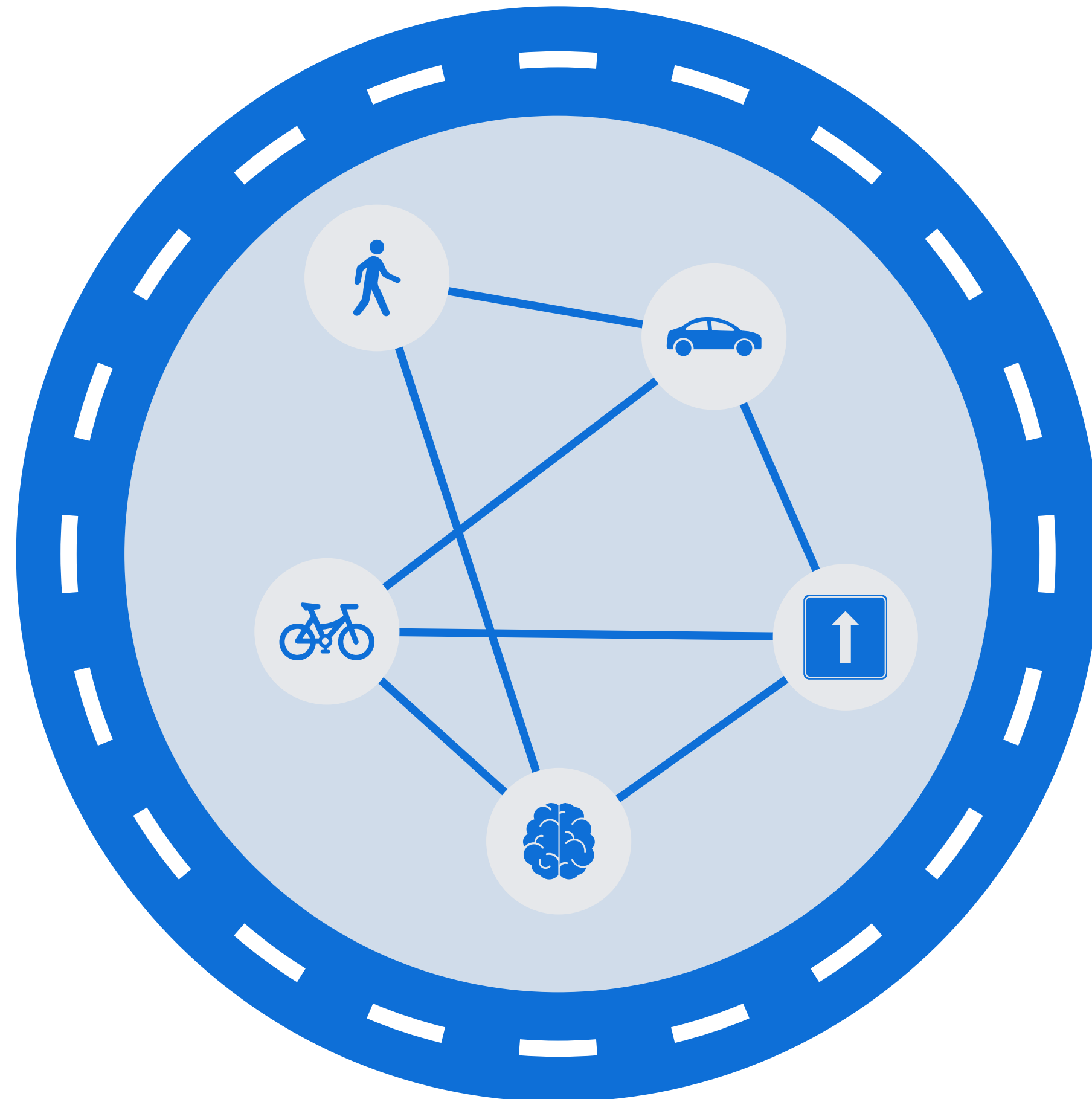Open Summer Of Code 2021

# RoadBase

Vlaanderen
is mobiliteit &
openbare werken

AGENTSCHAP
BINNENLANDS
BESTUUR

AGENTSCHAP
WEGEN
& VERKEER

# Introduction

## About the project

**RoadBase** is a one-month project created in a collaboration between Open Summer of Code, Agentschap Binnenlands Bestuur, Agentschap Wegen en Verkeer and Departement Mobiliteit en Openbare Werken Vlaanderen. The aim of this project is to create a tool to gather and integrate up to date information from different sources regarding road signs and road marks so that citizens, road managers and policy makers can effectively contribute to make their communities safer. Through linked open data, this tool is expected to provide convenience to road users and encourage them to actively engage in providing information to enhance road safety. The linked open data will ease the decision making process for policy makers and road managers and incorporate the voice of citizens in their job.

## About the team

RoadBase has been created by a team of nine multidisciplinary students with different backgrounds and a lot of dedication. Due to the global pandemic, virtual meetings are the main channel of communication and diverse digital tools (e.g. Figma, Trello, Notion, Ember) are deployed daily. Together with the coaches and student coaches, the team strives to provide the partners with the most concrete and valuable solution so that the organisations, citizens and all involved parties can truly benefit. To increase efficiency and flexibility, the team is divided into 2 subteams; the strategic team and the technical team.

The strategic team aims at gathering insights from the target groups and providing conceptual solutions for the partners. This process includes identifying representatives, forming interview protocols, conducting virtual interviews, building persona, creating user stories and developing wireframes and mockups. The outcomes of this process are expected to provide (1) a preliminary understanding of the target groups which serves as a direction for the technical team (2) prototypes of tools that can show policy makers and citizens the possibilities of linked open data to increase road safety in a more democratic and effective manner.

The technical team aims at providing a revamp vision of the internal tools used by the policy makers of the Flemish Government. Next to that, we will provide a working Proof-Of-Concept in order to demonstrate the technical capabilities of the technologies chosen by the stakeholders. These requirements are shown by using wireframes, a working Proof-Of-Concept and additional documentation in order to aid future developers with improving and refining these internal tools.

## Methodology

We carried out primary and secondary research to gather information on road safety in Flanders. As part of this research, we conducted seven digital interviews with different stakeholders and target groups. To gather data from a broader public, we also administered an online survey with the use of Google forms. Later on, we will discuss the results of these methods more in depth. The combination of qualitative and quantitative research methods helped us validate the accuracy of the findings.

# Context

We conducted multi-methodical research to determine our target groups and gather insights for the persona, user stories and wireframes. We combined qualitative and quantitative research to get the best possible overview of stakeholders, their ideal experience and problems. In what follows, we will give a summary of our main findings before we introduce our persona and user stories that were based on this information.

## Target groups

To formulate some strategic and long-term advice, we brainstormed on who could benefit from linking the open data that our partners collect. By working with linked open data, we demolish the information silos that are present between the already existing initiatives on road safety. This way, we allow everyone to use, navigate and build on data considerably easier and more efficiently. An important part of our application would be a continuous data lifecycle. To keep linked open data accurate and fueled at all times, we need the stakeholders to use the data, as well as feed data back into the system. Keeping this in mind, we conducted a list of possible stakeholders to appeal to with this application.

- Policy makers. The people actually creating policy and making decisions on road safety would benefit from having easy access to all different layers of data, gathered from different sources. This way they can use quantifiable, objective data and link it to make well-founded decisions on road policy. As a bonus, they will have a good overview of what citizens truly want by being able to use the information and complaints they put into the platform by crowdsourcing.

- Road management. Several experts on road management told us that road managers are always short of resources (e.g. time, employees, budget). By linking and opening up all the data, road managers can create ways to use their resources more efficiently. An example here could be an algorithm. By linking all the data, an algorithm could tell road managers where most problems are situated, what type of problems these are and how they can better organise their resources for example to provide more funding in big cities since most public transport and bicycle accidents happen here. Furthermore, road asset management and its lifecycle can be made more efficient, as the information on replacement, stock management and location can be linked.
- Police. The police are an important stakeholder in reporting and providing accurate information on the location of problems with road safety. With linked open data, the information they provide will be used more efficiently. Also, the communication between the police, the road managers and the notification system (e.g. Meldpunt Wegen), will be simplified.
- Citizens and citizen organisations. By linking the open data, citizens finally have one centralised platform where every request can be documented. Linked open data will help citizens benefit from seeing all the data, seeing the studies that are done or ongoing, seeing how policy makers decide on this data and use this for the better.

