



Visual Analytics Component, API and developer documentation (version 1)

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PANDEM-2

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Full Name	Short Name	Beneficiary Number	Role
NATIONAL UNIVERSITY OF IRELAND GALWAY	NUIG	1	Coordinator
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1 Executive Summary

This deliverable describes the research, design, and development of visual analytical components that can be implemented in an application to allow pandemic managers to derive assessment and decision analytics for planning and response. The objective is to research and develop human-computer visual interaction models tailored to the analytical workflows of the public health analyst using participatory design methodologies. The research explores the current best practises, workflows, methods, and visualisations for pandemic management and supports the design and development of the PANDEM-2 visual analytical components. These are being instantiated in a suite of interactive data visualisations and user interface components within the PANDEM-2 WP3 Dashboard environment. These components will be used for viewing, querying, and reporting pandemic data of high dimensionality and complexity to support rapid evidence-based assessment and decision making. This will ensure a standard, consistent and intuitive interaction experience for public health planners and first responders. The visual analytics components will support the services outlined in WP3, as well as the pandemic planning tools developed in WP4.

2 Introduction & Background

2.1 Introduction

Humans are visual creatures by nature, visual learning is one of the primary forms of interpreting information. People absorb information in graphic form that would escape them in other formats. Images and visualisations are highly effective forms of storytelling, especially when the story is complicated, as is often the case with technical or scientific information. Data visualisation is one of the most important components of research presentation and communication due to its ability to synthesise large amounts of data into effective graphics (Ware, 2000).

Data visualisations can be essential for analysing, communicating, and making discoveries within data. They can reveal patterns, trends, and connections in data that are otherwise difficult or impossible to find. Visualising data can allow us to see the underlying structure of the data and to see outlying patterns or trends that we wouldn't see if we were just looking at a table.

Technological advances have allowed us to take advantage of visual learning by enhancing visual presentation, enabling the creation and distribution of complex visual information. This is a boon but can also be problematic. The increasing menu of visualisation tools and options can lead to a poor fit between the data and its presentation. The complexity and amount of data available does not always fit into a simple and ready-made visualisation. Some visualisations are more easily read and parsed than others, so choosing the correct ones is important to avoid the unintended consequence of creating confusion or misunderstandings surrounding the data being presented.

Within the context of these points, it is important that the data visualisations created within the PANDEM-2 project should be transparent, clear, accessible, and ethical. The best way to achieve these goals is to research, design, and engage the end users in a participatory process. This will allow the development of principles and the inclusion of user feedback to guide the design and implementation of these data visualisations.

2.2 Visual Analytics

Visual Analytics (VA) is the study of analytical reasoning and decision-making processes that are supported by interactive visual interfaces (Thomas and Cook, 2005). Fundamentally, it is concerned with the development of software and interactive processes that support the flexibility, creativity and background knowledge of human reasoning required to solve problems that are complex, dynamic, and often poorly defined.

The human analytical process typically involves a sequence of incremental search and exploration, sense-making, and evidence retention activities (Pirolli & Card, 2005; Klein et al., 2006; Bodnar, 2003). VA seeks to facilitate a human-information dialogue in which analytical activities are distributed between the user and analytical components of the tool (Ola & Sedig, 2014). The availability of appropriate analytical processes, interpretable visual representations and lightweight interactive models extend human cognitive capabilities by summarising, analysing, and presenting data in such a way that it can be read efficiently by the human visual and reasoning apparatus. Visual summaries can virtually expand human short-term working memory and visual representations of emerging patterns and relationships allow human reasoning about second order analytical artefacts which would otherwise be unavailable.

A key role for VA is the support of evidence-based decision making and effective action-taking by human analysts (Brownson et al., 2009; Ola & Sedig, 2014).

The process of making decisions from data may be represented by the four stages in Figure 1: Assemble, Visualise, Interact, Decide (AVID). The VA task (Task 4.3) addresses the Interaction models required to lead the analyst towards Understanding and Decision making, the final two stages of the process.

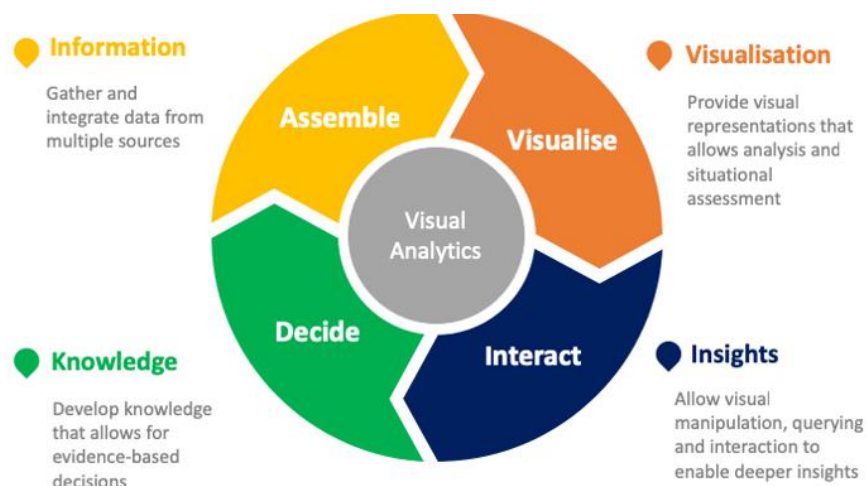


Figure 1: AVID: Assemble, Visualise, Interact, Decide: the four key stages of the visual analytical sense making process

VA support for the public health analyst has been proposed in tasks such as a) monitoring and assessing risk signals b) situational assessment and understanding of impact of past events/actions c) prediction of the outcome of a threat, and assessment on future capabilities, vulnerabilities and the recovery possibilities d) policy development which includes priority setting, advocacy and development of prevention and control policies (Ola & Sedig, 2014). All definitions of VA agree that the handling of heterogeneous data sources, its transformation and integration and the accommodation of noisy and

fast-moving data sources are necessary challenges that a VA system must address to support the stakeholders' analytical reasoning tasks. Examples are demographic data, mortality data, clinical data, location data, relationship data, patient and pathogen genetics, medical imaging, travel logistics and timelines (Carroll et al. 2014).

While significant challenges in this field lie in the integration, management and visual rendering of large and disparate data sets, the greatest challenge lies in the development of a VA system that anticipates and serves the functional requirements of the decision maker and is flexible enough to be extended as new challenges, data and user requirements emerge. A key requirement is a deep understanding of the sense-making processes typically used by the analyst in the domain, from which supportive human-machine interaction models can be developed (Parsons and Sedig, 2013). This requires firstly modelling the analytic workflows of the analyst, including collaborative analytical scenarios where synchronous and asynchronous inputs contribute to group reasoning processes. The outputs of these workflow models will underpin the development of the interaction and visualisation techniques at the core of the VA system.

Several studies have focused on optimising the end-usability of visual and analytical tools, focusing on how the tools service the functional requirements of analyst stakeholders. Methods include observation of participant work, 'talk aloud' sessions (where analysts explicitly articulate their goals and actions), interviews and workflow analysis (Roth et al. 2009). Several studies report the outcomes of participatory design approaches where analyst stakeholders were consulted throughout the VA design and development process (Roth et al. 2009).

2.3 Background Context

This deliverable describes the processes and outputs of Task 4.3 in work package 4 of the PANDEM-2 project to provide an effective visual analytics service to enable pandemic managers to be able to make decisions from the pandemic data that is available to them. This task will develop a common design framework that will provide consistency, usability, transparency, and functionality to the user in a way that will support rapid evidence-based assessment and decision making. This will ensure a standard consistent user experience for the end user.

To enable creation of this common design framework we explored data visualisation best practices, carried out a review of current COVID-19 dashboards and participated in the gathering and categorising of user requirements.

We conducted a literature review of the current state of the art COVID-19 dashboards that have been developed since the beginning of the pandemic. This review gave us insight into expert opinion in the COVID-19 field, the data visualisation field, and the development field, allowing us to view best practices within the context of current dashboards and current expert thinking. From this research we created a COVID-19 visualisation database that allowed us to store and annotate COVID-19 visualisations. To interact with this resource, we built a novel cataloguing tool that allowed us to search through these visualisations by indicator, visualisation, area, or other types, creating a reference catalogue for use with work package 4 and work package 3.

We participated in the gathering of user requirements and the development of processes to generate user stories to gain insight into what PANDEM-2 end users needed and wanted from the dashboard (D3.2 Dashboard Design). We implemented a participatory design process to allow end users to be involved in the design process without imposing too much on their time. We integrated their feedback into the design of the visual analytic components which enabled asynchronous collaboration and communication between the visual analytics team, the end users, and the software development team.

This deliverable is the interaction layer between the users and the dashboard. It defines, based on best practices, how the information should be presented to the user and how the user can change it, interact with it, and gain analysis from it. The visual analytics components developed in this Task 4.3 form the basis for the visual model and interaction model for the dashboard. This work has relationships with work packages 2, 3, 4, and 6. The outputs of work packages 2 and 4 will be viewed and interacted with through the visual analytics components developed in Task 4.3. work package 3 will implement the visual analytical models that are developed in this task and the scenarios and documentation for users in work package 6 will take advantage of the interaction models developed in this task.

3 Approach

The work in this deliverable was carried out by the visual analytics team in NUI Galway. To work for this deliverable was made up of 3 phases.

1. Research
2. Exploratory prototype design and development
3. Design and prototype development using a participatory design approach.

Each phase consisted of several processes to achieve the phase goals. In the initial research phase, we investigated visualisation best practices, explored the current approaches to public health dashboard design, and researched interaction models in the context of data visualisations. From this research we developed a set of visualisation guidelines to follow and an image reference catalogue where we could store and view current pandemic visualisations.

Using this research, we began our initial design work exploring the possible data visualisations that would satisfy the user requirements within the project and provide users with data visualisations that would allow them to view and explore pandemic data, to allow for preparedness and response in this and future pandemics. As part of this phase of the deliverable we developed a web prototype application to explore geographic mapping and presentation of pandemic information.

Data visualisation and user interaction design principles were based on current best practices. Following the initial design phase we began a participatory design process, involving the end users in the design of the dashboard. This phase consisted of parallel interactions with different members of the consortium, designing prototypes, delivering them to users, developing them further depending on user feedback and interacting with the software team to enable the development of the prototypes and software components.

3.1 Review of Best Practices

Data visualisation is a continually growing field and there has been much research into the various aspects of visualisation. In the context of PANDEM-2 where end users are those working in health care fields, it is important that visualisations developed should have a strong scientific foundation based on evidence and research. To deliver these strong foundations we began with a review of current best practices in the field of data visualisation. The Grammar of Graphics (Wilkinson, 2012) presents a technical analysis of the structure of data visualisation, breaking down the notion of visualisation into its constituent parts, as grammar breaks down a paragraph or a sentence. Data, scales, coordinates, geometries, and aesthetics all play a part in how a user perceives and interacts with a data visualisation. By exploring visual design principles and their implementation we can build our visual analytical components on a strong base and provide the user with coherent and valuable interactive data visualisations.

Several guidelines came out of our review of best practices

1. Prioritisation of information.

The primary goal of any visualisation is to convey information to the user. Information is the first and most important driving force behind the visualisation, and its prioritisation should be the goal of any data visualisation. Evaluating what information the user needs and designing around it is the first guideline. The data visualisation will depend on the information objective first and foremost. The purpose of the graph will be defined by the information it aims to visualise.

2. Use of Software

Use of the correct software is an important step in the process. Software that can accomplish the end goals and handle the complexities of the data visualisations whilst allowing any user to interact and use it are critical for developing data visualisations and conveying the design decisions and interaction models that will be implemented. At the early stages of the project, we conducted a survey of available prototyping tools, grading them on availability, accessibility, functionality, and cost. As part of the participatory design process we needed methods to convey design to end users in an interactive way before the engineering and development work would begin.

3. Showing and Telling (Geometries and data)

It is important to choose the right graphs and geometrical components within those graphs to represent the data in terms of categories, values, compositions, and relationships. Most geometries fall into the categories of representation, amounts, compositions, distributions, or relationships. The correct graphs and their geometries are important for showing data in an understandable way. Location and time are examples of data that have requirements that other data does not, and they need to be represented in a certain way. Regardless of the representations chosen for visualising the data, the data itself should be accessible in the graph (Tufte, 2001). Including the data in the data visualisation in a way that complements it, allows context and clarity should the user need it. It enables transparency, allowing the user to see how the data has been encoded in the visualisation, and providing a source for the data. User interaction models are important, allowing the user to access this information. These will be

discussed in section 3.1.2. The goal should be a clear data visualisation whilst also allowing users to access the complexity of the data within the visualisation.

4. Emphasise important points

Visualisations should highlight important data to the user. Thresholds, size, and colour are methods of highlighting certain information should the user wish it. These elements can provide instant visual cues and attract the user's attention to important trends or data points. They can also highlight how certain decisions or interventions can influence the data being shown.

5. Colour

Colour is a powerful way to represent information (Borkin et al., 2013). There are three schemes of colour representation: sequential, diverging, and qualitative. Sequential schemes are schemes that range from light to dark. They can be different hues of one colour, or a scale of colours combined. Diverging schemes are a combination of two sequential schemes which represent two extremes either side of a value. Qualitative schemes are schemes that don't represent quantitative data, where the intensity of the colour is not of primary importance, differentiation is. Within these schemes it is important to design so that any schemes work both in colour and in black and white. Colour schemes should also take into consideration accessibility issues like colour blindness.

6. Uncertainty

Within the context of pandemics, pandemic modelling, and pandemic preparedness, showing all aspects of the data is important, including any model uncertainty. Most models produce outputs that include a measure of uncertainty. Visualisation components must provide information on data and model provenance and model uncertainty. This will allow for a more complete and nuanced approach to data and model interpretation.

7. Explainable Data Visualisations

Data visualisations should include captions to explain and clarify the data being shown (Cooper, 2002). Visualisations are often summarisations or generalisations of the data into a more accessible format, so it is important to provide the context of the information. Where possible, the original data points should be shown or accessible. The context of the data includes its source, the time of its capture, what the visualisation is showing, how the data was formatted or transformed, and why these transformations are used. Visuals should be simple; captions and explanations should be detailed.

8. Participatory Design

Participatory design involves including the end user in the design process. The users are the experts in their fields, and all designs and visualisations should align with what the user expects to see and what they can read.

9. Allow access to data

Visualisations are a useful resource for analysing and understanding data but sometimes users will want to explore the data themselves in a more in-depth way. Any visualisations presented

to the user should also allow the user to access the data itself. Each graph should be viewable as a data table, with the additional provision of downloadable file formats like json, and csv.

3.2 Review of interaction models

The second part of our research was in the field of interaction modelling. Data visualisation is about the display of information within a certain domain context. Most of the time this display falls into two categories: the presentation of information to a user or the exploration or analysis of information. The following section provides an overview of the review of interaction models and background research in the area.

At its simplest level data visualisation is the communication of certain information within a context, telling a story with data. This context can be decision making, planning, forecasting, or instructional purposes. Going beyond this simple presentation we need to provide the user with an interaction model guiding them through the story with a series of informative steps.

Data visualisations can be used to produce new data artefacts, they can transform or be used to derive new data, they can be used for annotation, recording visual interactions, or producing screenshots or images of the visualisation in a certain state. Interaction models enable these new visualisation analytics.

A typical VA session involves interactive cycles of filtering and querying, visualisation, analysis, parameter setting and result retention (Keim et al., 2010; Ola & Sedig, 2014). While data visualisation techniques, grounded in theories of human perception are essential, visual interaction models are also vital to allow appropriate exploration during the sense-making process. By interacting on visual representations, the user can interact and reach deeply into the underlying data. In contrast, poorly designed visual representation and interaction models will frustrate the analytical and decision-making goals of the user (Zhang, 2001; Parsons and Sedig, 2014).

There are two primary interactions with data visualisations. These are similar to Andreinko's concept of reference and characteristics (Andrienko & Andrienko, 2006). A user's interactions will fall into one of these categories depending on whether their search target is known or not. When the search target is known the user is searching by reference, and they interact with the data visualisation based on this known search reference. The action is known as looking up or locating.

The other interaction is if the user does not know the search target before the interaction. In this case the user may be searching for characteristics rather than references. These characteristics could be values, certain thresholds, anomalies, trends, or ranges (Amar, 2005). This is known as browsing or exploring. Exploring in particular entails searching for characteristics without regard to their location, often beginning at a high-level visualisation before delving into specifics in terms of the data, location, or time.

Once a user has found the results or set of results they are looking for, they can then identify, compare, or summarise these results. If the interaction was locating, searching with a known reference, identification will return the characteristics of that target. Conversely if a search returns a target or targets matching a characteristic or several characteristics, via explore, identification will return the references for those characteristics. Moving between identification, comparison, and summation corresponds to an increase in the number of search targets the user is interacting with (Andrienko &

Andrienko, 2006; Buja et al., 1996; Tweedie, 1997). Identification generally refers to a single search target, comparison to multiple targets or subsets of targets, and summation to a whole set of targets. Summation, similarly to explore, is often associated with overviews of the data (Lee, 2006).

Several classes of methods are available within these interactions; encode, manipulate, select, navigate, arrange, filter, aggregate, derive, and record.

Encoding refers to how the data has been formatted to present it to the user. Data visualisation regularly formats or summarises the data to allow it to be presented in a visual manner. The encoding should be available to the user. See 3.1.1 point 3.

Manipulation covers the range of interactions that enable the user to modify the elements of a visualisation in some manner. These can include the other classes such as select, navigate, arrange, etc. Manipulation and encoding are closely related as manipulation, in changing the visualisation, may also change the encoding of the data in the visualisation.

- Select refers to the selection of specific elements, geometries, or groups of the former, within a visualisation, differentiating the selected elements from unselected elements or interacting with the selected elements.
- Navigate is the process of changing the user's viewpoint of the data, changing the view the user is exploring, or changing their view of the data, panning or zooming. Navigate and select can be combined to trigger detailed information based around a set of data or a particular datum.
- Arrange is the process of organising elements spatially within the data visualisation.
- Change is the altering in the visual encoding, changing the type of visualisation itself or changing elements of the encoding of the visualisation such as colour or scale.
- Filter is used to adjust the data criteria within the visualisation. The user can include or exclude certain elements, removing or adding sections or subsections of data, based on their characteristics.
- Aggregate refers to a change in the granularity of the visualisation, such as viewing the data in larger or smaller time frames or geographic locations.
- Derive encompasses methods that compute new data elements given existing data elements. Aggregating data often implies deriving data, though this is not always true.
- Record refers to methods of saving or capturing the visualisation in a specific state or context. These methods allow the user to create persistent data artefacts from the visualisation, such as screenshots, images, or reports.

3.3 Review of current dashboards

The final part of the initial research was to conduct a review of the current state of public health dashboards. When PANDEM-2 was proposed the COVID-19 pandemic had not hit. Since that time numerous dashboards have been developed by countries, organisations, and individuals. Dashboards can be described as a dynamic set of data visualisations displaying several key indicators, arranged on a single screen or in a single application to allow viewing at a glance (Yigitbasioglu, 2012). Dashboards are designed to manage large datasets, and their ability to make that data available in near real time makes them suitable for tackling issues such as information presentation and dissemination during a pandemic (Boulos & Geraghty, 2020).

Actionable Dashboards

Dashboard should present information that is *actionable*. The information should be both *fit for purpose* (meeting a specific information need) and *fit for use* (placing the right information into the right hands at the right time and in a manner that can be understood; Barbazza et al. 2021a, 2021b).

Ivanković et al. have summarised the seven key features of actionable COVID-19 dashboards, which we present below (Ivanković et al. 2021). While these features relate to a review of COVID-19 dashboards in 2020, it is reasonable to consider these features will be relevant to the information needs generated by other pandemic scenarios.

- Know the audience and their information needs: The intended audience and their information needs are known and responded to.
- Manage the type, volume, and flow of information: The type, volume, and flow of information on the dashboard are well managed.
- Report data sources and methods clearly: The data sources and methods for calculating values are made clear.
- Link time trends to policy decisions: Information is reported over time and contextualised with policy decisions made.
- Provide data “close to home”: Data are reported at relevant geographic break downs.
- Break down the population to relevant subgroups: Data are reported by relevant population subgroups.
- Use storytelling and visual cues: Brief narratives and visual cues are used to explain the meaning of data.

While Ivanković et al.'s (2021) review was published after the PANDEM-2 project had begun, we had developed a similar set of principles derived from the extensive meetings with the project's public health user group, the subsequent process of identification of requirements, use-cases and user-stories, and from our own review and cataloguing of contemporary public health dashboards.

Review of existing dashboards

The numerous dashboards that were developed provided us with an opportunity to review the public health indicators presented, the visualisation approaches used, and the design decisions made. As observed by Barbazza et al. 2020, many dashboards were developed hastily, with resource and data constraints and did not necessarily reflect all health indicators that would be useful to public health officials. Many were designed to face the public, rather than as decision support tools for public health. Nevertheless, we began our participatory design process, under the assumption that our consortium partners' dashboards reflected some of their information needs, without imposing on the time of the end users. We could also conduct an exploration of our best practices guidelines and interaction model research in the context of currently available dashboards, researching the prioritisation of information, the geometries and trends that experts expected to see, and the encoding and interactions in those dashboards. Subsequent meetings and interviews with end users allowed us to gain a deeper and wider understanding of the information needs and workflows of our user partners.

We surveyed the COVID-19 dashboards of consortium users, other dashboards that consortium users found useful, and searched and explored online resources. There were several research questions we wanted to explore under the previous two research categories, best practices and interaction models.

We broke down each dashboard in terms of specific requirements and questions. We looked at the aims, users, and content of the dashboards. We explored the data sources for these dashboards and the breakdowns of this data within each dashboard, in terms of population, time, and location. We studied the data display, interpretations of the data, and data visualisations. We looked at how users interacted with each dashboard, how they navigated them, how they located information, and how they explored the data available.

We recorded the data in excel spreadsheets under our research categories. We were then able to collate the data to allow us to see what was prioritised and common throughout the dashboards. This research enabled us to start the participatory design process with our users. Participatory design is an approach to design, attempting to actively involve all stakeholders in the design process to help ensure the result meets their needs and is usable. Participatory design is an approach focused on processes and procedures of design (Trischler, 2018). Our end users had already contributed to the design process of many of the dashboards we explored, so we could infer a certain amount from those dashboards.

The review of dashboards posed a unique problem for our team, how to view or reference the data visualisations themselves. We could provide links in the excel sheets we recorded our data in but to find a relevant visualisation during the design process would be cumbersome and time consuming. We developed the idea of a visualisation catalogue, an application that would store data visualisations with annotations that would allow them to be easily searchable and with links back to the original visualisation. The objective of the visualisation catalogue was to provide a directory of existing public health visualisation approaches which team members or partners could refer to during the participatory design process.

3.4 Cataloguing of data visualisations

The visualisation catalogue was initially designed in the prototyping software tool Justinmind. It consisted of four pages. The initial page was the upload and tagging page. This would allow users to choose or drop a file to upload it, and tag it with certain attributes that would make it searchable.

Figure 2: Visualisation catalogue upload page with tags covering data, visualisation, and interaction types.

The other 3 initial design pages, the tag editing page, the search page, and the data visualisation page can be viewed in the [Visualisation catalogue section](#) of the Appendices.

The visualisation catalogue was designed as a relatively typical web application, with 2 main functionalities, (1) The ability to upload data visualisations and the metadata attached to them, and (2) the presentation of all those uploaded visualisations and methods to search and filter them. This would provide us with a catalogue of relevant visualisations searchable by category or tag, for reference both for design work and for end user interaction.

1. Upload and storage of images.

A MySQL database was developed with four main models: images, categories, tags, and comments. Images were the primary model and had categories, tags, and comments as relationships. A python flask server was then built on top of the database to handle the interactions with it. This server, built for the internal visualisation reference catalogue, was a restless server with a number of API points to handle interactions with the front end of the application.

2. Presentation and search of images.

The front end of the application was built with React, a single page application library that enabled a design friendly user interface. The front end of the application has two pages, the catalogue page and the upload image page. The upload image page was designed and developed so that any user within the project could upload a visualisation to the system with ease. When uploading an image the user must select a category and then can add as many categories and comments as they like. The front end communicates with the backend and the uploaded image is made immediately available on the catalogue page. The catalogue page displays all the images on initial load. In the top menu bar is a search bar and on the left the tags are presented as selectable boxes. The search bar has an autocomplete that will prompt the user with the relevant tags once they begin typing. Either the search bar or the tag boxes can be used to filter the catalogue. The tags combine to allow filtering to a high-level.

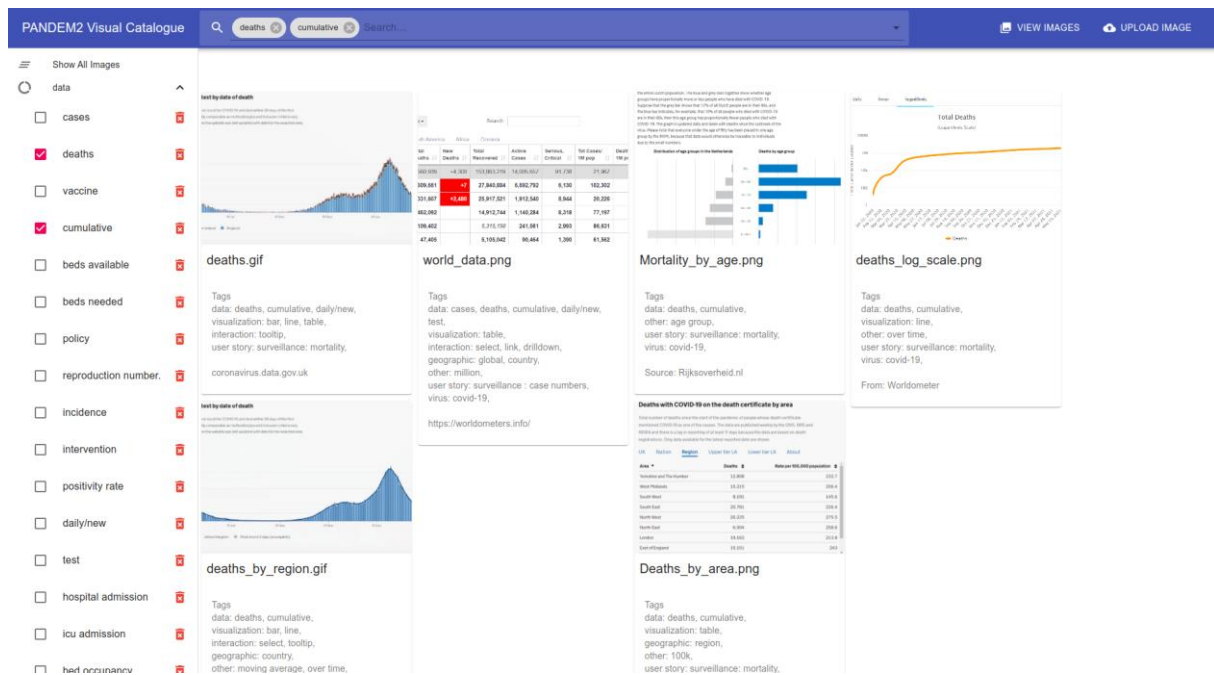


Figure 3: Visualisation catalogue application. Visualisation presentation with filters.

3.5 Prototype Design

3.5.1 Development of early prototype

Time and location were prevalent and recurring aspects of user requirements and of the PANDEM-2 proposal itself. The outputs that arose from the deliverable D3.2 Dashboard Design (already submitted to the commission) reinforced the need for cross border views and the requirement to have mapping functionality within the application. To explore these views and the geospatial functionality that would be needed the VA team decided to design and implement an early prototype application. The design and development of this prototype application would allow the investigation of the relevant research goals

- Investigation of open-source data API's for development of early prototype
- Exploration of mapping data, libraries, and visualisation of geographical data
- Prototype design and development

3.5.1.1 Investigation of data API's for development of early prototype

The prototype proposed using COVID-19 data from two neighbouring countries, Germany and The Netherlands. The goal was to explore showing regional data for an individual country or a combined view of multiple neighbouring countries. The data presented would be total reported cases, total deaths, the 7-day average of cases, and deaths all across a specific geographical region. The prototype would also need to implement several expected user interactions.

Research into publicly available data was the first step in this process. An exploration of the available datasets and API's was conducted and a couple of data sources were chosen because they matched the necessary criteria; they provided data for the countries that were selected, they were updated

regularly, they contained real world data, and they had location and time elements with the data objects.

1. The COVID-19 data source for German data was - <https://api.corona-zahlen.org/docs>
2. The data source for the Netherlands was from the National Institute for Public Health and the Environment in the Netherlands - <https://data.rivm.nl/covid-19/>

The German data came from PANDEM-2 partner the Robert Koch Institute (Robert Koch Institute, 2021) and was wrapped in a JSON (JavaScript Object Notation) API for easy querying. It allowed for querying of several endpoints that would return COVID data in JSON format.

The Netherlands data was available daily in varying formats from Rijksinstituut voor Volksgezondheid en Milieu (RIVM), but was only available as files not as endpoints, bringing with it the issue that all data is combined in one file. The Netherlands data also contained historical and geographical data so there was a size issue with the files available as they currently are.

The prototype application would need to implement a solution that would download the data from each country and format it with a similar encoding, both in terms of geographical elements and also date and time elements. This would need to be done at regular intervals, and then make this encoded data available to the frontend of the application. Similar to the visualisation catalogue the prototype would need a backend to process and serve the encoded data and a frontend for the dashboard user interface (UI).

