to mark significant events or shifts in trends.

4. Integration with filters on top of the map for detailed view for any purpose research related with RWAs.

Indicative Use Cases:

- Monitoring the progression of remote work adoption over months or years.
- Identifying seasonal trends or anomalies in regional economic activity.

6.2.3 Comparative Data Visualizations

Comparative data visualizations in the R-Map platform allow users to evaluate and contrast multiple datasets side by side, fostering a deeper understanding of the relationships and differences between them. These visualizations include bar charts, pie charts, and scatter plots, which offer flexible and visually engaging ways to analyze data.

Users can leverage these tools to compare metrics across categories, such as urban versus rural remote work adoption rates, or across locations, such as regions within a country. Interactive toggles allow for quick switching between datasets or demographic groups, making the visualizations highly adaptable to the user's needs. Additionally, multi-region comparisons on geospatial maps further enhance the analytical capabilities, enabling stakeholders to draw meaningful conclusions about regional disparities and their underlying causes.

For example, policymakers can use comparative visualizations to evaluate which regions have benefited most from remote work initiatives and which require additional support. By providing clear and actionable insights, these tools empower users to make informed decisions and effectively address regional disparities.

These visualization types ensure that the R-Map platform delivers actionable insights to users, making complex datasets easier to interpret and apply in decision-making.

6.3 User Interaction

Export and Sharing Options. To facilitate collaboration and reporting, the platform includes options to export data visualizations in various formats, such as CSV, PDF, or image files. These export features enable users to share insights with colleagues or stakeholders efficiently, ensuring that the platform's findings can be shared widely.

Collaboration and Sharing

A feature to share customized visualizations or datasets with other platform users via secure links or export options will be added. Users will also be able to annotate charts and maps, making it easier to communicate insights within teams or during policy discussions.

Advanced Filtering Options

The platform will introduce conditional filtering capabilities, enabling users to create complex queries (e.g., "Show regions where remote work adoption exceeds 50% and average income is below €30,000"). This advanced filtering will provide greater granularity in data exploration.

Accessibility Improvements

Additional customization options for accessibility, such as high-contrast themes and adjustable font sizes, will ensure inclusivity for users with disabilities.

Data Annotation

Users will be able to annotate data points or visualizations directly within the platform, making it easier to document observations, insights, or questions for collaboration.

7. DATASETS TO BE VISUALIZED AND THEIR VISUALIZATION POTENTIAL

7.1 Integration of Open and Survey Data for R-Map Visualization

This section presents the core outcomes of Task 3.2, which is dedicated to the comprehensive collection, evaluation, and integration of open and survey-based datasets into the R-Map platform. As a major technical component of Work Package 3, Task 3.2 serves to implement the architectural vision established in Task 3.1 by supplying the platform with real-world, harmonized, and spatially enabled data that informs the visual capabilities of the system.

Whereas Deliverable D3.1 version 1 focused on system architecture and platform design, this section provides empirical and implementation-driven complement. It documents the process by which the R-Map consortium identified, sourced and standardized datasets from institutional repositories and the R-Map large-scale EU-wide survey (Task 1.5). The data selected for integration reflects the project's multidimensional impact framework, spanning social, economic, spatial, and environmental indicators related to remote working arrangements (RWAs).

Under the coordination of ARX.NET, and with thematic support from AUTh, UT, UB, KU, SEERC, SURREY and Q-PLAN, Task 3.2 undertook a data acquisition process that was simultaneously decentralized—leveraging the domain expertise of each partner—and harmonized through central validation and platform integration protocols. This collaborative approach ensured both relevance and technical coherence.

This section further describes how these datasets were structured and stored to enable interactive, multi-layered visualizations. In doing so, it builds on and extends the "Data Sources and Integration" and "Visualization Strategy" section s from D3.1 v1. Specific emphasis is placed on how different data streams—such as Eurostat's labor market indicators and EWCS data from Eurofound—were combined with individual survey responses to support spatially explicit dashboards and comparative regional profiles.

Examples of planned and prototyped visualization outputs are included to illustrate how the integrated datasets enable novel analytical use cases. These include regional dashboards that visualize digital infrastructure alongside perceived work-from-home productivity, interactive maps combining environmental quality with RWA frequency, and charts highlighting urban-rural contrasts in broadband access and job satisfaction.

This section provides not only a technical description of the data lifecycle from acquisition to visualization but also an applied perspective on how these integrated data products can inform evidence-based policy and regional strategy formulation. Depending on the availability of sector-specific datasets and the implemented capabilities of the R-Map model, the platform will progressively evolve to support enriched visual policy scenarios—enabling stakeholders to explore, compare, and interpret the projected impacts of different policy pathways across spatial, social, economic, and environmental dimensions.

7.2 Data Collection Activities from Task 3.2

Task 3.2 of the R-Map project was designed to collect, harmonize, and integrate diverse datasets essential for the development of the R-Map visualization platform. From the outset, it was evident that this would require close collaboration among consortium partners, each contributing complementary expertise across spatial, socio-economic, and environmental domains.

Initially, Task 3.2 focused on independently sourcing datasets relevant to understanding the multifaceted impacts of remote working arrangements (RWAs). To support collaborative data integration, a shared repository was established, enabling all partners to contribute relevant datasets along with corresponding metadata and contextual information. Through this coordinated effort, a total of 87 data sources—spanning local, EU, and global levels—were identified and compiled. These datasets covered a comprehensive range of thematic domains critical to the R-Map project, including accessibility, demographics, digital infrastructure, economy, education, environment, health, housing, ICT infrastructure, labor, mobility, quality of life, research, social and socio-economic indicators, spatial and environmental conditions, tourism, urban development, and well-being.

However, during the task's implementation—through consortium-wide meetings and bilateral discussions—it became apparent that Task 2.2, led by the University of Twente (UT), was already undertaking comprehensive data collection and harmonization to support the R-Map integrated impact assessment model.

UT had established a robust harmonization protocol under Task 2.2, aligning datasets to common spatial units (e.g., NUTS-2 and NUTS-3), applying temporal standardization, and normalizing variable definitions. This included quality assurance measures such as validation checks and transformation pipelines to address missing or inconsistent data.

Recognizing the technical soundness and efficiency of UT's approach, the consortium decided to extend these harmonization practices to Task 3.2. This decision ensured consistency across work packages and enabled reuse of harmonized datasets wherever applicable. Notably, the datasets prepared for Task 2.2 could also serve the needs of Task 2.3—focused on typologies of EU regions in the context of RWAs—and Task 3.2, which underpins the visualization component of the R-Map platform.

This integrated and cross-WP strategy meant that each partner could contribute domain-specific datasets—UT and AUTh on spatial and environmental data; KU, SURREY, SEERC, and UB on socio-economic data—while aligning with a unified data architecture. Task 3.2 thus shifted from raw data collection to building the critical interface between the harmonized model input (Task 2.2) and the user-facing R-Map visualization platform.