- Studies on the Flemish roads. Several students and experts on road safety mentioned that Flanders, when compared to for example The Netherlands and France, does not have a lot of studies on road safety. This is a shame, as such information and knowledge could benefit citizens, policy makers and road managers. Linked open data would allow organisations and students to conduct studies on information that the Flemish government collects, which they can then again implement into the application. This way, a continuous data implementation is guaranteed and all parties benefit from opening up the data.
- Private sector. Linked open data would allow the private sector and start-up companies to actually build on this data and benefit the overall economy. These private companies can use the data and the insights collected to build applications (e.g. gamification of a city, gamification of road signs for students who learn how to drive) that can benefit citizens, policy, local authorities, organisations and the overall economy. This also allows for the government to outsource some of the possibilities linked data brings to other companies, as they often do not have the time, funding or people for it themselves.

## Interview insights

Following the qualitative research method, we conducted several interviews with experts in the field of road safety. Because of the pandemic, the interviews took place through Zoom or Microsoft Teams. They were analysed by using an interview protocol. We interviewed:

- Dries Van Ransbeeck, a passionate cyclist with knowledge of open source communities and citizen engagement.
- Maarten Wens, a traffic engineering student who could inform us on road safety, traffic legislation and engineering.
- Hans Zegers, a former counselor of the former minister of mobility.
- Lieselotte Bailly, a customer service employee at Meldpunt Wegen.
- Pieter Colpaert from OpenStreetMap Belgium, an open source application where citizens can upload geographical data.
- Bruno Coessens from MeetFiets, an initiative from Fietsersbond that gathers information about the Belgian bicycle paths.
- Miguel Vertriest, a sustainable mobility expert who represents the stakes of citizen organisations in policy debates.

We also attempted to contact Inter (a disability organisation), David Covent (a road manager), Bart Overloop (a data analyst for Meldpunt Wegen) and Fietsbult (an organisation that crowdsources information from cyclists). Unfortunately, these people / organisations did not respond or were not able to participate within the limited timeframe of this project. However, it would be interesting to keep them in mind for follow-up research and interviews, as it is important to represent all voices in this application.

The interviews gave us insights with regards to the scope and context of this project. Next to that, the insights of the interviews were used to form our persona and create user stories. They were also very useful when creating the wireframes and mockups, as we got a lot of opinions on the ideal experience all target groups could have. In what follows, we will summarize some of the main take-aways from the interviews.

In general, multiple interviewees mentioned that the situation in Belgium regarding road safety is quite fragmented. In terms of road safety, Flanders is not on the same level as for example The Netherlands. Experts mentioned that Flanders is in need of a lot more studies on road safety, which leaves significant room for improvement. Next to that, decision making takes place on different levels, such as the regional level, making the legislation and improvement process slow and fragmented.

Right now, there are several platforms, initiatives and organisations that collect road data. Citizens sometimes feel overwhelmed and do not know who will be able to address their complaints the best. Numerous interviewees were convinced of the benefits a platform using linked open data can bring. However, this new platform would have to bring all existing initiatives together instead of just adding on to them. In that way, citizens and road managers do not just get another way to make and receive notifications (e.g. Meldpunt Wegen) and it does not become even more confusing.

Some interviewees already use existing initiatives to report road safety issues (Meldpunt Wegen). However, they mentioned that the long notification forms, the lack of a user friendly interface, of decent feedback and of the ability to follow their reports is holding them back from continuing to use it on a regular basis. On the administration side (Meldpunt Wegen), an important issue came across. The team had a shortage of staff in order to take into account all the issues flagged by citizens. By providing a transparent overview of all the road safety issues, Meldpunt Wegen could attract more funding and awareness from citizens and policy makers in order to support their work.

Citizen organisations also reported some frustrations, as they felt they needed intermediary organisations to make their voices heard. Furthermore, the data on road safety issues flagged by citizens is not open data nor accessible to policy makers or citizens. Additionally, it is not structured in a linked data form, which prevents the creation of traffic and safety intelligence accessible to everyone. The interviews shed light into the benefits of public access to more knowledge on road safety issues, as every individual would be empowered to contribute to making their communities safer. This project took that into account, by connecting them directly to the policy makers to increase their input on road safety.

# Survey insights

As a quantitative research method, we conducted a survey among the Flemish population. We used Google Forms to create the survey and based the questions on research, insights from the interviews and knowledge that was lacking. The survey questions can be found **here**, the responses can be found **here**. We spread the survey through our personal networks and the Open Summer Of Code community. Eventually, we got 68 responses. In what follows, we will give you an overview of the main insights we got from the survey.

On average, the respondents of our survey would score the road safety in Flanders as 6/10. When it comes to issues on road safety in general, the score is much higher (8/10). This indicates that the respondents encounter issues in regards to road safety on a regular basis. To solve these, a significant part of the respondents would be willing to contribute to road safety by taking action on their own (e.g. taking pictures and reporting an issue). However, over 70% of the respondents have not done something like this in the past and have no idea on how to start doing something like this. This is a problem that our project tackles by bringing together all data and ways to make a notification. When contributing, the majority would like to receive some sort of a reward or incentive, like for example movie tickets, a voucher or a badge. Overall, we can conclude that the respondents are worried about road safety and want to contribute to improving this, but do not know how to do that exactly yet.
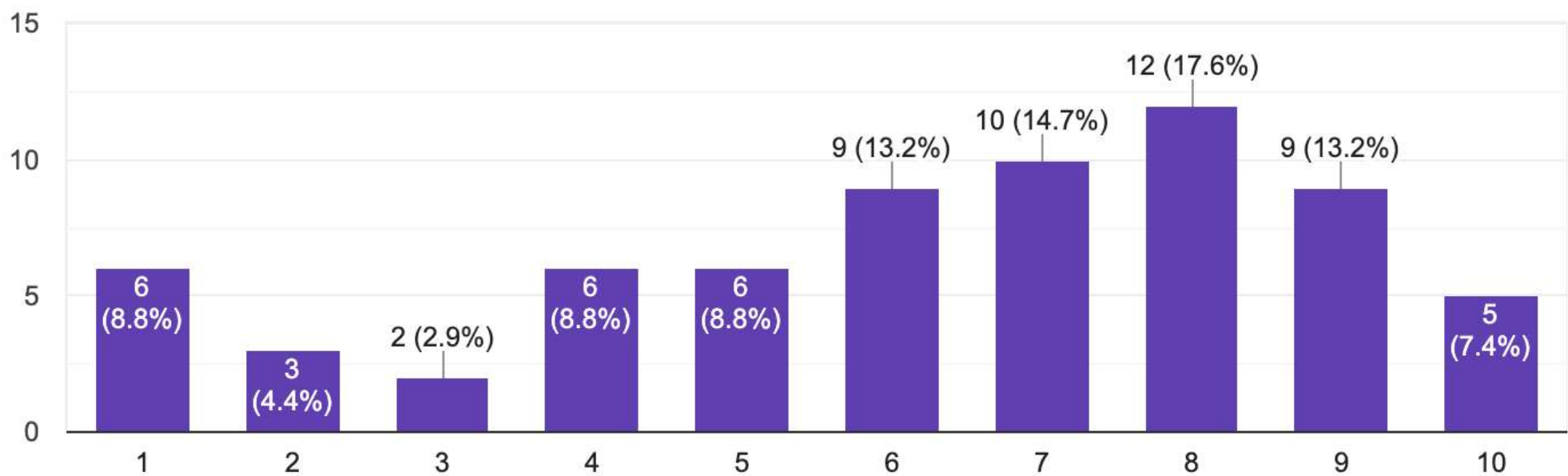
How safe would you rate the roads in Belgium?