3.5.1.2 Exploration of mapping data, libraries, and visualisation of geographical data

The next step was to source mapping software, explore mapping libraries, and data formats. An exploration of mapping sources led to OpenStreetMap. The OpenStreetMap foundation is a collaborative project that aims to provide an open-source community mapping solution (OpenStreetMap, 2021). For the presentation layer Leafletjs (Leafletjs, 2021) was chosen. This is a small open-source mapping library developed in JavaScript that would provide the maps and the interactions that would be needed. The data format chosen was GeoJSON (GeoJSON, 2021), a JavaScript Object Notation format for encoding a variety of geographic data structures. These choices would allow the prototype to present a map and then add several data layers on top of it to highlight the data being used.

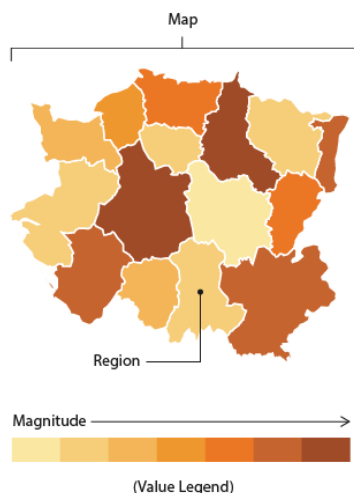


Figure 4: Anatomy of a choropleth - <https://datavizcatalogue.com/methods/choropleth.html>

In terms of visualising quantitative data on a map, a common and well understood visualisation is a choropleth (see Figure 4).

Choropleth maps display geographical areas that are coloured or patterned in relation to the data. This provides a way to visualise values over a geographical area. Through the use of colour, variations, patterns, or outliers can be viewed within a geographical context (The Data Visualisation Catalogue, 2021).

A choropleth can use a progressive or a single colour scheme with hue progression, blending the colours based on stop points in the range of the data.

It is important to be aware of visual uncertainties when using choropleths. These include assumptions that darker colours mean higher values, that larger areas can appear more emphasised, and that data should be encoded in some way to normalise the visualisation for features like population and area.

3.5.1.3 Prototype design and development

The prototype was built and deployed using web technologies, HTML, CSS, and JavaScript. Vercel (Vercel, 2021), a cloud integration and deployment platform was used to host the application. Vercel works on a freemium basis, providing free services depending on the level of interaction with the application being deployed. Given this was an initial demonstration prototype there would not be much interaction with it and Vercel would provide a simple method to host the application.

ExpressJS, a “Fast, unopinionated, minimalist web framework for Node.js” (ExpressJS, 2021) was used to build the necessary backend services. Express was chosen for its size, speed, and stability. The main functions of the back end of the prototype application were to process the data at set intervals and serve it to the front end. It would not be handling vast amounts of data or requests, so a server that would be quick and simple to develop was the priority.

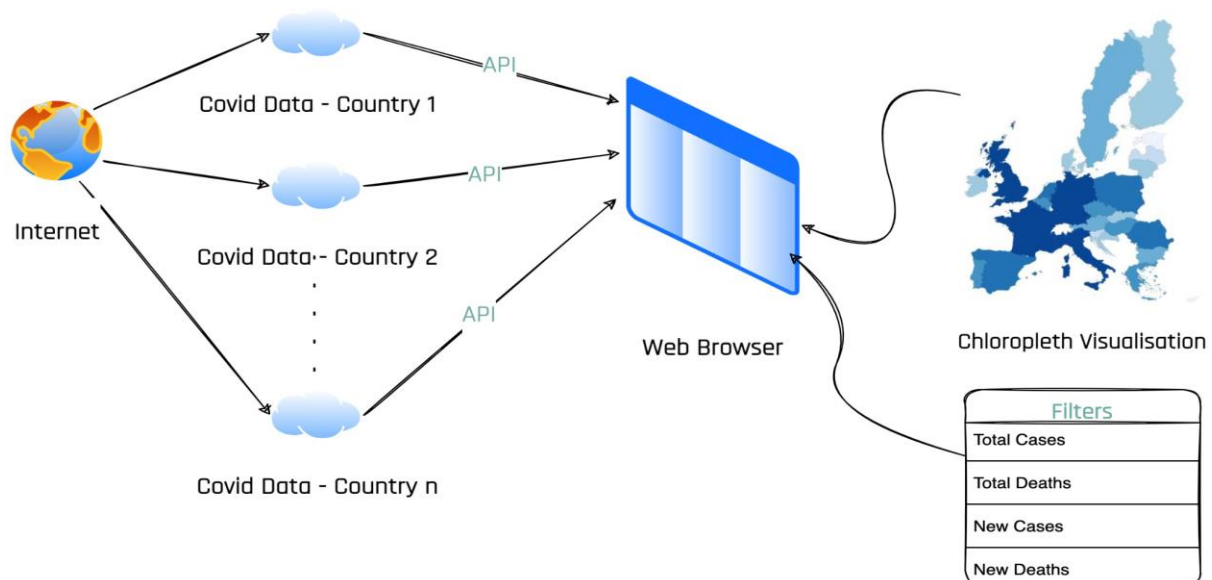


Figure 5: Web Application architecture

React was used to build the user interface of the application. React is “A JavaScript library for building user interfaces.” (React, 2021). It is open-source and one of the most popular and developed libraries in the domain today. It is a declarative, component-based system, allowing for highly interactive web Visual Analytics Component, API and developer documentation (version 1)

pages. Component based development allows for abstract, interactive, reusable building structures. These components have their own interactions but can also inherit them from parent components making them highly adaptable. Developing components in this manner within this initial prototype would provide insight into how future design components should be developed.

The front end was divided into a number of components.

- The choropleth map. This component has several interactive layers which show the current indicator data selected. Upon hovering on a region in the map a tooltip presents the relevant information for that region. Upon clicking on a region, the map zooms to that region and the region's data is loaded into the time series line chart component.
- The time series line chart displays historical data, current data, and simple forecast data. The forecast data is the simple moving average of the data points from the historical data projected 30 days into the future.
- The filter box allows the users to select the current data layer and visualise the selected indicator data.
- A country selector allows the user to zoom out to view both chosen countries or to zoom into a specific country.
- Finally, a legend displays the quantitative data and relevant colour that is being shown on the map.

3.5.2 Participatory design approach

The goal of this deliverable is to produce visual analytical components, to be instantiated in the WP3 dashboard, for pandemic managers and public health analysts to derive assessment and decision support for planning and response. To develop these components for pandemic preparedness and response we implemented a participatory design approach.

Participatory design represents a design approach in which the people destined to use the system being designed play a critical role in its design (Schuler & Namioka, 1993). The approach, pioneered in Scandinavia, differs from traditional design in a number of ways:

1. It rejects the assumption that the goal of computerisation is to automate the skills of human workers, instead seeing it as an attempt to give workers better tools to help them do their jobs.
2. It assumes the users of the system are in the best position to determine how to improve their work and workflows. This is particularly true in the case of specific domains like healthcare or pandemic management.
3. It reverses the traditional designer-user process, viewing the users as the experts, and the designers as technical consultants.
4. Finally, it views the computer system, not in isolation, but in the context of a wider workplace, as a series of processes rather than products.

Generally participatory design is conducted in face-to-face sessions with the users themselves, recording requirements and teasing out the functionalities that are necessary to implement these requirements. In the context of the COVID-19 pandemic these meetings would not be possible with all the stakeholders involved, which left the issue of how to establish meaningful and productive interactions among the design team, the development team, and the users of the system. For most end users chronic lack of time caused by the pandemics' urgency and the need to meet various

workload demands meant analysing user behaviour, managing feedback, improving visualisations, and engaging all stakeholders became a significant challenge.

To meet the goals of participatory design and ensure the designed components would be useful to users of the system, the participatory design processes would have to be adapted to the pandemic context. Several asynchronous methods would allow the members of the necessary teams to design and develop in a participatory manner within the context of their pandemic workload.

Our participatory design process involves four distinct steps to enable collaboration across multiple teams, and based on received inputs, design the analytical components for the dashboard application. First, we focused on understanding the context in which end users will use the dashboard. In this step, we learned from different stakeholders about end-user requirements and which COVID-19 public dashboards are essential to analyse. The next step was to create a document with prioritised characteristics and indicators. After this, the asynchronous participatory design step consists of a weekly asynchronous interaction with users, by delivering prototypes, receiving feedback, and integrating that feedback into the prototype the following week. From here, the prototype designs are sent to the software team who carries out the implementation of designs towards the final prototype.

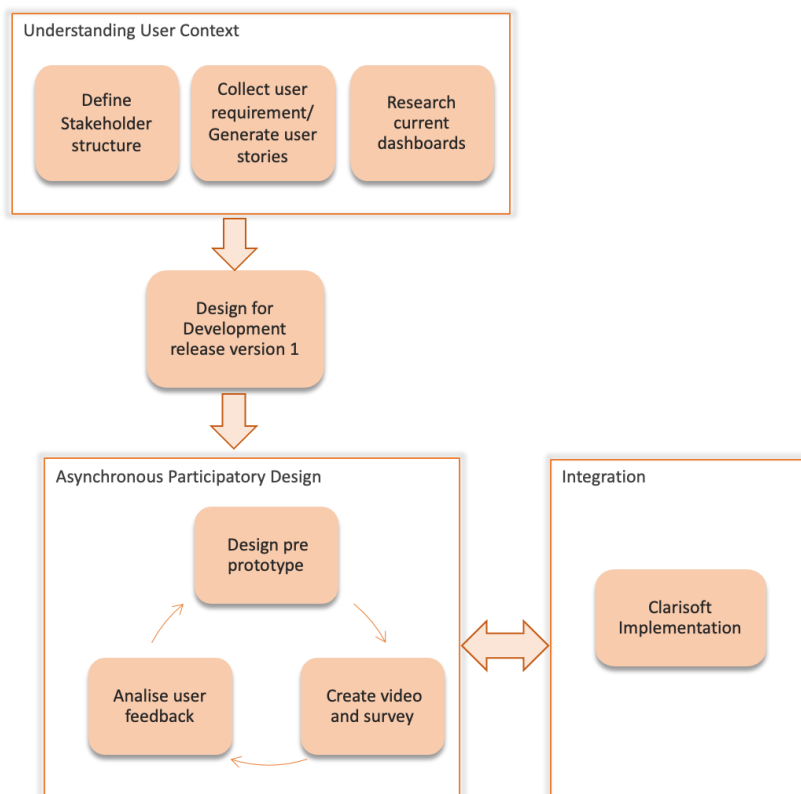


Figure 6: Participatory design approach

3.5.2.1 Stakeholders group structure

At the outset of the project several working groups were set up to enable the relevant partners to work together within the context of each of the deliverables. A technical team (those involved in the practical technological development within the project) was created with all the partners involved in work packages 2, 3, and 4. This team consisted of team members from NUI Galway (NUIG), Clarisoft (CLAR), and Epiconcept (EPIC). This team had weekly meetings to discuss agenda points, development

issues, design, and implementation issues. Much of the work was interdependent on other parts of the work and so it was necessary for all the team members to work together. The working groups partook in initial plenary, group, and interactive user sessions to discuss and decide on the processes for moving forward. An initial functional design was created based on these initial meetings to give a structure and a plan to the groups for moving forward.

As part of this initial collaborative process a shared workspace was created on google drive with each work package having its own space. This shared workspace was used for collecting user requirements, storing relevant documents relating to each work package, and collaborating with other partners.

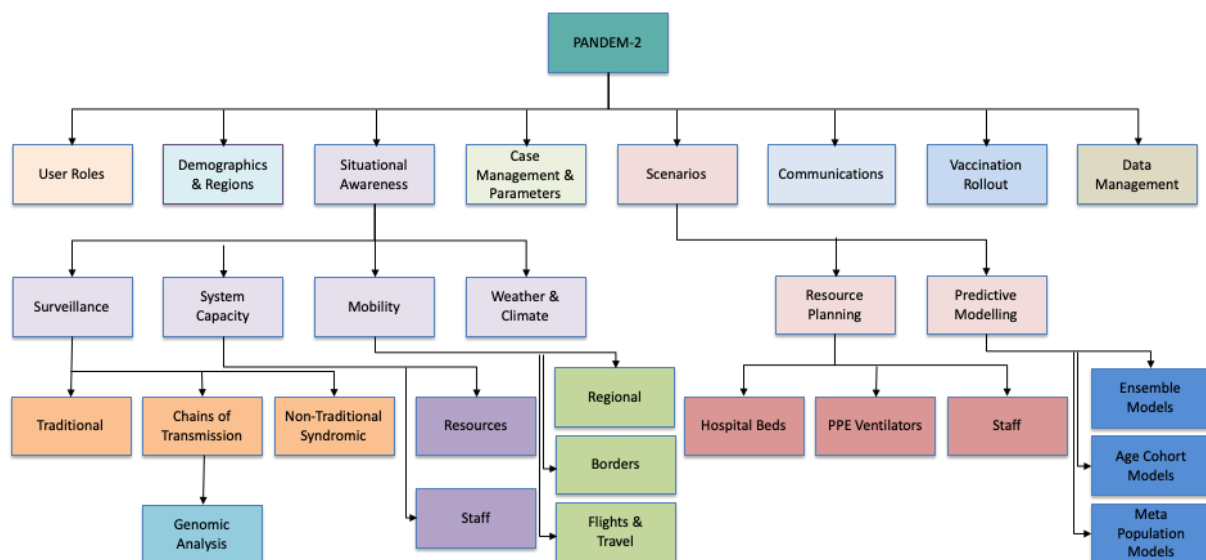


Figure 7: A functional overview of user requirements

3.5.2.2 User requirements and generation of user stories

The next step of the participatory design process was the capture of end-user requirements (described in detail in D3.2). Each of the public health consortium partners selected a point of contact to collect the internal user requirements of the organisation and to pass this information along to the technical team. These point-of-contacts would also serve as representatives in the initial user forums at the beginning of the project. A number of workshops with members of the technical team and the end users took place at this stage of the project to explore the user requirements and gain clarification on any questions that had arisen during the initial user requirements gathering process.

Given the number of partners and the number of requirements at the outset, the requirements were divided between the technical team groups to explore and develop into user stories. A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer (Atlassian, 2021). This process of exploring the user requirements and generating user stories would allow the technical team to combine similar requirements, investigate which requirements were common to all users, prioritise the requirements, and gain a better understanding of the main functionalities that the PANDEM-2 dashboard would need to provide.

Use case: Cases: Numbers

In terms of Situational awareness and possible scenarios the user should have access to:

Query	Functional Category	Links	Query Resources
Number of Cases	Situational Awareness, Scenarios	RUNMC-36 , ORK-14 , ORK-15 , ORK-16 , RKI-24 , RKI-26 , INEM-02 , INEM-05 , RIVM-12 , RIVM-16 , RIVM-20 , RIVM-27 , NIPH-01 , NIPH-02 , NIPH-03 , FOHM-12 ,	<ul style="list-style-type: none"> - Total Number - With proven infection - With suspected infection - Severity of cases - Genetic subtype of pathogen - New cases over time/Incidence rates - With isolation status - 7 day incidence per 100,000 - Cluster by T-SNE analysis - Characteristics of patients (monitor outbreak and determine at risk groups) - Stratified by age - Stratified by sex - Underlying Condition - Stratified over time - Change in trend - Vulnerable groups - Effect of treatment - Personal Info: <ul style="list-style-type: none"> • Name, personal identifier, age, gender, address, phone, occupation
View over Time			Daily, Weekly, Monthly, Yearly
View by Area			<ul style="list-style-type: none"> - Local, Regional, National, NUTS - Identify and visualise clusters of cases.

Figure 8: User story. Query, links, and query resources example (for full details see D3.2)

Each user story had a main query based around an indicator, for example the number of cases. This query was related to the initial functional design of the application. The query had links to all the requirements and linked back to those requirements in the initial requirements document so the user story could be traced back to the initial requirements. Finally, the user story had several query resources. These are linked to the [interaction models](#) and would provide the user interaction functionality to allow methods to change the data via filtering, aggregation, create new data artefacts, or creating records. Finally, each user story had a time element and a geographical element.

Further details about generating user stories and about the requirements gathering process are available in deliverable D3.2 Dashboard design.

3.5.2.3 Research of current public health dashboards

As referenced in [section 3.1.3](#) a review was conducted of current public facing COVID-19 and other public health dashboards. Included in this review were the dashboards of the consortium partners. These reviews allowed for a secondary indirect type of participatory design to take place, through dashboards that they developed themselves. These dashboards had been in design, development, and implementation for up to a year at the start of PANDEM-2. The review of these dashboards and the Visual Analytics Component, API and developer documentation (version 1)

outcomes of this review indicated functional user designs and data visualisation decisions. Under the initial research headings of [best practices](#) and [interaction models](#) user requirements could be recorded within the context of the end users domain expertise. Through the collation of data and data visualisations in consortium partner dashboards best practices such as prioritisation of information, geometries and data, emphasis, the use of colour, explainability, and data transparency could be extracted. Data visualisation interactions within those dashboards highlighted the different data interaction models that were of use in the domain and how data artefacts were aggregated, filtered, changed, and recorded. These data visualisations were recorded in the visualisation catalogue for future reference and design use.

3.5.2.4 Development of asynchronous participatory design process

Moving forward into the project in the context of a pandemic with the time constraints on end-users' availability, and the need of multiple partners to interact with them, the traditional methods of user interaction would not be suitable. We would need to adapt our working processes to the constraints of the pandemic, but in a way that would allow the continued collaboration of all parties.

We developed a short asynchronous participatory design process (APD). The asynchronous nature of the process would allow the users time to consider the questions and data visualisations that were being put to them. It would also allow them to include the process around their current work schedule and would not impose on their already hectic schedules. It would allow us to document user feedback and collate it for reference moving forward in the project. It would also allow us to see any divergences in requirements between the different end users.

This APD consisted of regular short interactions. This process would be a consistent cycle, a weekly interaction of delivering prototypes, receiving feedback, and integrating that feedback into the following week's prototype. The structure of the process was based around a prototype, documentation for the prototype, and a focused survey about the data visualisations and interactions within the prototype. Each prototype would be based around one indicator. The outputs of D3.2, the user story, the user requirements, and the dashboard design were the basis for the initial data that would be needed in the design. Then with reference to best practices, interaction models, and the visual catalogue, we created an interactive indicator view with design prototyping software (Figma, 2021).

Following the creation of the interactive view, video documentation was created. This documentation stuck to the APD principle of brevity with a goal of no more than 5 minutes in length. This video documentation explained the indicator view to the user, the data visualisations within the view, and the interactions that were available to the users. Finally, a survey was created, asking the users targeted questions, and asking them to evaluate the data visualisations and the interaction functionalities.

Once these components were created, they were sent to the end users and the technology team, with a deadline of a week for the user to complete the survey. This provided the end users with the freedom to view the video documentation, interact with the prototype, and complete the survey on their own timeframe, when it suited them. Once the week's deadline had passed the user responses were collected, explored, and the feedback was integrated into the next prototype model. This allowed for a continued process of participatory design and improvement within the context of pandemic constraints.

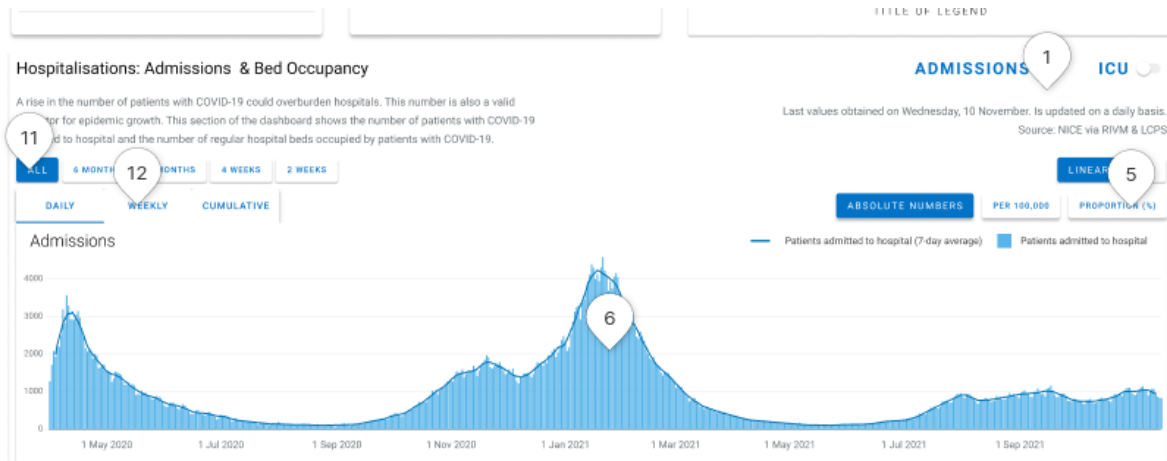


Figure 9: Example of prototype model with interactive comments regarding specific aspects of the design

As this iterative process was taking place there was a parallel process of interaction with the technology team and with the software development team. The development team were sent the interactive prototype but also the design model behind the prototype with comments explaining the design decisions for the team. This allowed for focused collaboration between the two teams on specific sections of the prototype. The model was also logged in Jira (Jira, 2021), an issue and project tracking software, so it could be tracked within the context of the whole project. Each technology team partner has an account on Jira to further the collaborative process and help with any questions outside of the design domain.

Projects / Pandem2 Global

Issues

Search issues Project Type Status Assignee: Current User More + Reset Save filter

Share Export issues Go to advanced search LIST VIEW DETAIL VIEW BASIC JQL

Type	Key	Summary	Assignee	Reporter	P	Status	Resolution	Created	Updated	Due
<input checked="" type="checkbox"/>	P2G-658	Deliver the general UI elements in the visual context of UX scenarios movie and access to the model in Figma to be able to implement the content of DDX and EM content.	Carlos Tighe	Gheorghe PACU...	IN PROGRESS	Unresolved	29 Oct 2021	16 Dec 2021		
<input checked="" type="checkbox"/>	P2G-620	Deliver the general UI elements in the visual context of UX scenarios movie and access to the model in Figma to be able to implement the content of HA and HBC content.	Carlos Tighe	Gheorghe PACU...	DONE	Done	29 Oct 2021	5 Dec 2021		
<input checked="" type="checkbox"/>	P2G-594	Deliver the general UI elements in the visual context of UX scenarios movie and access to the model in Figma to be able to implement the content of Surveillance --> Cases content.	Carlos Tighe	Gheorghe PACU...	DONE	Done	28 Oct 2021	11 Nov 2021		

Give feedback 1-3 of 3

Figure 10: Jira issue reporting and tracking

These parallel iterative processes enabled continuous participatory design between multiple teams to facilitate the design, development, improvement, and implementation of the analytical components within the dashboard application.

3.5.2.5 Design for Development release version 1. January 2022

The work that informed the asynchronous participatory design process was a collaborative document created by the technology team to decide what features and indicators should be prioritised for the first version release of the Dashboard and Visual Analytics tools. Each technology team partner created their own minimal viable product (MVP) document detailing what should be the minimal goals that

should be set for this first version release.

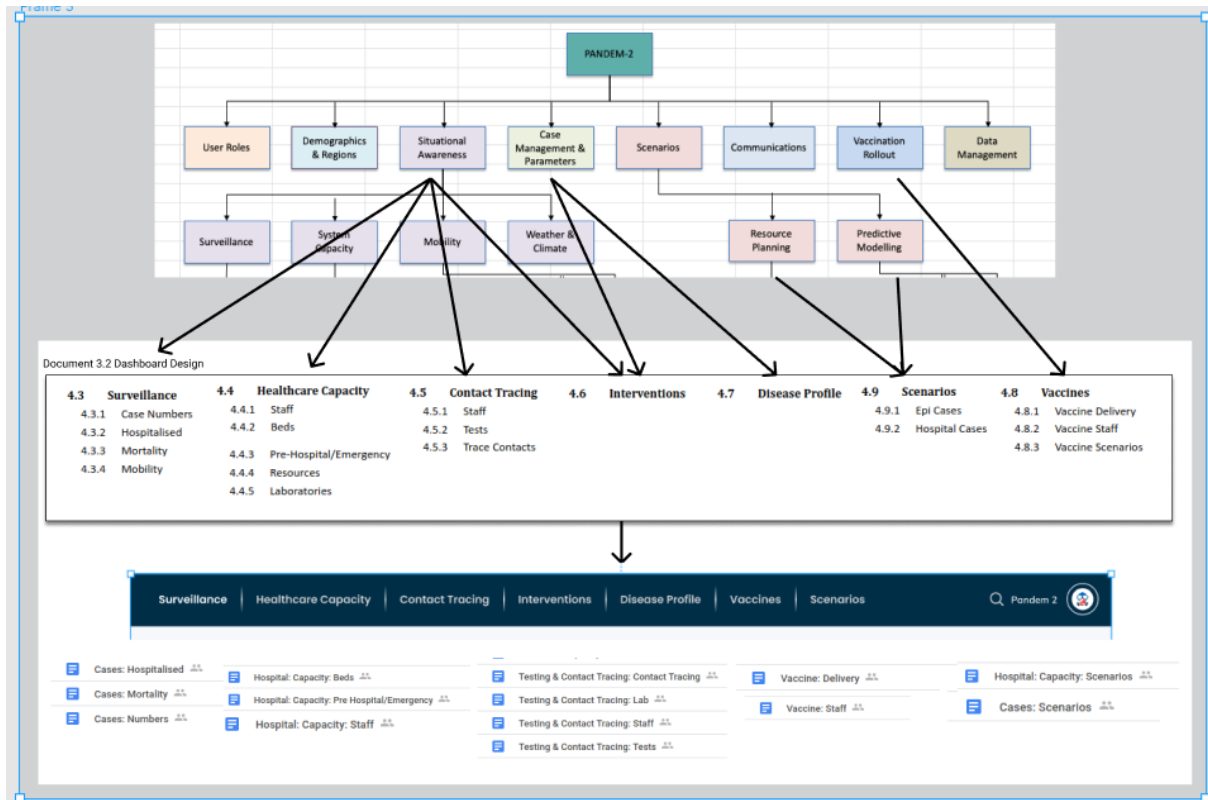


Figure 11: Mapping from user requirements to the minimal viable product.

The process started by going back to the initial functional design that was created at the start of the project. This was then mapped to the outputs of D3.2 Dashboard Design. User stories were added, and the Visual analytics team developed their initial design. This initial design looked at several items that should be delivered in the MVP. The main menu header categorised all the indicators. Each indicator would be viewable from this menu. Then a view for each indicator was developed, highlighting the data that should be available and presented, the components that would be needed for that view, and the interactions that would take place within the view.

Each partner's expertise and requirements were combined into a set of slides prioritising the work for the first version release. These slides reduced the requirements into a meaningful and achievable number of deliverable indicators within one release. These requirements were then visualised in a design prototype to give an idea of the different views and links that would be available. [Appendix section 7.4.2.1](#)

Each of the requirements and interactions was then encoded as an issue within the Jira issue tracking system by our partners CLAR. This enabled tracking and collaboration at a granular level regarding each of the requirements and functionalities.

Once the indicators for the first and second version releases were defined and agreed upon, the design work involved in creating the views and the components that made up those views began.

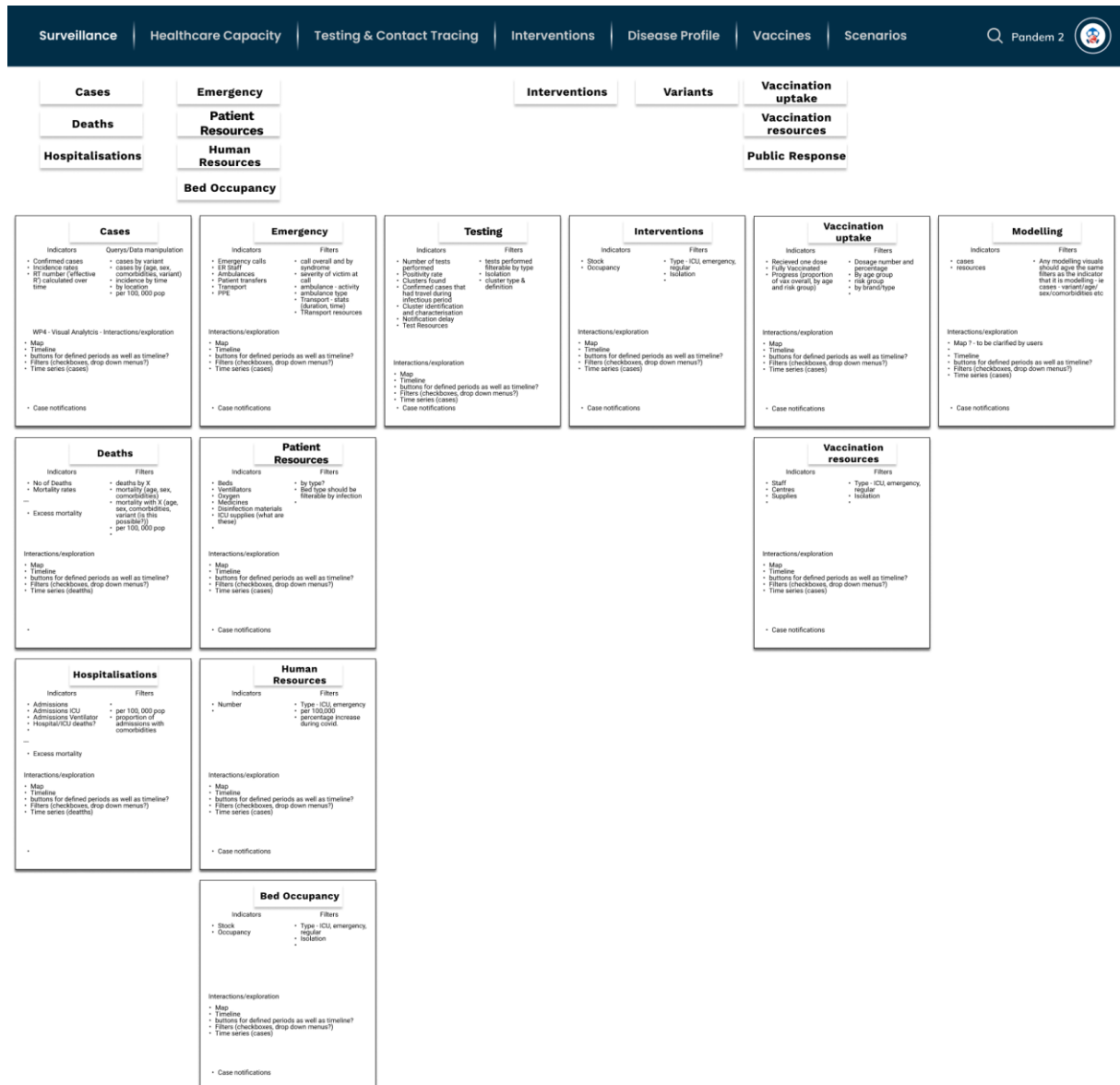


Figure 12: The VA team's initial MVP diagram.