This transition presented challenges related to data interoperability. The collected datasets varied significantly in format, spatial and temporal resolution, and metadata conventions. Addressing these challenges became a central focus of Task 3.2 to ensure that the visualization platform could seamlessly render analytical outputs from the R-Map model.

As a result, the data infrastructure developed in Task 3.2 represents not just collaborative planning but also a technical extension of the harmonization framework initiated in WP2. This ensures that the R-Map platform operates on a foundation of high-quality, interoperable, and analytically coherent datasets—supporting regional monitoring, cross-case comparisons, and evidence-based policymaking aligned with the project's overarching goals.

7.3 Thematic Domains and Partner Responsibilities in Data Collection

Before the decision was made to adopt the harmonized datasets from Task 2.2, the initial approach for Task 3.2 aimed to support collaborative data collection through the creation of a shared repository. This repository allowed consortium partners to contribute relevant datasets according to their expertise, accompanied by key metadata and contextual descriptions to ensure transparency and usability. Through this coordinated effort, a total of 87 data sources were identified and compiled, spanning local, EU, and global levels. These datasets cover a wide array of thematic areas critical to the R-Map project, including accessibility, demographics, digital infrastructure, economy, education, environment, health, housing, ICT infrastructure, labor, mobility, quality of life, research, social and socio-economic indicators, spatial and environmental conditions, tourism, urban development, and well-being.

While the version of the table shared in Appendix 10.3 presents only the core metadata for clarity, additional columns with detailed metadata—including data formats, spatial and temporal resolution, and licensing terms—are also maintained within the project's internal documentation.

A complementary group of datasets from Task 2.3, which is in progress until M20, is also available on the project's internal repository and will significantly contribute to the R-Map platform's enhancement. The full visualization potential of this dataset will be the outcome of Task 2.3, aligning with the platform development goals.

Below is an aggregated table summarizing the thematic areas of the datasets that are being utilized in Task 2.3:

Table 4: Datasets per Factor from T2.3

Factor	Count of Datasets
Access to labor market	4
Carbon Emissions	4
Cost of living	2
Digital infrastructure	2
Economy	14
Employment	3
Industry	1
Mobility	1
Land Consumption	1

Population	3
Productivity	7
Quality of Life	1
RWA	1
Tourism	1
Work-life Balance	4

7.4 Data Interoperability and Integration

The interoperability fabric of the R-Map platform is a robust, plug-and-play layer that takes in various data sources, such as open GIS databases, citizen questionnaires, national telework surveys, and custom R-Map metrics, and converts them into a single, machine-readable format. Three essential subsystems collaborate behind the scenes

1. **Schema Registry & Evolution**
   Schema definitions will be created in collaboration with UT and stored in a centralized JSON Schema repository. Each incoming dataset is automatically validated against its schema; any discrepancies trigger semi-automated migration scripts to preserve backward compatibility and log every change in a versioned history.

2. **Connectors & Adapters**
   The mechanics of data gathering are handled by modular ETL components:
   a. For dynamic JSON/CSV endpoints, a RESTful API client
   b. On-demand file ingestors for CSV, XLS, and XLSX dumps
   c. Geospatial raster and vector tile OGC tile fetchers (WMS/WMTS)

3. **Semantic Alignment**
   The R-Map conceptual model is systematically linked to fields such as "admin_region_code" and "telework_pct_2020" using relational crosswalk tables and OWL-based ontology mappings. End-to-end traceability and audit are made easier by the integrated provenance metadata—source URL, timestamp, and transformation step—found in all entries.

Integration in Action

Now, importing a new municipal registry only takes a few minutes: the adapter spins up, the schema is registered, and the data passes through our pipelines, is verified, and shows up in the analytics layer without any manual involvement in a matter of hours.

A modular data interoperability layer underpins the R-Map platform, harmonizing survey outputs, open-source geographic and socio-economic datasets, and bespoke R-Map indicators. Leveraging a flexible schema registry, each incoming dataset—irrespective of format or granularity—is ingested, validated, and mapped into a canonical internal representation at runtime.

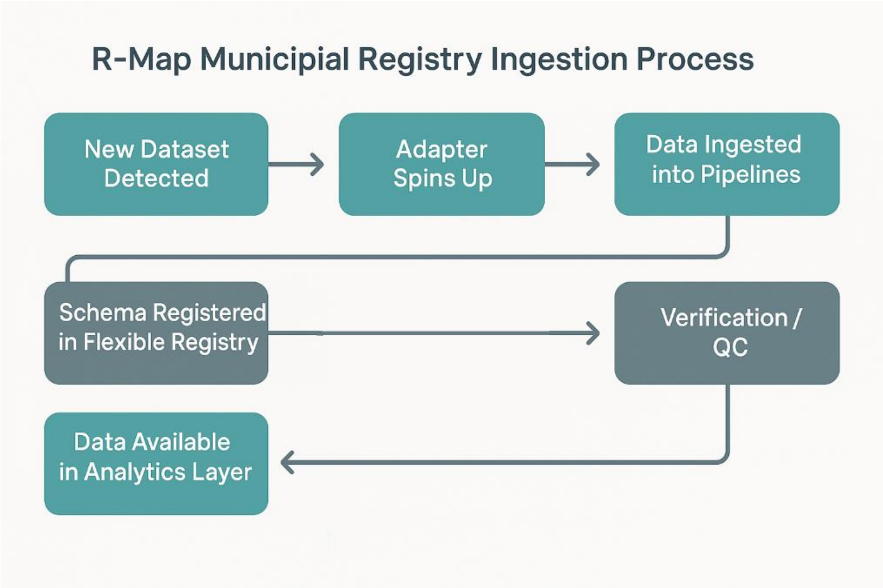

Figure 18: Ingestion Process

7.5 Visualization Potential and Synergies of Integrated Data

With a rich, integrated dataset in place, the R-Map platform can unlock powerful visualization potentials and synergies that would not be apparent from individual data sources alone. The combination of multiple datasets allows the platform to generate multi-dimensional insights – users can overlay and compare different types of information in interactive ways to observe patterns, correlations, and trends related to remote working. The "one-stop" R-Map observatory envisioned in D3.1 v1 is now being realized: it will present data through dashboards, maps, graphs, and charts drawn from the integrated datasets.

For example, consider a policymaker interested in how digital connectivity influences remote work adoption in rural areas. Using the R-Map platform, they could view a thematic map of Europe showing broadband coverage (an open dataset) and overlay markers or color-coding indicating the percentage of survey respondents in each region who primarily work from home (survey data). This combined visualization might reveal clusters of regions where high connectivity coincides with high remote work uptake, versus regions where a gap exists.

Similarly, the platform can generate comparative charts: a user might plot an economic indicator (such as regional GDP or unemployment rate) alongside a "remote work readiness" index, both sourced from datasets already available within the platform, to assess whether economically stronger regions are also better poised for remote work transitions. Because all these data are in one system, such comparisons are straightforward. The platform's interface enables users to select multiple indicators across domains and instantly render visual comparisons (e.g., bar charts, scatter plots). This integrated setup facilitates the exploration of cross-domain relationships. For instance, a scatter plot could display each region's commute-related CO_2 emissions against its remote working rate to investigate potential correlations. These are the kinds of synergistic insights the integrated R-Map data can provide.