68 responses
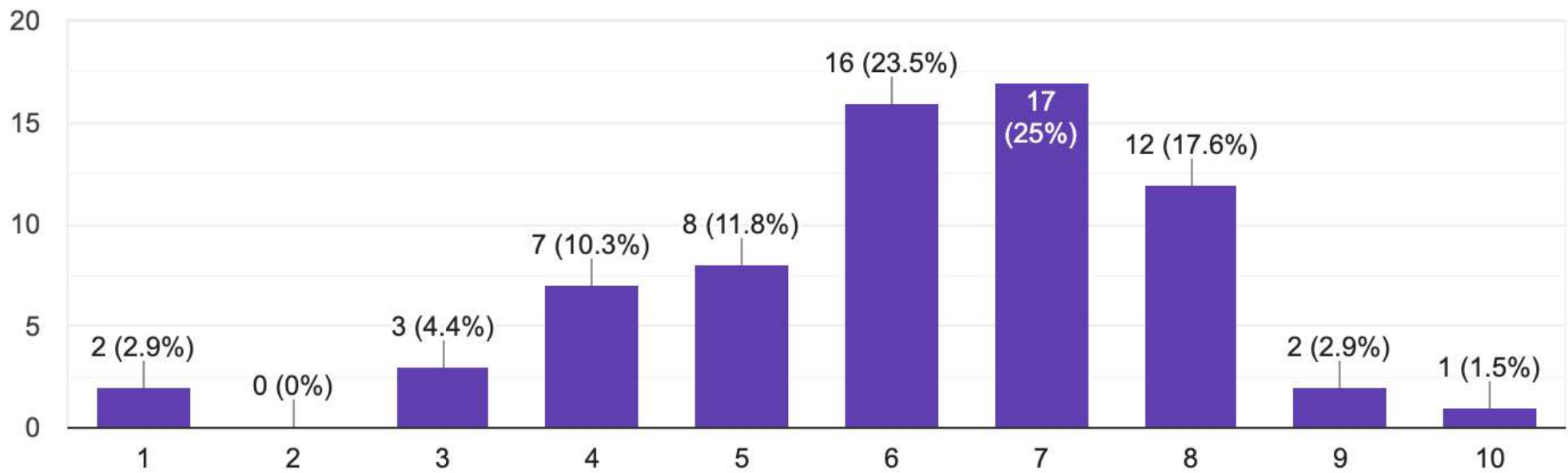


Would you like to contribute in providing information? For example, taking a photo of a bad traffic sign and share it in our tool?

68 responses

# Persona

Based on the target groups, interviews and survey, we developed three persona. These persona give an overview of the main parties involved in the application and what these people's pains, gains and typical profiles are. We present policy makers, road managers and citizens.

Though there are many active road users (e.g. pedestrians and motorists), cyclists are considered representatives for the citizens in our application. According to a study on hospital admissions, almost 80% of bike accidents on Belgian and Dutch roads do not involve a motorised vehicle. The majority of hospitalizations are caused by 'one-sided' events, such as falls without other people present or collisions with an object. Both this study and our experts identified cyclists as the road users that suffer most from road safety issues such as bad signaling or infrastructure.

Meet Lucas, Laura and Jonathan in the following sections.

**Lucas Delveaux**     **Laura Lookers**

**Jonathan Geerlings**

# The cooperative cyclist

## Lucas Delveaux

- 26 years old
- Professional cyclist & personal trainer
- Hobbies
  - Gardening
  - Volunteering
  - Meeting friends

### Pains

- Lack of comfortable bicycle infrastructure
- Vulnerable group on the road
- Unclear road signs, unexpected detours,...
- Wants to be heard by policy makers & have his feedback improve his neighbourhood
- Wants to be able to check his biking trail ahead of time

### Gains

- Improved safety
- Ability to check data easily
- Actually contributing and influencing traffic policy
- One unified tool instead of current fragmented situation (Fix My Street, Meldpunt Wegen, Fietsbult forum, ...)

### Solution requirements

- Easy to use
- Doesn't take a lot of time
- Clear feedback loop
- Clearly defined project, goal and incentives
- Good framing of the project

### Possible obstacles

- Lack of time
- Bad feedback or a lack of it
- No feeling of community
- Not feeling appreciated

> " When we're talking about road safety, I would say the cyclists are suffering most from the bad infrastructure and signaling. The cycling infrastructure is very bad. Every active road user is in danger here. "

# The proficient policy maker

## Pains

- Scattered data prevents creation of intelligence
- Lack of connection to citizens and complaints
- Different parties have different objectives
- Bad infrastructure/road users cause traffic issues
- Lack of data on road users and road safety studies
- Legislations vary among different levels
- General lack of knowledge on road sign conditions

## Gains

- Real-time monitoring of road safety
- Enhance safety with intelligence like crash data
- Convenient data integration from different sources
- Convince other parties of primary objectives
- Identify bad infrastructure to solve traffic problems
- Unified tool to ease communication between users
- Solve conflicts among different needs of road users

## Solution requirements

- Easy overview for strategic decision making
- Ability to add different layers to the map
- Ability to construct direct policy using the map
- Ability to use map when presenting policy decisions

## Possible obstacles

- Getting overwhelmed with all incorporated data
- Too time consuming
- Decision on what to solve is still subjective

" It would be interesting to have a platform where citizens can contribute to increasing road safety in their communities. "

## Laura Lookers

- **42 years old**
- **Flemish ministry of mobility**
- **Hobbies**
    - **Playing tennis**
    - **Painting**
    - **Horseback riding**

# Jonathan Geerlings

- 48 years old
- Road manager
- Hobbies
  - Racing cars
  - Playing pool
  - Traveling

# The rational road manager

### Pains

- Incomplete or double notifications
- Has to prioritize most urgent requests
- No direct contact with citizens/notifiers
- Relies on customer service team for assignments
- Budget, staff and time issues limit given feedback
- Surplus of notification channels causes confusion
- Limited time to respond to notifications

### Gains

- Direct contact with citizens making notifications
- Increasing road safety in more efficient way
- Manageable workload thanks to effective reporting/notification system
- Easier administration because data is linked
- Better location overview of different problem types

### Solution requirements

- Easy, fast and clearly time-saving
- Exact location and description of the problem
- Overview of other issues at same location
- One way channel where everything is bundled without additional administration or contact

### Possible obstacles

- Lack of time
- Unfiltered/double requests from citizens
- Too many requests in general
- Incomplete information
- Lack of budget to fix issues

" Being able to manage all the notifications from citizens effectively has always been my top priority. "

# User stories

The user stories represent how these three persona would use the application we designed. With user stories, we can envision their ideal experience and take their pains and goals into account throughout the entire project. The application will be used by several groups of people, so these user stories can help to keep those different stakeholders in mind. The user stories could be applied in a broader context of road safety beyond road signs and road marks information.

## Citizens

**#1 Reporting road signs and road marks issues**

| | |
|---|---|
| **As a** | citizen |
| **I want to** | report damaged road signs / road marks |
| **So that** | I will make sure my city / neighbourhood is safe |

*Acceptance criteria*

| | |
|---|---|
| **Given** | I notice a road safety issue with regards to road signs / road marks. |
| **When** | I use RoadBase to connect to a road manager so that an asset will be fixed (eg. a sign has been run over by a car) |
| **Then** | The request is implemented (Eg. road sign replaced / road mark painted) and I receive clear feedback depending on my preferences (eg. update on the map), so I can see that my efforts to report have been taken into account |

**#2 Requesting policy makers road sign and road marks changes to make my community safer**

| | |
|---|---|
| **As a** | citizen |
| **I want to** | request a change of an unsafe road sign or add certain road marks (eg. a cross road/a bike lane) |
| **So that** | I will make sure my city / neighbourhood is safe |

*Acceptance criteria*

| | |
|---|---|
| **Given** | I notice a road safety issue with regards to road signs / road marks |
| **When** | I use Road Base to connect with a local policy maker to request certain road marks / road signs in a map to make my area safer (Eg. lowering the speed limit / adding a cross road in certain places) |
| **Then** | I can easily follow the decision making process up until my request is implemented / handled by a policy maker. Reception of request by a policy maker > … > Final Legal Text implementing my request |

**#3 Engaging with other citizens and policy makers in making roads safer**

| | |
|---|---|
| **As a** | citizen |
| **I want to** | be able to engage with my community and support grassroots initiatives to change road signs and road marks |
| **So that** | I will make sure my city / neighbourhood is safe |

*Acceptance criteria*

**Given**   I see other citizen requests with regards to road signs and road marks in the RoadBase map

**When**    I join other citizen requests

**Then**    I can support other initiatives and also easily follow the decision making process up until this request is implemented / or handled by a policy maker

**#4 Being rewarded for great citizenship engagement**

**As a**        citizen

**I want to**   feel my efforts have been acknowledged and have an impact

**So that**     I feel part of a community which is helping to protect people

*Acceptance criteria*

**Given**   I make a contribution to RoadBase

**When**    I crowdsource some information about a road sign or a road mark

**Then**    I receive badges / diplomas for my contribution, so that I can share them with my friends and family and I can entice them to join the initiative

# Policy makers

**#1 Obtaining up to date mobility intelligence and reports based on linked open data to inform road signs and road marks policy making**

**As a**        policy maker

**I want to**   obtain a better understanding of the current up-to-date mobility situation, accident information and citizens requests in order to make well informed decisions on road safety, mobility and road signs and road marks

**So that**     I will make sure citizens are safe / traffic accidents and their gravity are minimal

*Acceptance criteria*

**Given**   I have to make a decision about road signs and road marks. I receive a request from many citizens / a citizen or the Flemish government is working on road signs and road marks policy development

