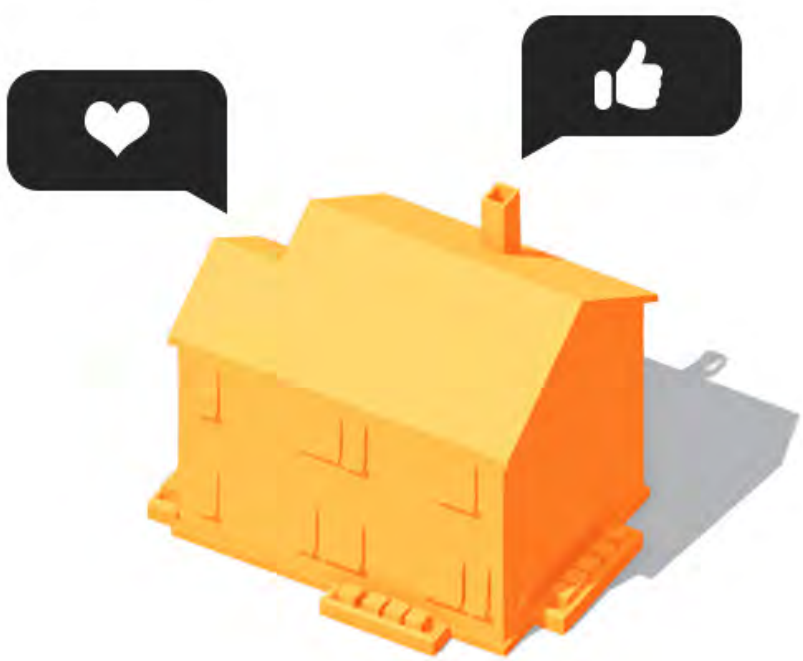

Designing for dialogue

The challenges of facilitating online civil dialogue for the urban planning process

Master's thesis in Computer science and engineering

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CHALMERS UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF GOTHENBURG
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Cover: 3D model of house with chat bubbles above it.

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Abstract

This thesis explores the challenges and possibilities encountered when designing software aimed for civil dialogue within urban development. The project was initiated by *ATGIS* to explore the possibilities of a public online module for their urban planning tool *InPlan*.

The process of designing and implementing the prototype was conducted through an iterative design process, containing one phase of research and data gathering followed by four stages of iterative design work and was concluded with an attempt to implement our user interface into the *InPlan* application. The completed prototype enables users to gather information about development projects and to contribute with comments.

During the project we have performed interviews with a total of four people from two different municipalities, held two workshops with a total of ten people at *Lerum, Sweden* municipality and performed two rounds of user testing for our final prototype. Takeaways from these encounters have been compiled into a list of essential guidelines to consider when designing for urban development.

Keywords: urban planning, civil dialogue, interaction design, graphical user interface design

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We want to thank our supervisor Beata Stahre Wästberg as well as Liane Thuvander and Monica Billger for the continuous help, guidance and enjoyable discussions throughout the project while also motivating us with positive and constructive feedback. We would also like to thank Mafalda Samuelsson Gamboa for helping us out early in the thesis work with our research question and for connecting us with contacts within the municipalities and referring us to Beata.

We would also like to give thanks to all those that took their time out of their day to participate in our workshops, interviews and user tests, especially the municipality of Lerum for providing a location and participants for the workshops. Thanks also to Peter Wallberg, CEO of Atvis AB and ATGIS, by connecting us with the municipality of Lerum and by supporting us throughout the process.

Finally, we would like to thank all our friends and family for their support and encouragement in our project.

Henrik Tran & Isak Persson, Gothenburg, May 2019

Contents

0.1 Dictionary

Geographic information system (GIS)	GIS is a system that is used to capture, examine, manage, and present spatial or geographic data
Computer-aided design (CAD)	CAD aids in the production, modification, analysis, or optimization of designs through the use of computers.
Design system	Design systems contain information surrounding the design of an interface. The information contained in a design system could, for example, be component libraries, documentation, design language, style guidelines.
Codebase	Codebase is a software development term and refers to a collection of human-written source codes.
Volume study	Volume study is a term used in urban planning and involves placing simple 3D volumes on a map to see how the urban project affects it's surroundings, for example, to see how shadows fall on the surrounding environment.

1

Introduction

In urban planning, a multitude of software and tools are used, and the path from having the urban planner performing planning and letting the citizens view the result is often time-consuming and work intensive. Atvis AB[1], a company based in Gothenburg, Sweden specializing in visualization software, is trying to solve this problem by developing an application called *InPlan*[2] meant for fast and easy urban planning, where the planners quickly can layout and create new development projects and easily share them with citizens of the municipality. In this project, we will design and implement a web module for InPlan, enabling citizens to access relevant information and dialogue tools, without having to learn actual urban planning tools. The project will be performed in cooperation with Atvis and with the help of Lerum municipality[3], helping us to organize workshops together with its employees.

An essential factor for this, in the age of communication, is tools to effortlessly publish development plans to the internet, where they can be easily accessed and evaluated by the citizens. Our project will explore what guidelines to consider when designing a public view of a project created by a urban planner, how to communicate the development process and ideas to the citizen as well as allowing them to respond with valuable feedback.

Since InPlan is aimed towards the Swedish market, we will design and follow specifications according to Swedish law in urban development detail planning[4].

1.1 Problem definition

The study aims to research methods and design principles to better utilize feedback from civil dialogue. A common problem with the feedback is the lack of dialogue, meaning that citizens can contribute with comments and votes but seldom get a comment back due to different reasons such as lack of time and resources. The research question can be summarized to the following:

What should be considered when designing a city building tool to generate dialogue between urban planners and citizens

1.2 Stakeholders

The two main stakeholders for the InPlan module are the Swedish municipalities and their citizens. The two stakeholders will have two different use cases, meaning that InPlan will have to accommodate both of them. The stakeholders for the Swedish municipalities will be those working with urban planning, which means that the they will consist of architects, engineers, and geographers. The municipal stakeholders that are involved with urban planning are likely to have previous experience with maps and navigating through a 3D space, for example, Google Maps. The municipality of Lerum is the customer of the dialogue tool and is involved throughout the process of this project.

The municipalities will need tools to publish and edit new or ongoing urban development projects. The complexity of the module will need to be at a low difficulty level so that anyone can get started right away without the need for training. Lastly, publishing to the InPlan servers should also be available.

The other main stakeholder is all the citizens in the municipality. The citizens will consist of those with widely ranging background, technological skills, and ages, meaning that the dialogue tool will need to be accessible to as many as possible. Most important is that the dialogue tool is available and easy to use. The tool distributed to municipalities will be different from those used by a citizen. The citizens will be limited in what they can do, but they will also have access to some other tools such as the possibility of commenting on projects.

1.3 Planned result

Our planned result is a working web module prototype for InPlan with the accompanied tools for publishing in the main InPlan application. The module should be accessible from a desktop browser and designed to be used intermittently by citizens, preferably with some feedback tools if suitable. We will limit the module to work only with web module due to time restrictions and also for better performance when

running the web module. We also plan to evaluate our design with the stakeholders to gather results in the form of takeaways and design guidelines.

1.3.1 Guidelines

Researching the domain is the first step in our process. We plan to perform this through analyzes of existing similar applications, interviews with stakeholders as well as design workshops involving municipality employees. The result of this will be gathered into a condensed list of guidelines to pursue when designing for citizen dialogue in urban planning. The guidelines will focus on usability for the stakeholders as well as to facilitate valuable dialogue, and in regards to this, we will not consider any of the economic, safety, or business aspects. Our guidelines will also not reflect on some aspects of our work such as our methodology and process.

1.3.2 Design

The second of our results is the design itself, presented as an annotated document with screenshots. This should follow the current design system of InPlan or add to the design system when necessary. The design should be semi-interactive (through Adobe XD's prototyping tool) to be properly evaluated and cover all necessary screens and prompts.

1.3.3 Online module

The third part of our result is the actual implementation. This expands on the current InPlan project to include our module, based on the design. Due to time limitations, the module may have limited functionality. Therefore, we aim for a non-finished product suitable for testing, which means that it probably will not be released without further development. Our goal for the module is to implement the core features to enable further testing and evaluation.

2

Background

This chapter will explore the different types of visualizations, how urban development works in Sweden and lastly examples of existing tools.

Civil dialogue is an essential aspect of the success of an urban planning project. These projects will eventually become a part of the citizens' everyday life. Visualizations and interactive tools can be used to help citizens to understand the urban planning projects further. The communication with citizens in urban planning was traditionally facilitated in public meetings using two-dimensional perspective drawings, similar to figure 2.2. Emerging technologies of 3D visualizations can further ease citizens into more involvement in the process with the help of intuitive interactions with digital 3D environments.[5]

2.1 Planning process for urban development in Sweden

The detailed planning process is the process for determining what should be developed in a particular area or plot of land. The resulting detailed plan displays streets, parks, and areas where buildings are allowed to be built. These areas specify what kind of buildings are allowed, for example, apartment or office buildings.

The process may be started by the municipality itself or with a request by a property owner or developer to the municipality. Developers often cooperate with the municipality to provide ideas and requirements. The environmental impact of the proposed development also needs to be considered.[4]

The process also needs to take into account the stakeholders, mainly the citizens affected by the development. The process usually starts with an announcement to inform there is a plan proposal and necessary documents available. The municipality has to provide a period where stakeholders can submit comments and make adjustments based on them. After the comments have been reviewed and adjustments been made, only minor modifications are allowed, or the process has to be restarted.[4]

Before approving the plan, an agreement between the municipality and the developer is signed. The municipality approve the plan, when all financial and practical matters are concluded. Affected stakeholders that have not had their remarks addressed have a right to appeal the plan within three weeks from when the plan was passed.[4]

2.2 InPlan

InPlan[2] is an application aiming to visualize urban development projects in a fast and simple process. InPlan aims to provide the tools to create visualizations for use in presentations and discussions both for internal use and for civil dialogue with the citizens of the municipality. InPlan is currently used by about ten different municipalities located throughout Sweden. Features include a range of different 3D-modification tools like terrain modification and drawing tools, the creation of simple structures and importations of more elaborate models to be placed together with the already existing buildings of the municipality. The existing terrain, buildings, and vegetation is imported for each municipality and can be further modified within each project.