With the data landscape of R-Map consolidated, we can produce multi-dimensional, rich visualizations that show patterns that are impossible to discern separately. Synergistic visualizations include, for example:

Table 5: Visualization Types

Visualization Type	Description	Key Benefit
Linked Dashboards	Choropleth maps of remote work intensity, in comparison with broadband coverage, as well as from both Rural and Urban perspective—all synchronized by filter	Spot spatial vs. temporal correlations immediately
Interactive Dashboard	A guided sequence of maps and plots where stakeholders can adjust parameters (e.g., broadband coverage) and immediately see projected impacts on GDP	Easily identify policy impact
Collaborative Annotations	Shared workspaces embedded in the dashboard let users pin notes, propose policy tweaks, and attach documents directly to map locations	Accelerate decision-making with contextual commentary preserved alongside data

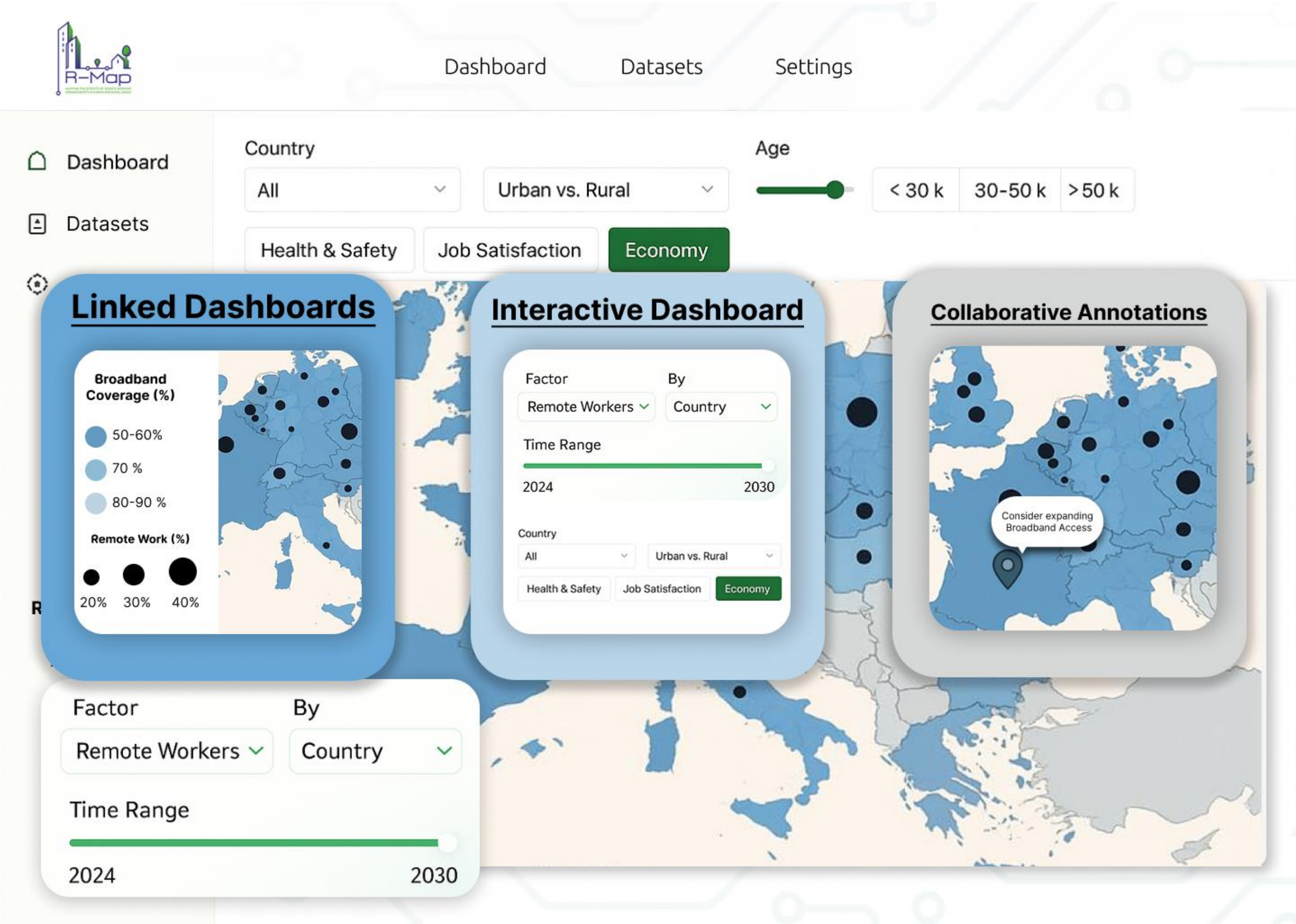

Figure 19: Visualization examples

The next paragraph presents a guided walkthrough of the R-Map platform's initial data configuration and visualization output.