**When**    I use RoadBase to understand what citizens want/need and what is required to increase / maintain road safety

**Then**    I can get clear visualizations, knowledge and insights, visualizing accident heatmaps and with input from citizens in order to make an informed decision on how to manage road signs and road marks. Furthermore, I can easily see what legislative documents and decisions are related to the road asset (and who is involved in the decision making process)

**#2 Developing effective traffic legislation (on road signs and road marks) understood by all jurisdictions**

**As a** policy maker

**I want to** make the traffic legislation development smooth and more efficient by making sure all jurisdictions can refer to road signs and road marks in a consistent way and include these references in legislative documents

**So that** we can have effective and efficient policy making on road signs and road marks understood by everyone

*Acceptance criteria*

**Given** I have to deal with legislative documents on road signs and road marks

**When** I have to write or debate legislative documents on road signs and road marks

**Then** I can clearly understand what road signs and road marks we are debating about, regardless of the jurisdiction I am reading the document from. I can access all the information available on that particular road sign / road mark (accident statistics, citizen requests…) and I can refer to this particular road sign / road mark in the legislative document I am writing

**#3 Drawing / moving road signs and road marks on a map to make visual policy proposals**

**As a** policy maker

**I want to** draw maps of road signs and road markers

**So that** I can effectively communicate my ideas based on reliable and comprehensive data taking into account road safety and citizenship data

*Acceptance criteria*

**Given** I have to make proposals on road signs and road marks placements

**When** I use RoadBase

**Then** I can clearly show my ideas in a visual way

# Road managers

**#1 Fixing road assets**

**As a** road manager

**I want to** effectively and efficiently fix road assets

**So that** I will make sure road users are safe by fixing road assets

*Acceptance criteria*

**Given**   I receive a request to fix a road sign / road mark (from a citizen) with the correct location and all the required information (avoiding duplicate requests)

**When**   I use Road Base to spot the tasks I need to manage

**Then**   I can efficiently prioritize the issues that I can fix, closests to me and based on gravity with regards to road safety

**#2 Maintaining road assets**

**As a**   road manager

**I want to**   effectively and efficiently maintain road assets

**So that**   I will make sure road users are safe by maintaining roads in a good state

*Acceptance criteria*

**Given**   I need to manage the maintenance and lifecycle of road signs and road marks

**When**   I use Road Base I am able to see the technical information of road signs and road marks as well as its remaining life span, which is linked to stock supplies

**Then**   I will be notified when I have to replace certain road assets, as I can efficiently manage the road signs and road marks (as Road Base can notify me when an asset will need replacement based on an algorithm)

# Creating the product

Our final product is a tool for policy makers that enables them to view, design and edit signs and road markings. As a team, we have decided to visualize this product in two ways for the stakeholders:

- A wireframe that contains the flow of adding road signs and marking, displaying them, filtering and searching them, which can be found **here**.
- A Proof-Of-Concept that allows viewing the location of the signs on a map and adding a new sign. This Proof-Of-Concept is also automatically deployed onto a server that is accessible on **RedPencil Servers**. We have also put great care into the documentation. We have provided a guide to deploy this project **locally** and on a **remote server**. The code for the application is viewable on **GitHub**, alongside an **introduction page** of the project and the team.

The Proof-Of-Concept needs to greatly increase the usability of the former tool and elevate it to modern standards, akin to the modern suite of tools, used by the Flemish government. We have found that the biggest problem was adding and designing signs, which was a very complex process within the former tool. We have focused on lowering the difficulty of the tool by clearly defining every step and automating several tasks. This results in a more natural and human-centric process that makes the tool more accessible.

## Branding

For this project, we followed the style guide the Flemish government provided us with. We used their 'Flanders Art' font and color scheme for the conceptual mockups, but also tried elevating the branding by adding our own touch to the deliverables when the readability was too low. The pre-made components they provided us with, helped the team to create on brand mockups fast. We did have to design some more components that were not included in the 'web universe', but we attempted to match them perfectly, so we could stay within their branding.
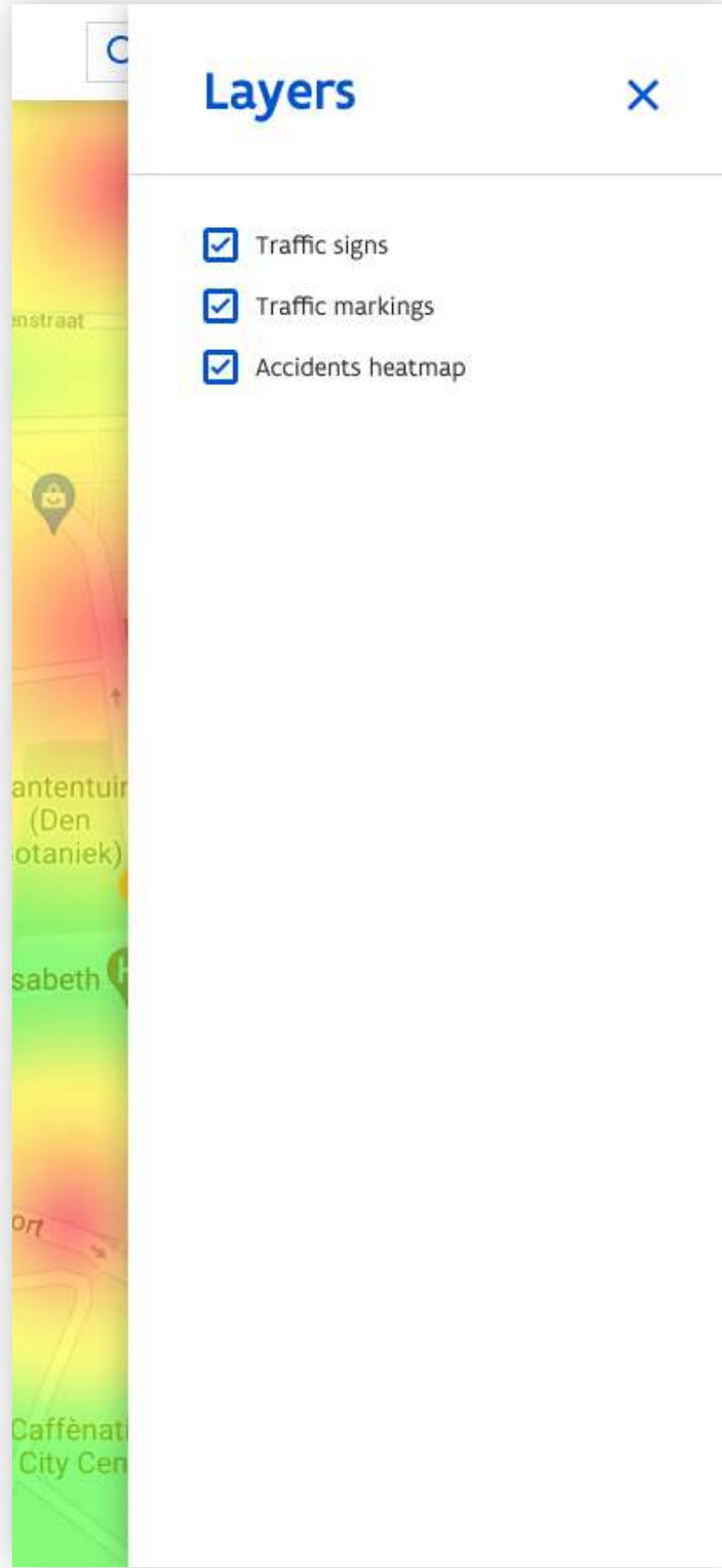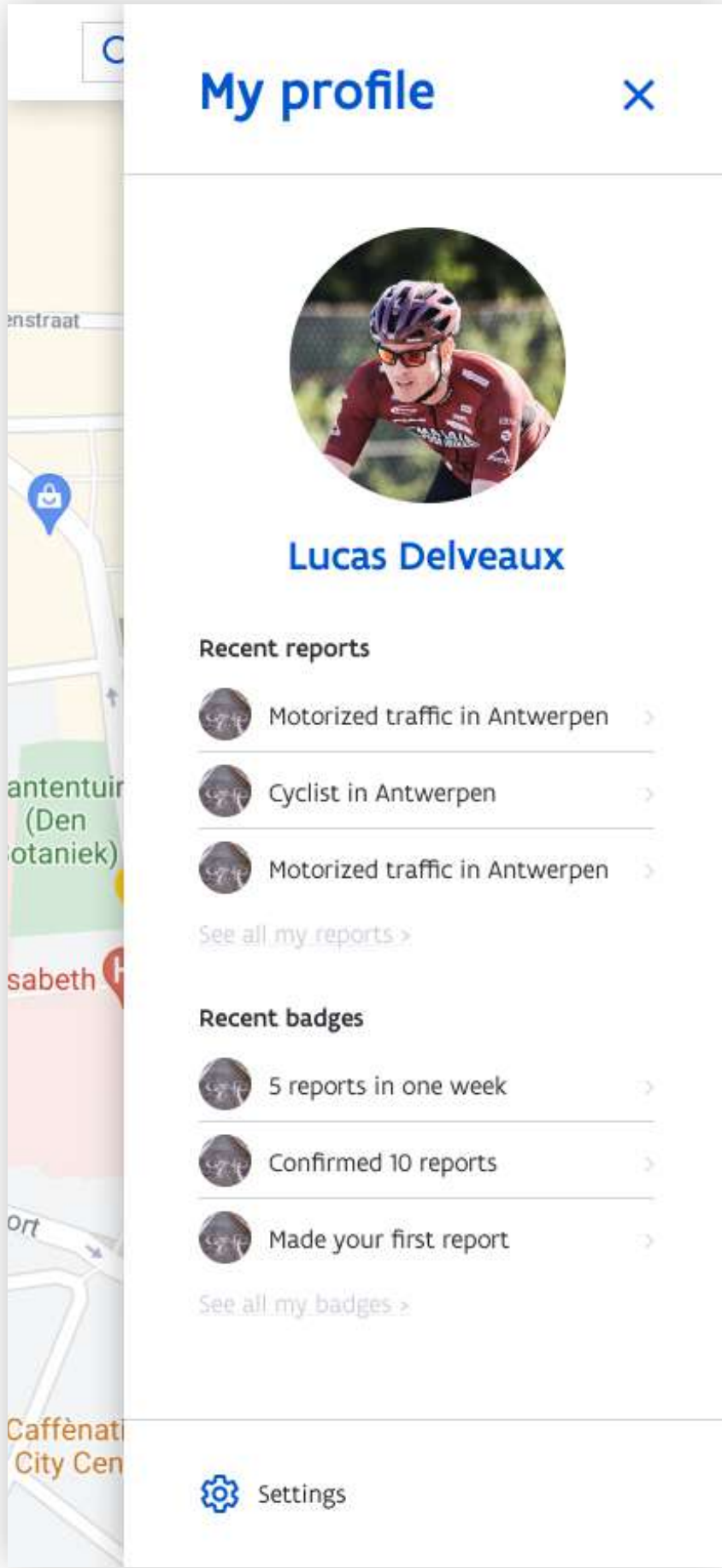
## Sketches, wireframes and mockups