4 Results

4.1 Research Outputs

The outputs from the research section of this work package were the processes and guidelines used in the design part of this work. The [review of best practices](#) highlighted best practices to consider in the process of designing any data visualisation. From the prioritisation of information to the careful consideration of graph choice, geometry and shape choice, and colour, to the inclusion of data, in terms of context and transparency, the review carried out at the beginning of the project gave a strong foundational understanding of the process we should use in the design of any data visualisations. The [review of interaction models](#) built upon that foundation adding user interaction and exploration to this design process. Understanding the methods and functions of the user interaction models further guided the design process illuminating how data visualisations should present information and how they should allow a user to interact and gain further understanding of the data through a variety of

interactive methods, organising data, filtering data, creating new data, and saving data within a context, facilitating the creation of situational reports. The [review of current dashboards](#) gave us insights into how experts in the pandemic and health domains present, view and interact with information. It allowed us to continue the participatory design process without large time impositions on the end users in this critical time. The review of their work on actionable dashboards gave us further insight into how to plan and design the data visualisations within the user workflow of a larger dashboard application. The [data visualisation catalogue](#) provided a useful reference tool to query and explore different ideas in how to create and present different information in different interactive formats.

4.2 Design Outputs

4.2.1 Initial Research Designs

At the beginning of the project, we began to internally explore the interactions and data visualisations that might be needed, investigating different presentations of information in a visual format. This initial work included an initial map prototype, data comparison between two countries, and various formats of data presentation.

4.2.1.1 Initial Map

This initial prototype explored how to switch between regions.

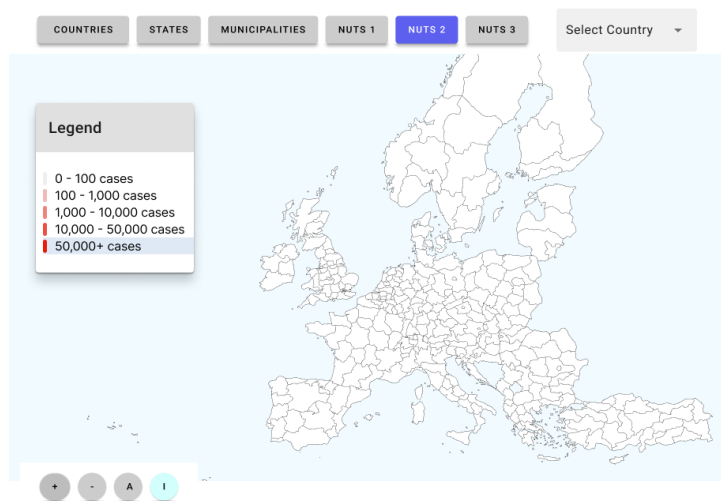


Figure 13: Initial map prototype

A visual map of the interactions can be viewed in the appendix: [section 7.2](#)

Interactive model:

<https://www.figma.com/proto/J3a9muWys6942h4y4Quy2P/Map-Component?node-id=2%3A153&scaling=min-zoom&page-id=0%3A1&starting-point-node-id=2%3A153>

4.2.1.2 Country Comparison

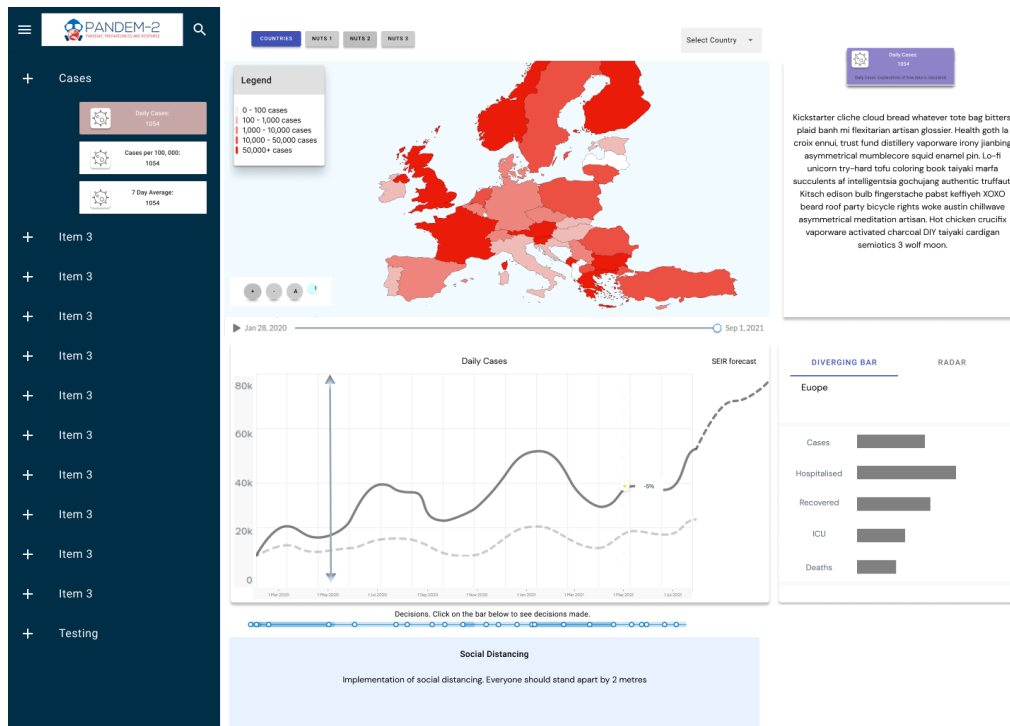


Figure 14: Country Comparison initial design

This design explored how a user might use a map as a driver for interacting with data, and how comparison of data between 2 countries might look. Germany and Spain were developed as selectable sections of the map, with the data on the page being updated when a region was selected by clicking on it.

A mapping of the interactions in this design can be found in the appendix [section 7.2](#)

Interactive Model:

<https://www.figma.com/proto/oCVquiMZxf9chIMc8xPGBn/Desktop-Example?node-id=0%3A251&scaling=min-zoom&page-id=0%3A1&starting-point-node-id=0%3A251&show-prot-sidebar=1>

Other initial design work can be found in the appendix in [section 7.2](#).

4.2.2 Prototype Mapping Application

The creation and deployment of a prototype mapping application

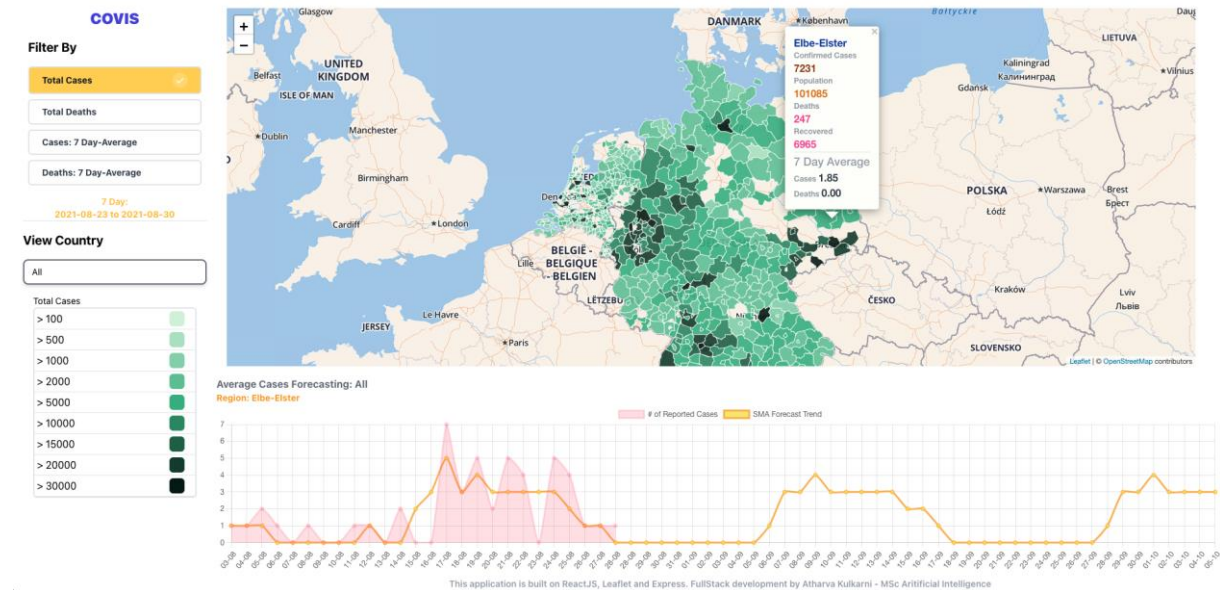


Figure 15: Map prototype

The implementation of the mapping application has a number of features. On the left of the application are the data interaction components. These include a data filter that allows changing of the data under four different headings:

1. Total Cases
2. Mortality or Total Deaths
3. The 7-day average of cases
4. The 7-day average of deaths

Below this is a Country select box which allows the user to select the country visible within the application. Finally, below this is the legend, an explanation of the data being shown in the map that show the values corresponding to the colours.

The main part of the application is a map component is a map of Europe focused on the two countries chosen for the application. Overlaid on the map is a choropleth layer divided into NUTS2 regions. Leaflet is used to create this data layer and allows the filters to toggle between data layers. The choropleth visualises the data via the hue of the colour, the darker the hue the higher the value of the data. The main interactions of the map are zooming, clicking, and hovering. Zooming allows the user to view different levels of granularity in the component. Zooming can be done via the buttons in the top left of the map component, via touchpad, or via mouse. Clicking allows the user to select a region. Clicking on a region will zoom to that region and load that region's data into the time series line graph component. Finally hovering over a region will show a tooltip that contains information specific to that region.

4.2.3 Pre-Prototype design phase

With the prioritisation of information and indicators in mind the design of the data visualisation began. Each indicator view would be a page made up of various relevant components. Developing similar abstract components that could be adapted to each indicator page would create a unity of design and Visual Analytics Component, API and developer documentation (version 1)

interaction. The user having figured out how interactions and components would work on one page would have an intuitive idea of how the components would work throughout the design.

4.2.3.1 The menu bar component

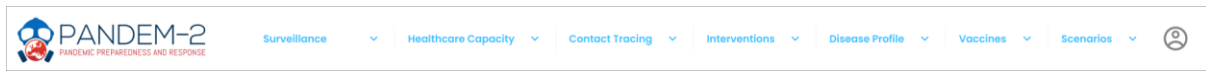


Figure 16: Menu bar component

The Menu bar sits at the top of each page within the PANDEM-2 dashboard. It is the main method of user navigation. The menu bar consists of a number of items; the PANDEM-2 logo, the high-level functional groupings within the dashboard, and the user icon. The PANDEM-2 logo acts as a link to the landing page and will bring the user back to that page on clicking. The high-level functional groupings combine indicators under relevant high-level headings. These functional groupings were proposed at the initial stage of the project and evolved from the user requirements. Each of these headings contains a drop-down list of relevant indicators which will bring the user to the relevant indicator view. Finally, the user icon will allow the user to control how the PANDEM-2 dashboard will work for them. This icon will lead to the user settings page allowing users to choose which indicators are important to them and therefore which should be shown in various parts of the dashboard, what region they wish to view, and other settings like default timeframes.

4.2.3.2 The overview component

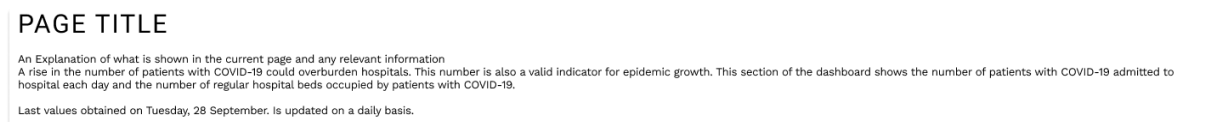


Figure 17: overview section

The first component in the content section of each of the views is the overview section. This component has several features. The first is the title of the view that the user is on. This is usually the indicator the user is viewing. Alongside the title will be the region that the user is viewing that indicator for, whether it be at a national level or regional level. This region will be a clickable drop-down menu allowing the user to easily switch between regions at the top of the page, updating the information for the whole view. Underneath the page title is an explanation of what is being shown on the current view. This is a description and explanation of the indicator, why it is relevant, and any other important information that the user should be shown with regards to that indicator. Finally at the bottom of this component is the date when this data was last updated. This allows the user to see how up to date the information is and allows for transparency. Data provenance and traceability is an important issue and one considered throughout the project. Given the social and political issues that surround decision making in pandemic preparedness and response, being able to confirm data sources and dates is important for transparency and trust.

4.2.3.3 Indicator card component

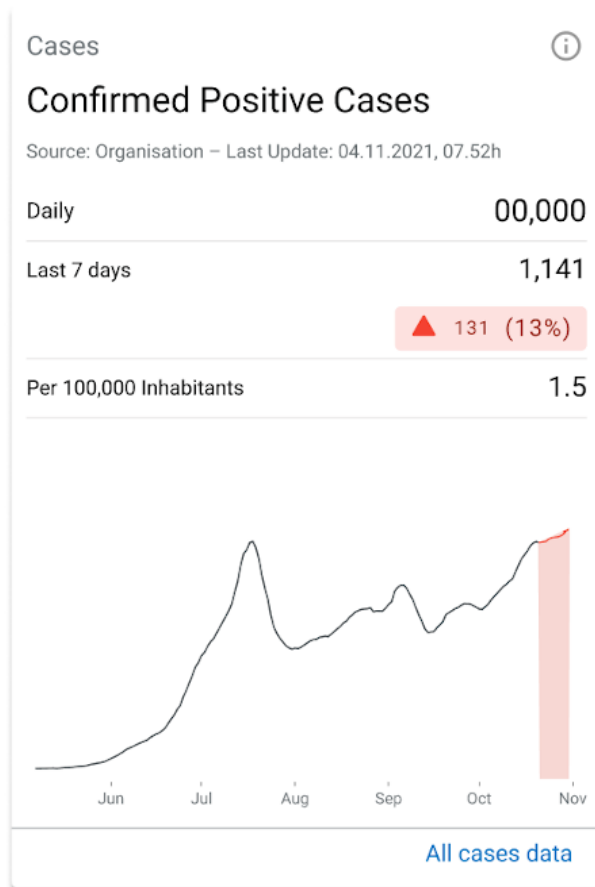


Figure 18: Indicator card component

Indicator cards are the next component in a view. An indicator card gives an overview of the specific indicator related to the view the user is on. These indicator cards allow the user to quickly assess the current situation with regards to that indicator. Indicator cards have a high-level indicator title, along with a specific indicator title, the source, and the time of the last update of the data within the card.

There are two adaptable versions of the indicator card, one for the landing view, and one for the indicator views. The landing view has less information but also includes a small graph to allow the user to see the current trend of the indicator. The landing view indicator card also has an action at the bottom of the card to allow the user to explore this data further. The indicator view card has more information about that specific indicator as the user is specifically looking at data about that indicator. It does not have a graph as there will be more detailed data visualisations on the page that this card is on.

The indicator card has been designed to allow the user to see quickly and easily the data within the card. Relevant filtered views of the indicator alongside values for those views, coupled with visual cues like colour, arrows, and a trend line, allow the user to view the data in multiple formats at the same time giving them an understanding of complex data with a quick glance at the card.

The card also has an information action icon in the top right corner. Clicking on this icon expands the card and provides further information regarding each of the filtered views on the card. This action icon allows the user to get clarification or relevant information regarding the filtered data without cluttering or detracting from the initial clear data centred view.

4.2.3.4 Map component

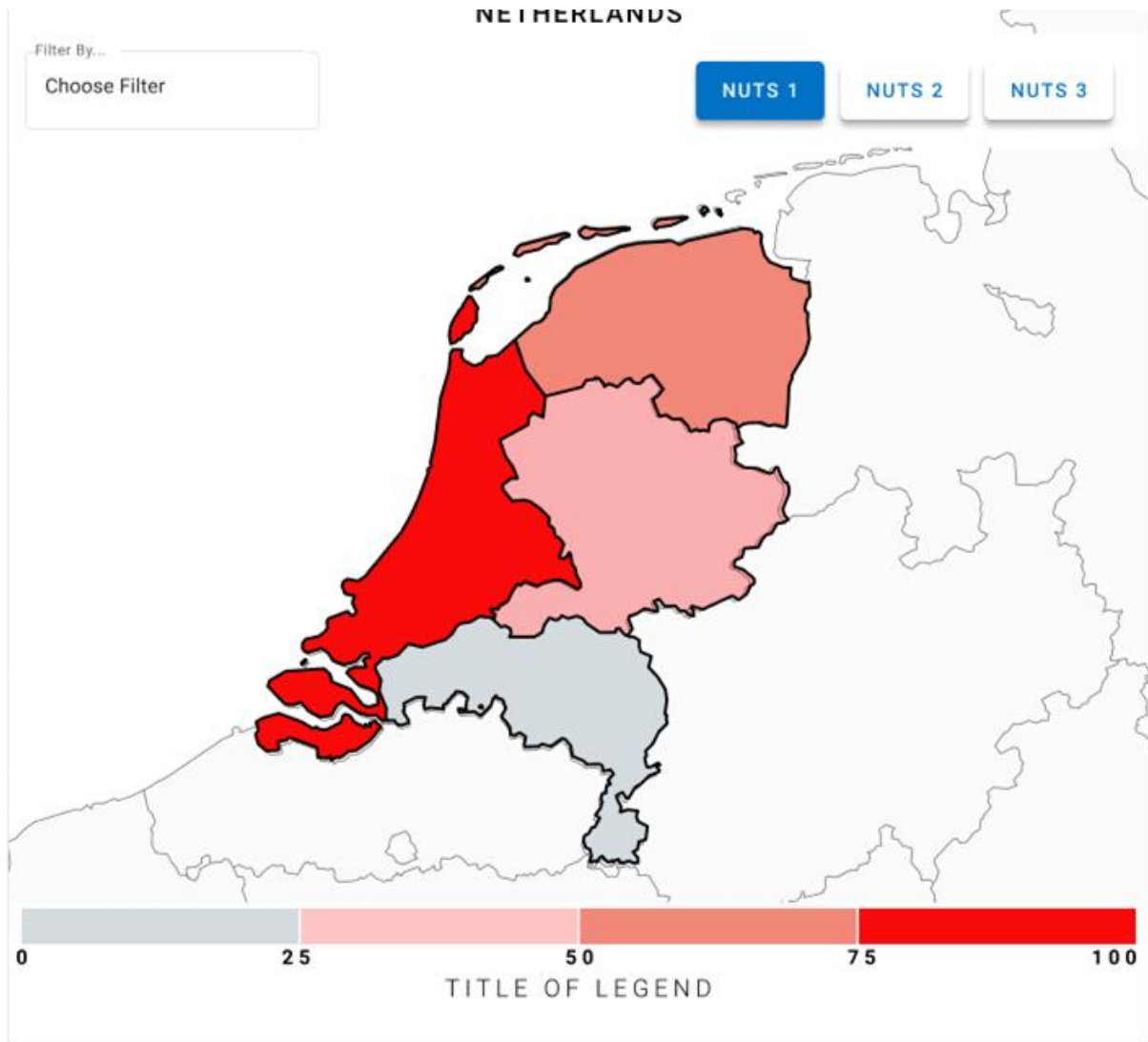


Figure 19: Map component. It shows the selected region of the Netherlands. Although 4 regions are shown, the region title, at the top of the map, highlights that the data on the page is for the whole of the Netherlands.

The map is a way to view information within a regional context. The map is a component for both viewing information and driving page and data interactions.

Within the map are different components:

- The region title
- The filter menu
- The Nomenclature of Territorial Units for Statistics (NUTS) buttons

- The map itself
- The Legend

The region title displays the area that the user is viewing. As the user views different regions, the region title will update illustrating clearly and concisely which region the data on the current view is for.

The filter menu is a menu to change what data is being displayed on the map. On initial load of the page the map will display data from the high-level indicator. This can be changed with the filter to show filtered versions of this data or other indicators within each region in the map.

The NUTS buttons allow the changing of the NUTS regions on view within the map. This allows the user to switch between regions and drill down into the data at a click of a button.

The map itself is interactive:

- Hoverable - a tooltip will display showing the indicators and the data for the region that is hovered.
- Clickable - clicking on a region will select that region and update the view. This will change the region title on the map, the region of the view in general and update the view to display the information for that region. This allows the user to visually select regions that might be of interest to them or regions of concern.
- The combination of the NUTS buttons and the clickable map will allow users to view regions and localities simply and intuitively.

The Legend has a hover feature that highlights relevant regions in terms of the part of the legend hovered. This visual highlighting aids the user in seeing the relevant regions in a map with many small regions and gives them a better understanding of those regions.

4.2.3.5 Graph component

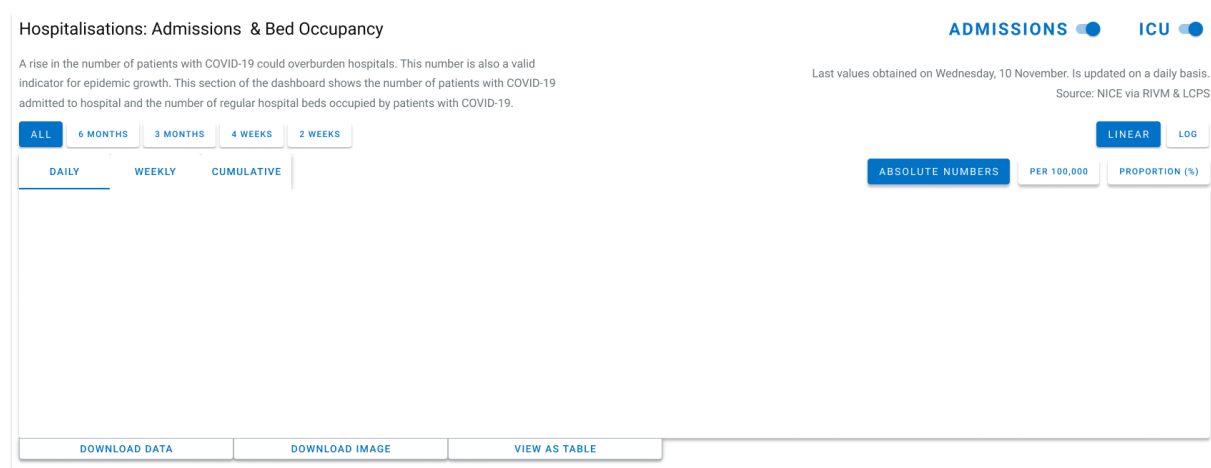


Figure 20: Graph component.

This is how the user interacts with the data they are viewing. This component is an abstract wrapper for the graph itself, a container that can hold any graph with its own built-in functionality.

The first row contains a title and toggle buttons. The title makes clear what data is being shown. The toggle buttons allow a simple interaction to change the data if needed.

The next row has a detailed explanation of the data being shown in the graph and explanations of how that data is being calculated. This row also contains the date of when the data was last updated and the source of the data.

The next two rows contain more data change and filter buttons. The first set of buttons allow the user to view a specific period with one easy click. The buttons opposite this allow viewing of the data in either linear or logarithmic form. The next buttons combine the data into a specific interval period, whether it is one day, weekly, or cumulative. Finally, the last set of buttons provide more filtering functionality, allowing normalisation of the data by population, viewing the data by proportion, or viewing the raw figures of the data.

At the bottom of the component are three data interaction buttons. The user can use these to interact with the data that is shown in the component. They can view or download the data in its raw and complete form, as recommended in our best practices, or they can save the data in its current state and context by downloading an image of the graph as it currently is. The “download data” button allows the data that was passed to the graph to be downloaded in a number of formats. The “download image” button allows the user to download the image as it is currently configured, recording the data in a range of different states. Finally, the “view as table” button allows the user to replace the graph with a data table that contains the raw data for the graph. This enables the user to interact with the raw data within the component itself.

4.2.3.6 Synchronised graph component

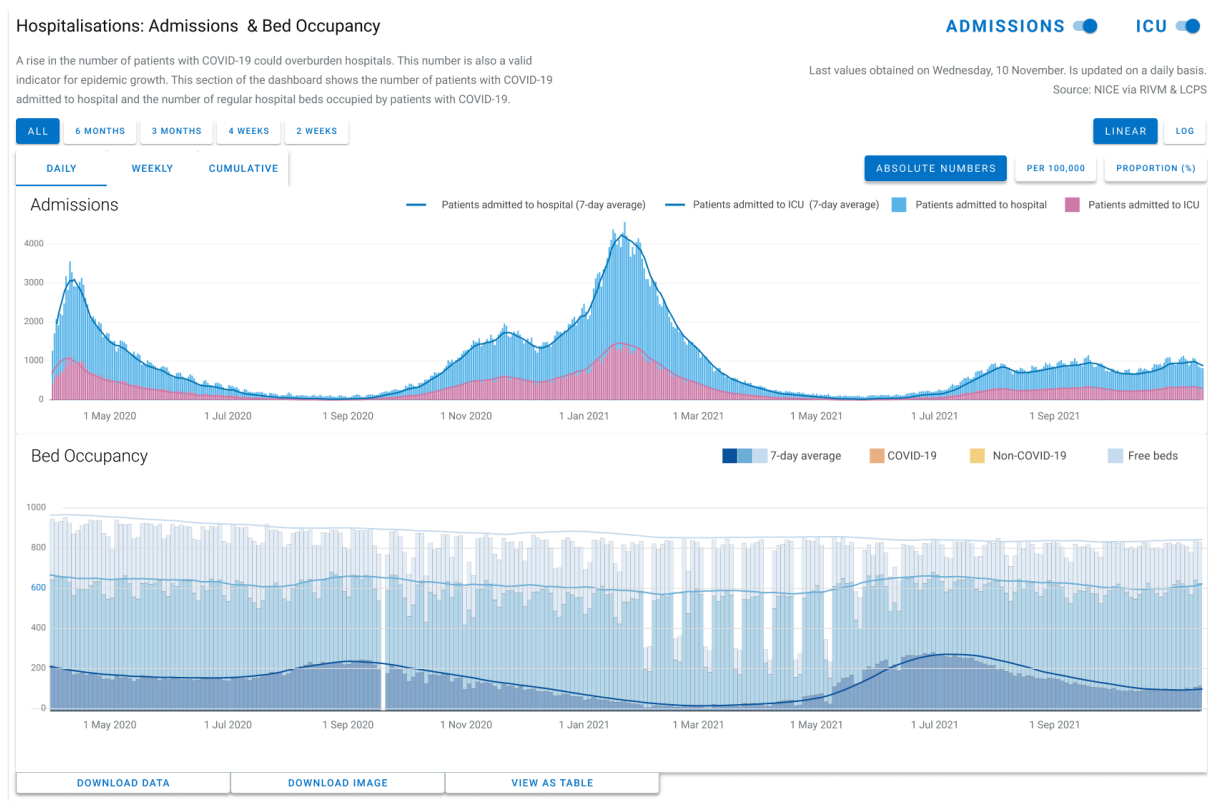


Figure 21: Synchronised graph component

This component (figure 18: Synchronised graph component) is an expansion of the graph component. An explanation of the main sections of the component can be seen in the previous section. This graph

has some added functionality. This graph contains two interrelated graphs in terms of presentation. The data in each graph is situated in the same location and the same time frame. Interactions with the graph change the data in both graphs. The hover functionality in this graph will have a pop up over both graphs at the same time for the same time frame. This allows the user to view correlated information across multiple indicators but within the same context.