Figure 2.1: InPlan in use. Screenshot taken by the authors.

InPlan started development in 2014 by ATGIS[6] and have over the years expanded to provide more features to a larger group of customers. ATGIS is a part of Atvis AB[1] and focuses on software involving urban planning, visualization, and civil dialogue. Atvis AB is a company based in Gothenburg with a focus on software development. The company helps customers with the development of custom made software using a wide range of technologies from front-/back-end development to VR-sales tool.

2.3 Visualization solutions for civil dialogue

Visualization of urban development can be done in a multitude of different ways, each with its own set of drawbacks and advantages. Often, the result of the visualization is represented in a two-dimensional format suitable for printing. Figure 2.2 below shows an example of how visualization could look like when digital images did not exist.

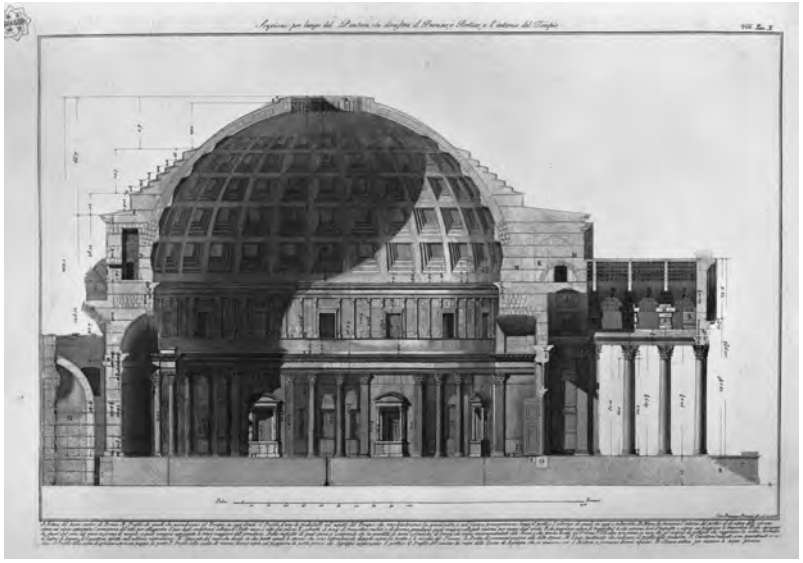

Figure 2.2: Hand drawn section of Pantheon by Piranesi from year 1790[7].

The conventional method to present visualization has, up until recently, been paper. As R.M Levy puts it in his article from 1994, produced at the dawn of computer visualization:

> *Historically, planners have relied on architects' plans and elevations for presenting urban design concepts. The use of orthogonal projections, perspectives, and photographic collages are, however, generally reserved for projects with sufficient financial resources. Even more rarely, scale models are built for display or as public relations vehicles.* [8, p.344]

Visualizations techniques has been used in various forms which traditionally meant using models, drawings and paintings. The techniques in 1990s started to progress in the field of digital visualization with improved CAD, GIS and other landscape visualizations. The modern approach now is to generate 3D outputs, for example, in the forms of rendered still images (explained more in section 2.3.2).[9]

2.3.1 Physical models

Physical models are representations of an idea on a smaller scale and have several purposes. The models purposefully suppress irrelevant details while also aiming for accuracy to distinguish the points of interest. Bente, Bombosch, and Langade[10] list a few examples of purposes for enterprise architectural models:

Design and planning Identify the gaps between *as is* and *to be* and the corresponding needs for action.

Analysis and assessment Allows assessing issues such as strategic fit, compliance with laws and regulations, or risk.

Implementation and operation The model is a framework of orientation for detailed design. The model is a knowledge base for operating and maintaining information systems.

Communication and enforcement The model is a foundation for explaining and motivating changes and assures that the intended architecture is implemented in an intended way.[10]

Älvrummet[11] has an example of a physical model located in the city of Gothenburg, Sweden. Älvrummet is a large open indoor area that bestows a giant model of the whole central part of the city, see figure 2.3. The model contains all currently completed buildings, built in wood, as well as all planned buildings for the coming 50 years, built in white styrofoam. Älvrummet is populated by staff during the day, who answer questions from visitors and holds lectures about the future of the city. It also works as an arena for urban development and regularly accommodates debates, workshops, and discussions. The physical model in Älvrummet can be used by visitors as a basis of discussion to be part of suggestions and ideas about the city. The model can also be used as a tool for urban planners by placing buildings in different contexts.[11]

Figure 2.3: Photograph of Älvrummet. Photograph taken by the authors.

2.3.2 Digital images

Rendering is the process of using computation processes to transfer a set of data (usually 3D-models) into pixels, enabling the data to be represented on a screen or paper. In other words, rendering generates digital images. In urban development, this is used to translate the construction models (usually in a CAD-like format) into images for evaluation. Depending on the purpose of the images, different styles and effects can be used for the renderings. For example, an inspector of the municipality may want to have images where only the edges of buildings are rendered together with their measurements, while images for public viewing may be rendered in a realistic style with added effects like weather and humans, see figure 2.4.

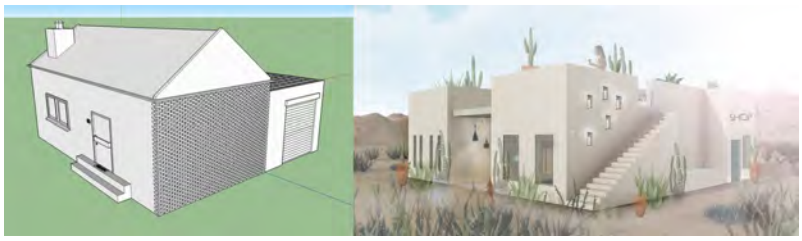

Figure 2.4: To the left, image of rendering style where edges are displayed[12]. To the right, photorealistic rendering style[13]. Images licensed under the Creative Commons.

Rendered images and video, though extremely usable, comes with a problem. The problem is that since the images are trying to represent a three dimensional model on a two-dimensional medium, the architectural relationships can be distorted or

hidden leading to misunderstanding by the observer [8, pp.343–344][14, p.231].

2.3.3 Digital 3D-environments

The common approach to visualizations in modern use is through 3D outputs as explained in section 2.3. 3D models allows for exact representation that can be used for both the construction process and for promotional use. These models are most often, as previously mentioned, rendered into a two-dimensional format. Another way to represent the models is to put them into 3D-environments, sometimes with the rest of the city or production site also represented around them. Use cases for these environments differ, they may be available as applications on public touch screen displays for viewing, sometimes exported into more lightweight application formats, as *WebGL*[15], and exported onto the web.

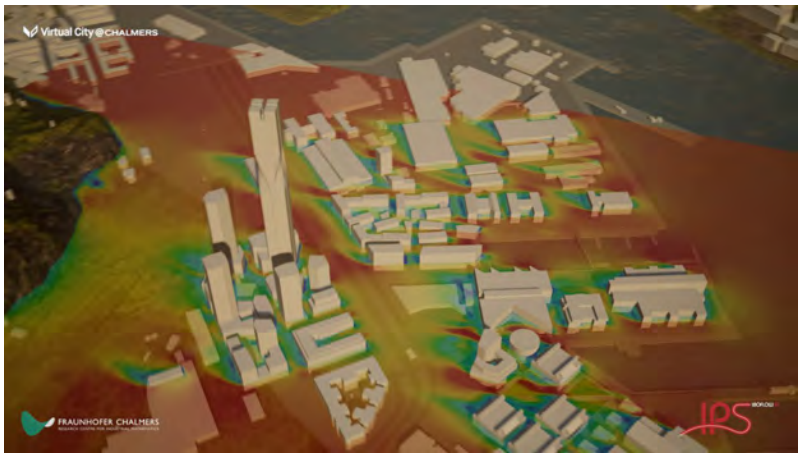

Figure 2.5: Example of a 3D Environment. Image retrieved from Fraunhofer-Chalmers Centre, 2018[16]

Use of modern technology, like virtual reality experiences, is also becoming increasingly more popular[17, pp.725–726]. Virtual reality allows users to experience the environment in true to life scale, making for a more immersive experience prone to fewer misunderstandings.

Figure 2.6: 3D environment through a virtual reality experience. Photograph by Atvis AB[18].

2.4 Examples of existing tools

This section briefly describes some related work and solutions to how they solved or assisted in civil dialogue concerning urban planning.

2.4.1 CityPlanner

CityPlanner[19] is a tool using 3D visualization for urban planning developed by Agency9. It is a web-based tool where users can upload various types of files to a 3D world. The benefits of CityPlanner is the wide range of supported files ranging from 3D-model files and geographical content data to images and video files. These files, however, cannot all be imported directly into the 3D world. Videos, texts, and other documents must be embedded into points of interest. The points of interest are icons placed in the 3D world by the users. CityPlanner also features various tools that the users can utilize directly in the browser to sketch and customize in 3D. Another useful feature is the possibility to collaborate within teams or other external stakeholders where the editors can invite other users to view or edit.

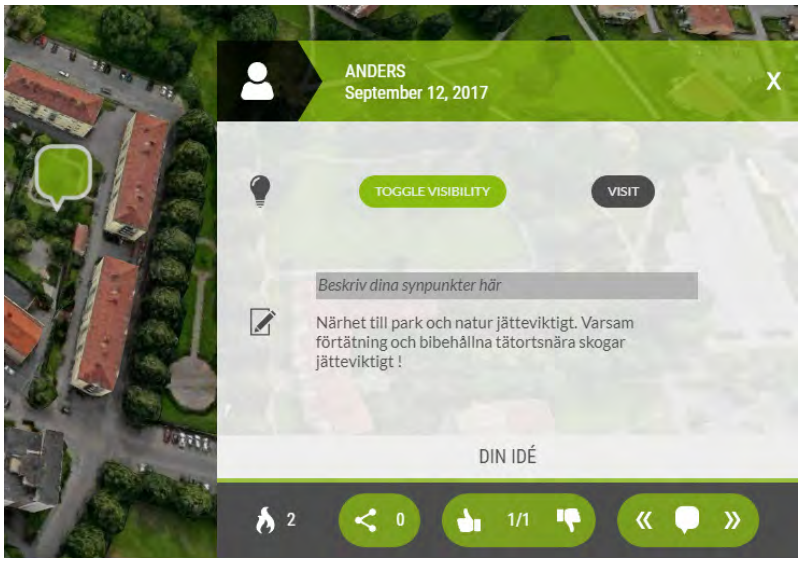

Figure 2.7: Screenshot of CityPlanner's civil dialogue. Screenshot taken by the authors.