Because OSOC 2021 was a remote edition, our team used Figma to collaborate on wireframes and mockups for both the **technical** and **strategic** aspect of this project. Here you can see some of the mockups:

# Technical mockups
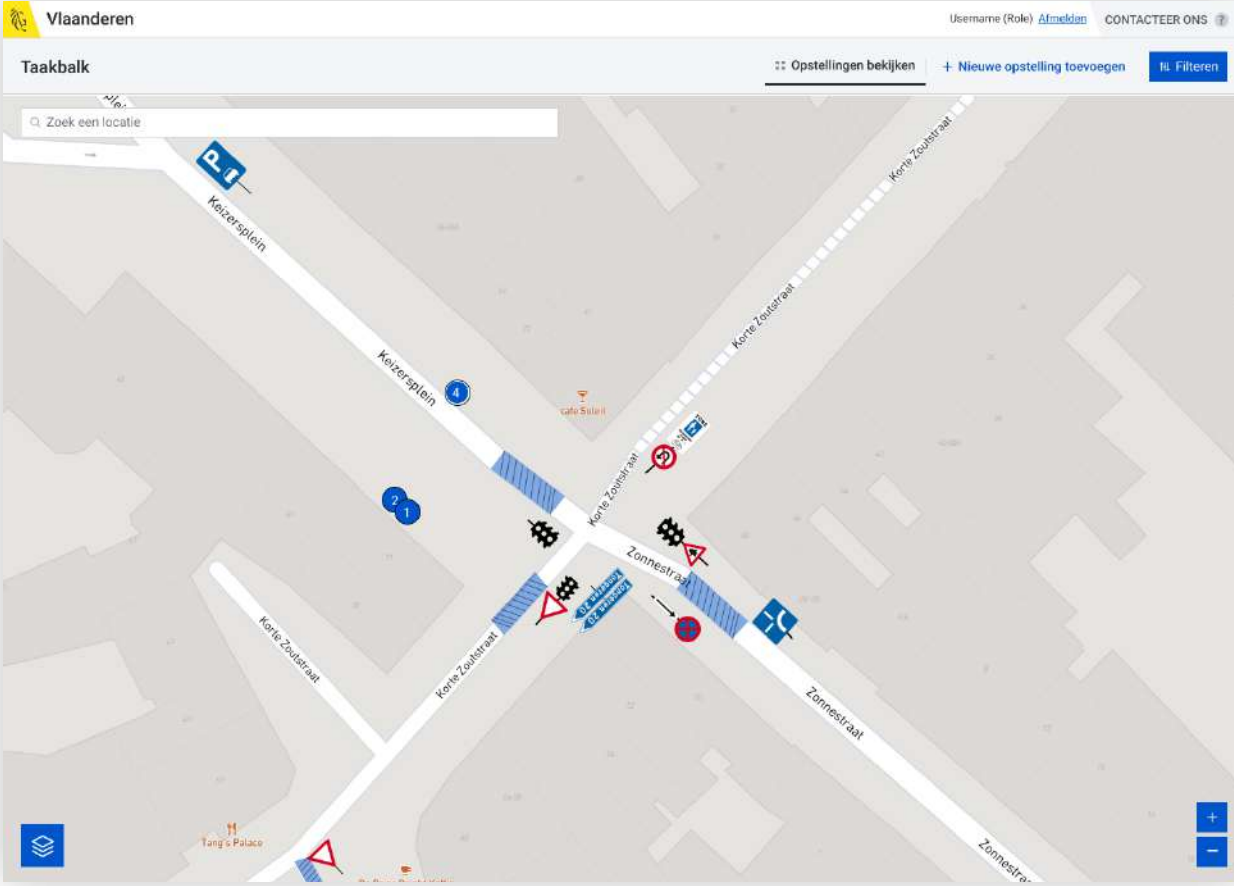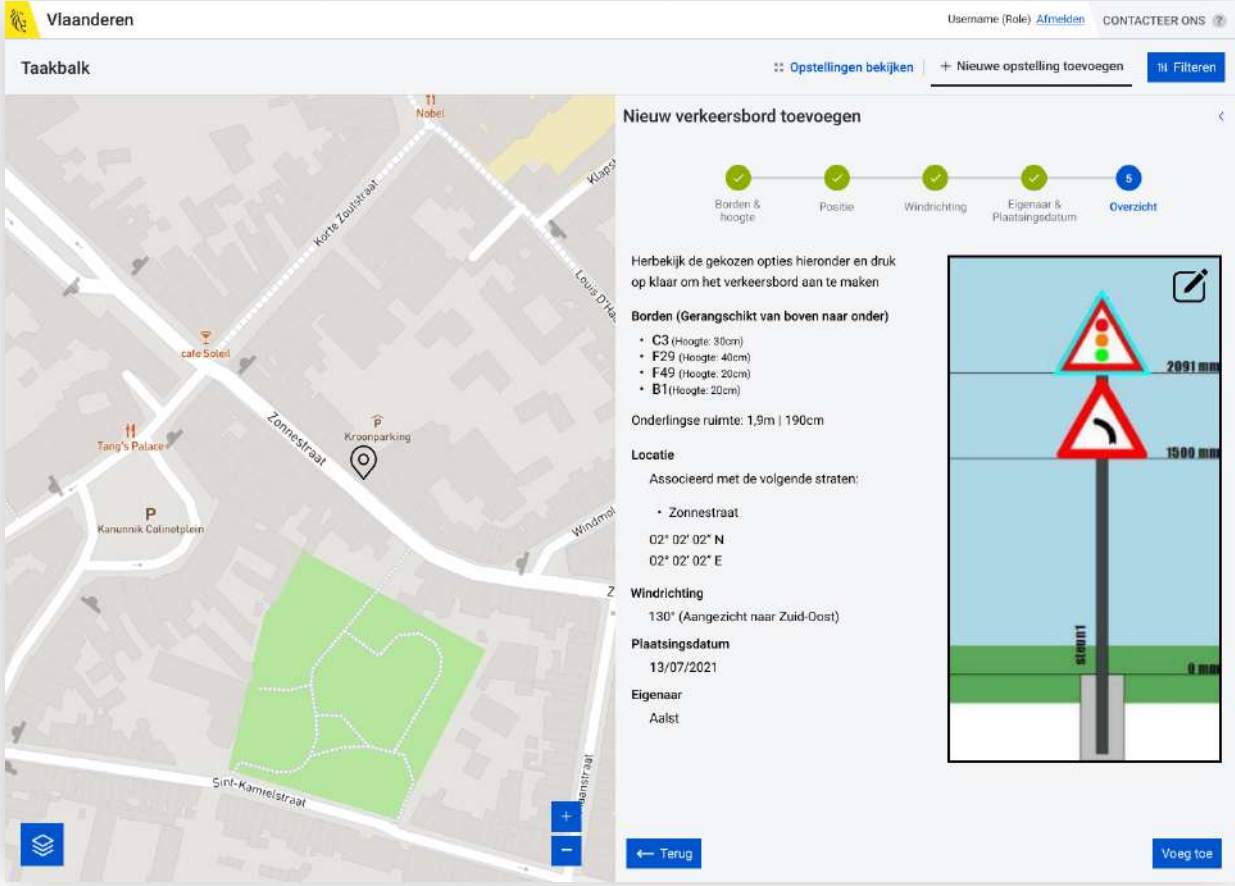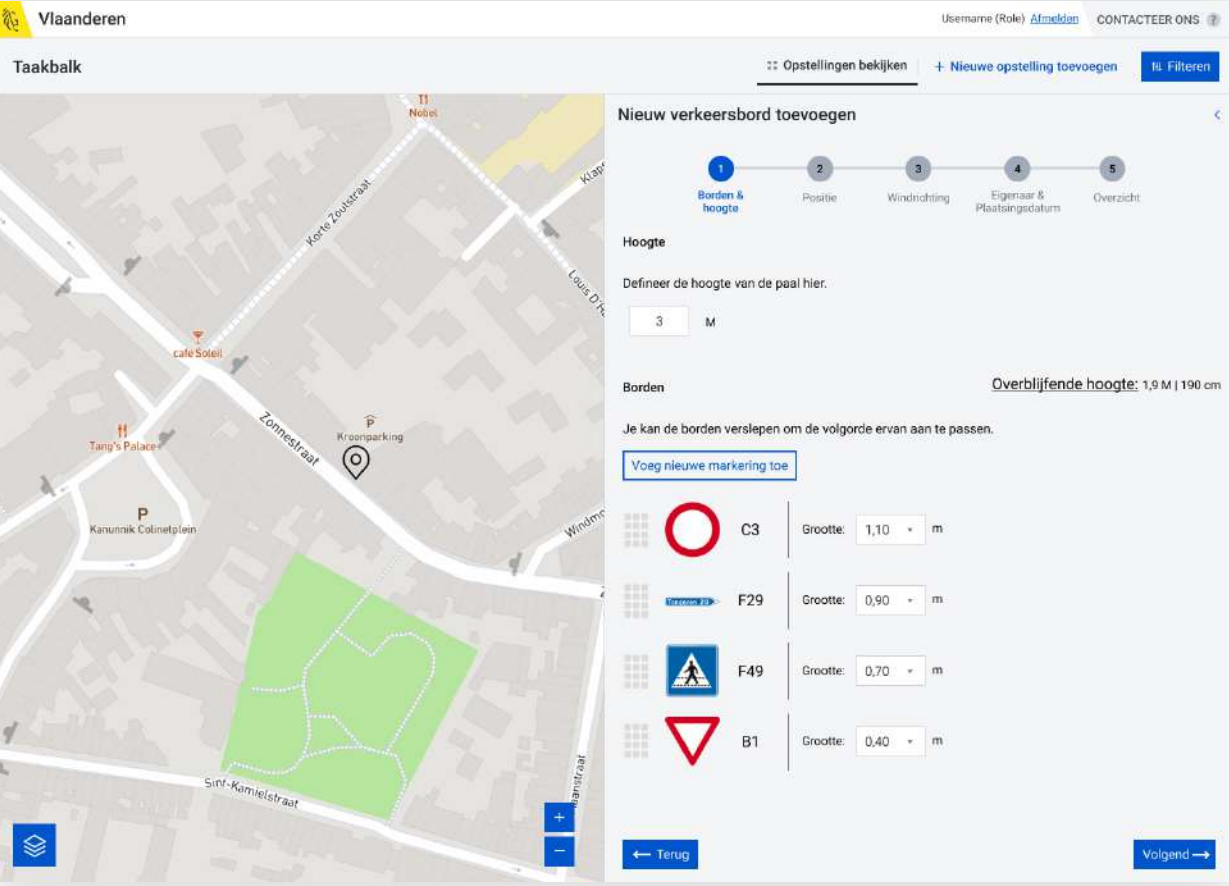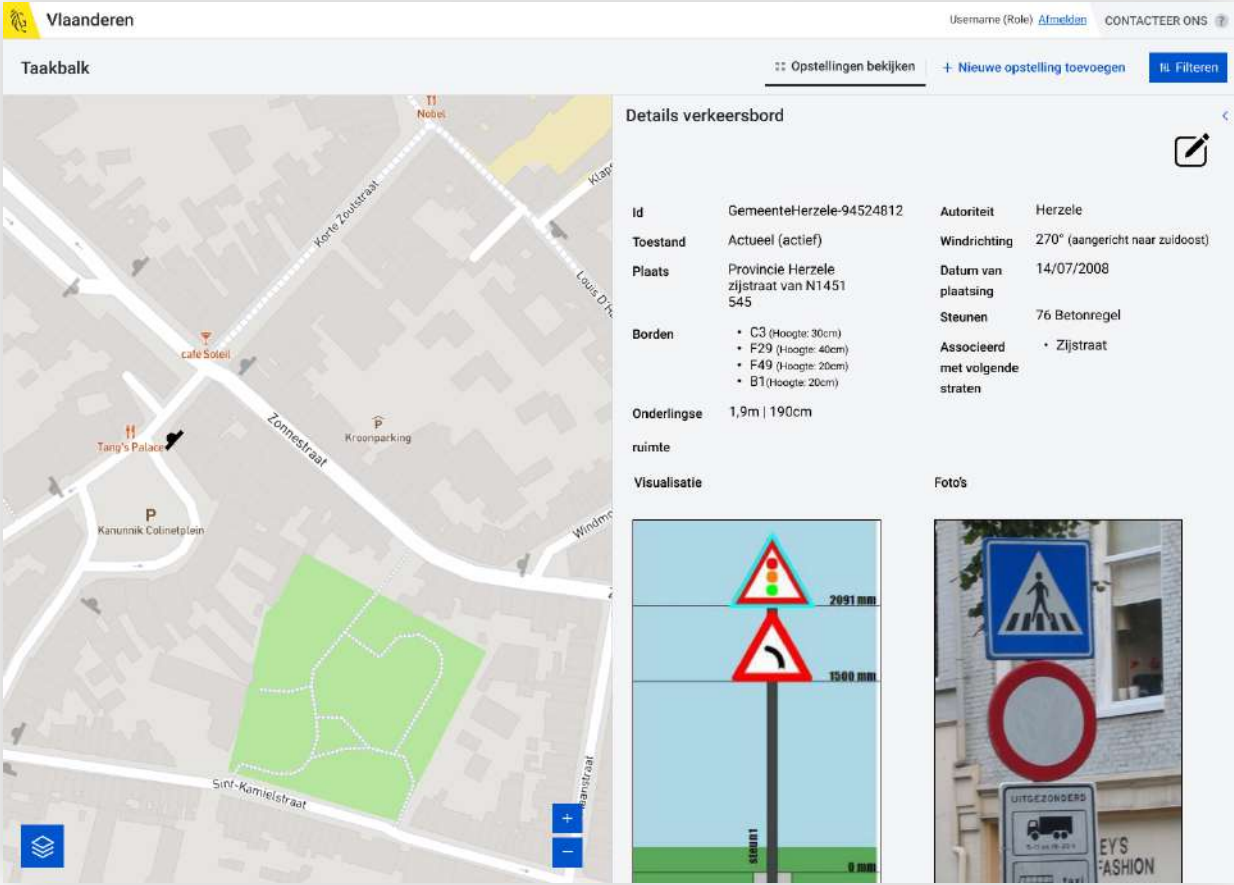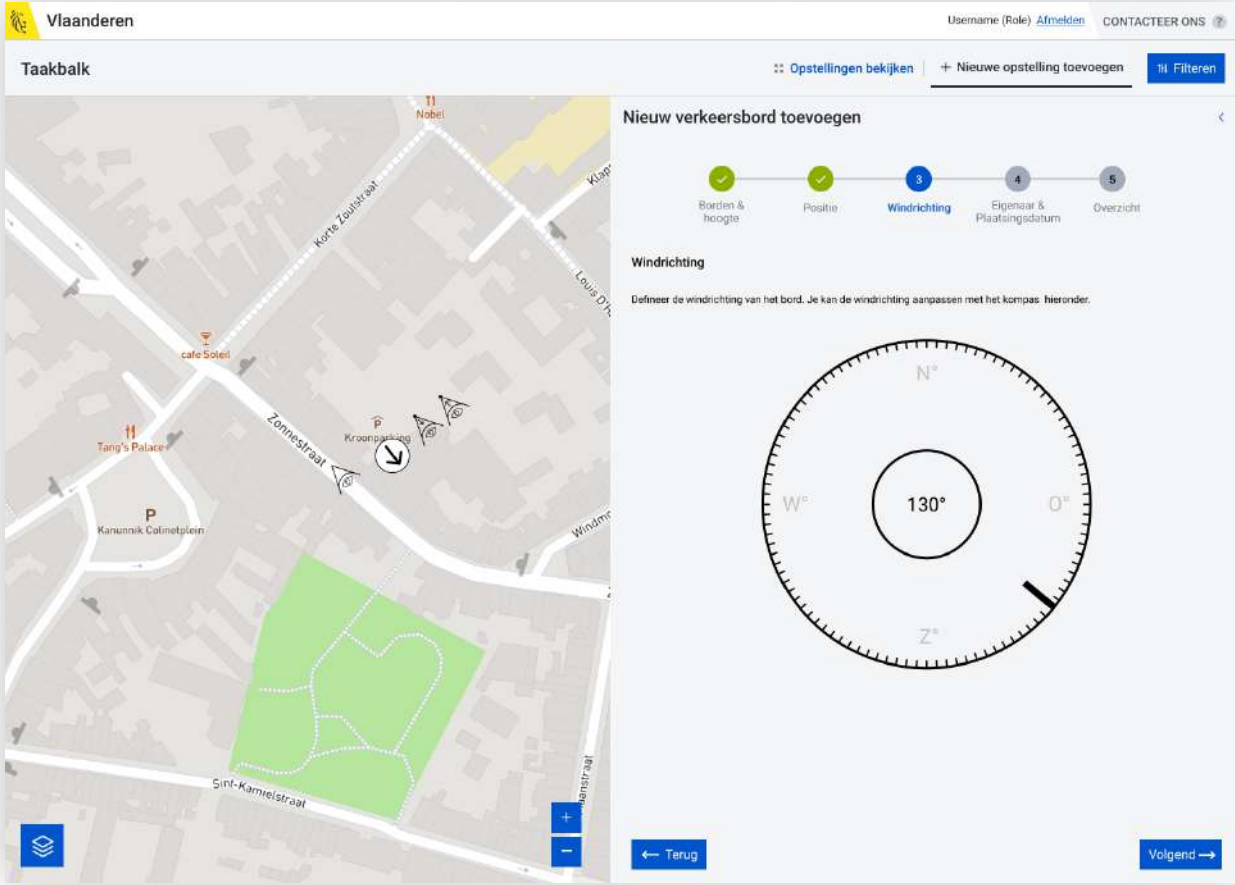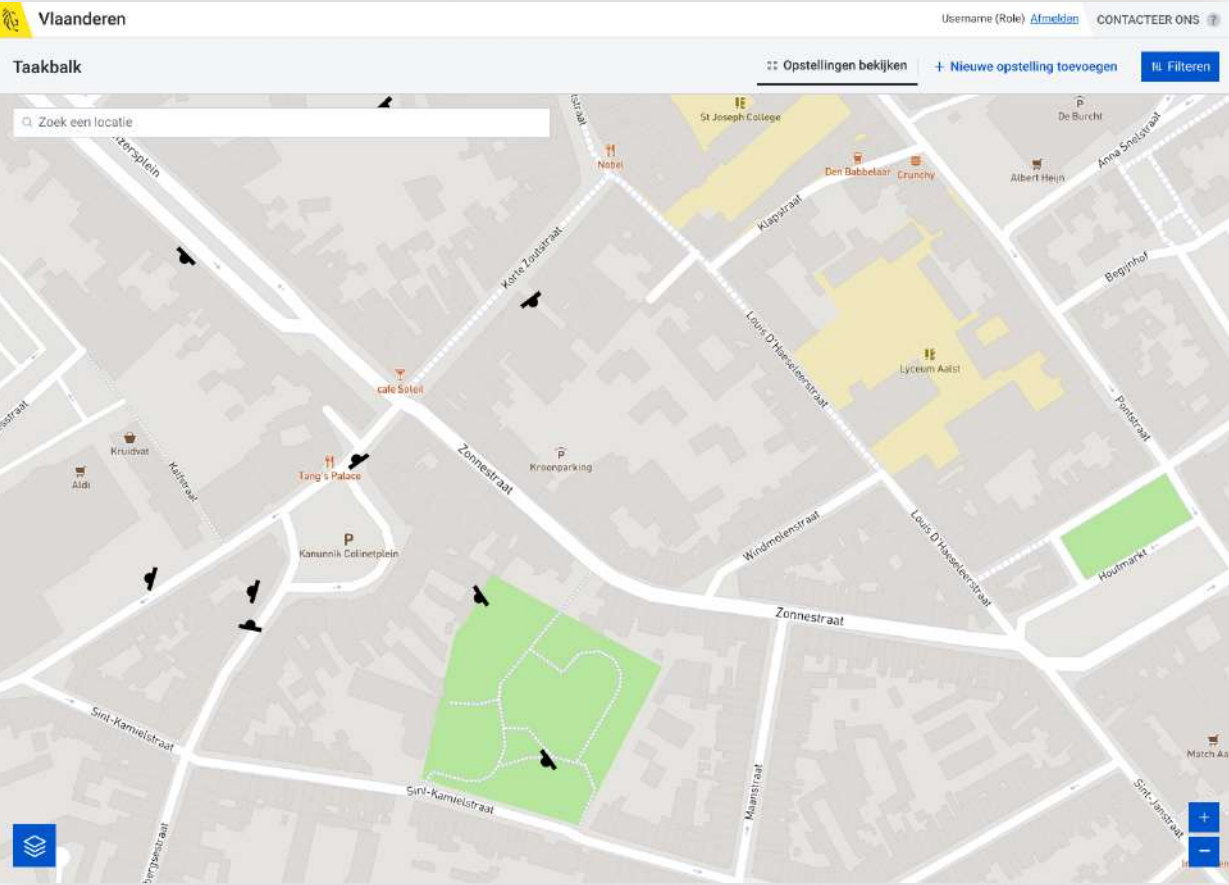
## Strategical mockups