4.2.3.7 Landing view Component

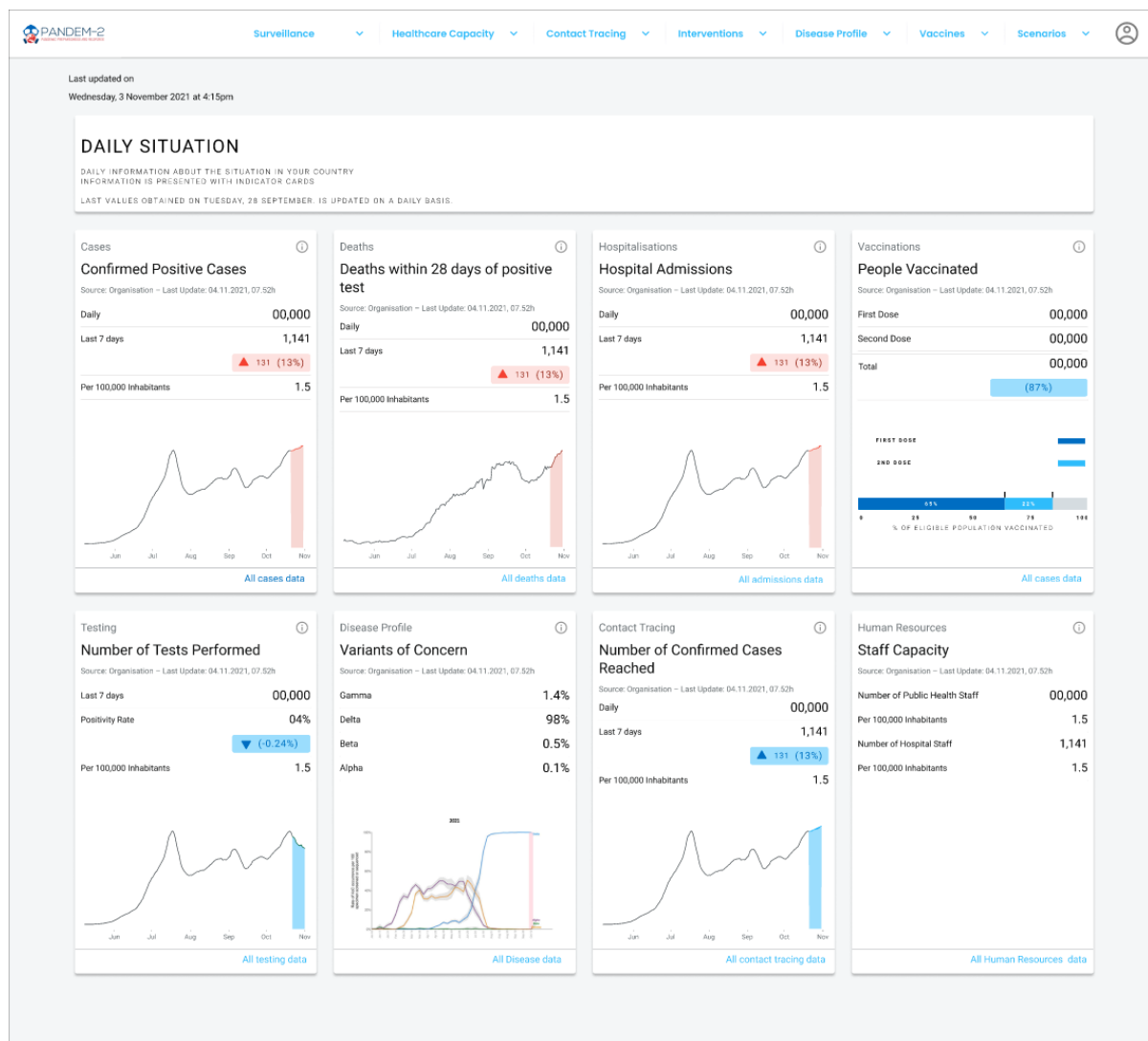


Figure 22: Landing view Component

The components described above were then used to build views for the dashboard. The initial view a user would see upon login is the landing page. This page needed to introduce the user to the system, but it also needed to be relevant to the user and serve a purpose. The view comprises a certain number of indicator cards which are part of a summary of the current context with regards to pathogen-x within a given time frame. The indicator cards shown above include Cases, Deaths, Hospitalisations, Vaccinations, Testing, Disease Profile, Contact Tracing, and Human Resources. Other windows are shown as and when they are required or visited by the user. The page will stay up to date with the current data so long as that data is available.

The landing page is a combination of relevant data for the end-user. The user will choose in the user settings page which indicator cards are important to them and these will be the cards that will show on the landing page. The goal of this view is to give the user situational awareness of the current situation with regards to pathogen-x within a defined period. The user will then be able to prioritise which indicators they wish to explore further.

4.2.3.8 Indicator view

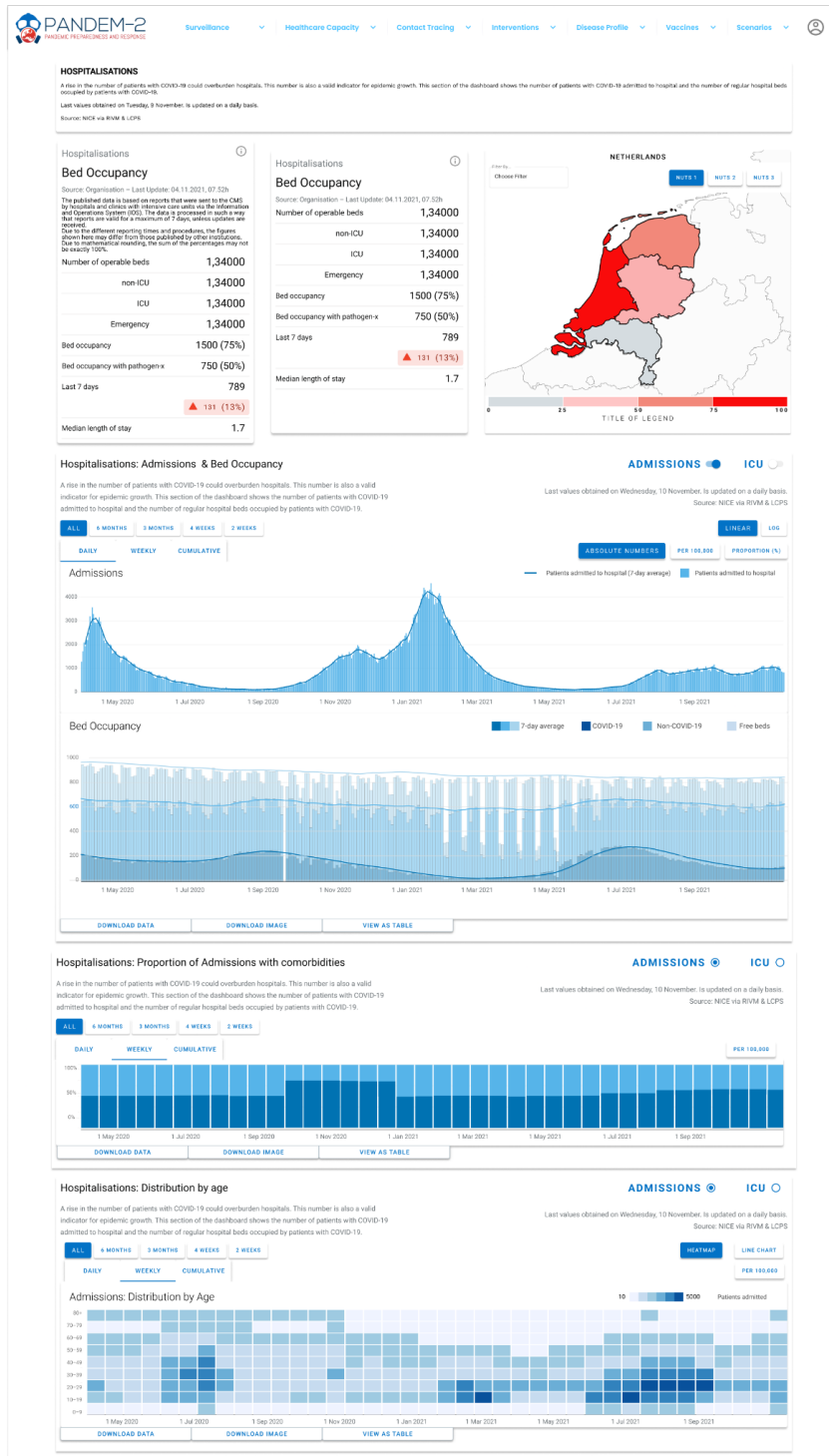


Figure 23: Indicator component

The indicator view was a view based around one indicator, hospitalisations in the above example. The view was built with the menu bar, the overview, two indicator cards, the map, and several graphs. The view as designed explains to the user what they are viewing and any other relevant information in the overview component. The user can then view the current situation and trends, with regards to the indicator being shown, at a glance via the indicator cards and map. Finally, the user can explore data about that indicator via the interactive graphs shown in the page.

4.2.4 Asynchronous Participatory Design Prototypes

The Asynchronous participatory design prototypes are based around one high-level indicator, showing information about that indicator based on the work carried out in section [3.5.2.5: Design for Development release version 1. January 2022](#).

Each prototype has a number of common components that were created within the Figma design software (Figma, 2021). These components can be viewed in the appendix, [section 7.4.1: Components](#)

- Overview explanation component that contains the title of the page and an explanation of the indicator and the data present in the page.
- Indicator cards. These cards contain high priority data relating to the indicator. These cards allow the user to gain an understanding of the current state of the pandemic at a glance. The cards also have an information button that will allow the user to view information about the data being shown.
- A map. This allows the user to see information about the pandemic within a geographical context. The user can choose what information is being shown in the map, can split the map by NUTS regions and can hover on the legend to highlight the relevant areas within the map that relate to that hovered section of the legend.
- A number of graphs. These show the information about the indicator in a more fine grained manner and allow the user to explore and filter the data.

4.2.4.1 Bed Occupancy View

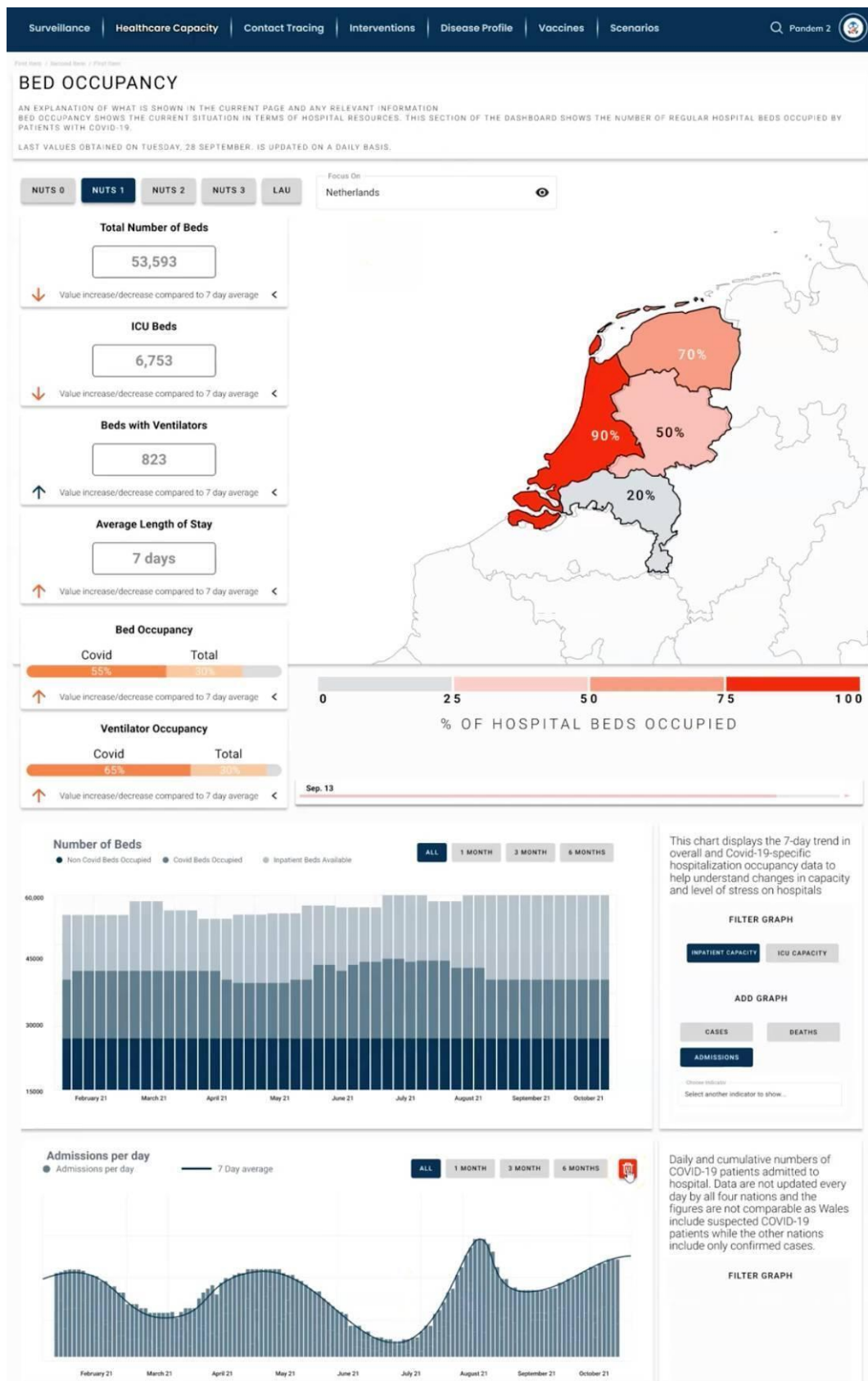


Figure 24: Bed Occupancy View

This pre-prototype view (Figure 24) shows information about pathogen-x bed occupancy. This was the second pre-prototype designed. The ideas in this design are similar to future designs but the implementation is different. The indicator cards are on the page and expandable but instead of one or two there are one for each information point. The map has all the features of the current map component but was much larger and the buttons were not intuitively placed. The participatory design process allowed us to interact with the users, get their feedback and then implement it. The feedback for this prototype informed future designs. The indicator cards in this design were combined into one more complete indicator card and users felt the map was too large on the screen. This view was later redesigned as the hospitalisations view.

The video documentation for this view is available here:

<https://youtu.be/LixMeNd1SD8>

4.2.4.2 Cases View

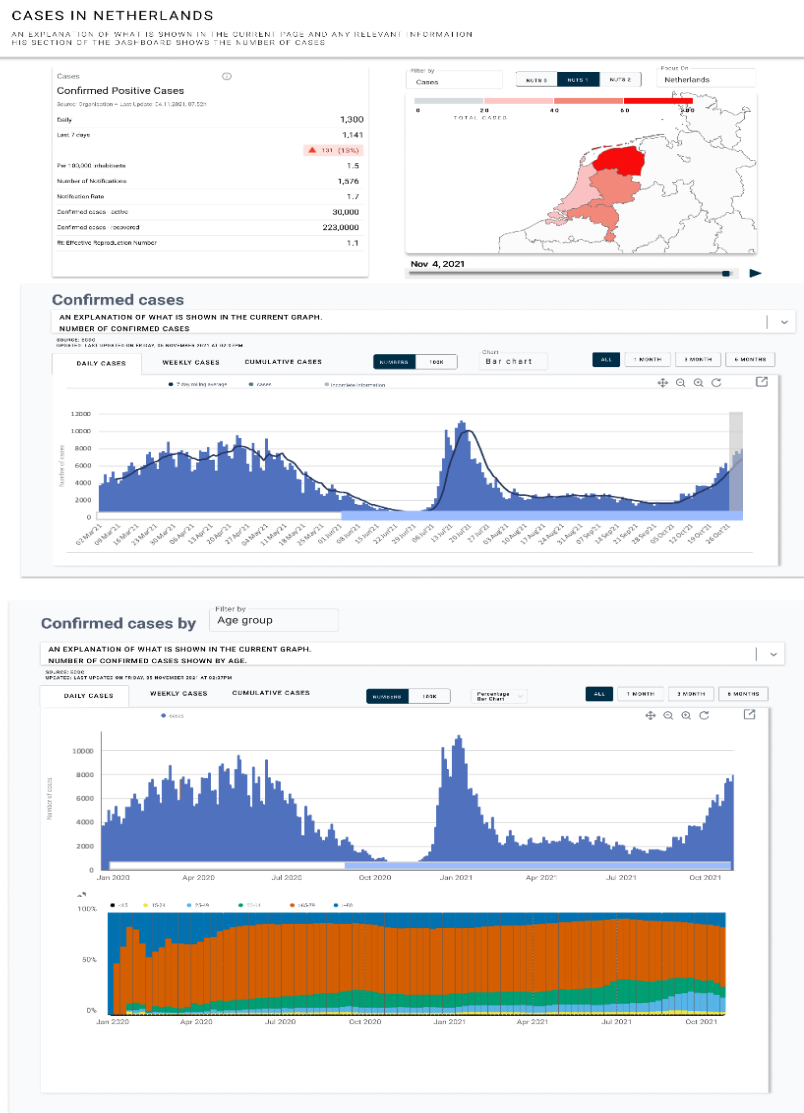


Figure 25: Cases View

This pre-prototype view (Figure 25) shows information about pathogen-x case notifications. The information in this page should be viewable by geographic area in the form of national and NUTS regions. The data should be viewable within specific time intervals (daily, weekly, monthly, and cumulative) and it should be filterable by variant, age, sex, and comorbidities.

The full data requirements of this view are available in the appendix, [section 7.4.2.2](#): Pathogen-x case notifications.

The interactive prototype is available here:

<https://tinyurl.com/4b5rttsx>

The video documentation for this view is available here:

<https://youtu.be/RGODS5Xj8Dk>

4.2.4.3 Hospitalisations View

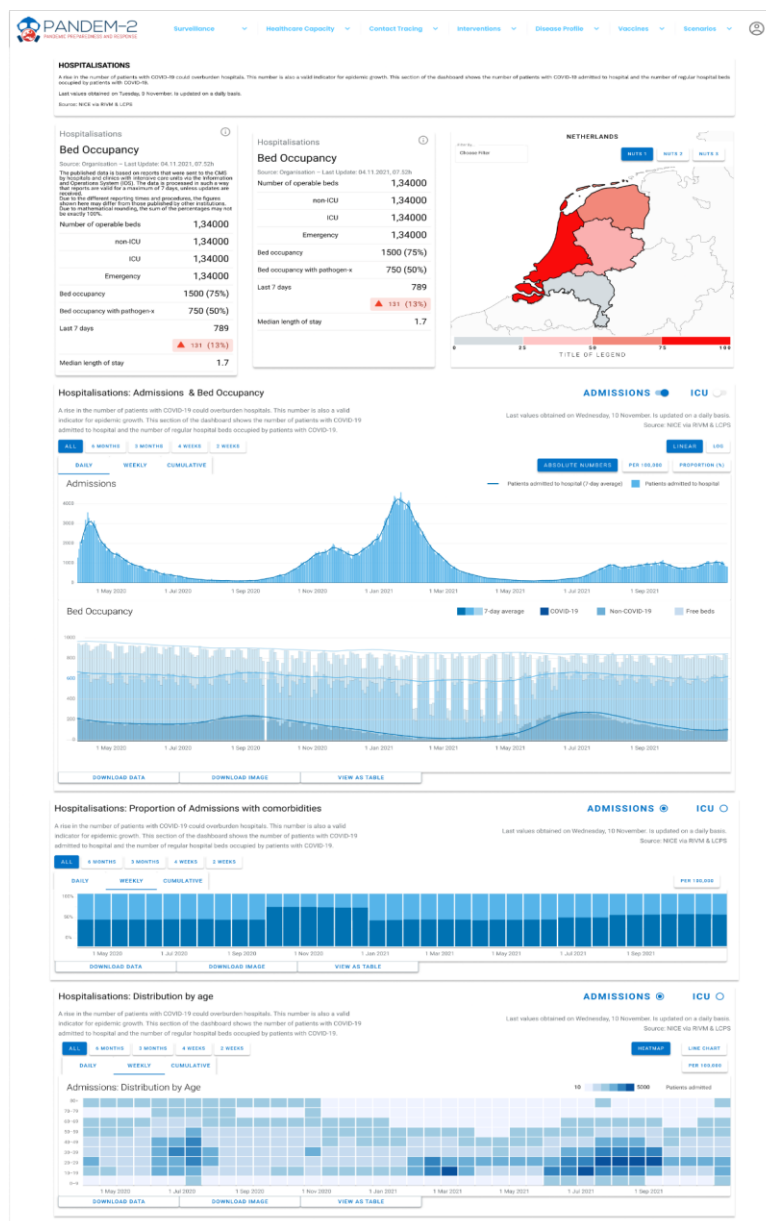


Figure 26: Hospitalisations View

This pre-prototype (Figure 26) view shows information about hospitalisations. The hospitalisations view covers data about pathogen-x hospital admissions and pathogen-x hospital bed capacity. Data about admissions should be viewable by geographic area in the form of national and NUTS regions. It should also be viewable within specific time intervals (daily, weekly, monthly, and cumulative), and it should be filterable by variant, age, sex, and comorbidities.

The full data requirements of this view are available in the appendix, [section 7.4.2.3](#): Pathogen-x hospital admissions.

Data about bed capacity should be viewable by geographic area.

The full data requirements of this view are available in the appendix, [section 7.4.2.4](#): Pathogen-x Hospital Bed capacity

The interactive prototype is available here:

<https://www.figma.com/proto/41nQQOBKFdeZwDABTy19R/Hospitalisations-January-Release?node-id=418%3A1294&scaling=min-zoom&page-id=0%3A1&starting-point-node-id=418%3A1294>

The video documentation for this view is available here:

<https://youtu.be/x-7DhJX1H44>

4.2.4.4 Mortality View

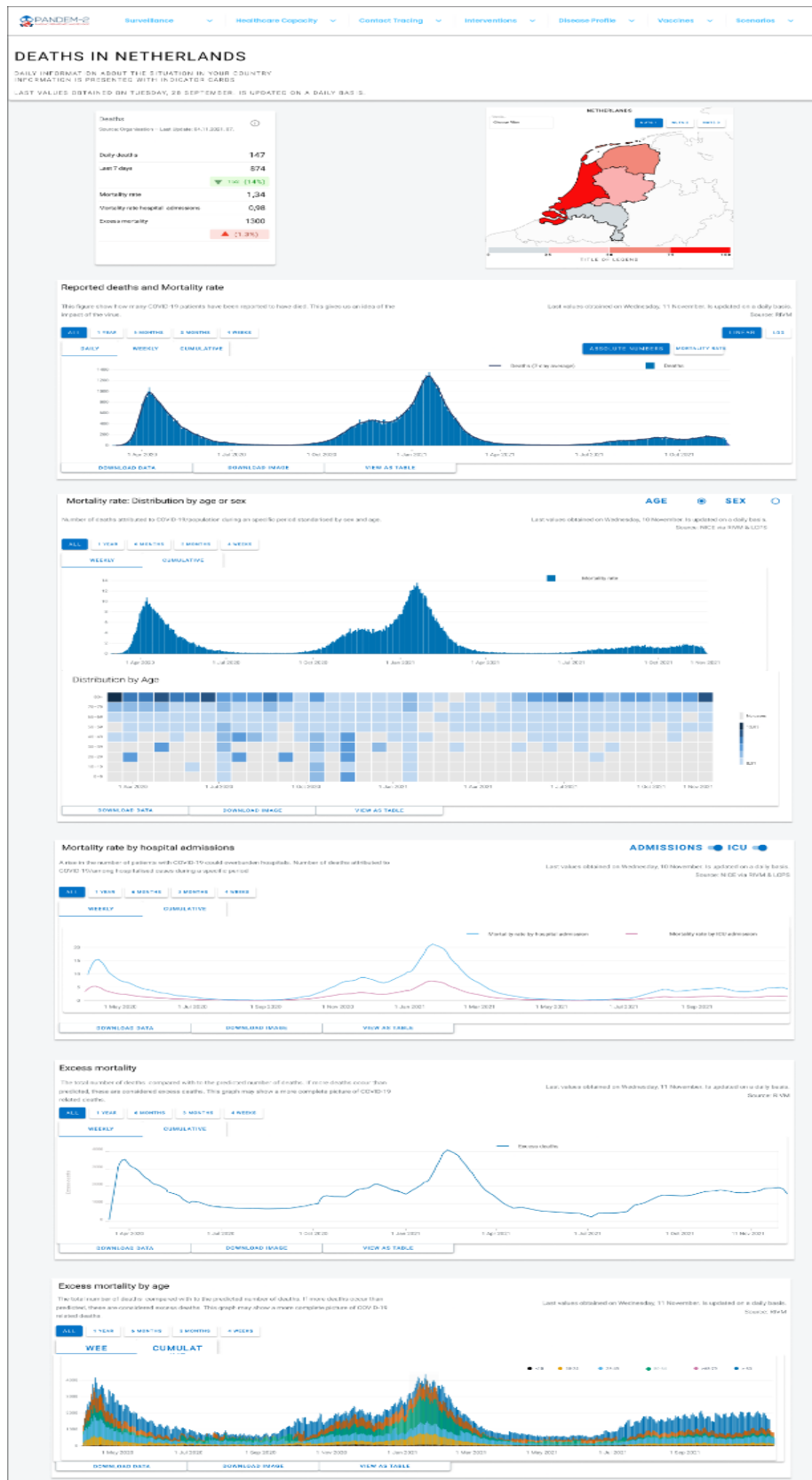


Figure 27: Mortality View

This pre-prototype (Figure 27) view shows information about mortality. The mortality view covers data about pathogen-x deaths and pathogen-x excess mortality. Data about deaths should be viewable by geographic area in the form of national and NUTS regions. It should also be viewable within specific time intervals (daily, weekly, monthly, and cumulative), and it should be filterable by age and sex.

Data about excess mortality should be viewable by geographic area and time interval.

The full data requirements of this view are available in the appendix, [section 7.4.2.5](#).

The interactive prototype is available here:

<https://tinyurl.com/5fw25una>

The video documentation for this view is available here:

<https://youtu.be/1oKLHW1r9IE>

4.2.4.5 Vaccination Uptake View

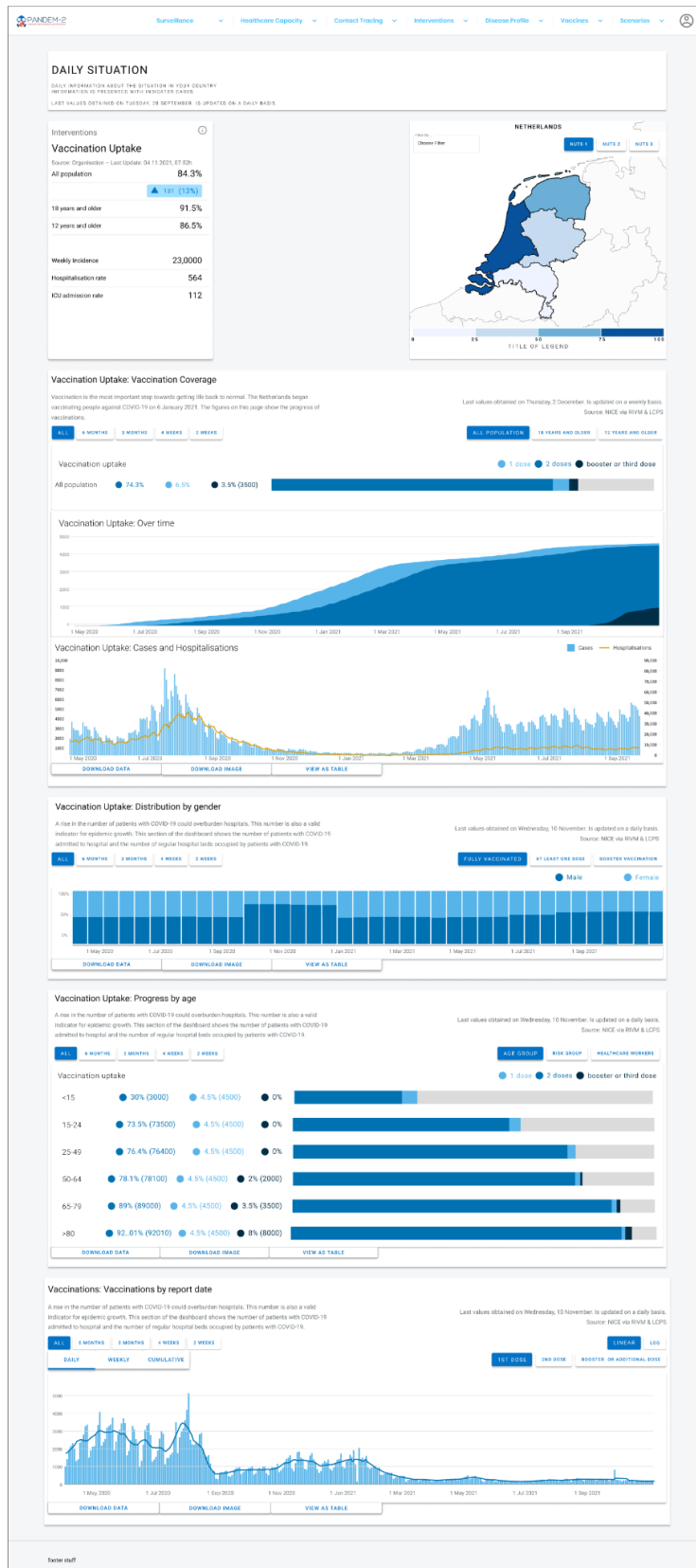


Figure 28: Vaccination Uptake View

This pre-prototype (Figure 28) view shows information about vaccination uptake. Data about vaccination uptake should be viewable by geographic area in the form of national and NUTS regions. It should also be viewable within specific time intervals (daily, weekly, monthly, and cumulative).