One of the main foci of CityPlanner is the Dialogue Project[20], where citizens can add their opinions and ideas that they have for the cities to the 3D world. Other citizens can then give a thumbs-up or share the inputs placed on the world. Users are given a set of tools to place their opinions. They can choose a category, for example, hazardous locations, service, or activities. These ideas or opinions can then be placed in a user-defined area, line, or spot along with a written input.

The tool for placing comments is highly visible for the user and contains few features, but that, in turn, makes it quick and easy to place comments. The only requirement for placing a comment is a name without any restrictions to what can be written.

Although the dialogue project is marketed as a dialogue tool, there is no option to start or keep a dialogue either between citizens or citizen and any of the stakeholders involved in urban projects. The only way to respond to an opinion placed on the map is, as mentioned before, by sharing it via any social media or giving thumbs up/down. An exception to this is *Min Stad*.

Min Stad - Göteborg
Min Stad[21] is a tool using 3D visualization based on CityPlanner specifically for civil dialogue by the city of Gothenburg, see figure 2.8. Min Stad is available on both the web and as an application for mobile phones.

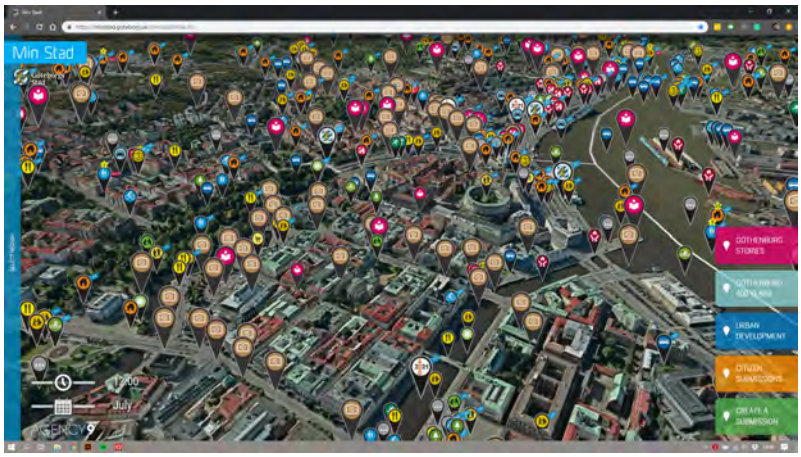

Figure 2.8: Screenshot of Min Stad. Screenshot taken by the authors.

There are more features available to the citizen than the other dialogue projects showcased on the City Planner website. The main features of Min Stad are:

- **Gothenburg Stories.** Citizens can submit any stories they have experienced in Gothenburg. The stories are then published and can be viewed in the tool.
- **Gothenburg 400 years.** Gothenburg will turn 400 years old in the year 2021, and citizens can view different jubilee projects.
- **Urban Development.** Urban development contains other projects that are ongoing or planned in Gothenburg
- **Citizen submission.** Features a list of citizen suggestions where users can sort by date or popular comments
- **Create a submission.** Users can submit either a suggestion or a story

The difference between this solution and the other dialogue projects is the option to comment on other submissions. Min Stad is also on a larger scale which encompasses the whole city, which itself contains many projects. There is no way to comment on projects published by the city of Gothenburg, which hints that the dialogue is only kept between citizens and strictly outside of the official projects.

2.4.2 4Dialog

4Dialog[22] is a company that offers a service to assist in civil dialogue by providing cloud-based virtual models to help customers visualize urban planning. The models are marketed as 4D-models and contain 3D-models with a time integrated into the model. The models can be presented at different times of the day, showcasing how the sun falls onto the building or how increased traffic affects the street environment.

The customers can order a visualization of an urban planning project along with presentation features such as virtual reality (VR), 360 films, 360 images, videos, and images, see figure 2.9.

4Dialog is in itself, not a solution to civil dialogue but is instead a technology to assist in civil dialogue that focuses on presentations. Their approach to showcasing urban planning is to integrate modern technology for an immersive feeling in order to facilitate understanding and communication around these development projects.

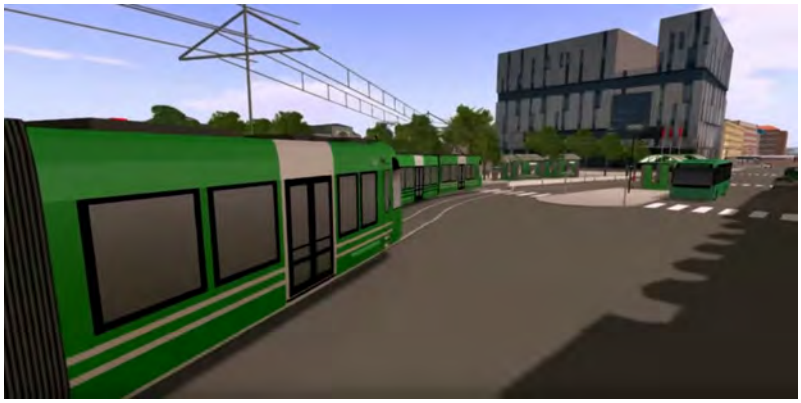

Figure 2.9: Screenshot of a presentation of Uppsala Light Rail by 4Dialog. Screenshot taken by authors from a 4Dialog presentation[23]

2.4.3 wec360° - Civil dialogue through modern technology

wec360°[24] is a company that provides intuitive tools to construction companies in the form of different 3D visualizations for marketing. Their provided technologies are rendered still images, 3d floor plans, and a full package with a variety of functions such as augmented reality (AR), VR, sun studies, film sequences, and many more. wec360° has worked with the city of Karlstad for civil dialogue and provided them with many types of technologies for the city such as interactive 360 images, VR and AR. wec360° try to make the solutions available on all devices by developing their products for web browsers and applications on phones.

This example of civil dialogue solution is similar to 4dialogue, in that it is more of a presentation tool. The products act more like a basis of discussions and to inform rather than providing a place for citizen and municipalities to communicate.

2.4.4 Urban Explorer Table

Urban Explorer Table[25] is an interactive table in the Urban Planning office in the city of Norrköping. Users can interact with the table to explore various urban development projects. The table utilizes an interactable multi-touch surface, enabling

collaboration between citizens and urban planners. The table features exploration in a digital 3D Norrköping where users can view buildings and apartments in some cases.

This solution focuses more on the collaboration in person rather than an over-the-internet solution where the main functionality is the touch screen. The limitations of this tool are limited accessibility by relying on a touch screen but can, on the other hand, strengthen the tangible interaction experience, meaning a more positive and meaningful experience for the users.

2.4.5 Google Maps

Google Maps[26] is an application used for browsing real world maps and comes with a wide range of features like markers, measurements, and navigational functionality. Many of the features revolve around navigation and exploring locations but there are also social features in app such as the custom maps that users can create to share their favorite spots. Users can also review restaurants, establishments, attractions and many other types of places in the world.

Figure 2.10: Google maps in street view mode. Screenshot taken by authors

Google Maps is not focused on the dialogue aspect or urban planning. Users can submit comments and reviews about locations but can not reply to any of the other users. The application is different from InPlan in terms of use case but share, at the same time, similarities. They both share features such as the navigation through a map environment and the ability to browse location-based information (example in figure 2.11). Google Maps support both a 2D and 3D view, where the latter shares much visual similarity to InPlan's orthophoto-mode.

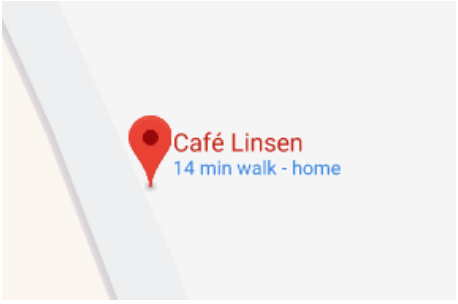

Figure 2.11: Example of location-based information. Users can press on this cafe marker to view information about it. Screenshot taken by authors

3

Theoretical research and related work

This chapter describes and identifies takeaways in different theoretical researches and related work surrounding civil dialogue and urban planning that can be used in this project.

3.1 What Role Does Visualization Play in Communication with Citizens?

The field study by Warren-Kretzschmar and Tiedke[27] investigates the role of visualization in communication with citizens. They investigate answering these three questions:

- Which characteristics of the visualizations are crucial for the support of citizen participation in the planning process?
- Which of the visualization methods are best suited for the different landscape planning tasks?
- How can visualization be successfully employed in citizen participation activities, both online and offline, and which organizational aspects are important? [27, p.2]

The field study involved presenting four different visualization methods to farmers, citizens, and other interested groups about soil conservation and nature protection goals. The visualizations were also available on the internet. The four visualization methods were sketches, digital photomontage, 3D renderings, and an interactive 3D-map editor. The visualizations were presented in small group discussions at four different stations. The results were formed based on questionnaires, reports, and observation protocols, all of which were collected during the meeting with the participants.[27, pp.6–7] The field study resulted in four conclusions:[27, p.10]

- Participants were excited by the visualizations but were often disappointed that the technology did not support the option to visualize their suggestions. Integrating the function to support editing or creation of new proposals could enable the participants to visualize their ideas for a more fruitful discussion.

- Citizens would have liked to see the development or process over time, which would offer a better understanding of the landscape processes.

- The planners responsible for creating the visualization would have liked to have a more flexible visualization technology to develop the specifics of planning measures "on the fly" instead of collecting them in advance. They also wanted the visualizations to support transparent or incremental landscape processes, such as soil erosion.

- Unclear how well the visualizations on the internet were received. This platform for the visualizations deserves further investigation.

Visualization has improved a lot since this field study was conducted in 2004 but still present some useful takeaways that can be used in this project. The visualizations shown in the field study show positive feedback from the participants but were at the time limited by the technology. Although the online version wasn't investigated thoroughly, it still shows promise based on the positive feedback from the physical meetings.