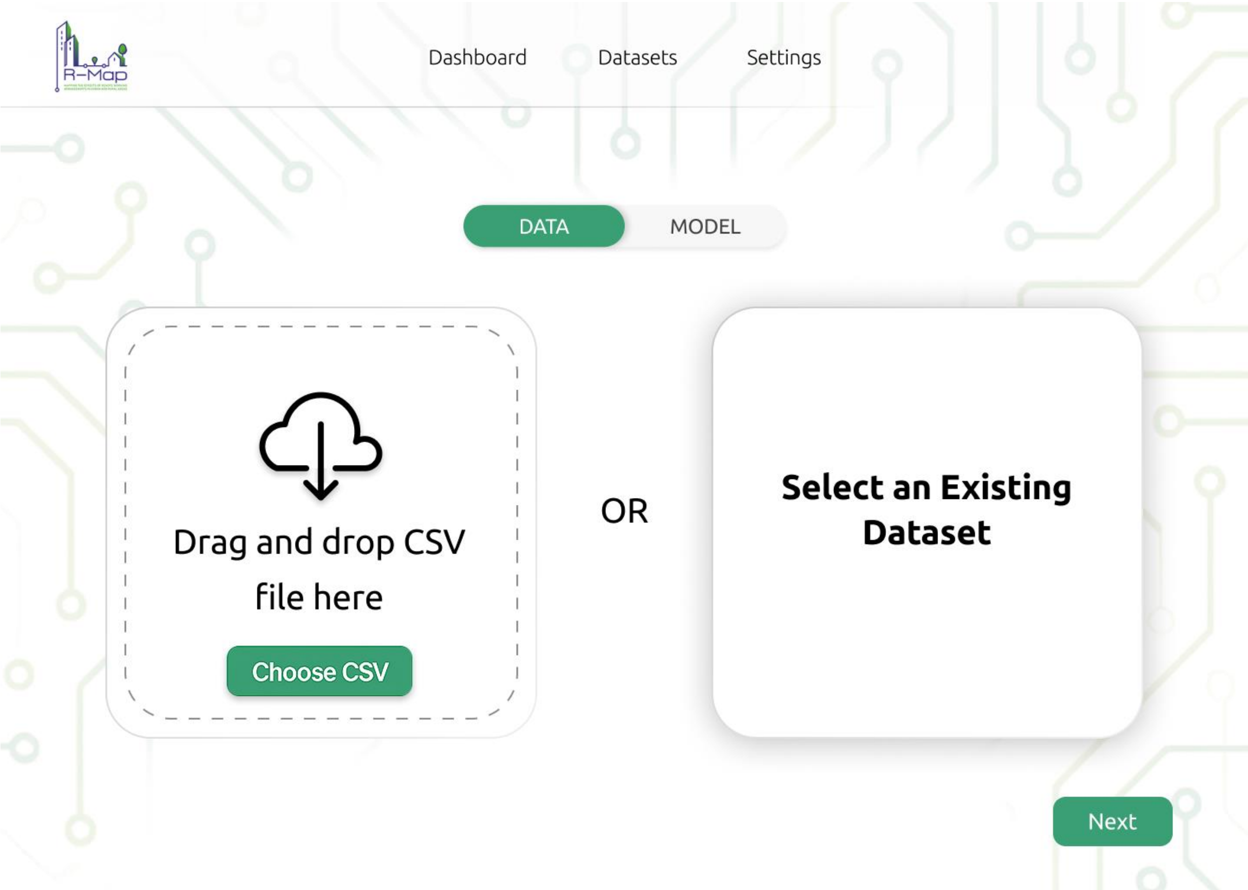

Figure 20: Walkthrough part 1

On this first screen, users choose their dataset source. They can drag-and-drop a CSV or click **Choose CSV** to upload new data, or switch to **Select an Existing Dataset** to pull in previously ingested tables. The **DATA / MODEL** toggle lets them switch contexts if they need to work on model definitions instead. Once a file is chosen or a dataset picked from the dropdown, hitting **Next** advances them to the review step.

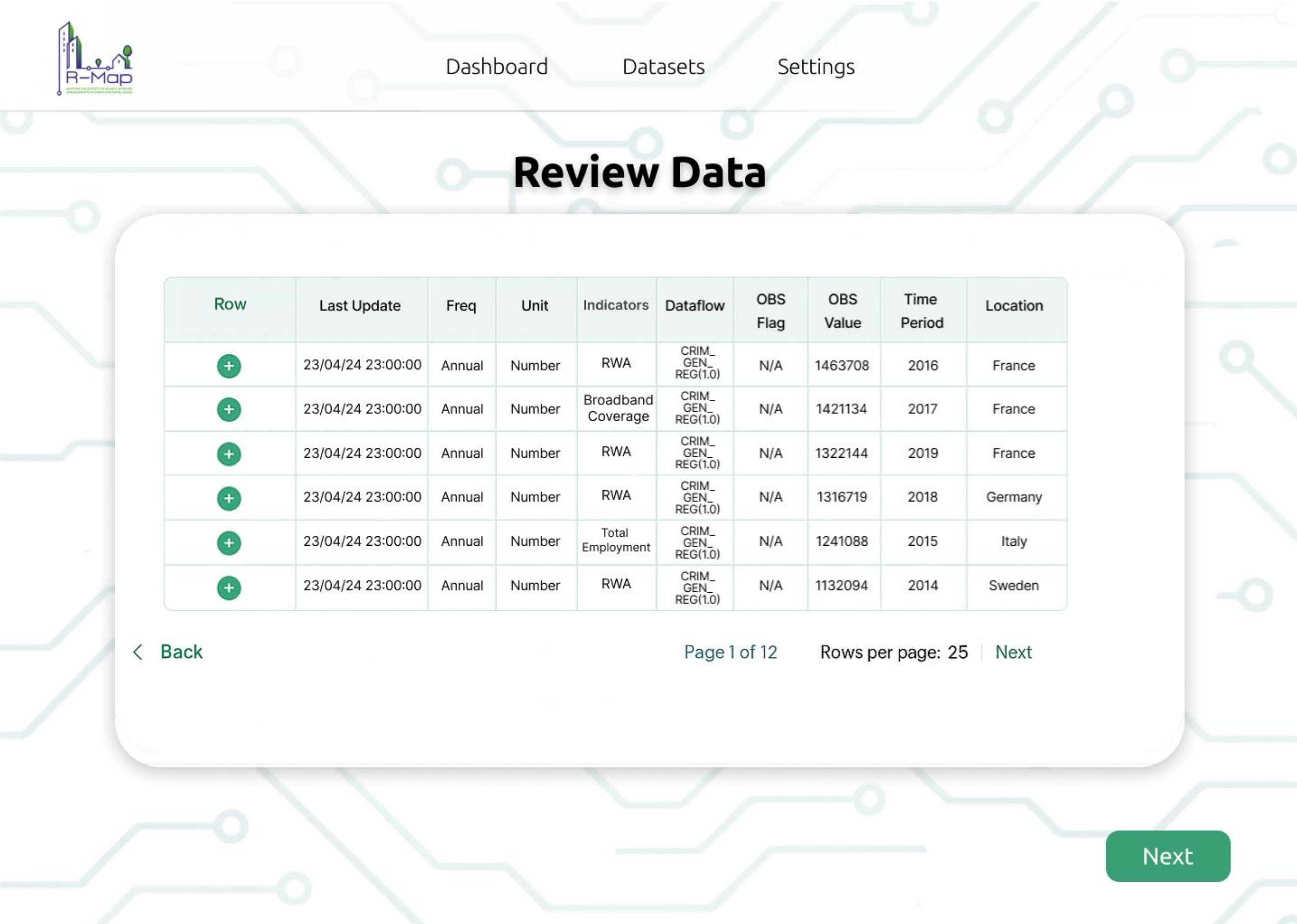

Figure 21: Walkthrough Part 2

Here, the uploaded or selected dataset is rendered in read-only tabular form for quick sanity checks. Each row shows key fields—update timestamp, frequency, unit, dataflow code, observation value, time period, and location—along with an expand **+** icon for drill-down details. Pagination controls and **Rows per page** let users navigate large files. If everything looks correct, the **Next** button moves them to factor configuration; otherwise they can click **Back** to re-upload or select a different dataset.