The full data requirements of this view are available in the appendix, [section 7.4.2.7](#): Vaccination uptake

The interactive prototype is available here:

<https://tinyurl.com/2p99zaxy>

The video documentation for this view is available here:

https://youtu.be/1ACI7a1_660

4.2.4.6 Testing View

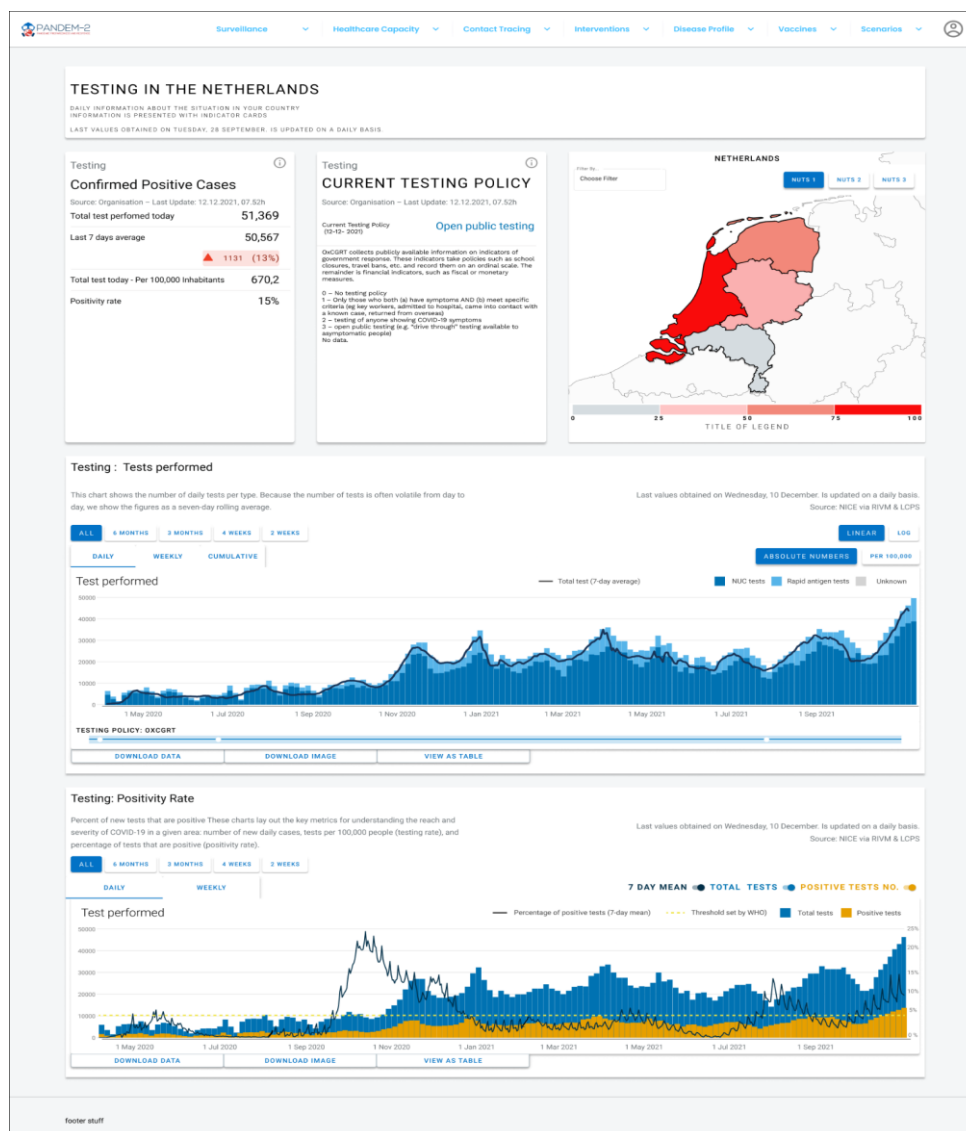


Figure 29: Testing View

This pre-prototype (Figure 29) view shows information about testing. Data about testing should be viewable by geographic area in the form of national and NUTS regions. It should also be viewable within specific time intervals (daily, weekly, monthly, and cumulative).

The full data requirements of this view are available in the appendix, [section 7.4.2.8](#) : Testing

The interactive prototype is available here:

<https://www.figma.com/proto/isqLYA4d9efLw0SH2TqUx0/Testing?node-id=2%3A111&scaling=min-zoom&page-id=0%3A1&starting-point-node-id=2%3A111>

The video documentation for this view is available here:

<https://youtu.be/xov1NJiphNA>

4.2.4.7 *Landing View*

This pre-prototype was developed as the initial entry point to the application once a user logged in. The design idea behind this prototype is that a user would be able to receive situational awareness about their chosen region at a glance. The user chooses which indicator cards will show on the page and then each time they log in they will be presented with those indicator cards allowing an interactive report of the information they need to see. The indicator cards in this view are adapted from the general indicator cards in the other views. The indicator cards on this page include a small data visualisation to allow the user to assess the situation for each indicator visually.

The interactive prototype is available here:

<https://www.figma.com/proto/Mbt4SYvHwb1NvKePRoRpfl/Landing-Page?node-id=507%3A4212&scaling=min-zoom&page-id=0%3A1&starting-point-node-id=507%3A4212>

The video documentation for this view is available here:

<https://youtu.be/nKKdyag2lDE>

4.2.4.8 Modelling View

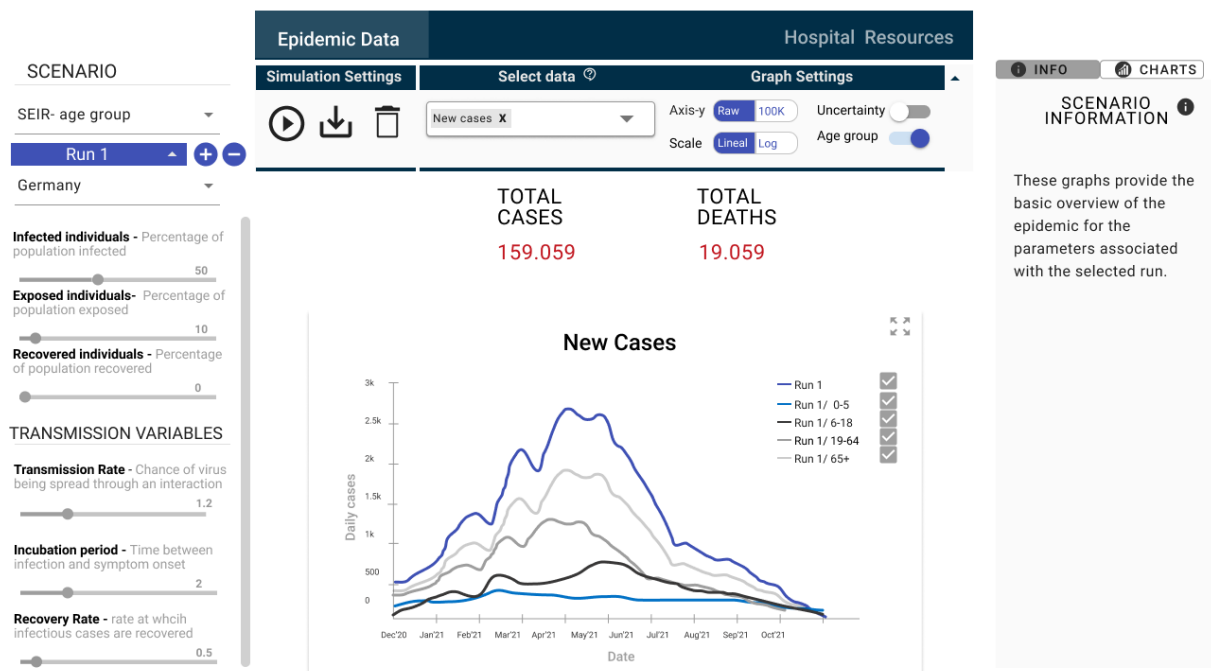


Figure 30: Modelling View

The modelling view was the first view developed based on the work done in the initial PANDEM-2 project and the requirements of this project. This pre-prototype view shows information about modelling and how a user might interact with the modelling API. At this stage of development, the inputs and outputs for the modelling API had not been developed so SEIR model inputs and outputs were used as an example. This pre-prototype was used to begin the asynchronous participatory design process and explore what users expected from a modelling interface and what the modelling team expected in terms of inputs and how the modelling outputs might be visualised.

The interactive prototype is available here:

<https://www.figma.com/proto/3AZoP9ymdBxw6dWBtbOhkv/scenarios--modelling-v2?node-id=317%3A27045&scaling=contain&page-id=165%3A6138&starting-point-node-id=317%3A27045&show-proto-sidebar=1>

The video documentation for this view is available here:

<https://youtu.be/9Pgb4h68T6Y>

4.2.5 Survey analysis

The main goal of each individual survey was to allow users to interact with a pre-prototype so they could explore possible interface designs. With this, we wanted participants to have a concrete view of the possible functionalities associated with the high-level indicators so they could provide more targeted feedback. More concretely, in the pre-prototype we showed different graphical representations of the data and enabled users to interact with it in different ways (e.g. filtering, switching views, etc.).

In general, from the survey, we wanted to know if users found graphical representations and interactions available to be useful for their roles. We allowed users to provide feedback on things to add, remove or modify from the different parts of the different components. Figma designs can be found in [section 4.2.3](#)

The main findings of each survey are presented below.

1. Survey #1: Feedback for the Pre-prototype of the Modelling View

- In this first survey, we wanted to understand if the participants felt comfortable with the pre-prototype interactive demo as we would continue to use it in association with the survey.
- We found that the majority of participants (7 out of 8) felt highly comfortable with the pre-prototype demo and received feedback on how to improve for future demos that we considered for the following surveys.
- From this survey, we discovered that participants find it valuable to view the same data related to the model with different graphical representations and be able to switch between them.
- It was noticeable that participants would like to have an overview page with several graphs (e.g. cases, hospital admissions) to facilitate obtaining a situational report.
- The design shows one graph that displays the output data from the model. The participants find it valuable to add more graphs to the main page. They also suggested having a download option to save the graphs. The pre-prototype designs of the following surveys were structured using several graphs to display the data from the different views.
- The participants advised adding interventions and other parameters to the model. In collaboration with the modelling team, we will examine these suggestions to improve the current design.

2. Survey #2: Feedback for the Pre-prototype of the Bed Occupancy View

- From received feedback, we found that all of the participants like to set a time frame (all/1 month/3 months/6 months) in the graphs. But they hold differing opinions on whether the graphs should depend on the same time frame or not.
- We also found that participants would like to see the bed occupancy on regular admission and ICU, split up in two different graphs.
- With the survey, we discovered that the indicators shown were unclear to the user. Participants asked to show both percentages and numbers relevant to occupied and available beds. Also, they would like flexibility in selecting which indicator should show on this view.
- The two main feedbacks were: (1) the map view takes too much space, and (2) the categories regular beds and ICU beds should be further split into beds of patients with and without disease X.

3. **Survey #3: Feedback for the Pre-prototype of the Landing View**

- Different cards with high-level information are displayed in the landing view.
- We found that most participants found the layout of the page to be clear, simple, and intuitive.
- The majority of the participants found the individual indicator cards provide relevant top level information. They also suggested adding other indicators to the cards, e.g. 14-day notification rate, ICU capacity to 'hospitalisation card', reproduction rate to 'cases card', total deaths to 'deaths card'.
- With the survey, we discovered that most participants found it valuable to customise the card.

4. **Survey #4: Feedback for the Pre-prototype of the Cases View**

- Cases view show information about notification cases by pathogen-X. With the survey, we found out that participants would like to use different mapping systems; for example, some countries do not use the NUTS level view. We are investigating the possibility of allowing custom maps to complement the NUTS regions views.
- Participants found the information shown in the confirmed graph was useful; they would like to be able to select a 14-days rolling average in addition to the 7-day rolling average presented in the graph.
- We presented synchronised graphs for active and recovered cases. Some participants would prefer to see this data only in one graph and switch between absolute or relative numbers instead of using the synchronised graphs.
- Participants would like to compare indicators that are not in the shown graphs, for example, they would like to compare new cases and recovered cases in the same graph. As an alternative to address this point, we are analysing the possibility of adding an exploration data view where the user can select the indicator they want to see.
- We asked if they would like to see the data grouped using a standardised method of counting weeks to compare data, commonly referred to as epi-weeks; 1 of 4 participants responded positively. Thus, we decide to keep using the calendar date in the axis for the graphs.

5. **Survey #5: Feedback for the Pre-prototype of the Hospitalisation View**

- From the survey, we learnt about functionalities that can be added. For example, one participant suggested that the map be made optional. If bed occupancy is almost constant, the map provides no extra information. Another participant mentioned download data and images are important, and they would like the option of embedding graphs on their web page.
- We wanted to know if any information was missing or was irrelevant in both Admissions and Bed Occupancy Indicator cards. The main feedback was to add indicators such as number of ventilators, the daily number of available ventilators, beds with oxygen source (other than ventilators), available beds with oxygen source (other than ventilators), and proportion of fully vaccinated people. The indicator card could be an accordion, allowing you to extend all indications to observe the distribution in the ICU and non-ICU.
- One participant mentioned that daily data could be very noisy and incorrect due to delays in reports of the daily number of admissions. The institution of this participant collects the data 3 times a week.
- All the participants agree that distribution by age intuitively adds relevant information, particularly the heat map view. One participant mentioned that when the numbers in some heat map boxes is very low (less than 5), they do not report the numbers for that specific group.

- We learnt that some participants did find it helpful to have three tabs (daily, weekly, and cumulative) to display the information. However, one participant found it was too much information. In contrast, another participant would like to zoom into the widget with a shorter period but with wider bars. We can conclude that it could be interesting to adapt the interface to the user's needs, based on their role in an organisation, in a future version.

6. **Survey #6: Feedback for the Pre-prototype of the Mortality View**

- All of the participants said that it is helpful to switch between viewing the data as "Absolute numbers" or "Mortality rate".
- The participants mentioned the importance of explaining how the mortality rate and excess deaths are calculated. In the following iteration, we will address this issue by giving detailed information on how these metrics are calculated.
- We learnt that participants have difficulties navigating the page because the page is very long. One participant suggested having a navigation panel below the indicator cards to select different content on the page. We are considering this idea for the subsequent improvement of the design.
- With the survey, we discovered that mortality by sex over time and excess mortality in long term care are graphs that are unnecessary for some participants.

7. **Survey #7: Feedback for the Pre-prototype of the Vaccination Uptake View**

- From the survey, we learnt that the vaccination indicator card needs more clarification; for example, it needs to explain if "all population" refers to all eligible people or the total size of the population. Also, some indicators such as weekly incidence, hospitalisation rate and ICU admission rate are unnecessary for some participants.
- The survey found that the information presented as a synchronised vaccination coverage graph has mixed opinions. We presented vaccination, cases, and hospitalisation data over time in these graphs. Some participants opined that it was easy to identify the effects of vaccination over hospitalisations. However, another participant believes deeper analyses are needed to understand how vaccinations affect hospitalisations, and the oversimplification generated by these graphs can lead the viewer to see correlations that may be unrelated.
- We also wanted to understand if participants prefer to see this information of combining the graphs in a synchronised manner or independent graphs. From feedback, 60% of participants (3 of 5) said that the combined graph was Ok.
- We learnt from the survey that 50% of participants (3 of 6) did not find the vaccination distribution by gender graph valuable. One reason was that vaccination policies are not gender-specific; another got confused by the type of graphical representation used.

8. **Survey #8: Feedback for the Pre-prototype of the Testing View**

- From the survey, we learnt that participants would like to add new indicators to the Confirmed Positive Cases Card. Some examples are total positive tests (Absolute number and per 100.000 inhabitants), number of tests by 14 day period, positive rate by age group, and testing capacities (e.g. number of testing stations per day, drive-in/ walk-in test centre, staff allocated for testing)
- From the survey, we found out that all participants found the information presented in the graphs useful. Also, it was noticeable that one participant suggested that cumulative and daily

numbers are not necessary. Another participant mentioned that Antigen-tests are used at home, then it is not possible to have an accurate breakdown of tests performed by type.

- We learnt that the availability of daily data is not possible for several participants; they reported that the data is registered with a week of delay.
- We will update the design to reflect the frequency of data that several participants register.

4.2.6 API Development

The initial description of Task 4.3 envisaged the development of a visual analytics service, with accompanying API's, however, in collaboration with the consortium partners the design of the project evolved into having the visual analytics components embedded directly into the dashboard prototype. This negated the need for the development of independent API's for the components. The inclusion of API in the deliverable title will be corrected (by amendment) ahead of the subsequent D4.4 (version 2 of the Visual Analytics Component) submission. This correction has been noted to our EC project officer Jana Paskajova. There are references to API's within this document but these references refer to other software, whether developed for internal use or open-source software that was used.

5 Impact & Conclusion

The work carried out in Task 4.3 is an integrated step in the process of delivering the pandemic preparedness and response platform. As part of a larger process of Database and Dashboard development, it is interdependent on other work packages in the project, using the outputs of some work packages and providing the inputs for other work packages. The design and development of the Database schema and setup report (D3.1), the design and implementation of server-side software to interact with this database, and the design, creation of, and implementation of the Dashboard user interface to allow end users to work with the platform is a collaborative process, each step in the process contributing to the next step and being contributed to by the previous step.

The outputs from D3.2 Dashboard Design developed a full set of requirements and a selection of base designs that formed the beginnings of the work in this Task. D3.3 Dashboard Initial Prototype required a subset of requirements, a minimal viable product, to deliver a prioritised set of indicators for month 12. The tech team developed an internal collaborative document, to prioritise and define these indicators and what information should be shown for each. From this collaborative document, Task 4.3 extracted the designs for the views that would be implemented in D3.3.

Once the views and indicators were prioritised Task 4.3 began the process of developing a set of visual analytical components that would allow the viewing, exploration of, and creation, of information. These visual analytical components were then brought together in data visualisation views based around indicators and developed into interactive prototypes that were shared with our partners in work package 3 to facilitate the implementation of D3.3 Dashboard Initial Prototype.

These visual analytical components will also be used for the interactions with Task 4.4 Design and Implement Resource Planning System and Task 4.5 Predictive Pandemic Modelling. The services that are developed in Tasks 4.4 and 4.5 will use the visual analytical components developed in this task to visualise their outputs and to enable user interaction with those outputs.

The processes and documentation developed within this package have been used within D6.2 Training Resources & Repository on Simulation Exercise. The interactive indicator prototypes and the video documentation of these prototypes provide users with training and documentation resources with regards to how the system works but also the design decisions behind the system. Task 4.3 has also begun initial user documentation based on the components and views that have been created in this package.

Task 4.3 (and D4.3 - version 1 of the Visual Analytics Component) is one of the many integrated steps on which a system like PANDEM-2 relies. In collaborating with other partners, these steps are developed in an iterative manner, each relying on and contributing to the others. In addition to the work with other partners, Task 4.3 researched how to develop visual analytical components in accordance with best practices, learning from the current situation and the systems that are already in active use in the domain. Participatory design processes were implemented to ensure that the work carried out would meet the users' expectations and requirements. This iterative process allowed a continuous collaboration between all partners involved. This process began with initial design work, user feedback of that initial design work, and then further design work. This process was parallel to other processes of interaction with the development team enabling a flow of design and implementation work without bottlenecks. The results of these processes are a set of visual analytical components that can be used to implement pandemic indicator views but are also abstract enough to

be adapted to future work in other work packages and tasks in the project. The participatory design approach that was taken enabled user interactions with end users in the context of time constraints and allowed for the documentation of user feedback.

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7 Appendices

7.1 Visualisation Catalogue

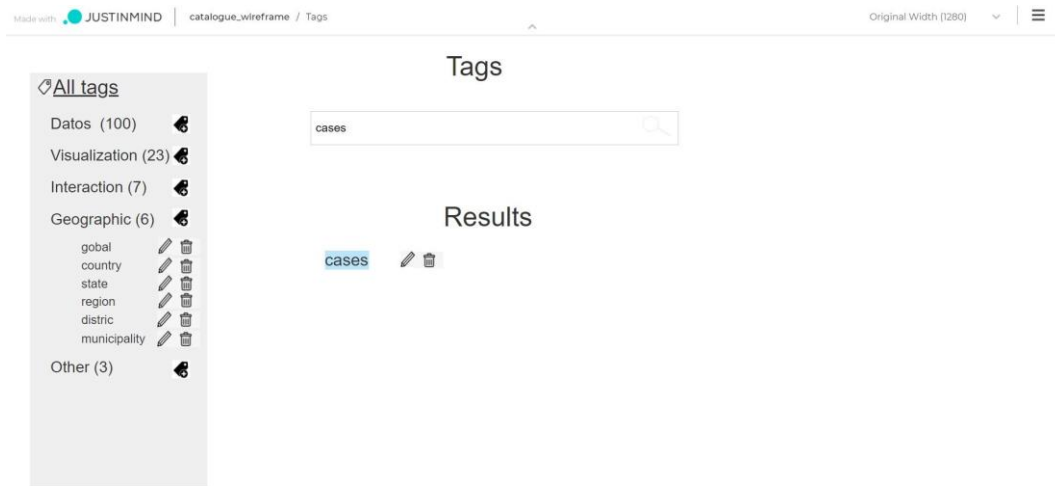


Figure 31: Visualisation catalogue tag page. Allow creation, updating, or deleting of tags

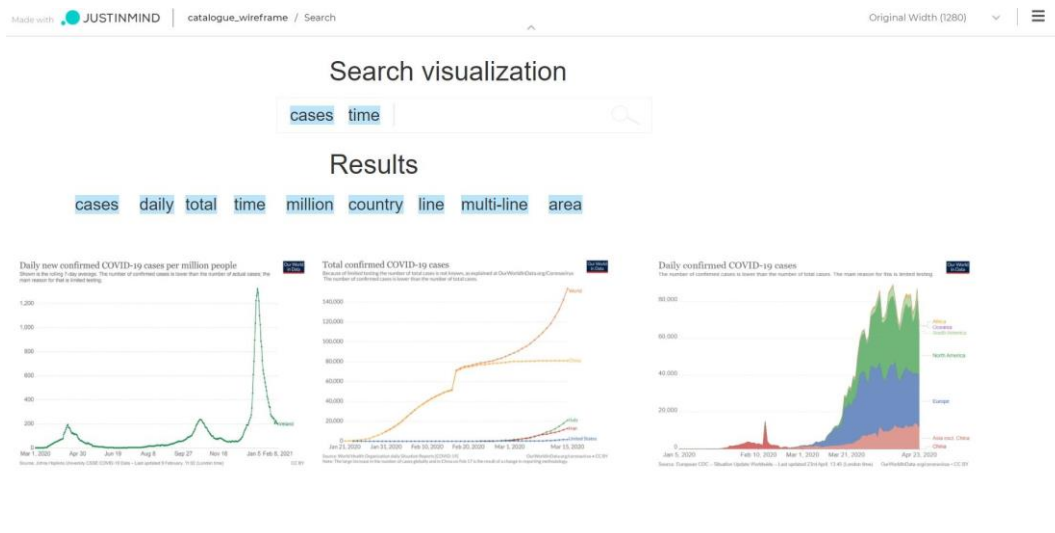


Figure 32: Visualisation catalogue search page. Search and display results of tag search

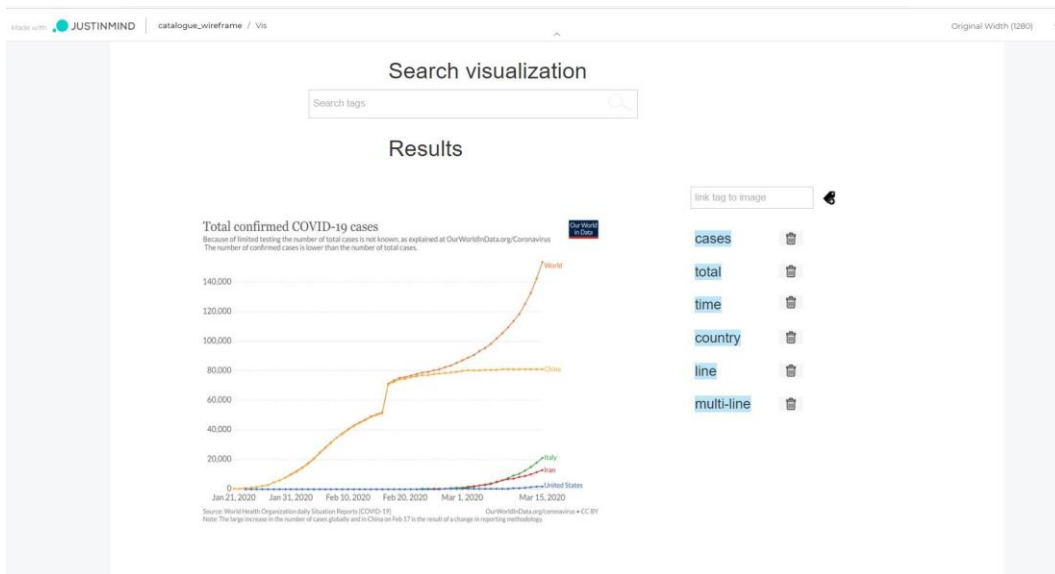


Figure 33: Visualisation catalogue visualisation view page. View full screen version of data visualisation along with attribute tags.

The screenshot shows the 'PANDEM2 Visual Catalogue' application. It has a blue header with a search bar and 'VIEW IMAGES' and 'UPLOAD IMAGE' buttons. Below the header is a tag selection section with radio buttons for 'data', 'visualization', 'interaction', 'geographic', 'other', 'user story', and 'virus'. Below this is an 'Upload Image' section with a text input for 'Please enter an image url or upload an image file' and a button 'ADD'. Below that is a section for 'Add tags to image' with a grid of checkboxes for various tags. The tags are organized into five columns: 'data', 'visualization', 'interaction', 'geographic', and 'other'. The 'data' column includes 'cases', 'deaths', 'vaccine', 'cumulative', 'beds available', 'beds needed', 'policy', 'reproduction number', 'incidence'. The 'visualization' column includes 'bar', 'line', 'area', 'stacked bar', 'animation', 'timeline', 'bubble map', 'choropleth map', 'map'. The 'interaction' column includes 'click', 'select', 'zoom', 'link', 'tooltip', 'hover', 'drilldown', 'drag'. The 'geographic' column includes 'global', 'country', 'state', 'region', 'district', 'municipality', 'city', 'county'. The 'other' column includes 'million', '100k', 'age group', 'modeling', 'moving average', 'over time', 'gender', 'uncertainty', 'change (percentage, abs number)'.