3.2 Public participation, GIS, and cyberdemocracy

The study *Public participation, GIS, and cyberdemocracy: evaluating on-line spatial decision support systems* by Carver et al.[28] explores the early endeavors of web-based public participation for local and regional developments. They explore ways of utilizing GIS to put power into the hands of the people. GIS was at the time already widely used throughout environmental planning, but accused of being an elitist technology unavailable to the general public.

The paper includes two case studies, one local and one regional, featuring the village of Slaithwaite and the Yorkshire Dales National Park respectively. A web-based interface is creating, displaying a map together with a smaller information-packed window. The two cases differ slightly. The local version features functionality where users can add comments to specific locations of the map, making them visible to all other users. The regional version instead allows the users to form the ecological landscape of the national park with the use of different properties and values, affecting the map in real time.

At the end of the study, a user study was performed. The study found the web-based

system to be both useful and accessible. However, the study also highlighted the low internet accessibility of the time and that there existed a considerable skew of who was prepared to use the system. When observing the users during tested, they noted some interesting patterns, listed below[28, pp.915-916]:

- When not able to find their desired locations, users quickly found a recognizable building or a central road to follow along until they reached their location.
- More users encountered problems in using the actual computer than navigating the web-based map.
- When technical problems were encountered, younger members of the community with more technical proficiency would often step in to assist.

The authors conclude the paper by highlighting the issues encountered during the study but encourages the use of participatory online systems for particular planning problems. Some of these issues can be disregarded when considered by us, simply because of the much higher technical capacity held by a large part of the population as well as the fact that most of the citizens today have access to the internet. Even when adjusting for the time difference, the study brings up some observations still relevant for our project, like how their users navigated through the map.

3.3 Visualisation Methods as a Bridge between Science and Democracy

The study by Golobič[29] explains the bridge between science and democracy in spatial planning and how visualizations should be used to shorten the gap. Golobič explains that scientists are reluctant to submit scientific conclusions for critique from the public, creating a source of misunderstanding and conflict. These conflicts are not due to lack of knowledge or misunderstanding of fact but rather due to a difference in underlying value.[29, p.1]

She explains further on that evaluation and forecasting requires cooperation between the public and experts with joint use of research and democratic methods. In other words, to lessen the gap between science and democracy, the people and experts have to cooperate in both research and democratic practices actively. This is achieved by allowing them to participate in decisions and giving them access to information they can understand.[29, p.11] Golobič then lists objectives that the visualizations should achieve[29, p.12]:

- Provide people with information about the decision problem which they can understand and process.
- Improve the transparency of the decision-making process.

- Establish communication between the public and decision makers.
- Obtaining and incorporating people's opinions and values in the decision-making process.
- Help to design new solutions and provide arguments for the decision.

This study shows how to integrate democracy into the planning process with experts, which is relevant to this study. The research shows a need for improvement of communication and the approach to make it successful. In our case, it is the communication between the municipalities and their citizens.

3.4 Study on identifying the challenges when visualizing urban planning

The study by Billger M, Thuvander L, and Wästberg BS aim to identify the challenges when visualizing urban planning[30]. The study found 114 articles related to the development and implementation of visualization tools for dialogue by utilizing snowball sampling. Guiding questions were asked to define the visualization challenges:

- What kind of digital visualization tools for dialogue in urban planning processes can be found in the research literature?
- Who develops for whom?
- How is usability evaluated in tool development processes?
- Which problems are stated concerning data handling and representation?
- Which problems with development and implementation of digital visualization tools are pointed out in the articles?

A wide range of tools for digital visualization was found, all based on either 2D maps, 3D environments, or gaming. The developers were found in different types of disciplines from urban planning, interaction design, virtual reality, 3D modeling, computer science, and geographic information science. The study found that usability evaluation has increased during the recent year and that there has been a tendency for the usability studies to go from experimental and prototype phases to an increased interest in real use in planning processes and implementation.[30]

The study contains information and results, all of which are relevant to the challenges of this study. The findings of the study have the potential to assist in many stages in designing the module for InPlan with the problems already well defined as well

as containing useful reference material.

3.5 Urban Sketching

The paper by Öhrn[31] describes the frustrations that urban planners have regarding sketching and lists 17 guidelines on how to design for a sketching tool, specifically for the earlier phases of urban planning. The guidelines were constructed by researching literature, conducting interviews, creating prototypes, and evaluating the said prototypes. The research question presented by Öhrn is following:

> *What should be considered when designing a sketching user interface for city planning?* [31, p.3]

Many of the guidelines listed by Öhrn applies to this project as they both share many similarities in stakeholders and topic of research. The guidelines listed[31, pp.76–78] below by Öhrn in bold are the most applicable to this project:

Keep it simple - Simple interface that is easy to learn.
This is generally useful for all types of interfaces and especially for such a wide range of users that is involved in the dialogue tool.

Allow for iterative work - Planning process is iterative; therefore the tool should be too
It is useful for the municipalities in the sense that the publishing tool will contain urban projects that are continuously updated and viewing previous iterations can show a clear progression of the project.

Design for a large touch screen - Allows easier collaboration and comfortable viewing.
Having a good design for large touch screen means that the dialogue tool can also be used in physical meetings and presentations.

Enable comments - For collaboration purposes.
What Öhrn describes is the option to comment on objects in a collaboration project for urban planners. In this case, a comment section enables collaboration between citizens and urban planners or even between citizens themselves.

Enable image import - Helps the transition to digital sketching and allows importing hand-made sketches
Having the option to present images or rendered images of building projects with surrounding environments and details can give the citizens a more understandable and realistic context rather than viewing a 3D model in a virtual city.

Display detailed information on demand - Present information about the selected object
The citizens should be able to view detailed information about ongoing projects while also having the option to dive deeper into projects.

Created objects should be distinct - User expects all objects to be distinct
Ongoing urban projects should be distinct not to be mistaken for other existing buildings.

3.6 Urban CoBuilder

The Urban CoBuilder[32] is an outdoor urban simulation tool based on an augmented reality tool used to explore a new approach to multi-stakeholder inclusion, specifically, within the design and planning of better urban qualities and resilience. Urban CoBuilder is developed specifically for this research.

The two approaches to promote inclusion are communicative planning and an agent-based approach. Both have their shortcomings, but The Urban CoBuilder explores a third approach, namely using rule-based emergent planning through a mobile application using augmented reality and gamification. Immotesjo and Kain list three objectives of the paper:

1. Identify a set of specifications detailing the necessary performance of a mobile augmented reality (MAR) tool.

2. Describe the development of a prototype MAR tool.

3. Assess this prototype MAR tool through the pilot application.

The findings in the paper describe that it is possible for multiple stakeholders to design urban environments through the tool. The tool also allows collecting crowd-sourced data on personal designs and their decisions. The immersive experience is welcomed but needed further development and lacks the realism of planning rules, building types, and other functions. The gamification also needs to be strengthened to make gameplay more attractive for a more significant number of stakeholders.[32, p.18]

4

Methodology

This chapter describes the methods used during the process of designing the module for InPlan. The methods used mainly focus on user experience (UX), which means researching through design. Research through design practices is by some considered as non-scientific and lacking in clear standards. Based on the fact that design problems are often described as Wicked problems, meaning that the problem lacks a distinctly identifiable solution [33][34]. The solution can only, concluded from evaluation, be considered good or bad instead of right or wrong as would be the situation with, for example, a mathematical equation.

The project will follow an iterative process where each iteration will loop around ideation, prototyping, and evaluation (see figure 4.1) and is based on the iteration cycle by Preece, Rogers, and Sharp[35, p.332]. The iteration cycle used in this project is adapted to work in quicker iterations by integrating the establish requirements step into our evaluation step, aiming to make the steps more proportional to their planned time distribution. The process starts with gathering data and follows the loop until the prototypes are good enough to start implementing.

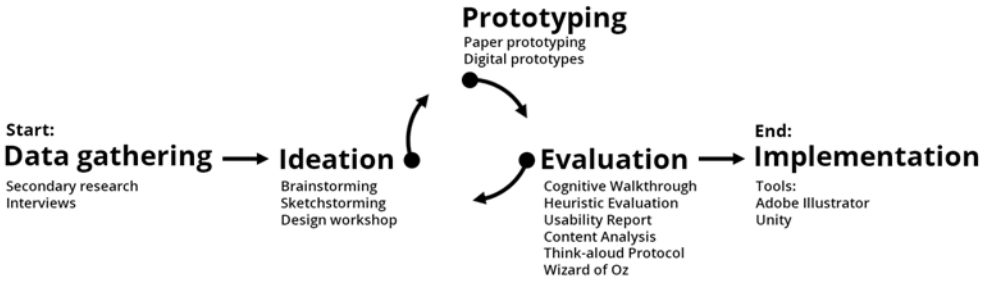

Figure 4.1: Modified version of the iteration cycle by Preece, Rogers and Sharp[35, p.332]. Image made by the authors.

The data gathering step (section 4.1) contains the methods *Secondary Research* and *Interviews*. This step focuses on gathering knowledge to check for relevant existing solutions and papers to get a deeper understanding of the stakeholders and the overall background about urban planning.

The Ideation step (section 4.2) consist of *Brainstorming*, *Sketchstorming* and *Design Workshop*. This step involves generating ideas for the prototype of the dialogue tool using the aforementioned methods.

The Prototyping step (section 4.3) contain *Paper prototyping*, and *Digital Prototypes*. Prototypes are created using the ideas from the previous step, which, in turn, will be used in the evaluation.

The Evaluation step (section 4.4) contains many methods and involves evaluating and analyzing systems and solutions. These methods are *Cognitive Walkthrough, Heuristic evaluation, Think-aloud protocol, Wizard of Oz, Content analysis*, and *Usability report*. The data generated from the evaluations can then be turned into requirements.

4.1 Data gathering

Gathering information and data is an essential step in the process in order to have material and knowledge for the other steps. This means learning more about the area that the project encompasses — in this case, learning more about the inner workings of urban planning and civil dialogue. This step can further improve the process overall and give a better result. For example, knowing more about urban planning could lead to more in-depth questions when interviewing.