# Technical

## Technical sheet

### Front-end

| | |
|---|---|
| **Routing Framework** | Ember.Js |
| **Template Engine** | Handlebars |
| **Style engine** | SCSS |
| **Components library** | Appuniversum (An ember derivative from WebUniversum) |

### Back-end

| | |
|---|---|
| **Framework** | Sem.tech Stack |
| **Database Request Handler** | Dispatcher |
| **Database engine** | Virtuoso |
| **Ember Request Handler** | Caddy |

### Deployment

| | |
|---|---|
| **Deployment strategy** | Microservices |
| **Platform** | Docker |

## Project structure

The directory structure of this project is twofold: a front-end directory, called front-end and a server directory, that contains all data that is needed to construct the databases.

### Front-end

Front-end is the directory that houses the Ember application, and thus the part of the application that the user will interact with.

Within this directory, the main app directory houses the actual codebase, where 10 types of files can be found:

- Routes define which address should return which pages. Because our application consists of a single page, our router has only one route, mainly index.
- Templates are the base webpages that can be used in the application. They act as a basis where components can be placed upon in order to make a complete web page. Because our app is a single page application, this only houses 1 page, namely the index.
- Components, as mentioned above, are the individual pieces that are used to add elements to a base template. This is done in order to evade repetition within a project and reduce code duplication and complexity.
- Modifiers modify text that is defined within templates or components.
- Styles are very self explanatory: they define the styling of the application. Ember has plugins that allow us to write more advanced forms of styling (Like SCSS) and automatically converts this to styling that is readable by the browser.