Figure 34: Visualisation catalogue application image upload page

7.2 Initial Research Designs

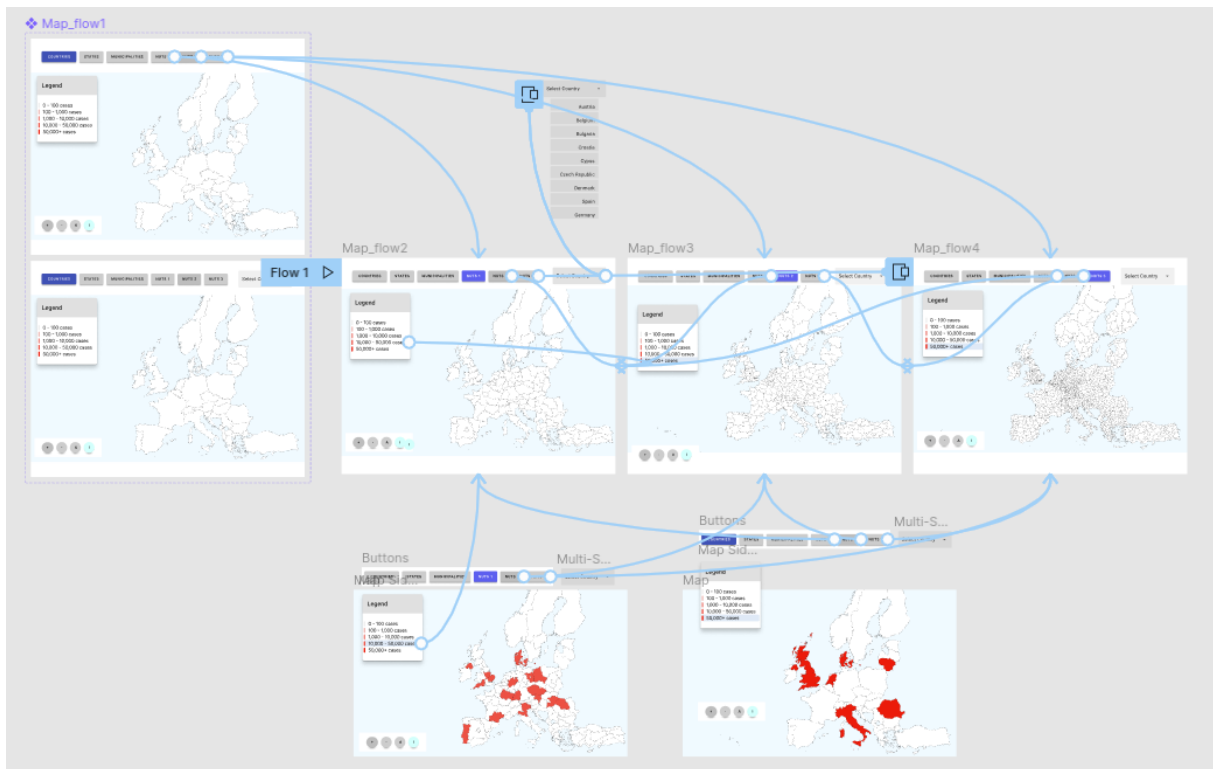


Figure 35: Initial Map with Interactions

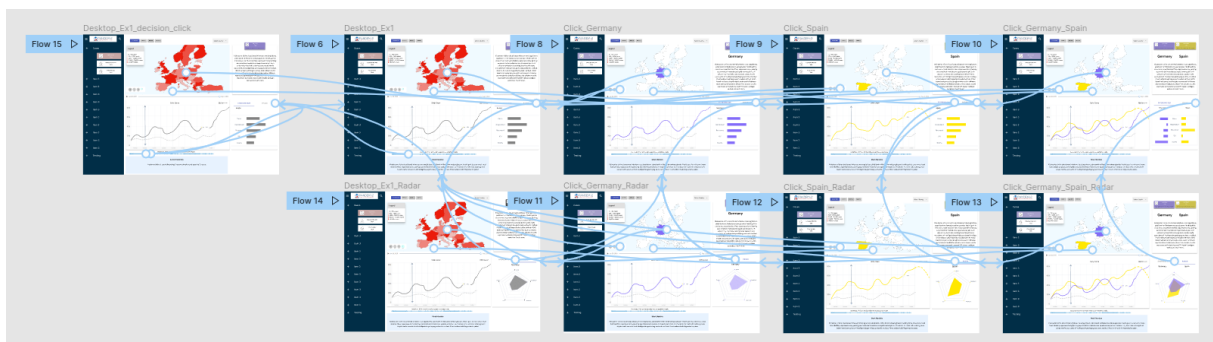


Figure 36: Country Comparison with interactions

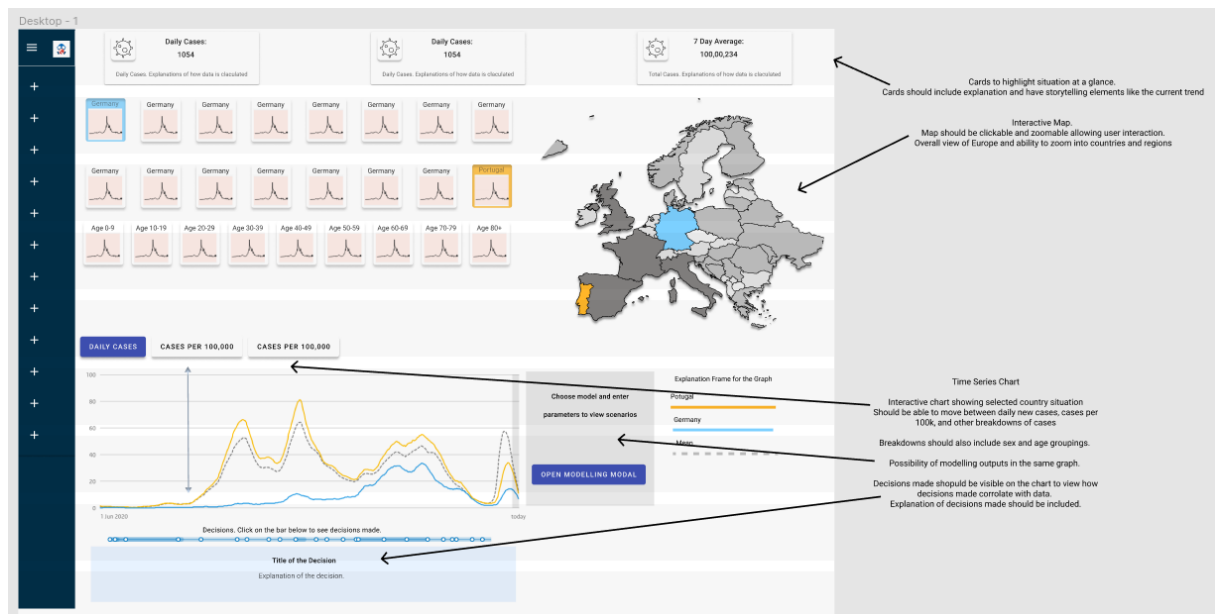


Figure 37: Dashboard exploration with European view and related graphs

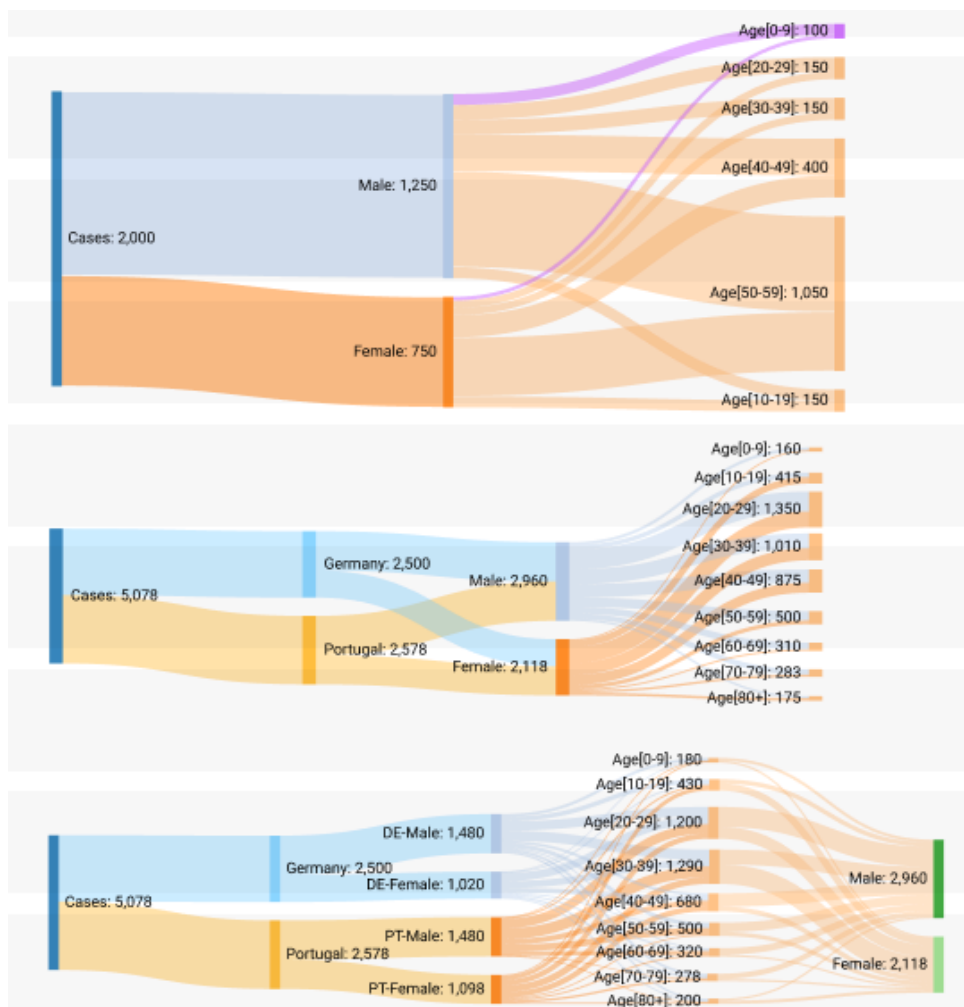


Figure 38: Population data visualisation exploration

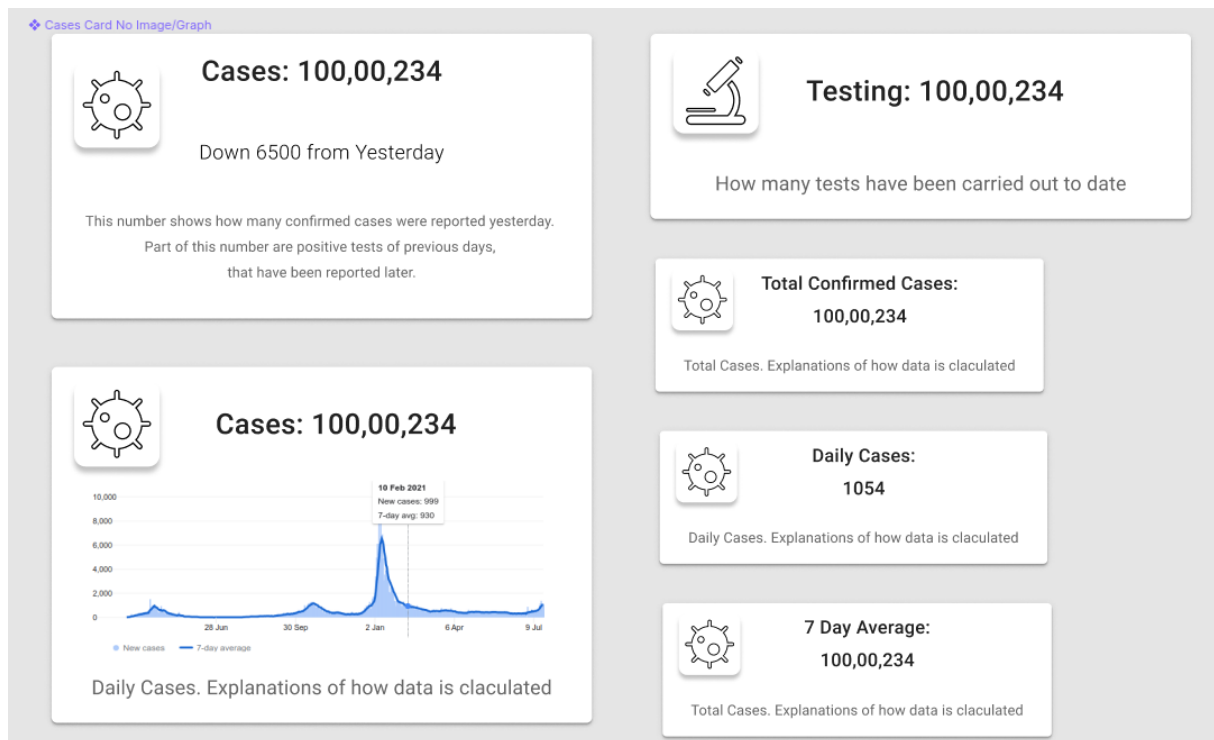


Figure 39: Initial Indicator card designs

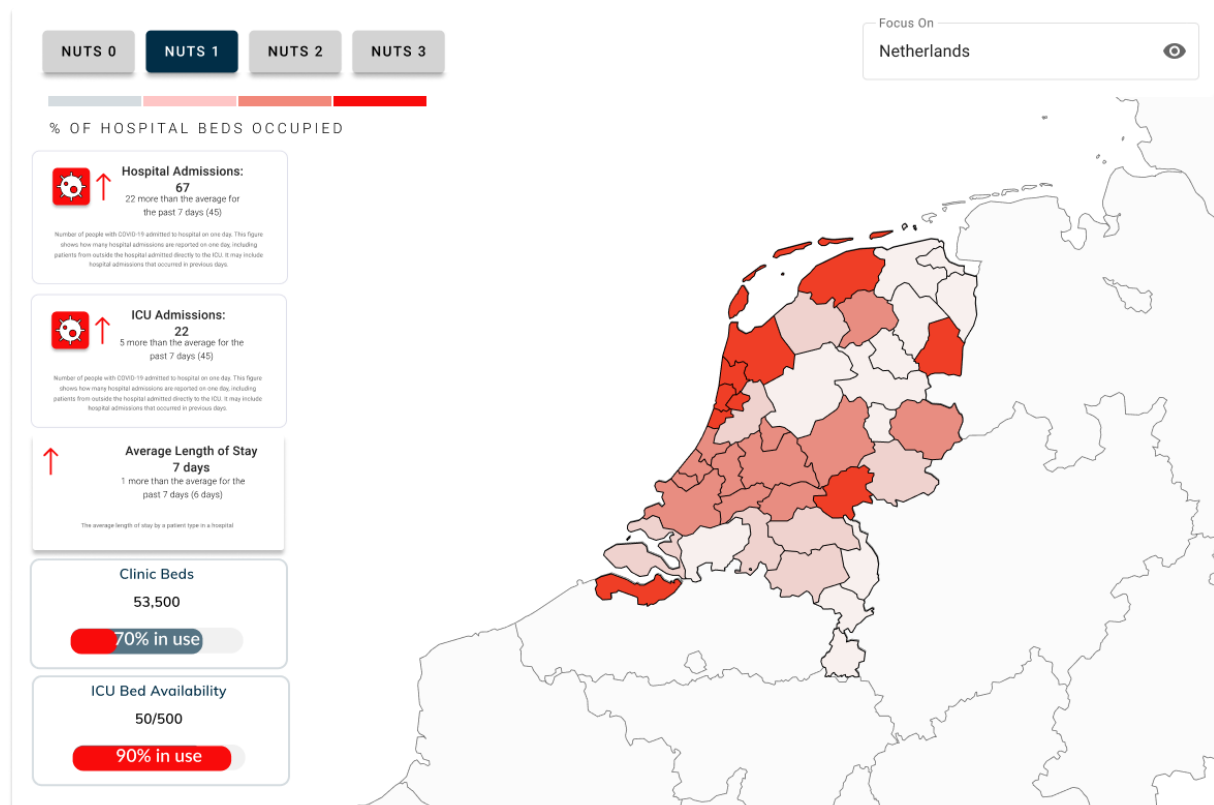


Figure 40: Dashboard Design with indicator cards

7.3 Prototype Mapping Application

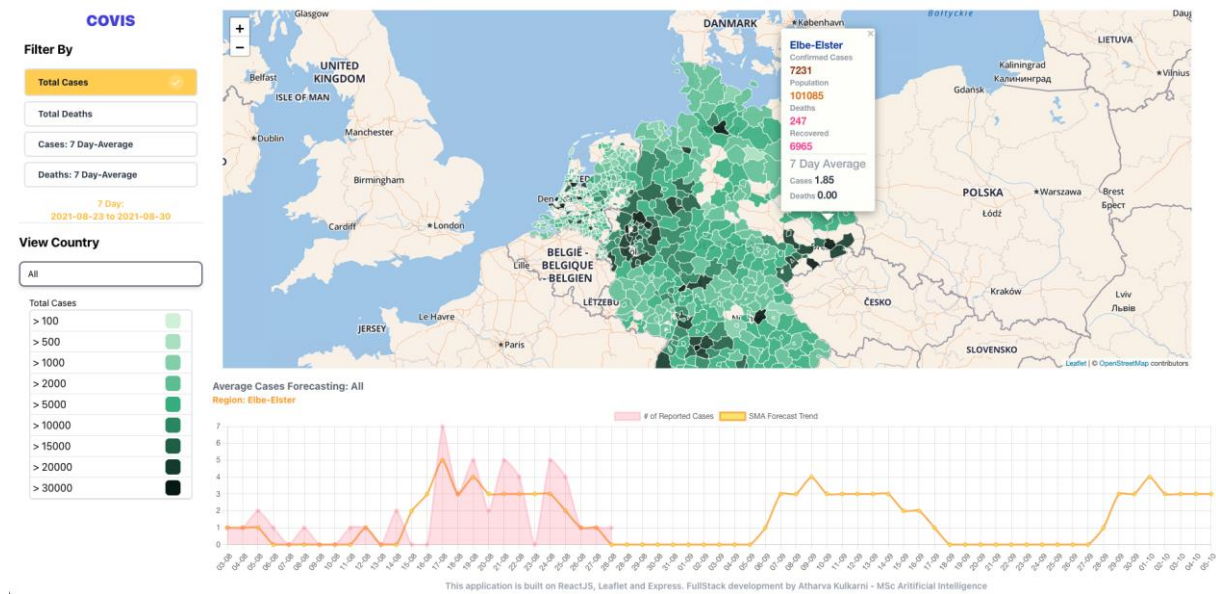


Figure 41: Initial page of Prototype Mapping Application

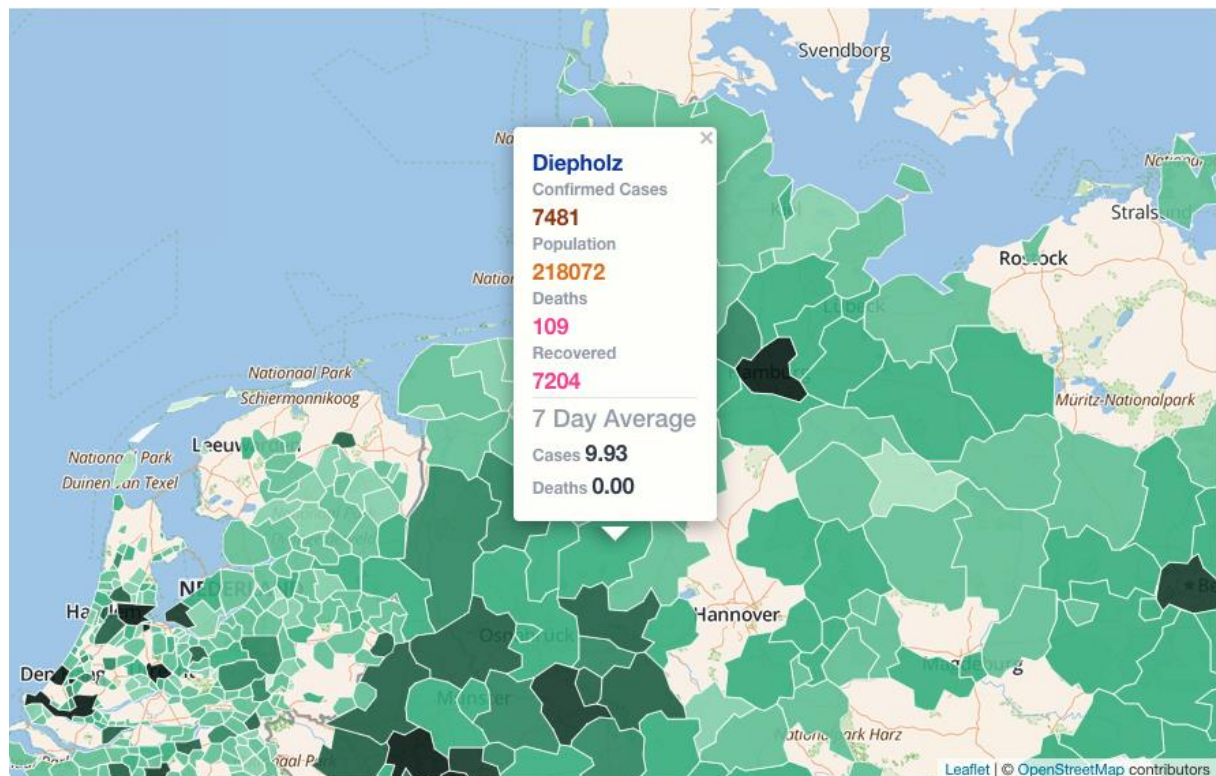


Figure 42: Hover interaction and tooltip visualisation in Prototype Mapping Application

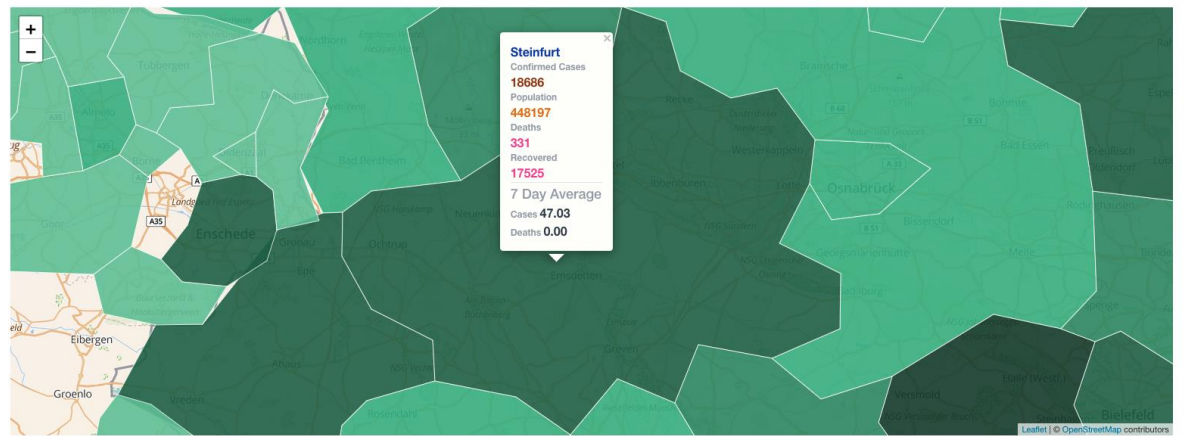


Figure 43: Detail of specific region with time series line graph. Prototype Mapping Application

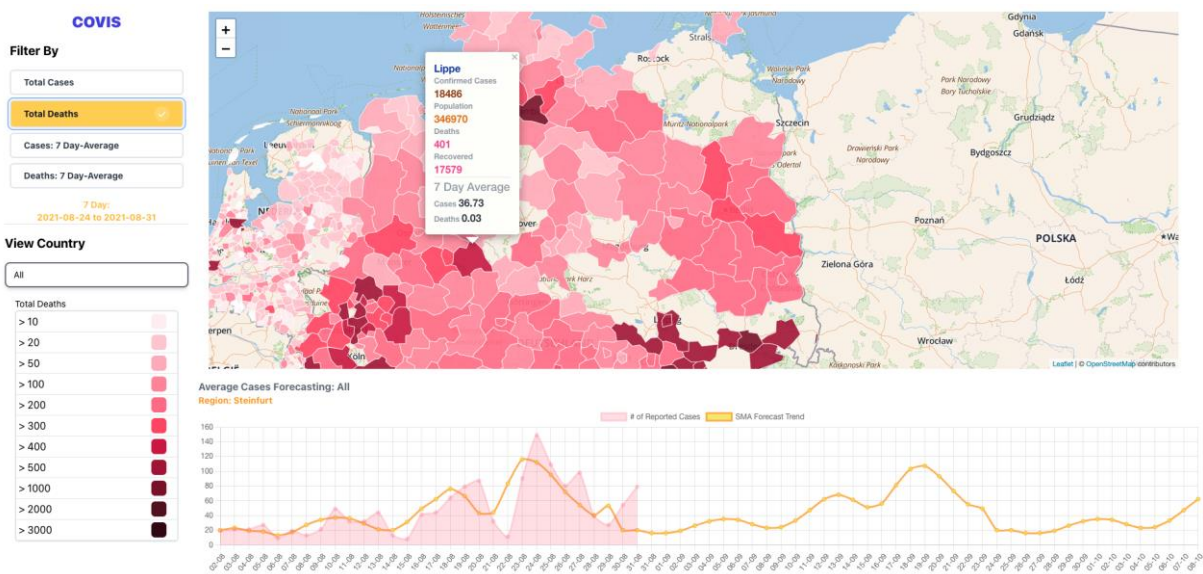


Figure 44: Mortality filter. Prototype Mapping Application

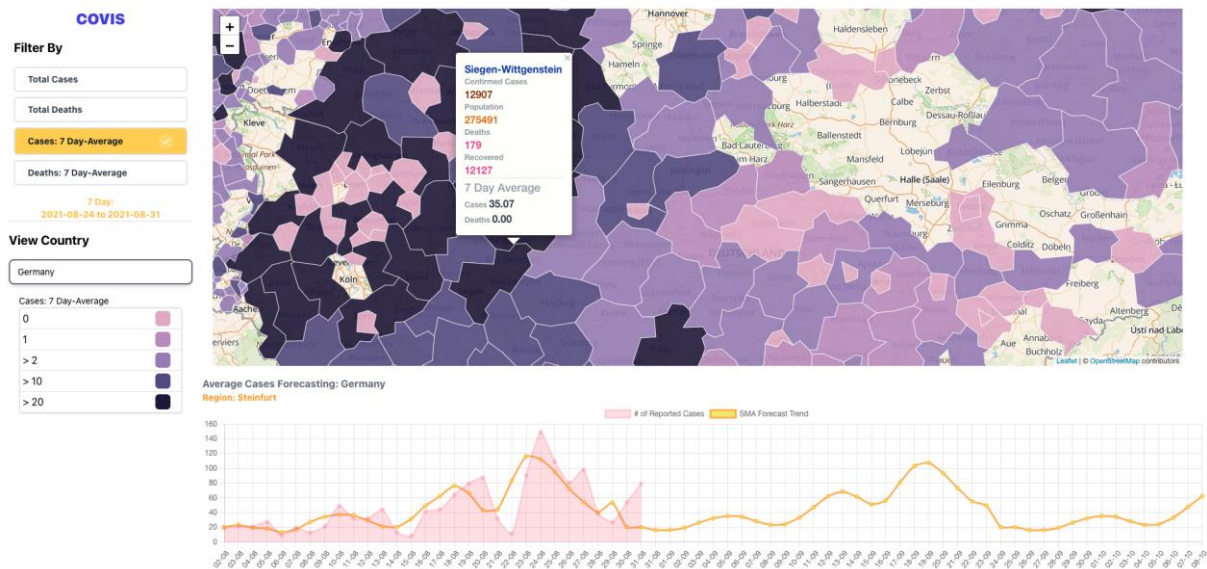


Figure 45: Cases 7 Day Average filter. Prototype Mapping Application

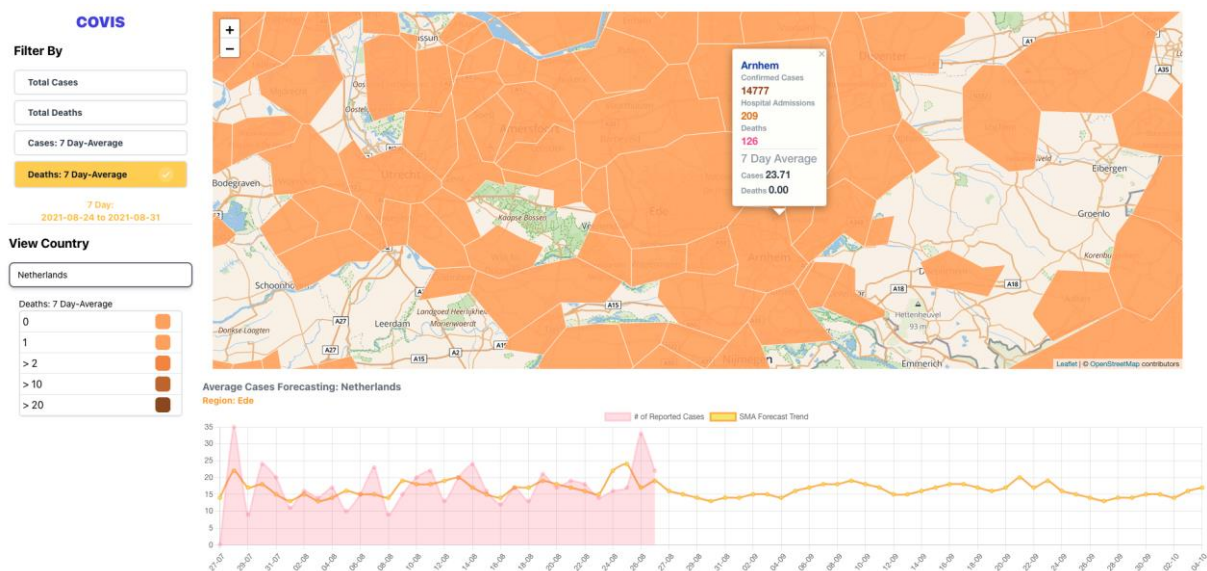


Figure 46: Mortality 7 Day Average filter. Prototype Mapping Application

7.4 Asynchronous Participatory Design Prototype Components

7.4.1 Components

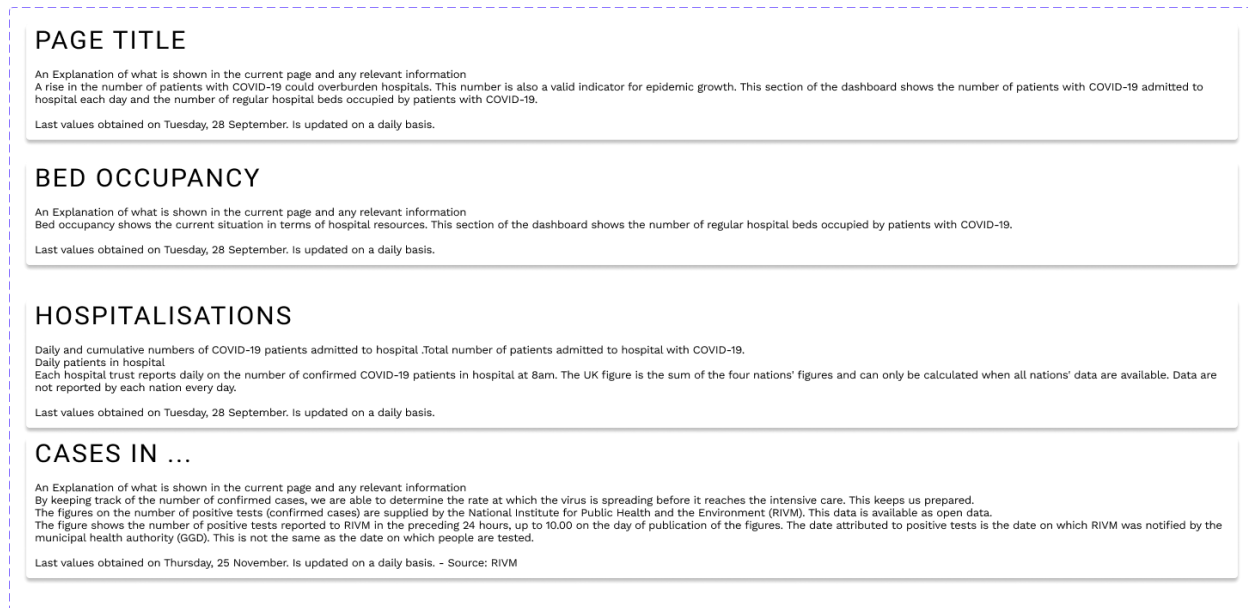


Figure 47: Overview Explanation header.

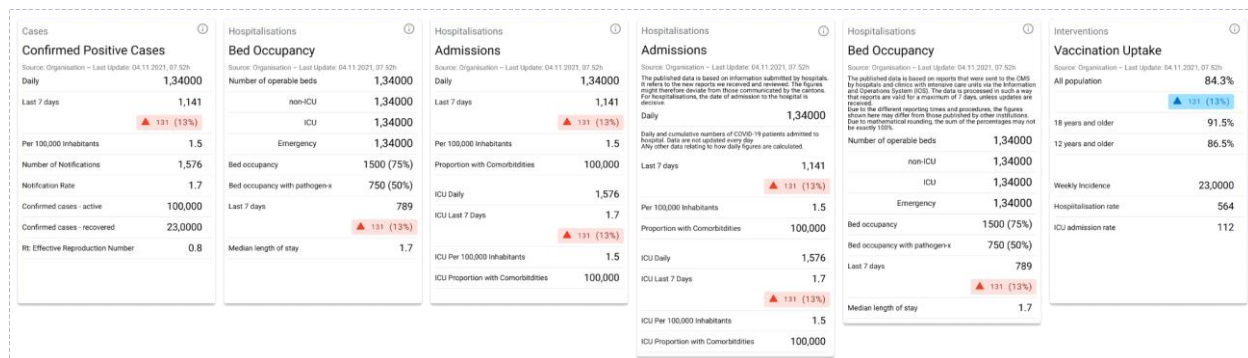


Figure 48: Indicator Card component with a number of variables.