4.1.1 Secondary Research

Secondary research[36, p.62] involves collecting and researching on already existing data in contrast to primary research, which involves gathering new data. This is a means of getting insights into what has been done and what has not. The data collected on secondary research can also serve as comparison data and can help suggest methods that can work with the ongoing study.

Sources of secondary research can, for example, be research papers, books, journal articles, books, and conference papers. Other projects or products can also be useful for design projects such as this. The data and information collected are traditionally summarized in different forms, such as systematic reviews, designs, and visual summaries.

The method, in our case, is applied to research for the sources mentioned previously about visualizations in urban planning. The results of our secondary research can be found in chapter 3.

4.1.2 Interviews

Interviews[36, p.102] are best if done in person for the reason that there are details that can be captured when observing the interviewee. Nuances of expressions and body language can be captured in person whereas these would be lost if the interview was conducted, for example, over the phone.

There are several approaches to structuring an interview ranging from a strictly structured to a more free and unstructured way that can be likened to a more casual conversation each with their respective advantages and disadvantages. A strictly structured interview would follow a script of questions where the participant would answer the question at hand and then go to the next one without allowance of diving deeper. This has the advantage of not relying entirely on the skills of the interviewer and is easier to control in terms of questions and timekeeping. The notes would also be more natural to analyze and above all, more comfortable to compare with other interviews conducted in the same fashion.

A more unstructured interview can and should have a set of guiding questions not to let the interview derail. The interviewer would allow flexible detours in a more conversation-like manner. This means diving deeper into some questions, which in turn can generate more meaningful insights. Unstructured interviews also have the advantage of being more comfortable for participants but rely more on the skills of the interviewer to guide the interview in the right directions while collecting the necessary information within the allotted time.

There are several approaches on how to capture the data from the interviews. One method is to take notes while interviewing, but this can distract the interviewer from following up after receiving answers resulting in a more unnatural conversation. A distracted interviewer can also result in difficulty remembering all of the contexts of the interview, such as body language and reactions. This problem happened in some of Öhrn's interviews[31, p.81].

Another method, which would have solved Öhrn's problem would be to record the interview in audio or video. A video recording would be preferable to capture the body language and other nuances, but this can also result in the interviewee feeling uncomfortable and not answering with their opinions and thoughts. The choice of interviewee also matters. The aim would be to interview someone representative of the stakeholders to get valid data.

In our case, the interviews were conducted with participants that work in the municipalities and actively worked with the urban planning process. The interview was recorded by audio and then transcribed. A content analysis was then conducted on the transcription to summarize common themes.

4.2 Ideation

The ideation step in the iteration cycle aims to gain practical ideas, validating the requirements gathered from the data gathering step and evaluation step. The ideation stages will focus on methods that focus on viable functionality and design rather than innovative ideation. The methods used for ideation in this project involves generating ideas for the main functionalities and overall structure of the user interface, using the requirements gathered from the previous step as a basis.

Brainstorming (section 4.2.1) is useful for ideating concepts and ideas on a higher level in written text in contrast to Sketchstorming (section 4.2.2) which involves sketching out a representation of the ideas. Brainstorming is used in this case to ideate functionalities for the dialogue tool. Sketchstorming is, however, used to sketch the appearance and behavior of the different components and buttons. Both of these methods use little resources and require little to no skills. Design workshops (section 4.2.3) are used as a participatory ideation method to gather ideas from relevant personnel working in the municipalities while also gathering more in-depth knowledge surrounding the communication between urban planners and citizens.

4.2.1 Brainstorming

Brainstorming[37, p.5–7] is a widely known method of ideation. Brainstorming follows a set of procedures with a base of three fundamental principles. The basic procedure for group brainstorming follow these steps:

1. Select a group of three to ten people with different backgrounds

2. Present a clear problem, question or topic to the group

3. Ask the group to generate solutions without anyone attempting to limit the type or number of solutions and without giving critique to each other during this step

4. Lastly, discuss, critique and prioritize the ideas and solutions

These steps are conducted while following the three fundamental principles of group brainstorming: Aim for sheer quantity, defer judgment about the quality of ideas, encourage new and wild ideas. The goal when brainstorming is to generate as many ideas as possible without any distractions. Meaning that the participants should be fully engrossed in generating ideas.

4.2.2 Sketchstorming

Sketchstorming[38] is a new take on the traditional brainstorming where the participants will convey their thoughts and ideas through sketching and writing. There are several variations of Sketchstorming with different structures. One of the variations focuses more on a game-like approach to make the method more fun and engaging. This variation is loosely based on the game Pictionary where the participants must guess what is sketched within a time limit after dividing into teams of two to seven players.

There is also another variation that is more similar to traditional brainstorming[39]. The participants are divided into groups of three to five with one leader per group. The role of the leader is to help the team through the process as mediator. Each participant individually gets to sketch ideas which are then collected into a more extensive collection of ideas for that group. Each group has one representative to present their ideas and inspirations.

Both these variations are described as a group activity. The sketchstorming used during this project is adapted to work with a smaller amount of participants (in this case, for two people). The participants will instead sketch individually within a time limit and focus on creating as many sketches as possible. Having a clear question or topic is essential as an ambiguous question or topic can be challenging to sketch on. This variation on sketchstorming follows brainstorming more closely than the two previous variations and has a similar procedure:

1. Select a group of two to five people

2. Present an apparent problem, question, or topic that the group is sketching ideas for. Clearer topic results in more relevant ideas.

3. Ask the group to generate solutions individually without talking

4. Discuss and prioritize the ideas and solutions

The fundamentals in this method have some similarities and differences from brainstorming: aim for quantity, always discuss the ideas from an objective standpoint, keep the sketches as simple as possible just enough to convey the idea. This adapted variation focuses on objectivity and efficiency.

4.2.3 Design Workshops

A design workshop[36, p.62] is participatory and activity-based research where participants will work with team members to explore designs. A workshop has several advantages, especially when there are stakeholders involved. Design workshops are a fun way of involving the stakeholder to gain both the trust as well as inputs from

them. The disadvantage is that workshops can be labor intensive and require much preparation beforehand while also relying on the skills of the organizers.

The structure of a workshop can vary greatly but, generally, a design workshop will consist of activities that are planned and orchestrated by the design team. An example of structure can be that the workshop begins with explaining the context and background as a way to get the participants on the same level. This could be followed by a general discussion of the topics presented beforehand to encourage the participants to think deeper. Next step could be the creative activity of the workshop where the participants get to express themselves through hands-on activities such as creating storyboards, sketches, and mockups.

The role of the organizers before, during and after would be first to gather materials for the workshop, orchestrate the workshop while following a plan while being adaptable, documenting the workshop and lastly collect and analyze the outcomes.

The design workshop conducted in this project consists of five main steps:

1. Introduction to civil dialogue and about us to get everyone on the same level of knowledge.

2. Discussion topics and questions are provided to participants about civil dialogue. The discussion is recorded using an audio recorder, while the answers to the questions are submitted to Mentimeter (section 4.5).

3. Participants are instructed to design their version of a civil dialogue tool using provided materials such as pins, strings, blank papers, pens, and pre-made components such as buttons.

4. Participants are then instructed to present their ideas one after the other without discussion.

5. Discussions are then held about their takeaways and thoughts about the other participants' designs.

4.3 Prototyping

This step in the iteration consists of creating prototypes in order to test the ideas generated from the previous iteration step. The process for prototyping can be divided into two steps: rapid low fidelity prototyping and high fidelity prototyping. Rapid prototyping entails creating prototypes in a short amount of time to test proof of concepts, and several methods are useful this such as paper prototyping.

High fidelity prototypes is a more time-consuming process, but the results represent the end product closer than what a rapid prototype would. The benefits to this

would be that evaluation will be more accurate and showcase a more realistic use scenario in contrast to users testing a system on pieces of papers. Another benefit is that hi-fi prototypes provide a more concrete base to work from when developing the real system. It reduces the chance that the developers interpret the prototype any differently, giving a clear idea of how the program should behave. While many benefits, there are also drawbacks when it comes to hi-fi prototypes, one of them being that more details in the prototype can result in the users focusing too much on the finer details. This means that the users will search for detail errors if the high fidelity has small imperfections, which could lead to redundant data.

Paper prototyping (section 4.3.1), one of the low fidelity methods, is a cheap way to create representations of ideas in paper format quickly. It is used for prototyping the user interface of the dialogue tool in varying quality throughout the process. Digital prototypes (section 4.3.2) are created to be used as a more realistic prototype in the user tests since paper prototyping does not accurately represent the end product. Digital prototypes are created using tools such as Adobe Illustrator (section 4.5), Adobe Photoshop(section 4.5) and Adobe XD (section 4.5). The tools are used to create components and interface elements.

4.3.1 Paper prototyping

Paper prototyping[40, pp.3–5] is a widely used method and categorized as a rapid prototyping method. It is used for designing, testing, and improving user interfaces by using a paper representation, created by the design team, of the interface. Snyder(2003) defines paper prototyping in her book as follows:

> *Paper prototyping is a variation of usability testing where representative users perform realistic tasks by interacting with a paper version of the interface that is manipulated by a person "playing computer" who does not explain how the interface is intended to work.*[40]

Paper prototyping has the advantage, as its name implies, of using paper. It is easily modifiable by simply making adjustments with a pen or eraser right after or even during a usability test. Paper prototyping is especially useful in the earlier stages of development because of how quick it is to create these prototypes and can save time by identifying problem areas before investing resources into implementation. The method also has a low skill threshold and requires little material. An example of a paper prototype can be seen in figure 4.2.

Figure 4.2: Example of a paper prototype. Photograph taken by the authors.

4.3.2 Digital prototypes

Digitally produced prototypes often fall into the category of high fidelity prototypes with some exception such as variations of wireframes. The designs of any user interfaces often use digital prototypes to test usability. High fidelity prototypes themselves have a range of complexity ranging from simple mockups such as a concept images to near fully functional interfaces created in software development tools.

Image editing tools are often used to create digital prototypes which, in turn, can be exported to various formats such as images, and presentations (see example in figure 4.3). Implementing a prototype in a software development tool can be expensive, but there are several ways to fake functionality. A designer can simulate functionality by creating multiple images of a user interface and linking them together. For example, a pdf page with an image of an interface could contain buttons that are linked to other pdf pages; creating an effect that simulates button functionality.