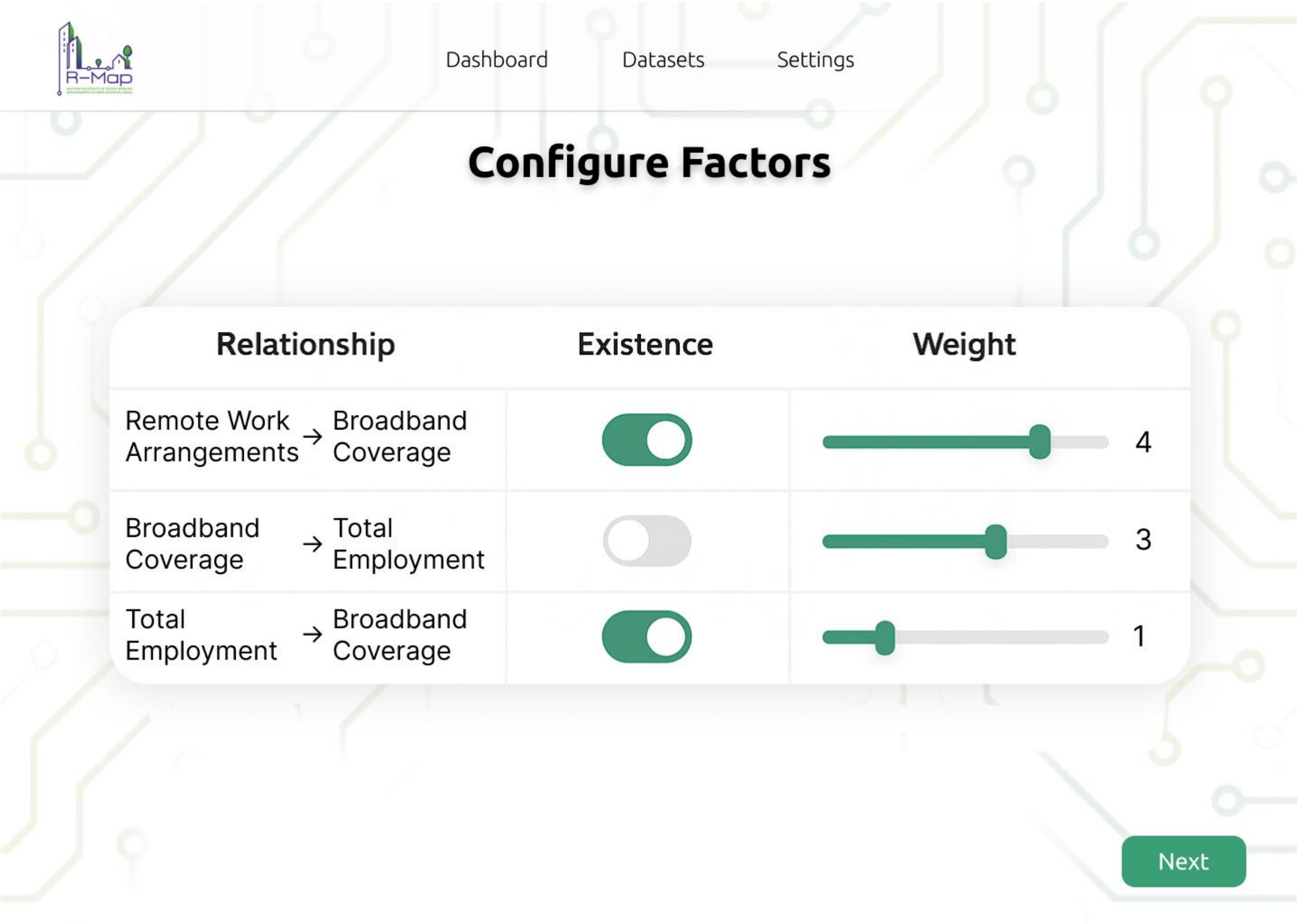

Figure 22: Walkthrough Part 3

This step presents each potential causal link in the R-Map model (e.g. *Internet Access* → *Work*). Users toggle **Existence** on or off to include/exclude a relationship, then assign its **Weight** via a slider (1–10). The numeric value updates live beside each slider. By turning off a link entirely, its slider grays out. Once the model structure and relative importances feel right, clicking **Next** will apply these settings to the map visualization. An extended explanation of factors and weights is provided in D2.1 in section 5.4.3 Model run and initial results.

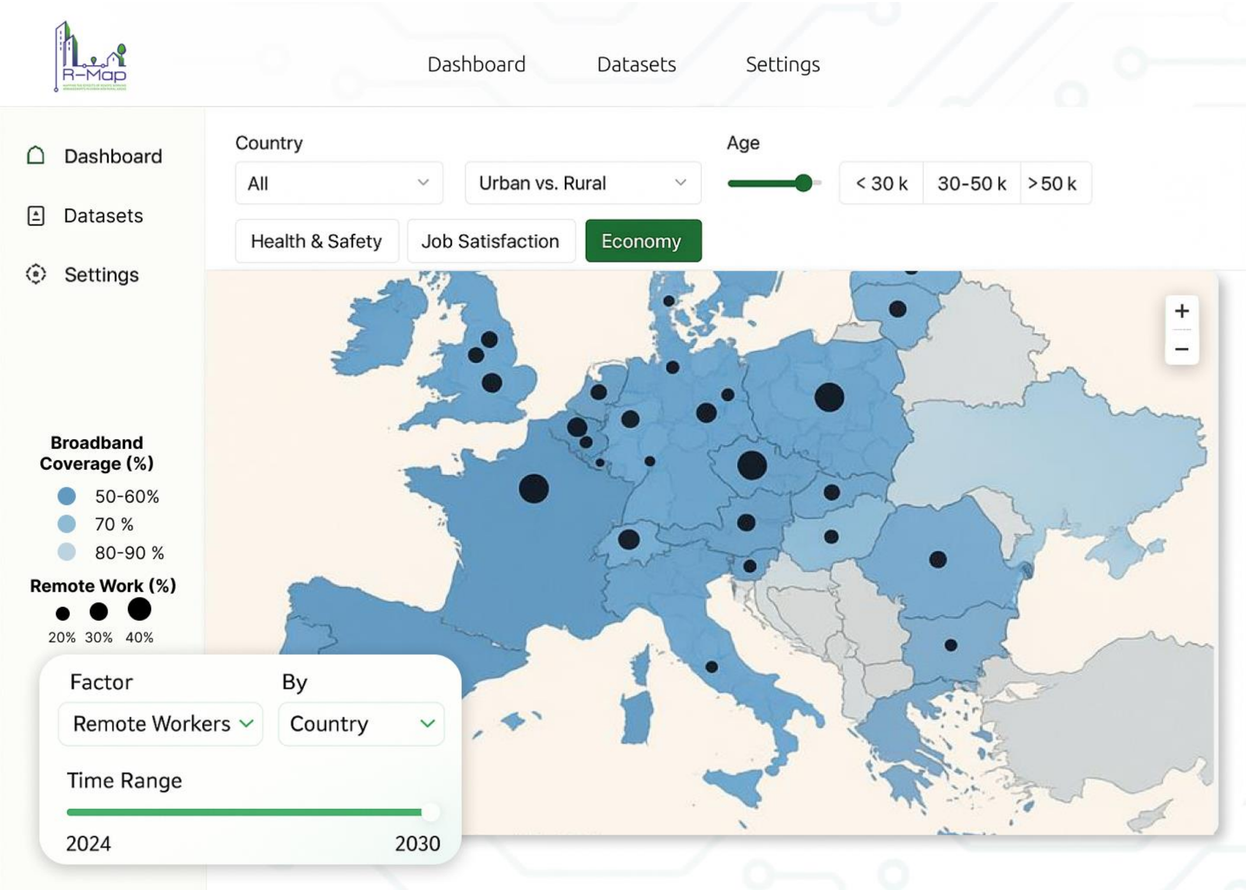

Figure 23: Walkthrough Part 4

Finally, the full-width Europe map displays thematic shading (here, broadband coverage) overlaid with proportional markers (remote work uptake). Above the map are filtering controls—country dropdown, age-group slider, and quick-select pills for Impact dimension (e.g. *Economy*)—so users slice and dice the view in real time. Zoom **+**/– buttons on the map let users hone in. Hovering over a region pops up a "detail" callout with exact percentages for both datasets.