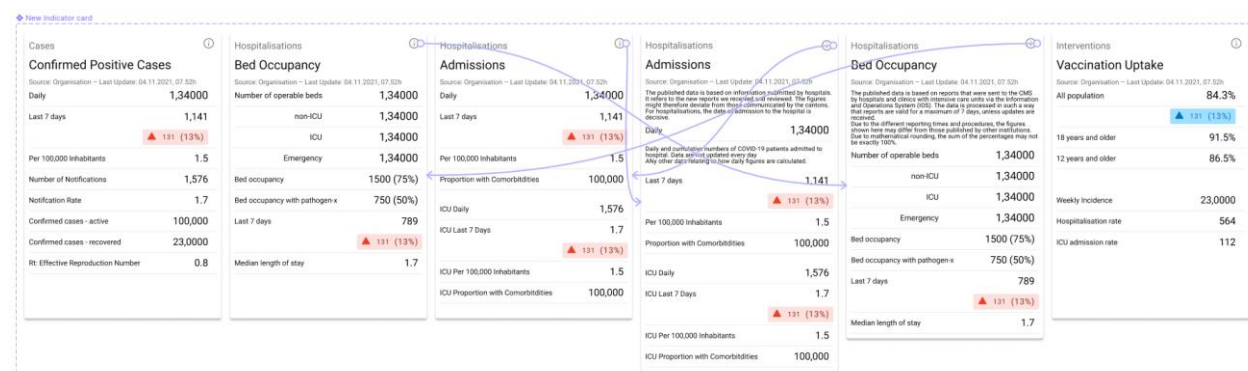


Figure 49: Indicator Card component with a number of variants. Information interactions mapped

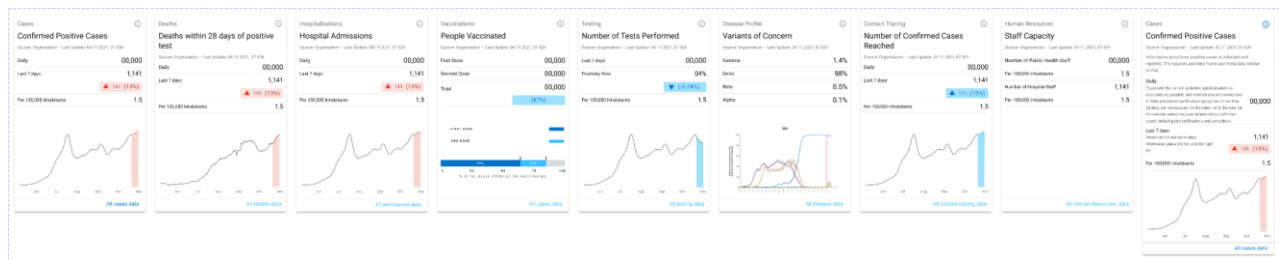


Figure 50: Landing Page indicator card and variants

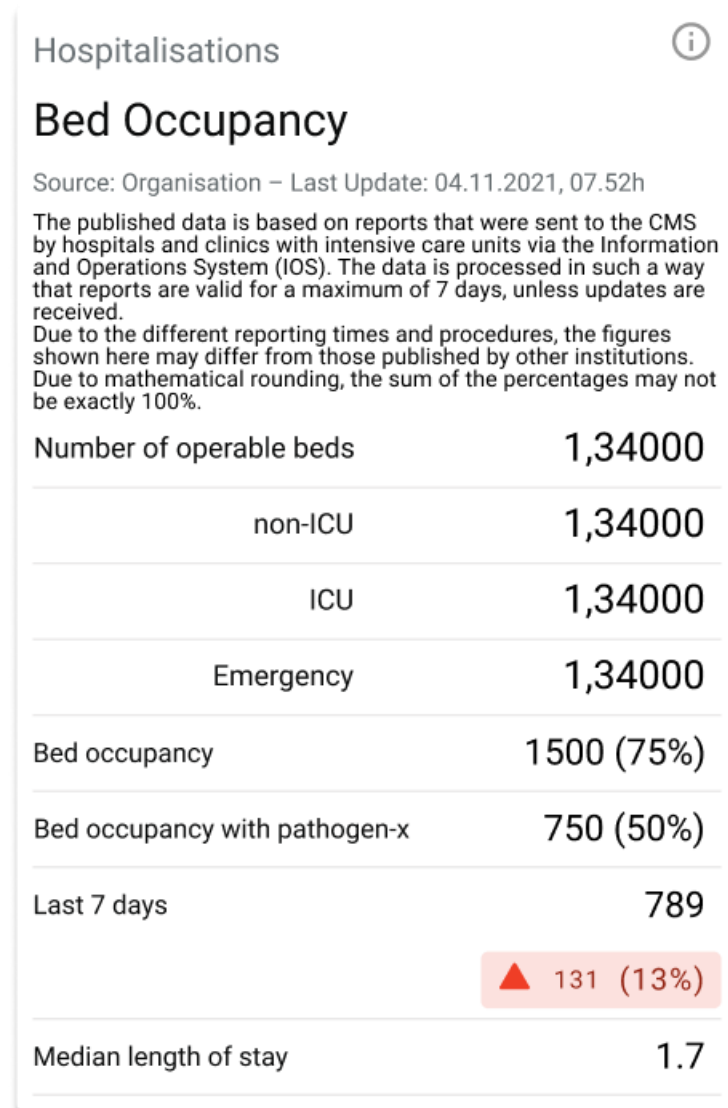


Figure 51: Single Indicator card with information button clicked and some example information being shown

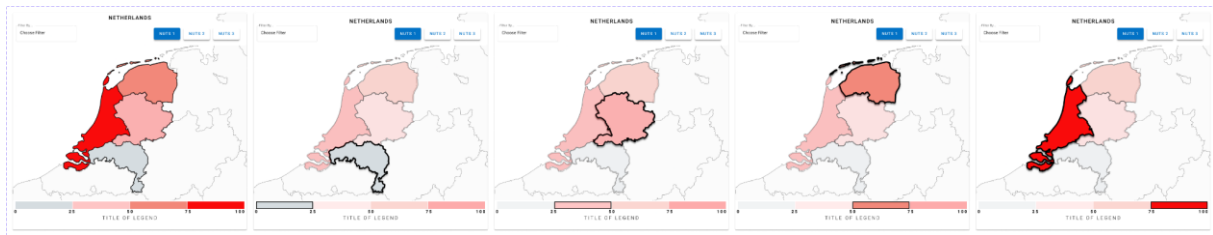


Figure 52: Map Component with hoverable selection variants.

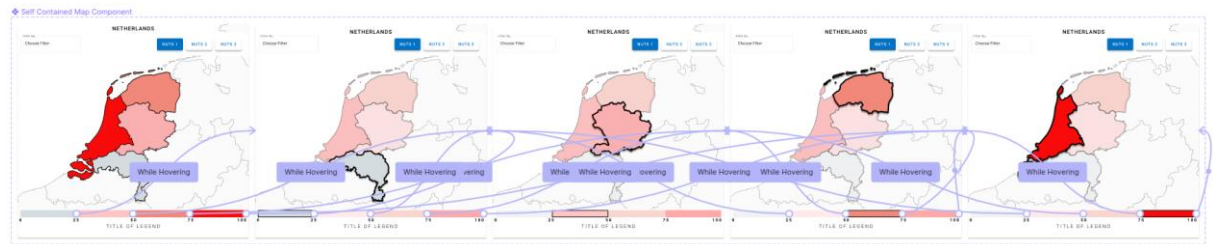


Figure 53: Map Component with hoverable selection variants. Interactions between variants shown

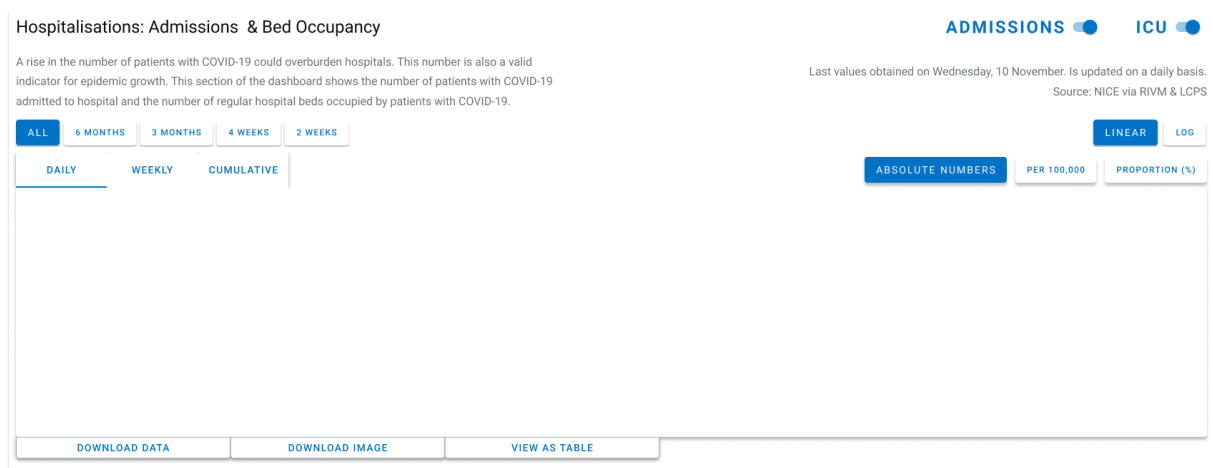


Figure 54: A basic graph frame with filter toggles, data filter buttons, and time filter buttons. This component forms the basis for the graph “cards” within the views and is adapted as necessary for the information being presented.



Figure 55: Vaccine progress by group buttons and variants to highlight selected button



Figure 56: Time selection buttons to view data within a specific time period. Variants and button interactions between variants mapped.

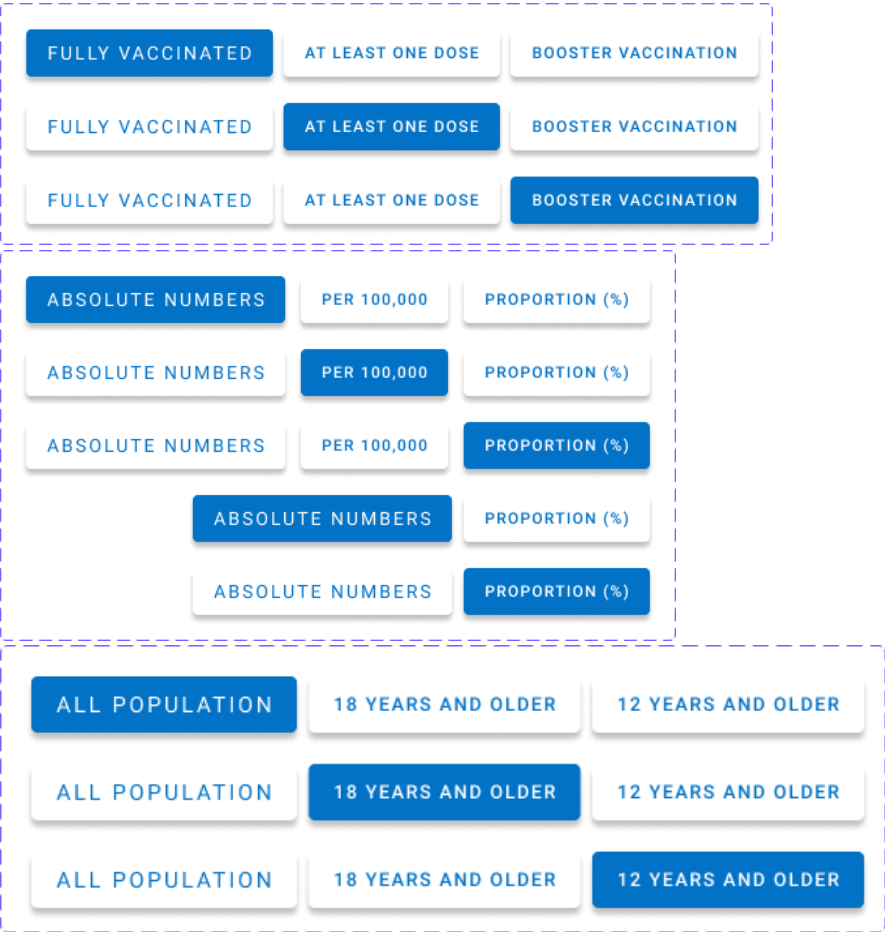


Figure 57: Selection of other button components showing variants to highlight selected buttons.

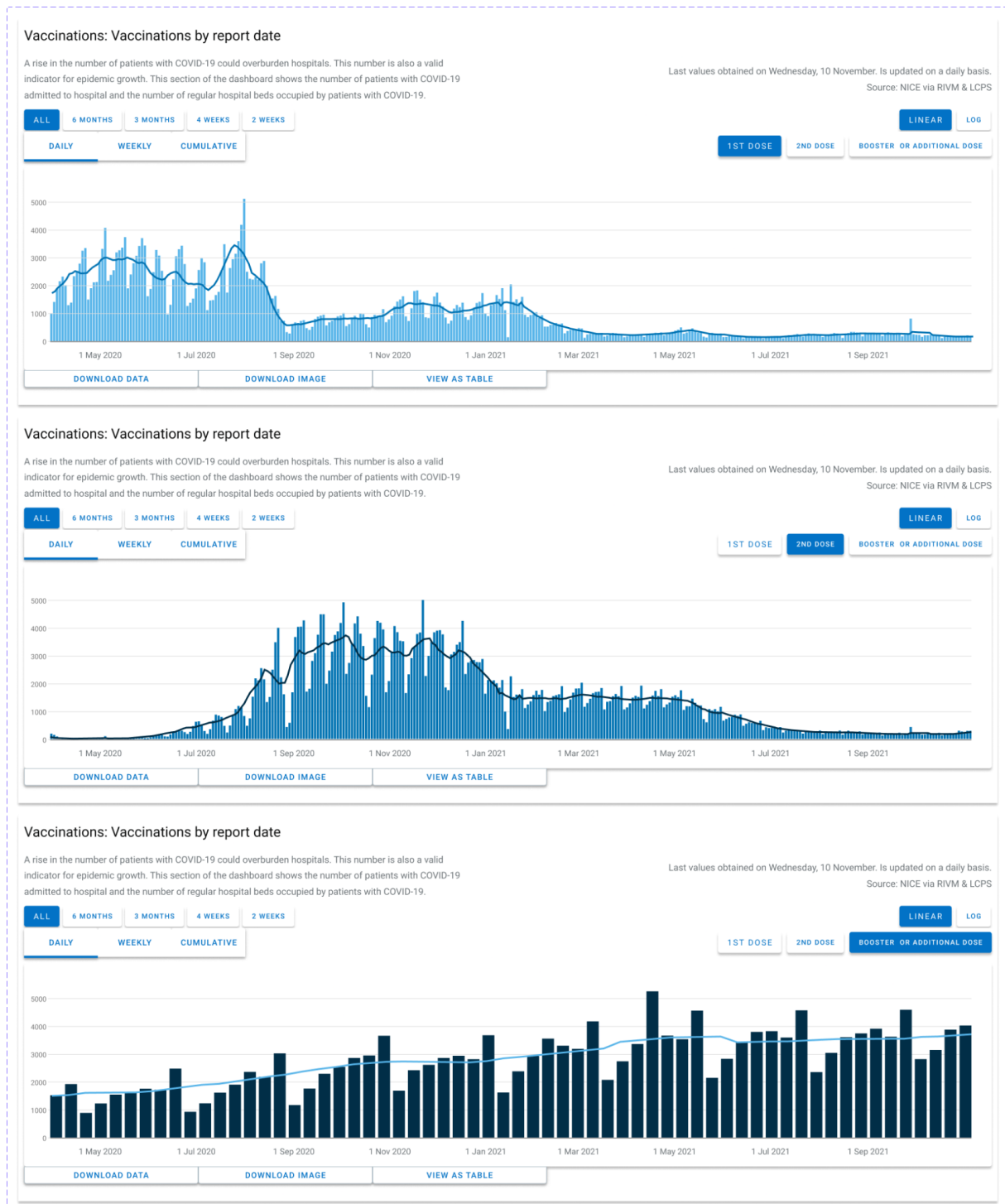


Figure 58: Vaccination uptake graph with variants. The top graph is the first dose, the second graph is the second dose, and the third, the third dose or booster shots. Interactions are handled via the buttons just above the graph on the right.

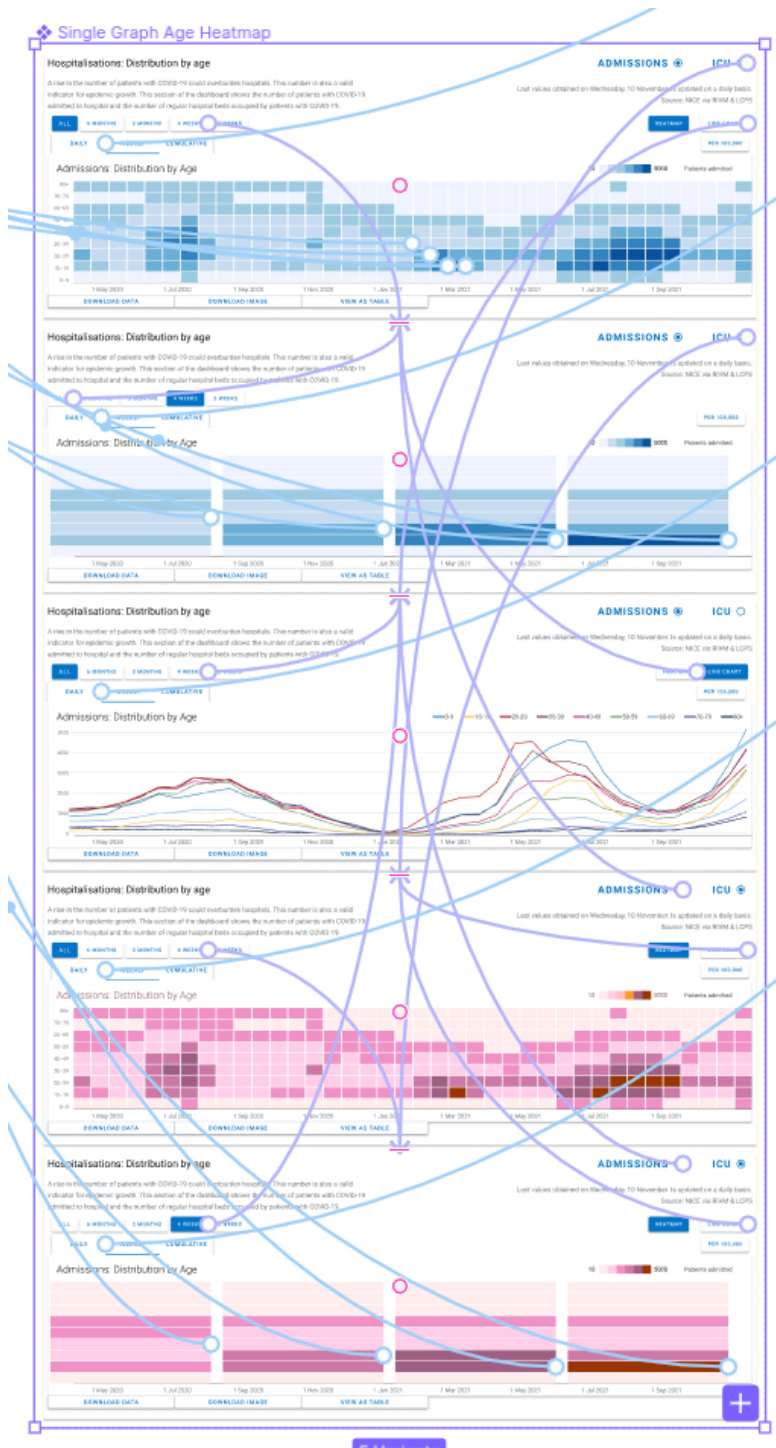


Figure 59: Hospitalisations distributed by age graph with variants and interactions mapped. The top graph is a heatmap showing admissions by age range over a few months in time. The next variant shows the same information but over 4 weeks. The variant after that shows the same information but in a line graph. The next variant shows ICU admissions in a heatmap. And the final variant shows ICU admissions but over a 4 week period. Each Interaction point is represented by a circle and a line.

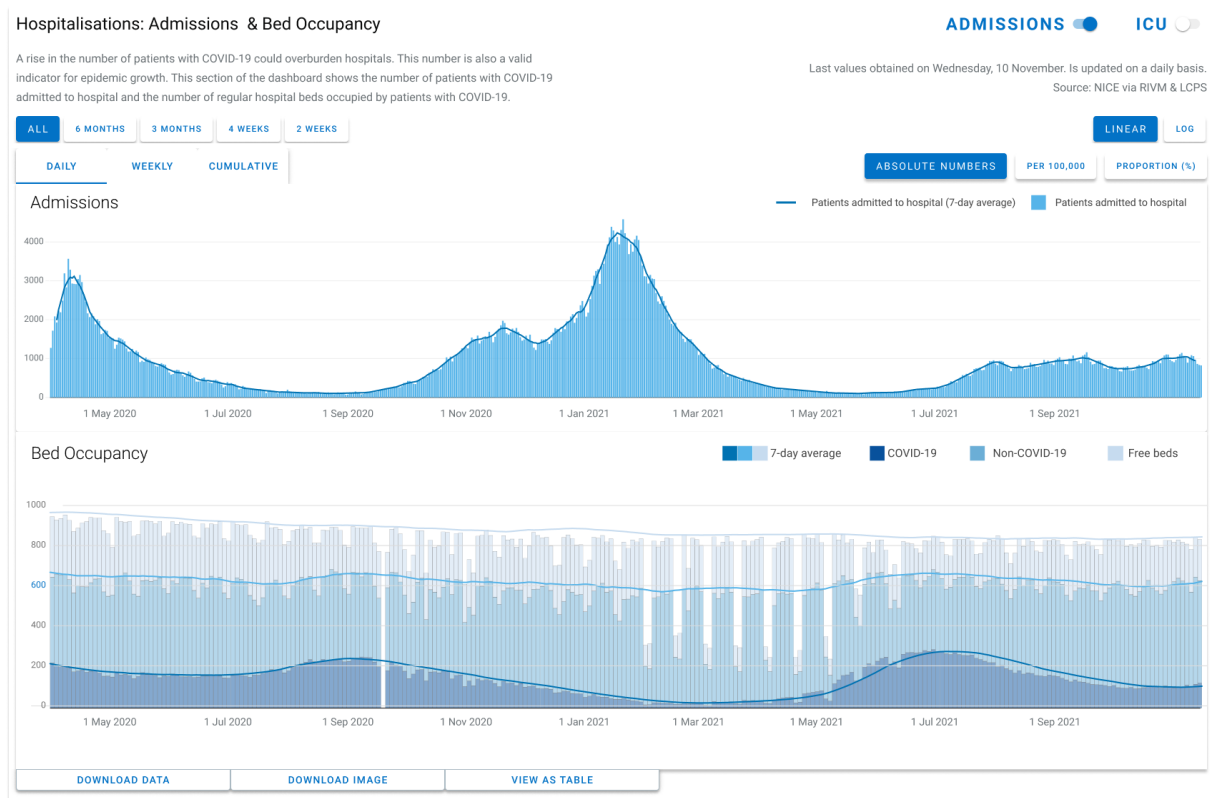


Figure 60: Synchronised Hospitalisations graph showing all admissions and also bed occupancy. Bed Occupancy is a stacked bar chart showing covid occupancy, non-covid occupancy, and free beds.

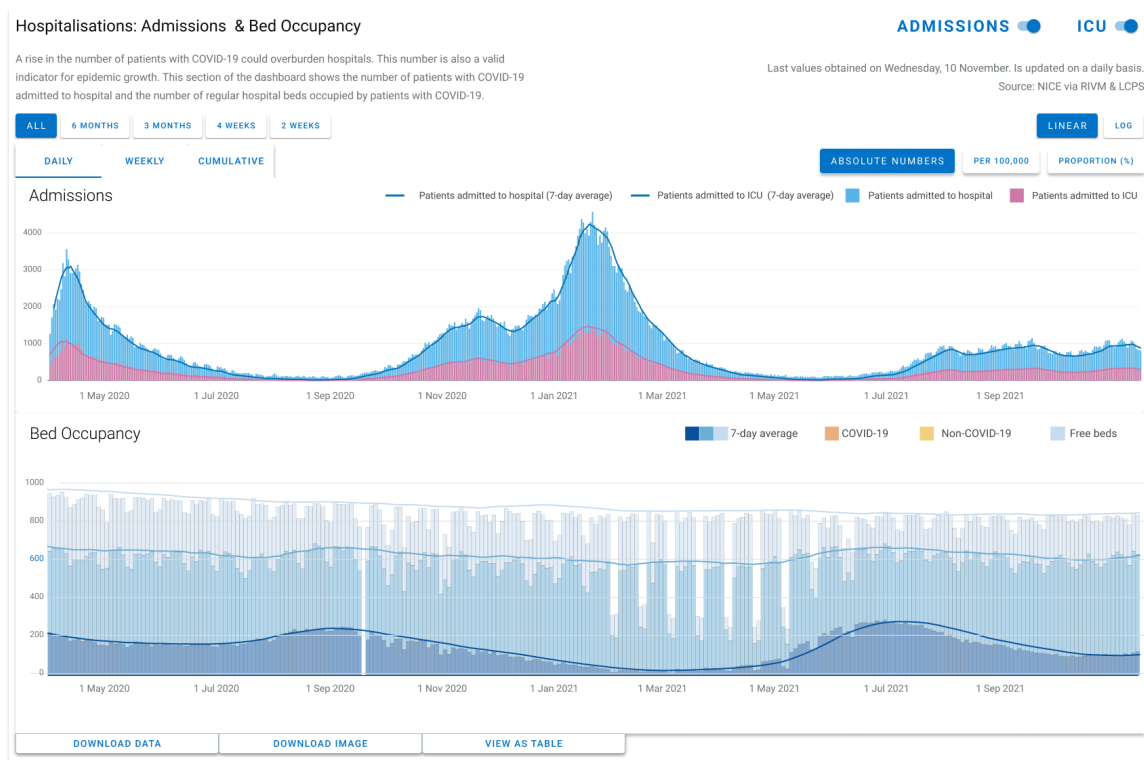


Figure 61: Synchronised Hospitalisations graph showing all admissions and also bed occupancy. ICU admissions are also shown as part of this graph to allow the user to see correlations in the data. Bed Occupancy is a stacked bar chart showing covid occupancy, non-covid occupancy, and free beds.

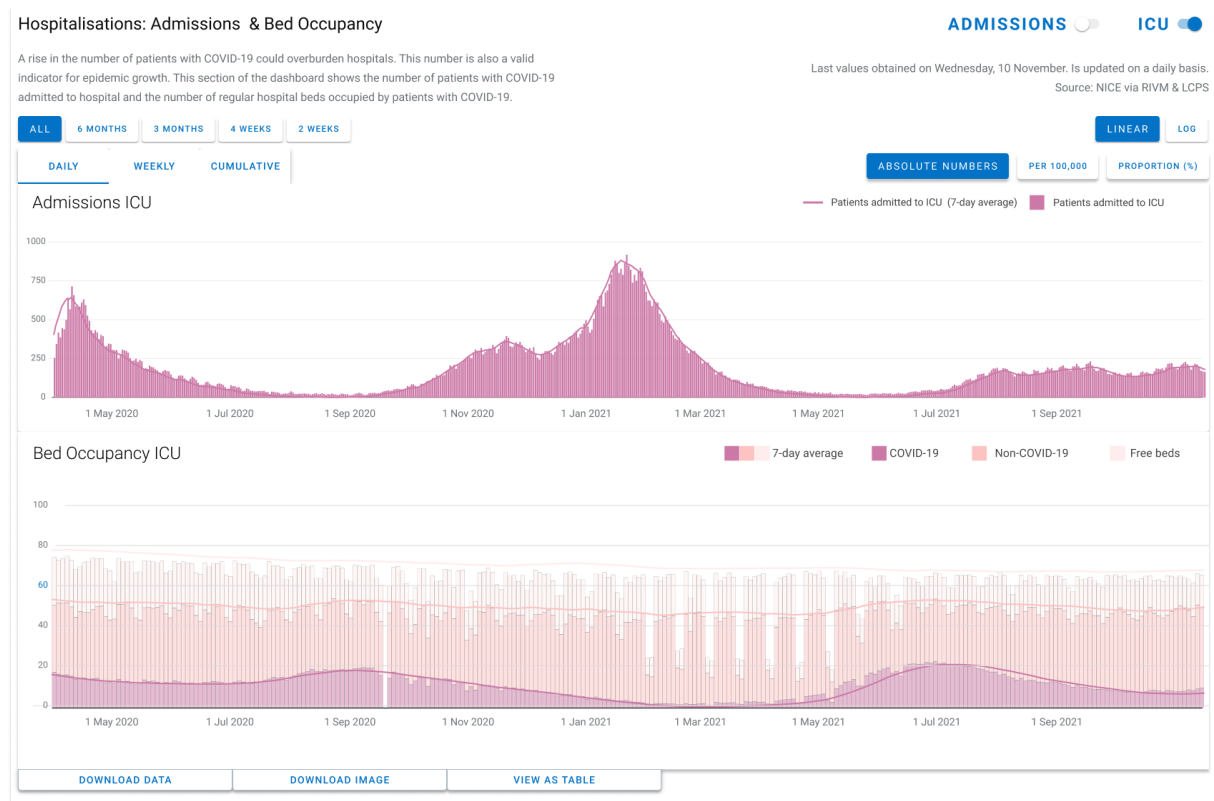


Figure 62: Synchronised Hospitalisations graph showing ICU admissions and ICU bed occupancy. Bed Occupancy is a stacked bar chart showing covid occupancy, non-covid occupancy, and free beds. The above three graphs are part of the same data visualisation with user interactions changing the presentation of the visualisation

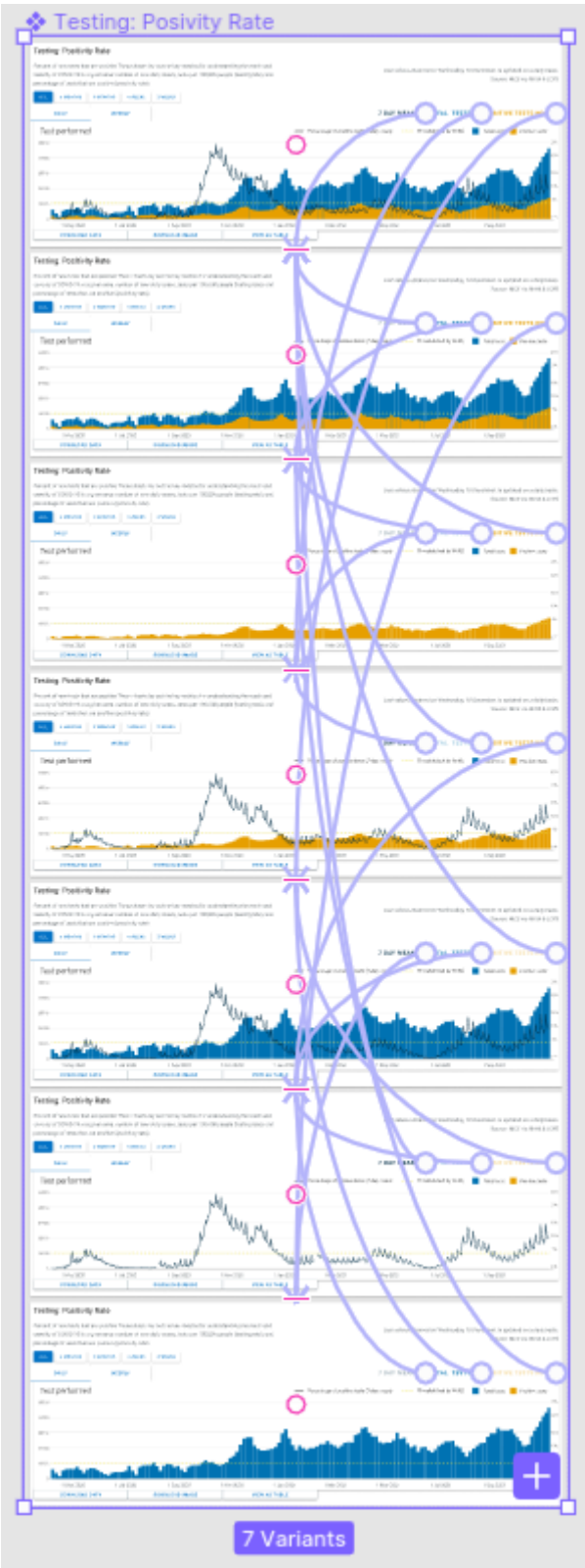


Figure 63: Testing positivity rates with interactions. The interaction mappings shown in this image highlight how a user interacts with the data and moves through the visualisation. Enabling these interactions allow a user to explore and see the data in its own right but also in the context of similar data, allowing for data correlations to be viewed.