Figure 4.3: Example of a digital prototype without any working functionality. Image made by the authors.

4.4 Evaluation

A way of verifying if the progress is on track is to evaluate the prototypes. Evaluations are especially crucial for examining the early rapid prototypes for the proof of concept. Determining if the prototype is viable or not in the early stages can save both energy and time in the long term by not having to invest too much into the prototype.

Cognitive walkthrough (section 4.4.1) and *Heuristic evaluation* (section 4.4.2) are two evaluation methods that are used extensively throughout the design process. Heuristic evaluation is used to check for the usability of the dialogue tool, and Cognitive Walkthrough is used to check for how easy or difficult it is to learn to use the tool.

The *Think-aloud protocol* (section 4.4.5) and *Wizard of Oz* (section 4.4.6) are two user testing methods which, in this case, is used in combination with each other. The two ways give insights about the user's thoughts, what they want to see in the tool as citizens and their behavior when navigating the dialogue tool prototype.

Content analysis (section 4.4.4) and *Usability report* (section 4.4.3) are two data analysis methods also used during the evaluation stage. These two methods involve analyzing and summarizing findings and are used after the interviews, design workshops with the municipalities and evaluations. The analysis will be used later on to construct a set of requirements for designing the dialogue interface and surrounding functionalities.

4.4.1 Cognitive Walkthrough

Cognitive walkthrough[36, p.32], in this case, will be used as an evaluation method where the experts perform a set of tasks while answering questions related to learning after each action. One action could, for example, be "Log into the online bank system.". The results of the evaluation will show the most intuitive sequence when evaluating each action in the task.

1. Will the user want to produce whatever effect the action has?

2. Will users see the control (button, menu, label, and other components) for the action?

3. Once the user finds the control, will they recognize that it will produce the effect they want?

4. After the action is taken, will users understand the feedback they get, so they can confidently continue on the next action?

4.4.2 Heuristic Evaluation

Heuristic Evaluation[36, p.98] is used during the process to evaluate the system from an expert's perspective. The method checks if the system at hand follows a set of design principles that are determined beforehand. In other words, the designers can quickly evaluate a design by checking if it follows the predetermined usability "rules of thumb". Heuristic evaluations is an inexpensive method and straightforward to perform, which is beneficial for small design teams. Nielsen provides a list of ten general heuristics for user interface design that is easily adaptable to better work with any other systems[41].

1. Visibility of system status

2. Match between system and the real world

3. User control and freedom

4. Consistency and standards

5. Error prevention

6. Recognition rather than recall

7. Flexibility and efficiency of use

8. Aesthetic and minimalist design

9. Help users recognize, diagnose, and recover from errors

10. Help and documentation

There are other lists of heuristics such as Shneiderman's "Eight Golden Rules of Interface Design"[42]. Schneiderman's heuristics use different wording but is very similar to Nielsen's list. Nielsen's list is less specific, but in turn, encompasses a broader evaluation for interfaces. Nielsen's list will be used, in this case, since Schneiderman's does not offer more than Nielsen as well as containing more encompassing heuristics.

This method used in this project will list all the heuristics and then rate the dialogue tool from 1 to 5, depending on how well the tool follows each heuristic followed by a sum of all points. A rating system is use to save time when conducting the evaluation as well as providing a quick overview of how well the dialogue tool scored using the sum of all points.

4.4.3 Usability Report

Usability report[36, p.192] is a method which can help design teams decide whether or not a product is usable enough to release. The method uses empirical data as a base to list different findings. Hanington and Martin[36, p.192] list what a usability report should contain:

- **Executive summary.** A summary of the most severe usability problems.
- **Total number of problems found.** List of problems containing the frequency, impact, and persistence of the problem.
- **The list of problems that will be fixed.** List of the most severe problems that will be fixed.
- **Reports on positive findings** List of positive findings with similar numbers to the list of problems as a way to motivate the team to keep going.
- **Detailed task and scenario description.** Includes information on the tasks and scenarios that are robust enough to get a large range of usability problems.

4.4.4 Content Analysis

Content analysis[36, p.40] is a method which analyzes data in a systematic and structured way by finding and collecting counted occurrences of words, phrases, images, or concepts. There are primarily two approaches to content analysis, inductive and deductive. Inductive content analysis involves categorizing the collected mate-

rial and gradually establishing categories that will be used for the following analysis of all collected data.

On the other hand, deductive content analysis involves listing the categories before the analysis often based on a theoretical framework.

4.4.5 Think-aloud Protocol

The think-aloud protocol[36, p.180] is a method where the participant tests a system or interface and is one of the most common methods of evaluation. The participant is given a set of tasks and must verbalize their actions and thoughts during the test, thus eliminating the need for interpretation by researchers when analyzing the evaluation.

There are two standard procedures: Concurrent Think-aloud and Retrospective Think-aloud. The former is the most common procedure and requires participants to complete a set of tasks while verbalizing what they are doing, thinking, and feeling while focusing on what is happening instead of why. The evaluators may have to remind the participant to verbalize their thoughts, depending on the participant's personality and the complexity of the task at hand.

Retrospective Think-aloud, in contrast to the other procedure, does not require the participants to verbalize their thoughts while completing the given tasks. They are instead instructed to complete the task in silence while being recorded on video or a screen-capture device. The participants then retrospectively comment on the recorded material.

4.4.6 Wizard of Oz

The Wizard of Oz technique(WOZ)[36, p.204] is a method that involves a participant testing a prototype while a researcher fakes functionality behind the scenes. The method is used to gauge how users will interact with the system and is a cheap way of testing a system without having a fully functioning system. Researchers conduct the Wizard of Oz method before the development of expensive prototypes.

Participants test the system in one location while the researcher acting as the "wizard" is in another location. The researches must be able to view the participant's actions either through video or a screen-sharing device. Early iterations of a WOZ-prototype require the researcher to control the majority of the functionality manually but will require less intervention from the researcher as the prototype improves for each iteration.

In this project, a modified version of WOZ is used. The modified version is adapted to work for early prototypes by conducting it with paper prototypes. The partic-

ipants, in this version, sit next to the wizard while performing their given task. This role of the wizard is to manually change layout and simulate functionality by hand.

4.5 Tools

This section lists the different tools used during the process, specifically for quick prototyping and mockups. The tools are chosen based on previous experiences and skill level. Different tools will be used accordingly during different phases. The earlier phases benefit from using tools that are efficient and quick to use without focusing on the aesthetic aspect by avoid investing too much time and resources too early. The later phases benefit from using tools that can create representations closer to the end product. The earlier phases are for testing proof of concepts, while the later phases serve to strengthen these concepts.

Adobe Photoshop

Adobe Photoshop[43], often referred to as only Photoshop, is a popular raster image/graphics editor tool created by Adobe and is used in many different fields such as photography, graphic designs, teaching. Photoshop, in this case, will be mainly used in the prototyping stage to create mockups and wireframes. Photoshop contains many tools, which in this case, can be used to create interface elements from scratch for the mockups. The flexibility of Photoshop allows use in both low- and high fidelity prototypes and will, therefore, be used in both early and later stages of the design process in this case.

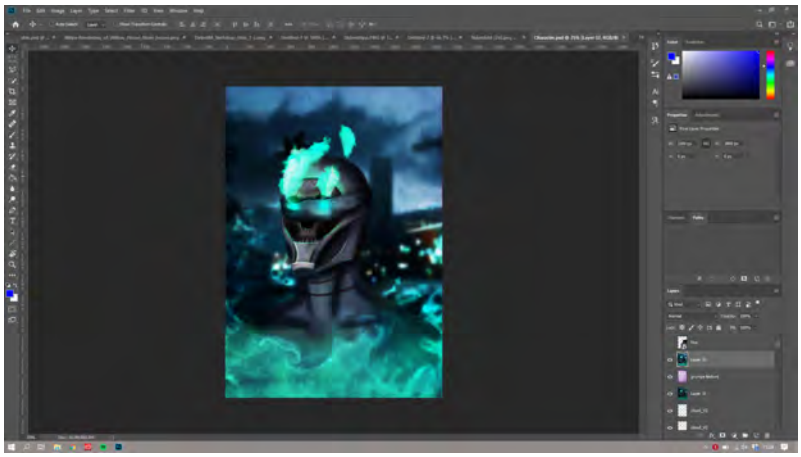

Figure 4.4: Screenshot of the interface in Photoshop during the creation of a poster for a festival. Screenshot taken by the authors.

Adobe Illustrator

Adobe Illustrator[44], often referred to as merely Illustrator, is also a popular graphics editor created by Adobe Illustrator, in contrast to Photoshop, contains tools that

are used for vector graphics and is generally used for graphic designs rather than image manipulation.

Figure 4.5: Screenshot of the interface in Illustrator during the creation of a graphic design. Screenshot taken by the authors.

Illustrator has the benefit of being creating designs that infinitely scalable without any loss of quality since it is vector-based. This is useful for creating interface elements which need to be flexible in terms of size. For example, buttons can be in many different sizes and would benefit from being scalable. The benefit of being able to scale designs also means that it can be flexible to be reused for other purposes.

Figure 4.6: Zoomed in details of a vector image(left) vs raster image(right). Image created by the authors.

Adobe XD

Adobe XD[45] is a program that specializes in creating high fidelity prototypes with functionality. Adobe XD can be used in combination with any other of the graphics editing tools to efficiently create prototypes with limited functionality. The program can connect sequences of screens by connecting buttons to screens, thus simulating

a functional button. This eliminates the need to organize a Wizard of Oz user testing.