In summary, the visualization potential of the integrated R-Map dataset is significant. By enabling multi-layered maps, cross-indicator charts, time-lapse visualizations (showing trends over time), and scenario simulations, the platform will provide users with the ability to explore "the big picture" and the details in one place. The synergies arising from integrated data — such as uncovering correlations between remote work and regional characteristics or visualizing the composite effects of remote work across different domains — are precisely what the R-Map project seeks to deliver. This validates the effort invested in data integration: the payoff is a dynamic visualization platform where the whole is greater than the sum of its parts, offering insights that would remain hidden if each dataset were viewed in isolation.

7.6 Alignment with D3.1 v1 Architecture and Visualization Strategy

All the efforts detailed in this section have been carefully aligned with the R-Map platform architecture and visualization strategy established in Deliverable D3.1v1. The first version provided a comprehensive blueprint of how the platform should be built – from data ingestion and management to front-end visualization tools – to meet the project's objectives. The data collection and integration activities for D3.2 are executed in accordance with that blueprint, ensuring continuity and consistency between the two versions of the deliverable.

Architectural alignment: In D3.1 v1, the platform's design was described as a modular system with distinct layers: a data ingestion layer, a data storage/processing layer, and a visualization & user interface layer. Over the course of Task 3.1 and 3.2, we implemented the dataset integration following this layered approach. The ingestion of open datasets and survey data has been handled through ETL (Extract-Transform-Load) processes that mirror the planned architecture – raw data is extracted from sources, transformed (cleaned and standardized) and loaded into the storage layer. The storage layer, as noted, uses a relational database which was exactly the strategy foreseen in D3.1 v1 for structured data management. By adhering to that plan, we ensure that the data pipelines are robust and scalable, capable of handling the current dataset volume and future expansions. Indeed, lessons learned during data integration are being fed back into the architecture design: for example, encountering divergent data formats and large file sizes early on allowed the team to optimize the ingestion scripts and database indexing strategies for better performance. We have followed through on this by adjusting the system architecture where needed (e.g., adding a caching layer for frequently accessed indicators etc.) to ensure that integrated data can be served to the front-end efficiently.

Visualization strategy alignment: D3.1 v1 also laid out a clear visualization strategy, centered on two main capabilities of the platform: (i) an interactive map visualizing R-Map model results for each region (with the ability to explore factors and typologies), and (ii) a one-stop dashboard observatory with charts and graphs of collected data on remote work and its impacts. The datasets gathered and described in this section directly support both of those pillars. The regional datasets (Task 3.2 outputs) and the survey data (WP1) provide the content that populates the one-stop observatory: thanks to our integration work, the dashboard can draw from a single unified dataset to populate multiple visualizations simultaneously (maps, bar charts, time series, etc.), exactly as envisioned. The connection established between the R-Map model and the platform means that with WP2 having delivered the model (and WP4 explores scenarios), the interactive map can query the model outputs from the database and update visuals in near real-time, fulfilling the promise of scenario-based visualization. Additionally, the forthcoming inclusion of regional typologies will reinforce the strategy of comparative visualization.

The alignment with the v1 strategy is also evident in how we addressed user requirements. The D3.1 v1 report emphasized that the platform must be *user-driven*, particularly highlighting policymakers as primary users. The integrated data is structured to answer policy-relevant questions, and the visualization options (maps, scenario tools) were chosen to be intuitive for non-technical decision-makers. Both types of users are supported by the flexible architecture and rich data described in this section. The interactive dashboards, scenario-building tools, and customizable reports highlighted in v1 are being built upon the datasets that are being collected and harmonized.

In conclusion, Section 7 of D3.1 v2 extends the groundwork of D3.1 v1 by detailing the specific datasets and formats that feed into the R-Map platform, while demonstrating that this detailed implementation remains fully aligned with the original architecture and visualization strategy. The collaborative, multi-partner approach to data collection (WP3 Task 3.2 in concert with WP1 and WP2 inputs) has validated and enhanced the platform design outlined in v1. As a result, the R-Map platform development is on a solid path: the architecture can seamlessly incorporate the diverse datasets, and the visualization strategy is empowered by these data to deliver impactful insights. This alignment ensures that the platform remains on track to meet its objectives of providing a data-driven, user-friendly observatory on remote working arrangements, ultimately supporting evidence-based policy across Europe.

8. REFLECTIONS ON THE R-Map PLATFORM ARCHITECTURE

8.1 Strengths and Challenges

The R-Map platform architecture is being designed to provide a comprehensive, scalable, and user-centric solution for assessing the impacts of remote working arrangements (RWAs) across Europe. The platform demonstrates several strengths, and we are convinced it can serve policymakers by offering data-driven insights into the evolving dynamics of remote work. However, like any complex system, it also faces challenges that must be addressed to ensure long-term effectiveness and sustainability.

Strengths

One of the key strengths of the R-Map platform is its modular and scalable architecture, which allows for the seamless integration of various data sources and analytical tools. This modularity ensures flexibility, enabling the system to adapt to new requirements and technological advancements with minimal disruption. The platform's data integration capabilities are another significant strength, combining structured datasets from the R-Map Large-Scale Survey and open data repositories to provide a holistic understanding of remote work patterns. By leveraging advanced data visualization techniques, such as geospatial mapping and interactive dashboards, the platform presents complex data in an intuitive and accessible manner, empowering users to make informed decisions. By maintaining a centralized, structured storage system, the platform can standardize and harmonize external data, reducing dependencies on real-time access to third-party sources while ensuring that validated datasets remain accessible even if external providers experience delays or restrictions.

The platform's compliance with established data protection regulations, such as the General Data Protection Regulation (GDPR), further enhances its credibility and usability. Additionally, the platform's user-centric design ensures that its stakeholders can access and interpret data with ease, supported by intuitive navigation, customizable reports, and scenario-building tools. Lastly, the predictive modeling capabilities based on the R-Map model that is being developed and will be embedded within the platform provide valuable foresight into the potential future impacts of RWAs, supporting evidence-based policymaking and strategic planning.

Challenges

Despite these strengths, several challenges must be addressed to ensure the successful deployment and long-term sustainability of the platform. One of the primary challenges is data quality and consistency, as the platform relies on multiple external sources that may vary in accuracy, completeness, and timeliness. Ensuring data harmonization across diverse datasets and maintaining high levels of data integrity will require continuous monitoring and validation processes.