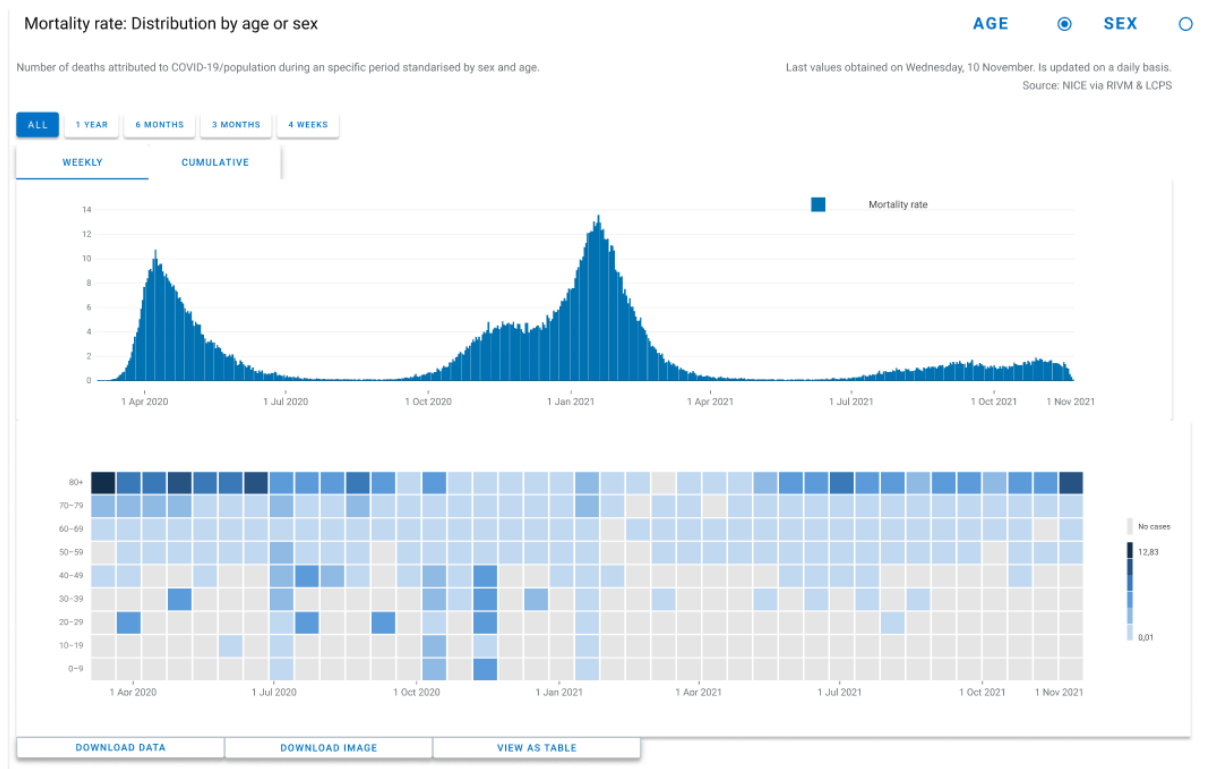


Figure 64: Mortality rate synchronised graph. The synchronised graphs can highlight correlated data and give the user specific insights. In the above example there is a mortality time series line chart charting mortality rates during the pandemic. A synchronised heat map chart below it, with the same time frame, allows the user to also see the breakdown of ages affected in terms of mortality as well as seeing the general trend. Users can quickly see correlations between general mortality rates and also get an idea of the age cohorts most affected.

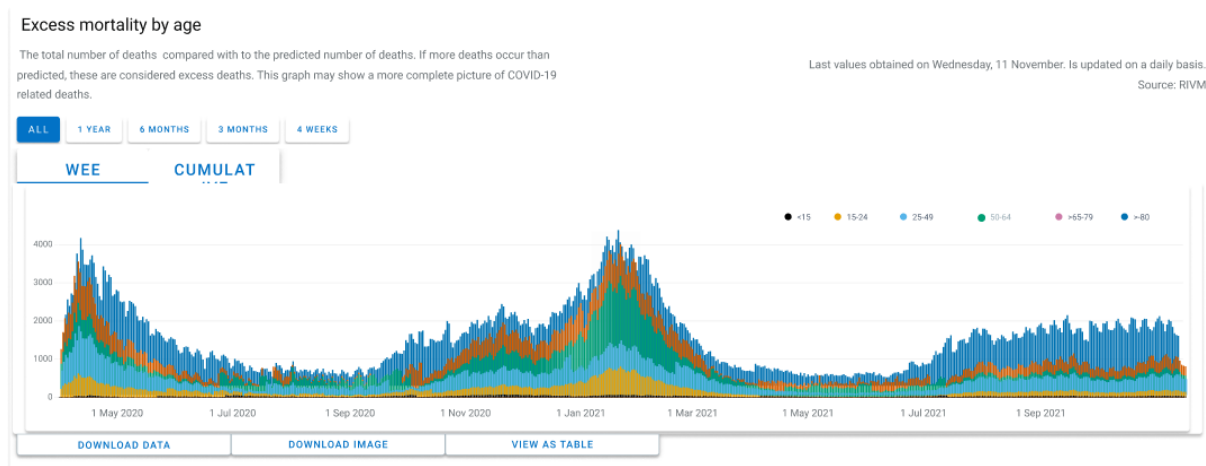


Figure 65: Excess mortality rate time series stacked bar chart. This allows the user to view excess mortality over the period of the pandemic and also see the age demographics most affected.

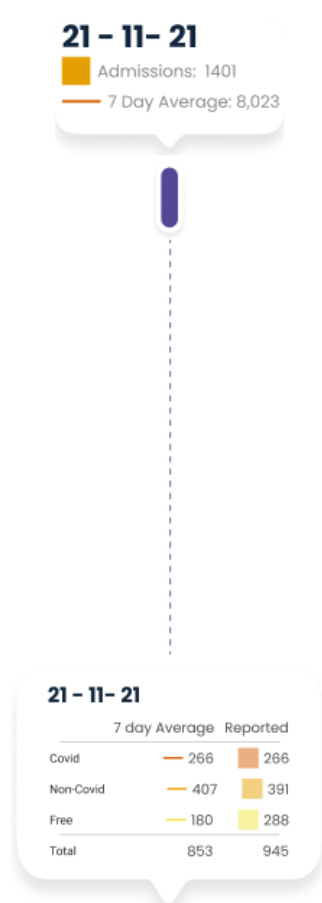


Figure 66: Tooltip for synchronised graphs. The synchronised tooltip shows the information for the same hovered time on both maps regardless of which map is hovered. This allows users to see correlated data, at the same period, within the synchronised graphs quickly and easily.

7.4.2 Full Data Requirements For Views

7.4.2.1 Design Prototype of minimal viable product document

Link to design prototype of mvp document

<https://www.figma.com/proto/F05GxYLw8MUElfVjUQRyS0/MVP?node-id=42%3A55&starting-point-node-id=42%3A55>

7.4.2.2 Pathogen-x Case Notifications (by region and time interval)

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, monthly, cumulative)
- by variant, age, sex, by comorbidities*
- Confirmed case Incidence
- Daily, weekly, monthly
 - per 100,000 population
- Confirmed Case Cumulative
 - Cumulative
 - Cases per 100,000 population
- Number of notifications**

- Notification rate
 - per 100,000 population
- Number and proportion of active confirmed cases
 - (from the number of confirmed cases minus the deaths and the estimated number of recovered cases.)
- Numbers and proportion of confirmed cases recovered
 - (assuming an average duration of illness from onset or hospitalisation date on)
- Syndromic/sentinel surveillance SARI/ILI/ARI/Pathogen-x-like.
 - Data source: GP sentinel sites? Influenzanet?
- Effective reproduction (R_t) number evolution. Source: to compute or provided by official source by country: <https://biocomsc.upc.edu/en/covid-19/Worldcovid-en>

7.4.2.3 *Pathogen-x Hospital Admissions (per region and time interval)*

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, biweekly, monthly, cumulative)
- by variant, age, sex, by comorbidities*
- Hospital Admissions
 - number
 - per 100,000 population
- Admissions ICU
 - number
 - per 100,000 population
- Admissions Ventilator
 - number
 - per 100,000 population
- Admissions Oxygen
 - number
 - per 100,000 population
- Proportion of Pathogen-x hospitalisations with comorbidities.
 - number
 - per 100,000 population

7.4.2.4 *Pathogen-x Hospital Bed capacity*

- Number of operable beds
 - ICU beds
 - non-ICU beds
 - Emergency beds
- Number/Percentage bed occupancy
 - ICU beds
 - non-ICU beds
 - Emergency beds
- Number/Percentage bed occupancy with Pathogen-x
 - ICU beds
 - non-ICU beds
 - Emergency beds

- Average length stay
 - ICU beds
 - non-ICU beds
 - Emergency beds

7.4.2.5 *Deaths by Disease X (by region and time interval)*

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, biweekly, monthly, cumulative)
- Deaths Total
 - by age
 - by sex
 - per 100,000 population
- Mortality rate
 - by age
 - by sex
- Mortality rate among hospital admissions
 - by age
 - by sex
- Mortality rate among ICU admissions
 - by age
 - by sex

7.4.2.6 *Excess Mortality (by region and time interval)*

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, biweekly, monthly, cumulative)
- Excess mortality
 - per 100,000 population. (Use euroMOMO measures, baseline for excess mortality 5 years)
- Cumulative excess deaths
 - per 100,000 (to account for mortality displacement)
- Excess deaths (number and rates)
 - By age groups
 - Important to include caveats of comparing excess mortality i.e. EuroMOMO doesn't adjust for demographic variations between countries)
- Excess deaths in long term care facility residents (number and rates)
 - Data source: EuroMOMO/Eurostat, The Economist

7.4.2.7 *Vaccination Uptake*

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, biweekly, monthly, cumulative)
- Total number of people and percentage of population who have received
 - 1 dose
 - 2 doses
 - 3 doses
 - By brand

- Progress (proportion of vaccination overall)
 - by age group
 - by risk group (aged 60 years and older, living in long-term care facilities, underlying health conditions)
 - In HCW (Health Care Workers)
- Weekly Incidence, hospitalisation rate, ICU admission rate with an indicator of vaccination uptake
 - by age group
 - per 100,000
 - over time (weekly, biweekly, monthly, cumulative)
- vaccine effectiveness by age group (Risk among unvaccinated group – risk among vaccinated group/Risk among unvaccinated group, Alternatively, $VE = 1 - RR$)

7.4.2.8 Testing

- by geographical area (National, NUTS-2 or equivalent)
- by time interval (daily, weekly, biweekly, monthly, cumulative)
- Number of tests performed
 - 100,000 population
- Positivity rate (generate alert at 5% threshold set by WHO)
- Testing policy
 - OxCGRT: No testing policy, only those who both (a) have symptoms and (b) meet specific criteria (e.g. key workers, admitted to hospital, came into contact with a known case, returned from overseas, testing of anyone showing COVID-19 symptoms, open public testing (e.g. “drive through” testing available to asymptomatic people.

7.5 Survey

This annex includes all the surveys that were carried out as part of the participatory design process. Participants were provided the survey along with a pre-prototype video and a pre-prototype carried out in Figma (Figma.com, 2021) that they could interact with. The goal was to interact first with the pre-prototype and offer feedback using the survey.

Figma designs can be found in section 4.2.3

Surveys were carried out using Google Forms.

In Google Forms possible answers can have different types that are chosen when the survey is designed. We restricted answers to one of the following types:

- Short answer: Answers that can be given in a short sentence.
- Paragraph: Long-form open-ended answers with one or more paragraphs.
- Multiple Choice: Respondents can choose one option among a predefined set of options. Every time we allowed a multiple choice question, we included "Other" as a possible option which allows people to provide a short answer.
- Checkboxes: Respondents can choose one or more options among a predefined set of options.

The following tables outline the questions per survey and the type of possible answer that respondents could provide.

Survey #1: Pre-prototype of the Modelling view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Have you ever used an infectious disease modelling tool? (8 responses)	Multiple Choice
3	Did you have any difficulty navigating the demo?	Multiple Choice
4	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
5	Does the layout of the page make sense to you?	Multiple Choice
6	Do you have any comments regarding the layout of the page?	Paragraph
7	In the “Model parameter area”, we show you different runs of the same model (different parameters set up). Is it valuable to be able to change model parameters and compare the results of different runs?	Multiple Choice
8	If you think it is valuable to compare results, how many maximum runs would you like to compare?	Short answer
9	Would a Map be a useful output on the page?	Multiple Choice
10	If a map was included how would you expect to see forecasting data represented?	Paragraph
11	In terms of geographic location what level of granularity would be useful for viewing the modelling results?	Checkboxes
12	Do you need to compare runs from different locations (e.g., RUN 1 results from Germany and RUN 2 results from the Netherlands)?	Multiple Choice
13	Does the graph in the demo (a time series graph) clearly illustrate the information?	Multiple Choice

14	In the “chart changing area” on the right panel, different chart views are available (in red) for the specific data selected. Is it valuable to be able to change the chart view?	Multiple Choice
15	Is there another graph type that would be helpful for viewing the information	Paragraph
16	In the “Graph settings” panel of the demo, we have added sample filters. The data filters for new cases would include linear and exponential, age, time, per 100k population, uncertainty. Are there any other filters that should be included?	Paragraph
17	In the “Main content area”, there is one graph displayed with the idea that this graph is filterable to show the different information the user might need. Is there a need to show more than one graph so the user can see the different information together? If so, would you prefer that the other graphs are already shown or that you can add a graph choosing what information should be presented in it?	Multiple Choice
18	If you wanted to save this output, what information should be saved? (tick all that apply)	Checkboxes
19	If you wanted to save this output, what format would you like to be able to save it in? (tick all that apply)	Checkboxes
20	Do you have feedback on the demo?	Paragraph
21	Do you have feedback on this survey?	Paragraph

Survey #2: Pre-prototype of the Bed Occupancy view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Did you have any difficulty navigating the demo?	Multiple Choice
3	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
4	Does the layout of the page make sense to you?	Multiple Choice

5	Do you have any comments regarding the layout of the page?	Paragraph
6	In terms of splitting the regions of the map, are NUTS regions sufficient?	Multiple Choice
7	The map currently shows bed occupancy in terms of percentage of beds occupied. Is this useful data to show on the map or would other data be more suitable? For instance numbers of beds available? Percentage of beds available?	Paragraph
8	There is a hover component for areas within the map. In terms of bed occupancy what information would you like to see within that hover component?	Paragraph
9	Are the interactions with the map intuitive?	Multiple Choice
10	Do you have any other comments on the map component and how it works?	Paragraph
11	Does the individual indicator card provide all the information you need about an indicator?	Multiple Choice
12	Would you remove any of the current indicators cards? If so, Which ones?	Paragraph
13	Do you want different indicator cards? If so, Which ones?	Paragraph
14	Do you need flexibility in changing the order of the indicator cards?	Multiple Choice
15	Do you need flexibility in choosing which indicator cards should show on each page/view?	Multiple Choice
16	In terms of the indicator cards with regards to Bed Occupancy, how should bed occupancy be shown? Is it a percentage, is it a number, is it something else?	Paragraph
17	Do you have any other comments relating to the indicator card components?	Paragraph
18	Is the graph that is shown useful to you in your role	Multiple Choice

19	What other information would be useful to see here?	Paragraph
20	Are the graph buttons that allow focusing on a set period of time useful?	Paragraph
21	Is it useful to be able to add graphs to view correlation?	Multiple Choice
22	If you have multiple graphs on display and you change the time frame for 1 graph should the other graph(s) change time frame also? or should each graph be independent?	Paragraph
23	Do you have feedback on the demo?	Paragraph
24	Do you have feedback on this survey?	Paragraph

Survey #3: Pre-prototype of the landing view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	Did you have any difficulty navigating the demo?	Multiple Choice
4	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
5	Does the layout of the page make sense to you?	Multiple Choice
6	Do you have any comments regarding the layout of the page?	Paragraph
7	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
8	Do the individual indicator cards provide you with relevant top level information about an indicator?	Paragraph

9	Would you remove any of the current indicators cards? If so, Which ones?	Paragraph
10	Do you need flexibility in changing the order of the indicator cards?	Multiple Choice
11	Do you need flexibility in choosing which indicator cards should be shown on the landing page on login?	Paragraph
12	In terms of the indicator cards, is daily and 7 day rolling average data useful to you in terms of an immediate situation analysis or would other data be preferable?	Paragraph
13	Are the graphs on the indicator cards useful in presenting the trend?	Paragraph
14	Are the graphs on the individual indicator cards useful in terms of the indicator or would you prefer a different graphical view? If a different graph would be useful, what would that graph be and for what indicator?	Paragraph
15	Do you have any other comments relating to the indicator card components?	Paragraph

Survey #4: Pre-prototype of the Cases view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	Did you have any difficulty navigating the demo?	Multiple Choice
4	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
5	Does the layout of the page make sense to you?	Multiple Choice
6	Do you have any comments regarding the layout of the page?	Paragraph

7	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
8	Would you require instruction on the functionality within the page? In other words, would it be useful to add a help button that will explain all the features and interactions related to the various graphs and items on the page?	Paragraph
9	Does the indicator card with general information about cases provide you with relevant level information to get a quick high-level view? Would you add, remove or modify any data displayed in this card?	Paragraph
10	The map will be filterable by cases, incidence rate, notification rate, active cases, and recovered cases in the current design. Would you add, remove or modify any of these filters?	Paragraph
11	Do you have any additional feedback on the map or indicator card?	Paragraph
12	Does this graph, as explained in the video walkthrough show all the information that you as an end-user would need?	Paragraph
13	Would you like to be able to view the data using epi-weeks?	Multiple Choice
14	Is it useful to access the same information with different graphs (bar chart, line chart and table)? Are there any other graphs that would be useful to view the data with?	Paragraph
15	Is the information shown in the first graph useful? Would you prefer different information to be shown or would you prefer a different graphical view? If yes, what information or graph would you like shown?	Paragraph
16	Do you have any additional feedback for this graph?	Paragraph
17	Are the graphs presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
18	In the video walk through when you hover on the graph a pop-up is shown on each part of the synchronised graph. Would you prefer all the information combined in one pop-up or as is; a pop-up for each graph?	Paragraph

19	Confirmed cases will be filterable by variant, age group, sex, or comorbidity in the current design. Would you add, remove or modify any of these filters?	Paragraph
20	Do you have any additional feedback for this graph?	Paragraph
21	Are the graphs presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
22	Do you have any additional feedback for this graph?	Paragraph
23	This card might display data that is not commonly used, would you still prefer to keep this card?	Paragraph
24	Are the graphs presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
25	Do you have any additional feedback for this graph?	Paragraph
26	Are the graphs presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
27	Do you have any additional feedback for these graphs?	Paragraph
28	In terms of information presented on the page, is there too much, just enough, or too little?	Paragraph
29	Are there any graphs on the page that you feel are superfluous? If so, which ones?	Paragraph
30	If there are too many graphs on the page, is there information on the page that doesn't need to be presented as a time series and could be presented as a number? example - R number	Paragraph
31	If there is too little information on the page, what are we missing?	Paragraph
32	Do you have any other feedback?	Paragraph

Survey #5: Pre-prototype of the Hospitalizations view

#	Question	Type of Possible Answer
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1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	Did you have any difficulty navigating the demo?	Multiple Choice
4	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
5	Does the layout of the page make sense to you?	Multiple Choice
6	Do you have any comments regarding the layout of the page?	Paragraph
7	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
8	Would you require instruction on the functionality within the page? In other words, would it be useful to add a help button that will explain all the features and interactions related to the various graphs and items on the page?	Paragraph
9	Admissions Indicator card: The admissions indicator card contains daily admissions, admissions for the last 7 days, per 100,000 population and proportion with commodities for regular beds and ICU beds. Is there any information that is missing from this indicator card? Is there any information on this indicator card that you do not need?	Paragraph
10	Bed Occupancy Indicator card: The bed occupancy indicator card contains the number of beds, the occupancy, the occupancy with a pathogen, the trend in occupancy, and the median length of stay. Is there any information that is missing from this indicator card? Is there any information on this indicator card that you do not need?	Paragraph
11	The map will be filterable by cases, incidence rate, notification rate, active cases, and recovered cases in the current design. Would you add, remove or modify any of these filters?	Paragraph
12	Do you have any additional feedback on the map or indicator card?	Paragraph

13	Does this synchronised graph show you the information you would like to see for admissions and bed occupancy?	Paragraph
14	At the top right of the admissions graph are the Admissions and ICU toggle buttons. Is it useful to be able to see ICU admissions in the same graph as all admissions?	Paragraph
15	Is the functionality of the toggle buttons clear and useful? Do you have any other comments on the toggle buttons?	Paragraph
16	Just above the admissions graph are three tabs - Daily, weekly, and cumulative. These allow the user to see the daily data, the weekly data, and all the data to date. Is it useful to have these filters? Do you have any other comments?	Paragraph
17	Is combining the graph in a synchronised manner useful to see correlations or would you prefer to see the information in independent graphs?	Paragraph
18	Do you have any other comments on the admissions and occupancy synchronised graph?	Paragraph
19	Is a graph containing the proportion of admissions with comorbidities useful?	Paragraph
20	Is there any other way you would view comorbidities, or would like to view comorbidities?	Paragraph
21	Do you have any additional feedback for this graph?	Paragraph
22	Are the graphs presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
23	Do you have any additional feedback for this graph?	Paragraph
24	In terms of information presented on the page, is there too much, just enough, or too little?	Paragraph
25	Is combining multiple graphs into one graph with interactions useful to see correlations? Are these correlations useful to see? or would it be preferable to have a single independent graph for each indicator?	Paragraph

26	Are there any graphs on the page that you feel are superfluous? If so, which ones?	Paragraph
27	If there is too little information on the page, what are we missing?	Paragraph
28	Do you have any other feedback?	Paragraph

Survey #6: Pre-prototype of the Mortality view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
4	Do you have any comments regarding the layout of the page?	Paragraph
5	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
6	Indicator card: Is there any information that is missing from this indicator card? Is there any information on this indicator card that you do not need?	Paragraph
7	The map will be filterable by deaths and excess deaths in the current design. Would you add, remove or modify any of these filters?	Paragraph
8	Do you have any additional feedback on the map or indicator card?	Paragraph
9	As presented, is the graph useful to you in your role? Would you prefer a different graphical view? Is it useful for you to have the option of switching between viewing the data as "Absolute numbers" or as "Mortality rate"? Is one of these options unnecessary?	Paragraph

10	Is it useful for you to have the option of switching between viewing the data in linear and log form? Is one of these options unnecessary?	Paragraph
11	Do you have any other comments on deaths and mortality rate graph?	Paragraph
12	Does the synchronised graph for mortality rate by **age** show you the information you would like to see? Is there anything that you would add, remove or change?	Paragraph
13	Does the synchronised graph for mortality rate by **sex** show you the information you would like to see? Is there anything that you would add, remove or change?	Paragraph
14	Does the graph for mortality rate show you the information you would like to see? Is there anything that you would add, remove or change?	Paragraph
15	Is the graph presented useful to you in your role? Would you prefer a different graphical view?	Paragraph
16	Do you have any additional feedback for this graph?	Paragraph
17	Is the information of excess deaths by age group useful for you?	Paragraph
18	Is a stacked bar chart a useful graphical view for you? Would you prefer a different graphical view?	Paragraph
19	Do you have any additional feedback for this graph?	Paragraph
20	Is the information of excess deaths in long term care facilities useful for you?	Paragraph
21	Do you have any additional feedback for this graph?	Paragraph
22	instead of having three separate graphs (excess deaths, excess deaths by age, and excess deaths in long-term care), would you prefer this information to be displayed in a single synchronised graph?	Paragraph

23	In terms of information presented on all the pages, is there too much, just enough, or too little?	Paragraph
24	Are there any graphs on the page that you feel are superfluous? If so, which ones?	Paragraph
25	If there is too little information on the page, what are we missing?	Paragraph
26	Do you have any other feedback?	Paragraph

Survey #7: Pre-prototype of the Vaccination view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
4	Do you have any comments regarding the layout of the page?	Paragraph
5	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
6	Vaccination Indicator Card. Is there anything you would add to this card? Is there anything you would take off this card?	Paragraph
7	Do you have any additional feedback on the map or indicator card?	Paragraph
8	Is it useful to see the information presented and in the manner presented?	Paragraph
9	This above graph shows vaccination coverage as a percentage of population filterable by 3 cohorts. Are these cohorts useful?	Paragraph

10	The bottom graph shows the correlation between vaccination uptake cases and hospitalisations. Are there other correlations that would be good to view?	Paragraph
11	Is combining the graph in a synchronised manner useful to see correlations or would you prefer to see the information in independent graphs?	Paragraph
12	Do you have any other comments on the synchronised graph?	Paragraph
13	Is a graph containing gender proportions useful for possible pandemics?	Paragraph
14	Do you have any additional feedback for this graph?	Paragraph
15	Is the graph clear in terms of presentation? Would you prefer it presented in a different manner?	Paragraph
16	Do you have any additional feedback for this graph?	Paragraph
17	In pandemics is it useful to be able to see the administration of vaccines in this way?	Paragraph
18	Do you have any other feedback?	Paragraph
19	In terms of information presented on the page, is there too much, just enough, or too little?	Paragraph
20	Is combining multiple graphs into one graph with interactions useful to see correlations? Are these correlations useful to see? or would it be preferable to have a single independent graph for each indicator?	Paragraph
21	Are there any graphs on the page that you feel are superfluous? If so, which ones?	Paragraph
22	If there is too little information on the page, what are we missing?	Paragraph
23	Do you have any other feedback?	Paragraph

Survey #8: Pre-prototype of the Testing view

#	Question	Type of Possible Answer
1	What is your role within your organisation?	Short answer
2	Email address (optional) - This would help with follow up questions if you don't mind sharing	Short answer
3	If you had difficulty navigating the demo, what parts caused the issues?	Paragraph
4	Do you have any comments regarding the layout of the page?	Paragraph
5	Is there anything missing from the page that you would like to see, or expect to see in terms of functionality or visual components?	Paragraph
6	Confirmed Positive Cases Card: Is there anything you would add to this card? Is there anything you would take off this card?	Paragraph
7	Current Testing Policy Card: Is the information displayed in this card useful for your role? Would you remove this card?	Paragraph
8	Do you have any additional feedback on the map or indicator cards?	Paragraph
9	Are the available time frames of "All / 6 months / 3 months / 4 weeks / 2 weeks" enough to support your decision making process? Would you add or remove possible timeframes?	Paragraph
10	Is it useful to see the information presented and in the manner presented?	Paragraph
11	Would you prefer a different graphical view for the testing policies timeline?	Paragraph
12	Do you have any other comments on Graph 1?	Paragraph
13	Is the presented graph useful for you in your role? Would you prefer a different graphical view?	Paragraph
14	Is there anything that you would add, remove or change from this graph?	Paragraph

15	Do you have any additional feedback for Graph 2?	Paragraph
16	In terms of information presented on the page, is there too much, just enough, or too little?	Paragraph
17	Are there any graphs on the page that you feel are superfluous? If so, which ones?	Paragraph
18	If there is too little information on the page, what are we missing?	Paragraph
19	Do you have any other feedback?	Paragraph