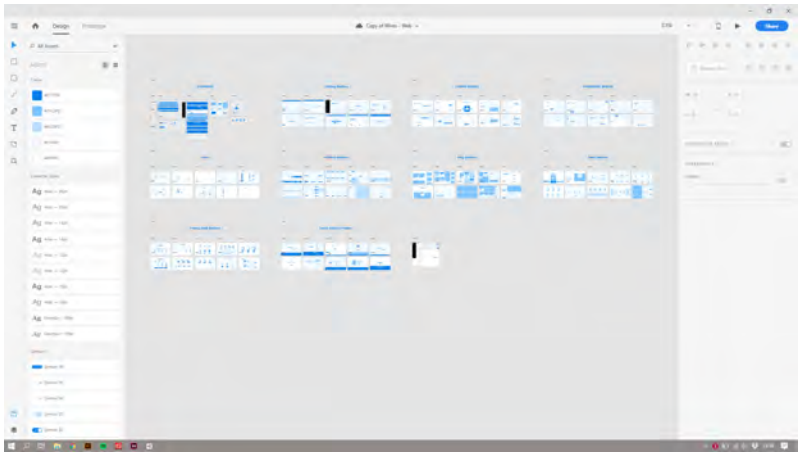

Figure 4.7: Screenshot of the interface in Adobe XD. Screenshots taken by the authors.

Unity

Unity[46] is a game engine with support for cross-platforms releases and is created by Unity Technologies. Unity is often labeled as a game developing software but also has solutions ranging from film making and visualizations to educational tools. One of the platforms that Unity support is WebGL, and it means that projects created in Unity can be published on the web, making it easy to spread the software. Unity will be used in this case to develop the prototype for web module with some functionality.[47]

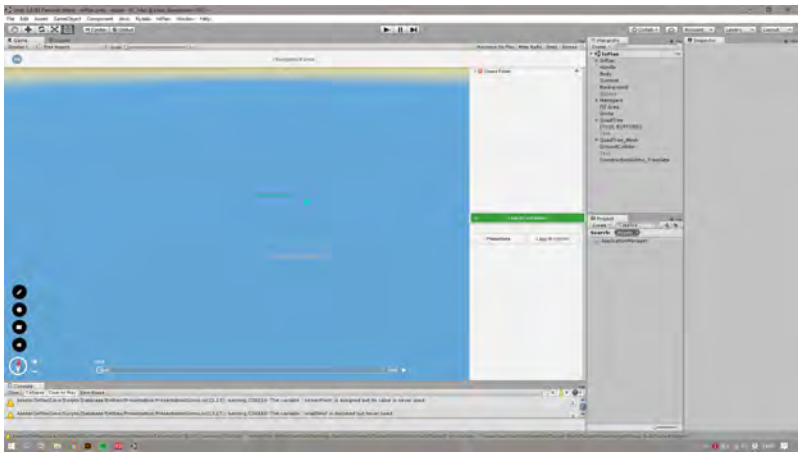

Figure 4.8: Screenshot of the interface in Unity. Screenshots taken by the authors.

Mentimeter

Mentimeter[48] is an interactive presentation tool similar to the well-known presentation program Powerpoint. Mentimeter features interactive questions and slides

where the presenter can, for example, engage the audience by presenting a question where each participant can send in answers through a website on their smartphones. There are also other features to engage with the audience, such as polls, word clouds, and quiz competitions.

5

Design Process

This chapter describes the design process in chronological order. Due to the iterative and inexact nature of our design process, it is divided into a series of design phases that each corresponds to a design iteration cycle. An overview of the whole process can be seen in figure 5.1.

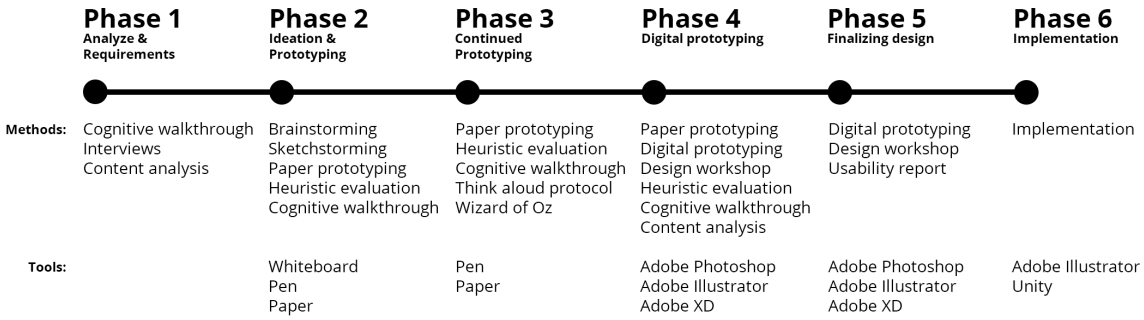

Figure 5.1: Overview of the whole process, and the methods and tools used during each phase. Image made by the authors.

The first phase corresponds to the Data gathering step of our iteration cycle. It consisted of collecting data from different sources to gain knowledge surrounding the stakeholders and existing tools. This data was then used to create a list of requirements and guidelines.

The second phase corresponds to the first iterative design cycle and involved generating ideas and creating a basic paper prototype based on the requirements gathered from the previous step. An evaluation was then conducted to check if the prototype could be improved and also to check if it fulfills the requirements from the previous phase.

The third phase corresponds to the second iterative design cycle and was a continuation of the second phase and focused on completing the paper prototyping, enough to be used in a user test. The second paper prototype was put together after the evaluation of the previous paper prototype, resulting in a more refined

prototype, which was then evaluated.

The fourth phase corresponds to the third iterative design cycle and consisted of moving the prototype from paper into a digital format to use in Adobe XD and gathering more ideas from the design workshop. A design workshop was used to gather more ideas and to gather more in-depth knowledge surrounding the communication between urban planners and citizens.

The fifth phase corresponds to the fourth iterative design cycle and revolved around completing the digital prototype by creating the components and graphics in Adobe Photoshop and Adobe Illustrator, which in turn was used to create an interactive prototype in Adobe UX.

The sixth and last stage corresponds to the Implementation step of our iteration cycle. It consisted of turning the prototyping into a working product in the development tool, Unity (section 4.5).

5.1 First phase - analyzing existing work and requirements

The first phase focused of gathering and analyzing data to be then able to draft a set of requirements that would lay as the ground to our design. We used interviews with different people from the urban development process as well as analyzing existing tools and solutions and the current state of InPlan.

5.1.1 Analyzing the current implementation of InPlan

To properly design for InPlan, we needed to analyze the application itself. This meant that we had to use it and try out different use cases. InPlan is currently in an ongoing process of development into its second version that includes a remake of its user interface. Therefore we needed to analyze the upcoming re-design, and its accompanying design system, allowing us to design according to its conventions.

Analyzing the application
The first step of our design process was using the application to get a good overview of its functionality along with how the user interface works and what we could apply from the current version to our design. The current state of InPlan is mainly focused on planning for internal use within the municipality with a user interface reflecting this.

The central part of InPlan, the standard interface (creation mode), is made to be used by urban planners working with the application. The focus of the user interface

is productivity with the help of toolbars, lists, and drop down menus. The graphical interface follows a light theme with white and grey backgrounds. The text is small to save valuable screen real estate. The central part of the interface is the sidebar, located to the far right. The top half contains a list of the objects present in the project, and properties of selected objects occupy the bottom half. Located at the top of the interface, spanning the whole width of the screen, is a thin toolbar that is home to a couple of buttons and informational text. At the bottom left corner of the user interface is a compass showing the direction of the 3D-view and above it are a group of buttons. These buttons contain a mix of functionality, some used for navigation, and some are shortcuts to access the drawing tool or sun and shadow studies.

While the creation mode of InPlan is fleshed out and features a lot of components and elements, the public view is the complete opposite. The public view only features the compass and the set of buttons in the bottom left corner. The rest of the user interface is turned off and not accessible. This gave us a good idea for what parts of the interface and functionality of InPlan was aimed for public users.

Analyzing the redesign
InPlan has recently started development on version 2, which will result in a ground-up rewrite of a big part of the code base, as well as a redesign in its user interface. This meant that it was more critical for us to make our design cater to the redesign, more than to the current state of InPlan. To do this, we followed the guidelines of the design system.

The redesign consists of a large set of different components. The base components are toolbars, movable windows, tabs, and menus. As with the current version of InPlan, the redesign also focuses heavily on the creative mode with all of its view mockups only covering this. Therefore we decided only to utilize the compass and navigation tool from the redesign, creating the rest of the interface ourselves while following the design system's guidelines.

5.1.2 Analyzing other similar applications

Before starting the design process, we used and analyzed other similar tools to the one being designed in this project (as seen in chapter 2.4). We analyzed City Planner, wec360°, 4Dialog, Urban Explorer Table and Google Maps. Of the analyzed tools, we choosed to focus on *Google Maps* and City Planner for design cues. Google Maps is a map service by Google that have different use cases than InPlan, but features a lot of similar mechanics. It also have a large amount of research behind it done by Google's UX-team, giving us a great start point in our design process. Another application we choose to analyze is City Planner that shares the same use cases as InPlan and has some additional features as a public mode, similar to what we aimed for. We did not use any concrete solutions from the other tools we analyzed as a basis in our design due to the differences between them and InPlan in regards to

navigational interaction and their publication medium.

Google Maps

While the use cases of Google Map vastly differs from InPlan, they share many similarities in that both are applications where users navigate through a map environment and browse location-based information as markers. While analyzing Google Maps, we took notice of the sidebar functionality of the application (Seen in Figure 5.2). The sidebar covers about 20 percent of the applications left side, from top to bottom. The sidebar contains essential information and functionality like a search input field and traffic information of the current area. The sidebar can also become minimized by clicking on the arrow at its top right corner, hiding it from view and allowing the map view to cover the entire window.

Figure 5.2: Google maps. Displaying a 3D view of Gothenburg with the side bar visible to provide further options and information. Navigational tools are visible in the bottom right corner. Screenshot taken by the authors.

Google Maps also contains a set of navigational tools similar to that of InPlan, including positional shortcuts and a compass. These are positioned in the bottom right corner and are therefore always visible even when the sidebar is covering the left side. The tools contain the possibility of zooming in and out of the map by pressing one of two buttons with a plus or a minus symbol. Zoom buttons are not present in the user interface of InPlan but might be of use for users not comfortable to zoom with the mouses scroll wheel or similar shortcuts. The navigational tools also includes some functionality not necessary to InPlan, such as the switch between 2D and 3D.

Another feature of Google Maps is to mark a location with the click of the mouse. Doing this invokes a small window in the bottom of the screen with some information and position specific functionality as entering street view mode at the location or start navigation to it.