Another important challenge pertains to system performance and scalability, not only in handling larger data volumes and an expanding user base but also when introducing new variables for region-specific insights in future work (e.g., WP4). Optimizing data pipelines and ensuring efficient query performance will be critical to maintaining a responsive user experience. Meanwhile, stakeholder engagement remains a potential hurdle, given the varying technical expertise and expectations across different user groups. Delivering an intuitive user interface will be essential for encouraging broad adoption and effective use of the platform.

Ensuring cybersecurity is another key challenge. Implementing robust security measures, such as encryption, and regular security audits, will be essential to mitigate potential risks and maintain user trust. Finally, long-term sustainability and maintenance of the platform beyond the project's duration present challenges related to funding, resource allocation, and continuous updates to keep the platform relevant and operational in a rapidly evolving digital landscape.

Addressing these challenges proactively through strategic planning, stakeholder collaboration, and technical refinements will be essential to maximize the impact and effectiveness of the R-Map platform in shaping policies and strategies related to remote work.

8.2 Limitations

While the R-Map platform offers a robust framework for assessing the impacts of remote working arrangements (RWAs), certain limitations must be acknowledged to enhance its effectiveness and ensure its continuous evolution. These limitations stem from technical, data-related, and user-experience challenges that, if addressed, can significantly improve the platform's overall functionality and adoption.

One of the key limitations of the R-Map platform is its dependence on external data sources, which can introduce inconsistencies in data quality, availability, and granularity. The reliance on publicly available datasets from various EU repositories and surveys means that gaps or delays in data updates may impact the accuracy and timeliness of insights provided by the platform. Additionally, variations in data collection methodologies across regions may pose challenges in ensuring cross-country comparability.

Another limitation lies in the current level of system automation, particularly in data processing and visualization workflows. Although the platform will provide insightful visualizations and predictive analytics, many processes—such as data cleaning, transformation, and validation—still require manual intervention, which may hinder scalability and efficiency in handling large and dynamic datasets.

The platform's user interface (UI) and user experience (UX), while designed to be intuitive, may still present challenges for non-technical users. Some policymakers with limited digital literacy may require additional guidance and support to fully utilize the platform's functionalities.

Another limitation concerns the predictive modeling capabilities of the platform. While the models provide valuable insights into potential future trends, their accuracy depends on the quality and completeness of input data. The platform may face challenges in accounting for unexpected socio-economic disruptions, such as policy changes, economic downturns, or public health crises, which can significantly impact remote work patterns.

Lastly, long-term sustainability and maintenance present a challenge, as the platform requires continuous updates and technical support beyond the project's lifecycle. Securing long-term funding and identifying responsible entities to manage the platform after the project's completion will be critical to ensuring its continued relevance and functionality.

9. CONCLUSIONS AND NEXT STEPS

The architectural design of the R-Map platform outlined in this deliverable provides a comprehensive framework for the development of a robust, scalable, and user-centric system aimed at supporting policymakers in assessing the impacts of remote working arrangements (RWAs) across Europe. The proposed architecture successfully addresses key aspects such as data integration, processing, visualization, and security, ensuring that the platform will be capable of providing actionable insights through an intuitive and accessible interface. The architecture is designed to accommodate a wide range of data sources, including structured datasets from surveys and open data repositories, while ensuring compliance with data protection regulations and best practices. Additionally, the adoption of a modular and layered approach ensures flexibility, allowing the system to evolve and expand based on stakeholder needs and technological advancements.

While the architectural blueprint sets a solid foundation, the next critical phase involves the implementation and validation of the platform, which will require close collaboration among technical partners and continuous engagement with stakeholders. A key focus will be on translating the proposed architecture into a functional system, beginning with the development of core components such as data ingestion pipelines, analytical models, and visualization tools. Iterative testing and refinement will be crucial to ensure that the platform meets performance, usability, and scalability requirements.

Another important next step is the integration of stakeholder feedback, particularly from policymakers who will be the primary end users. Their insights will help fine-tune the platform's functionalities, ensuring that it effectively addresses their policy analysis needs and provides meaningful support for decision-making. To facilitate this, pilot deployments and user testing sessions will be organized to gather practical feedback on system usability and visualization effectiveness.

Furthermore, attention will be given to addressing identified challenges, such as data harmonization across different sources, ensuring interoperability with existing EU-level platforms, and optimizing system performance for handling large-scale data. Security measures will also be further refined to ensure compliance with evolving regulatory requirements and protect sensitive information throughout the platform's lifecycle.

Looking beyond the project's timeline, the project consortium will focus on developing a roadmap for platform sustainability, including long-term maintenance strategies, potential partnerships, and funding opportunities to support the platform beyond the project's duration.

10. ANNEXES

10.1 Workshop with partners

Table 6: Workshop participation

#	First Name	Last Name	Partner Institute
1	Margarita	Angelidou	Q-PLAN
2	Henk	Bouwman	METREX
3	Katharina	Fellnhofer	RIM
4	Johannes	Flacke	UT
5	Lisa	Fontanella	UB
6	Mandy	Fransz	WFA
7	Kelly	Pasmatzi	SEERC
8	Sibel	Kiran	KU
9	Vidit	Kundu	UT
10	Thomas	Mone	AUTh
11	Panagiotis	Papanikolaou	Arx.Net
12	Karin	Pfeffer	UT
13	Dimitra	Plastara	AUTh
14	Georgia	Pozoukidou	AUTh
15	Margarita	Angelidou	Q-PLAN
16	Elli	Roma-Athanasiadou	Q-PLAN
17	Nikolas	Thomopoulos	SURREY
18	Nikos	Tetovas	Arx.Net

10.2 Workshop with members of the Advisory Board

Table 7: AB participation

#	First Name	Last Name	Institute
1	Dimitrios	Tselios	Nomads365
2	Maya	Middlemiss	Remote Work Europe
3	Iwo	Szapar	Remote First Institute
4	Mariana	Faver	Spatial Researcher
5	Goncalo	Hall	NOMADX
6	Kaisu	Koskela	Digital Nomad

10.3 Data sources identified during Task 3.2

Table 8: Data sources identified during Task 3.2

Dataset Name	Source/Provider	Collection Year	Region/Country	Category
European Working Conditions Telephone Survey, 2021	Eurofound	2021	EU27	Socio-economic
ESENER 2019 (how european workplaces manage OHS)	EU-OSHA	2019	33 EU+	Socio-economic
https://datacatalogue.cessda.eu/				Socio-economic
Population living in rural areas within 15 minutes driving time of a primary school, by degree of urbanisation level 2 (%)	Eurostat	2021	EU27	Spatial