- Adapters decide how the application interacts with data from different sources. This directory houses configuration options, like the address from where the data comes from, the HTTP headers that should be used, ...
- Serializers are files that aid the conversion of data with an outside origin. This is needed, because Ember Data, the service that handles the conversion, has specific requirements and behavioral traits that define how the data needs to come to.
- Models are blueprints that allow us to define what incoming data will look like. This is important because, besides defining the property of the data, this allows us to also define the complex relationships between models, which reduces code duplication.
- Helpers are business logics that are used exclusively within 1 component or template. This way, the code itself remains clean and is more readable for new developers.
- Services are business logics that interact with multiple components or templates. As mentioned above, this is to improve the codebases' readability.

One of the initial challenges with Ember was figuring all of these components out. Unfortunately, Ember is not a well-known framework, which has an indirect impact on its documentation. This worsens when looking at its plugins. The Ember leaflet documentation, the main map plugin that we use, is based upon leaflet 1.0.2's documentation, which is no longer available. This results that a large part of the documentation redirects to dead pages, significantly impacting the developer experience.

## Back-end

Back-end consists of all components needed for Sem.Tech framework, which are:

- Dispatcher, which is responsible for dispatching requests to the correct microservice.
- Migrations, which are ran automatically if the stack is constructed. This will fill the database with data, such as different traffic signs.
- Resources, which define the structure of the data that is housed within the virtuoso. In misc, there is an additional data source for traffic accidents, which are loaded into the database.
- Virtuoso, which is the database engine used in order to house the data.

An additional service that we used is Caddy, a web server that simplified setting up a connection between Ember and the Sem.tech Stack.
Similar to Ember, Sem.Tech is not a very well known stack within the development industry. If a developper understands the technology, its benefits become apparent, but because of a lack of visibility, the missing documentation formed an initial hurdle that we needed to overcome before starting.

# Content of the technical deliverables

As defined in 'creating the project', the overall goal of the technical team was to improve the user experience of the application for the policy makers. We have decided to tackle the creation of a traffic sign, since this process was very complicated in the original design. We reduced it to a four-step process with a review step in order to reduce mistakes within the process.

## Rendering of traffic signs

One of the biggest challenges that we faced while we designed was how we can display signs and road markings upon a map, without disrupting the user experience because of too much clutter. To achieve this, we decided to only automatically display sign under certain conditions:

- A traffic sign must have three or less plates in total
- A traffic sign cannot be in close proximity to another traffic sign

When these conditions are met, a sign will be displayed when the zoom level has passed a certain threshold. For all other signs, the traffic sign is only shown when a user hovers over its icon.

## Rendering of road markings

We chose to only show road markings when a user hovers over the indicated area for it. In light of the user experience, this would be the most feasible way to show the road markings. In light of the technology aspect, leaflet has a certain max zoom level, which causes it to render road markings upon a live map clearly.

## Simplified Searching Mechanism

The original tool has 3 ways of searching for a certain location:

- Map-based search
- Google-based search
- Area code search

We have decided to simplify this search functionality by merging the first two kinds of search types together, because the technology offered today allows us to cover all functionalities with one product and this improves user experience.

We have also decided to remove percenteel search, because we doubt its usability when it comes to daily usage of the application. We have learned from talking with the stakeholders that these values do not have any structure within its naming scheme, so we concluded that its usage is quite limited and removed it.

# Future implementation

In order to improve this tool and give guidance to future developers of this project, we propose the following additional features:

## High Risk Zones

The heatmap overlay 'high risk zones' can be put upon the map to spot zones of high risk. This data can come from different sources, such as police records, accident reports, reviews, … With this data, policy makers can make informed decisions and prioritize which areas should get priority on policy reforms.

## Citizen Priority Selection

The application could also take in account the opinion of the citizen in a system where citizens could vote about which streets would take priority when it comes to policy changes. This increases citizen participation and provides a feedback loop where if the citizens see a change in their surroundings, the user may be re-engaged with the application, which restarts the cycle.

## Standardization

The original policy maker tool suffered from the fact that some values needed to be manually filled in, which reduces usability. A future addition to this project could consist of adding standardized norms when it comes to supplier information and sign dimensions. This would greatly improve the workflow for a policy maker, but standard values have not yet been defined.

## Road marking database

As of 27/07/2021, there is no database that contains the essential information surrounding road markings that would be needed in this project. We highly recommend creating a database that contains the most commonly used patterns when it comes to road markings and contains the individual elements that make up these road markings.

# Communication plan

We have developed an extensive communication plan based on thorough research. Given that a big part of the data input will come from crowdsourcing, the way you communicate with citizens is essential. You can find the extensive document following this **link**. Here, we will present some of the key takeaways:

- Goal: To increase the awareness, engagement and usage of the application for citizens, road managers and policy makers in Flanders.
- Methodologies: We propose two strategies, a generic approach for citizens and a personalized approach for road managers and policy makers.
- Channels: Facebook and personal emails are considered the two most effective marketing channels to reach the target groups, based on the insights from primary research (an online survey) and secondary research (online articles).
    - Facebook marketing strategy: Videos as the ideal content marketing format, as there is a rise in using online video marketing. We suggest combining this marketing with special events (e.g. the World Road Championships).
    - Personalized email marketing strategy: this strategy can be executed through a three-step approach: (1) Build an email list with lead magnets and opt-in forms (2) Choose the email campaign type (lead nurturing email and co-marketing email) and (3) Measure results with three principal metrics (delivery rates, open rates and click through rates)

It is important to highlight that this communication plan is highly futuristic and conceptual, as the tool itself is still in the development phase. Nevertheless, efforts and thorough considerations have been made with the aim of obtaining the most relevant and up-to-date insights which can yield long-term benefits.

# Feedback

## The future

This project's purpose was to show the potential benefits linked open data can bring to the Flemish government. With our Proof-Of-Concept, the wireframes and the persona / user stories, we have shown that implementing linked open data can have a real impact on improving road safety. Collecting and linking all road data can simplify both the notification and decision making process, while taking some pressure away from organisations like Meldpunt Wegen. Next to that, linked open data can become the connecting factor between citizens, the private sector, road managers and policy makers.

This project is showing the great potential of linked open data. Since we only worked on it for a month and ran into quite a few technical problems, we have some suggestions to implement for the future.

First off, we suggest conducting even more interviews with stakeholders. The interviews proved very useful in showing the pain points on road safety in Flanders right now. Since this project would be fueled by crowdsourcing, it is important to incorporate the voice of as many people as possible. By including stakeholders, you can also show them the potential benefits that linked open data can offer them. A list of suggestions on who to interview can be found in the 'interview insights' section.

Second, we suggest limiting down the number of organisations and notification points for road safety issues. Right now, citizens feel overwhelmed and the existing organisations are overworked.

This application has the potential to integrate all other tools, since you can layer the data however you want. By easing the notification making application and process, citizens will crowdsource more, making the policy makers' job more clear and efficient.

Finally, the possibility for future refinement of the policy maker tool should be considered. A redesigned and more automated tool allows for a more efficient workflow and less obstruction when it comes to improving road safety. A couple of examples that can be added are listed within the 'future implementation' part.

## User testing

For this project, we worked closely together with several experts, such as traffic engineers, Veronique Volders, employees from Meldpunt Wegen, cyclist organisations and policy makers. Their feedback and input can be seen as a form of user testing, as we always explained the concept and idea to them and presented them with the information we had at the time. Based on that, they provided us with feedback and guided us in the right direction for this project. Due to time constraints, we were not able to engage in user testing at the end of the project. However, we would strongly recommend doing this in the future, as citizen input plays an important part in the application.

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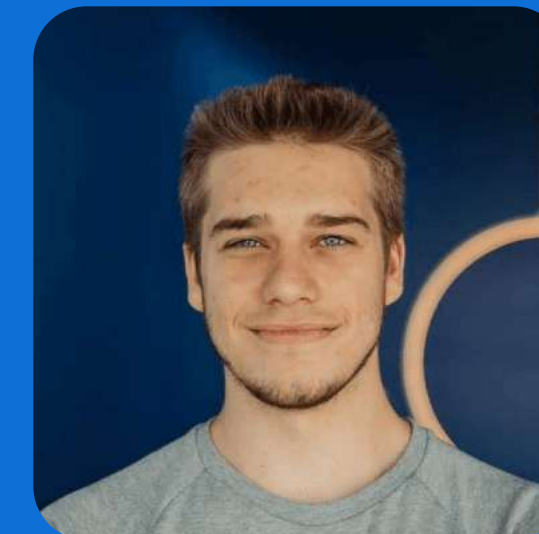
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