Population living in rural areas within 15 minutes driving time of a main healthcare service, by degree of urbanisation level 2 (%)	Eurostat	2021	EU27	Spatial
Transport performance by car, by degree of urbanisation (%)	Eurostat	2021	EU27	Spatial
How are national populations distributed, by degree of urbanization (%)	Eurostat	2021	EU27	Spatial
Population density, by urban-rural typology (inhabitants per km²)	Eurostat	2023	EU27	Spatial
TurkSTAT surveys (Turkish statistical Institute) below:	TUIK			Socio-economic
Türkiye Health Survey (2008 2010-2012-2014-2016-2019-2022)	TUIK	2022	Türkiye	Socio-economic
SILC (Income and living conditions research(section) 2006-2023, yearly	TUIK	2023	Türkiye	Socio-economic
SILC : Income and living conditions research(panel) 200-2022	TUIK	2021	Türkiye	Socio-economic
Adult life satisfaction survey, Household and idiv, 2003-2021, yearly	TUIK	2021	Türkiye	Socio-economic

Adult education survey, 2007, 2012, 2016, 2022	TUIK	2022	Türkiye	Socio-economic
World Settlement Footprint	DLR	2019	Global	Spatial
Urban Centre Database UCDB R2019A	EC JRC	2019	Global	Spatial/ Socio-economic
Share of total area by type and land cover (%)	Eurostat	2018	EU27	Spatial
Urban Atlas Land Cover/Land Use 2018 (vector), Europe, 6-yearly	Urban atlas-Copernicus	2018	Europe	Spatial
Overall life satisfaction by degree of urbanization	Eurostat	2018-2023	EU27	Socio-economic
Fixed Very High Capacity Network (VHCN) coverage, Rural Areas (Households living in sparsely populated area), DESI period: 2023 (data from 2022)	European Commission - Digital Decade DESI visualization tool	2022	EU27	Economic
Percentage of enterprises which conducted remote meetings via the internet	Eurostat	2022	EU27 & Euro Area	Socio-economic
Percentage of enterprises which have ICT security guidelines for conducting remote meetings via the internet		2022		Socio-economic

Percentage of enterprises having ICT security guidelines for remote access		2022		Socio-economic
Employed persons working from home as a percentage of the total employment	Eurostat	2023	EU27 & Euro Area	Socio-economic
Gender Equality Index	EIGE	2024	EU27	Socio-economic
Broadband statistics	OECD	2023	OECD	Economic
Housing prices	OECD	2024	OECD	Economic
Nights spent at tourist accommodation establishments by NUTS 2 region	Eurostat	2024	EU27	Economic
Employment activities	Eurostat		EU27	Socio-economic
Regional demography	OECD	2023	OECD	Social
Permanent immigrant inflows	OECD	2022	OECD	Social
New businesses started (% per population)	OECD	2024	OECD	Economic
User opinion on public transport	ISTAT	2022	Italy	Social
Resident population	ISTAT	2024	Italy	Social
Satisfaction for life and work	ISTAT	2024	Italy	Social
pollution	ISTAT	2024	Italy	Environmental
Employment	ISTAT	2024	Italy	Socio-economic

Remote Work & Productivity Study	NCBI / NIH	2022	Global	Socio-economic
Migration Data Vienna	City of Vienna	2020	Austria (Vienna)	Socio-economic
Quality of Life Rankings	Numbeo	2020	Global	Socio-economic
Tourism/Accommodation	Statistik Austria	Ongoing	Austria	Socio-economic
Internet Access	Statistik Austria	2021	Austria	Socio-economic
Transport Infrastructure	Austrian Ministry (BMVIT)	2020	Austria	Socio-economic
Economic Composition	Harvard Metroverse	Recent	Austria	Economic
Gross Value Added (GVA) by NUTS 3 Region	Eurostat, TUIK	2022	Türkiye	Socio-economic
Employment Productivity by NUTS 2	Eurostat	2012 - 2023	Türkiye	Socio-economic
Number of employed adults by NUTS2	Eurostat	2015 - 2024	Türkiye	Socio-economic
Number of employed adults by sex, age and educational attainment level NUTS 2	Eurostat	2016 - 2024	Türkiye	Socio-economic
Employment by NUTS 3	Eurostat, TUIK	2022	Türkiye	Socio-economic
Quality of Life Index	Eurostat, TUIK	2022	Türkiye	Socio-economic
Turkish Household ICT Usage Survey	TUIK	2022	Türkiye	Socio-economic

ICT Usage in Enterprises	TUIK	2022	Türkiye	Socio-economic
Hospital Days of In-Patients	Ministry of Health/TUIK	2023	Türkiye	Health
Commute Time (Mean One-Way)	Eurostat	2019	EU27	Mobility
Modal Usage	Eurostat	2020	Turkey	Mobility
Cost of Living Index	TUIK	2023	Türkiye	Socio-economic
Internet Access at Home	Eurostat	2022	Türkiye	Digital Infrastructure
Working Hours Weekly (avg.)	Eurostat	2022	Türkiye	Labor
Adult Education Survey	TUIK	2022	Türkiye	Education
Life Satisfaction Survey	TUIK	2021	Türkiye	Socio-economic
SILC Panel Income Survey	TUIK	2021	Türkiye	Socio-economic
SILC Cross-Section Income Survey	TUIK	2023	Türkiye	Socio-economic
Health Survey	TUIK	2022	Türkiye	Health
Migration Flows	Eurostat	2021	EU	Mobility
Household Internet Use (NUTS0)	Eurostat	2023	Türkiye	Digital Infrastructure
Transportation Use (OSM)	OSM/Geofabrik	2023	Türkiye	Mobility
OHS Management (ESENER)	EU-OSHA	2019	EU33	Socio-economic

Air Emissions (NO2)	Eurostat	2023	EU	Environmental
Real Estate Prices	Eurostat	2023	Türkiye	Socio-economic
Tourism (Guest Nights)	T.R. Ministry of Tourism	2024	Türkiye	Tourism
Polycentricity (POIs)	OSM	2023	Türkiye	Urban
Population Density	GHS (Copernicus)	2020	Global	Demographic
Commuting Distance (TR)	IBB	2022	Istanbul	Mobility
Good Life Index	OECD	2023	Global	Well-being
Time Use Survey	TUIK	2020	Türkiye	Labor
Public Transport Stops	OSM	2023	Türkiye	Accessibility
Digital Speed Data	BTK	2023	Türkiye	Infrastructure
Number of Second Homes	Eurostat	2022	Türkiye	Housing
Land Consumption (Built-up)	Copernicus	2020	Global	Environmental
TurkSTAT surveys (Turkish statistical Institute) below:	TUIK	Various	Türkiye	Socio-economic
TUrkiye Health Survey (2008 2010-2012-2014-2016-2019-2022)	TUIK	2022	Türkiye	Socio-economic
SILC (Income and living conditions research(section) 2006-2023, yearly	TUIK	2023	Türkiye	Socio-economic

SILC : Income and living conditions research(panel) 200-2022	TUIK	2021	Türkiye	Socio-economic
Adult life satisfaction survey, Household and idiv, 2003-2021, yearly	TUIK	2021	Türkiye	Socio-economic
Adult education survey, 2007, 2012, 2016, 2022	TUIK	2022	Türkiye	Socio-economic

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