Points of interests, or only markers as they are called in Google Maps, are also present for positions of particular interest. This includes addresses to particular

businesses, tourist hot spots, and public transit stations. Clicking one of these markers brings up information about the marker in the sidebar, replacing what was present there before. Displaying the information in the sidebar only allows for one active source of data at a time, something we expected to be inconvenient when comparing project-wide information to marker specific data.

After the analysis of Google Maps was done, we wanted to look at the possibility of adding some design functionality from it such as a sidebar, zoom buttons as well as marking a location to perform location specific actions.

City Planner and Min Stad
City Planner is considered as InPlan's biggest competitor. Though similar to InPlan in core functionality, they have a greater focus on their public mode for touch screens and the web. Many municipalities in Sweden, therefore, use City Planner for their upcoming projects. We chose to analyze the public modes of two municipalities utilizing it, to find out what they chose to put their focus on.

One of the municipalities utilizing City Planner is Kungälv[49]. They use it on a project basis for some of their new projects. All of their projects are created within a contained environment, meaning that no other projects can be accessed from City Planner than the one currently viewed. Contain projects allows them to be linked directly from their website, something that we wanted to investigate the possible use of in our prototype. In the public view of City Planner for Kungälv, a unique public user interface is available. This interface limits the functionality of City Planner down to a few different actions: the main information window, navigation controls, controlling the visibility of objects, measurements, and sun control.

Another municipality using City Planner is Gothenburg. They use a modified version branded as Min Stad[21]. The most significant difference of Min Stad compared to for example Kungälvs version is that it contains the entire city with a large amount of project available within it. Including the entire city makes it easy to get an overview of the general development, but harder to find specific projects of a certain area. Min Stad also puts much effort in gathering inputs from users, allowing them to submit general comments, pictures, and ideas in whatever place of the city they wish. One issue we immediately noticed with Min Stad was the cluttered interface, a result of the large amount of user content they had received. Min Stad performs no filtering on the visibility the user submitted points of interest and therefore shows everything at the same time. A solution to this problem could be a filtering system for user submitted content, something we took note of to evaluate the possibility of including it in our prototype.

After looking at the two municipalities' solutions we chose to go in a direction where we mixed functionality from both of them; projects could be linked and viewed in a contained environment but also available in a larger oversight together with all other projects. We deemed this solution to be able to fulfill the needs of both municipalities and therefore other in the same position.

5.1.3 Interviews

Two interviews were held at the start of the project as a means to get a set of requirements from our primary stakeholder, the municipalities. The interviews were carried out by representatives from the municipalities of both Lerum[3] and Kungälv[50].

Interview with an organizational developer from Lerum municipality
Lisa Bomble works at Lerum municipality as an organizational developer and is in charge of developing the municipality's communication between its developers and citizens and therefore, possess a lot of knowledge about the subject. She shared her experience of performing civil dialogue in a real-world environment and gave us much insight into how the process is usually carried out. Our goal with this interview was to get an insight into how the planning process is carried out, and especially what may go wrong.

The interview with Lisa Bomble was performed early on in the project. It was carried out over an hour in a semi-structured format.

The first and foremost point of hers was to not allow for room of interpretation. This means to include all necessary, new and old, information about the project and to communicate in what state the different parts of the project are in currently. A usual misunderstanding comes from the use of volume studies in planning projects, where citizens may conclude that the planned buildings of a project will be the plain blank volumes that are visualized.

Lisa also explained what type of citizens are usually involved in the dialogue and who takes the most space and effort. In a citizen meeting with 100 people present, there are usually about ten times that amount that is happy and do not feel a need to make their voices heard. Among the 100 present people, a group of about 20 people often has questions and concerns to voice about the project. These are the people most important to handle and build our cases around because they can steer the discussion in their direction and derail the project. Among those 20 it also exists a smaller group consisting of a couple of people that will voice their opinion solely for the sake of being opposed to newer planning. These are often firm on their position and are not worth to put the extra effort for required to construct dialogue solutions.

Working with these problems are hard but is according to Lisa Bomble best handled by providing as much relevant information as possible. Transparency about the project is to be handled with care, since a too small amount of information leads to frustrated people, while too much information might lead to people exploit the weaknesses of the project. The most important on our part is therefore to make a tool to allow the planners to use it by their preference, to allow and encourage them to provide as much useful information to the citizens as possible.

Interview with three representants from the urban planning division from Kungälv municipality
Our second interview was carried out in Kungälv, Sweden, with three officials from the municipality, deeply involved in different aspects of the planning process. The three attendants where Pernilla Olofsson unit manager of the planning division, Linda Andreasson land-use planner and Camilla Schalin GIS coordinator. Our goal with this interview was to get as clear of a picture as possible of the planning process.

The interview was carried out over an hour and a half in a semi-structured format. The interview was recorded and later transcribed.

During our interview, we discuss comments and how they are handled, usually by a case management system. The importance of being able to extract comment data is pointed out, but they also highlight that user comments do not need as formal statements while still being considered by planners and developers. Informal comments can primarily be used before the official consultation part of the process, to get an overview of the public's opinions.

In Kungälv, they are currently using City Planner for individual projects. What projects are integrated into City Planner depends on a couple of different factors, mainly if 3D models are readily available from the architect and if the area is of high enough importance. They explained that when using City Planner, they often specify a time frame where people can comment and gather and process these when the time frame has passed. The relevance of giving feedback to the user is pointed out, even a notice that they have read all of the feedback is essential for sustainable dialogue.

Content Analysis
A content analysis (as described in section 4.4.4) was conducted in order to list commonly occurring themes and words that were discussed in both of the interviews. Common themes and words are listed below in no particular order.

- Feedback from municipalities to citizens
- An effective system for communication
- Easy accessible information about projects
- Citizens should be able to view backstories about locations

Reoccurring words that came up in both of the interviews: *Supplementary questions, feedback, concerned parties, backstory, communication, focus groups, and information.*

5.1.4 Requirement specification and design guidelines

From our analyses of InPlan and similar programs, as well as the data gathered from the two interviews, we compiled a list of requirements and guidelines, utilizing content analysis, to consider when designing.

List of requirements and guidelines, in no specific order:

- The user should be able to toggle between the state of the project area before it was initiated and the end result.
- Certain actions, like selecting a project, should move the camera to a predefined position.
- Allow urban planners to provide as much information as possible, in different formats such as free text, images, and documents.
- The user should be able to place a marker with feedback or other information at their location of choice, without being connected to a specific project.
- The user should be able to, to some extent, toggle which markers and other content should be visible.
- The user should be able to leave feedback, comments, and other input without the need of being registered at a third party, a non-governmental platform like Facebook, Google, Twitter, or similar.
- The urban planner decides what information to include, but should be able and encouraged to include as much as possible of anything relevant to the project.
- The urban planners and responsible communication managers should be able to manage and respond to large volumes of feedback quickly and easily.
- Do not put boundaries where the user can move in the 3D-environment. Even if a selected project only covers a small part, allow the user to move around the entire municipality to observe different sight lines of importance to them.
- Feedback and input from users do not have to be regarded as official statements to be considered by the urban planners. Therefore there is no need to verify that users who comment are living in the affected area.
- Support for new technologies as Virtual Reality is a welcome addition due to the changes in perception of the environment it provides for the user.

5.2 Second phase - Ideation and paper prototyping

The second phase marked our first progress on the design itself. Based on the previously compiled list of requirements, we started to create the first rough drafts of the design. The design was created in two steps. First, we created flow charts where we specified what components and views was necessary for the design, and what functionality were accessed from them. Based on the flowcharts, we could then create our first design on paper, based on the flow charts. This results in a set of simple drawings where each component has it's functionality mapped to our flow charts, allowing for more direct evaluation.

5.2.1 Flowcharts

The first step in the path from requirements to design was creating a flow chart of our desired result. Flow charts allow us to structure our views and components in a non-linear way and to draw connections between them. The result was a mapping of all the different views, what they have to contain, and how they are situated in the application relative to the other views.

Brainstorming (as described in section 4.2.1) was used to generate ideas for the main features of the dialogue tool, using the guidelines and requirements from the previous phase (section 5.1.4). Non-viable ideas that did not fulfill the requirements were discarded while the rest of the ideas were organized and refined. We then decided to create two flow charts based on the ideas. The first was a basic chart describing the general structure of the user interface. The second flowchart was more advanced one describing not only the complete user interface but also how the different features interact with the rest of the application.

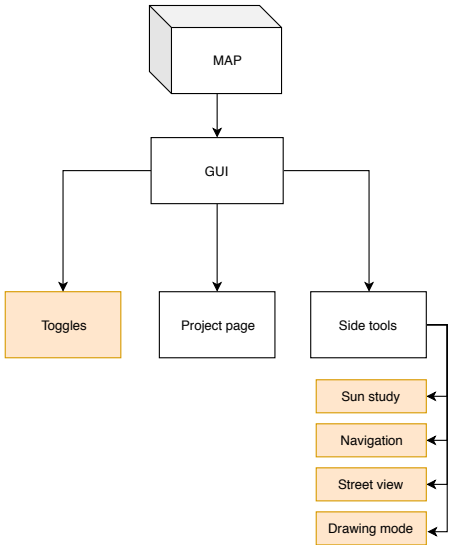

Figure 5.3: A basic flowchart describing the general structure of our user interface for the application. Image made by the authors.

The simple flowchart (Figure 5.3) describes the basic flow and dependencies of the interface where map actions change the graphical user interface (GUI). The GUI is split up into three main parts, the toggles deciding what contents are shown on the map, the project page showing project unique information and the sidebar with tools made for interacting with the 3D-environment itself.

Next, we moved on to split the big chunks of the first flowchart (Figure 5.3) into smaller, more specific components. The project page was split up into a set of different views (Home, Project mode, Drawing mode), each with a set of subcomponents that we considered needed for the view to fulfill its purpose. Each component was in turn connected to a function, and if the function was not self-contained (i.e., effects another part of the chart) it was further connected. Furthermore, the map was split up into further components; points of interests, project areas, and entities (objects placed in the 3D environment). The result was our second, more detailed flowchart (Figure 5.4).

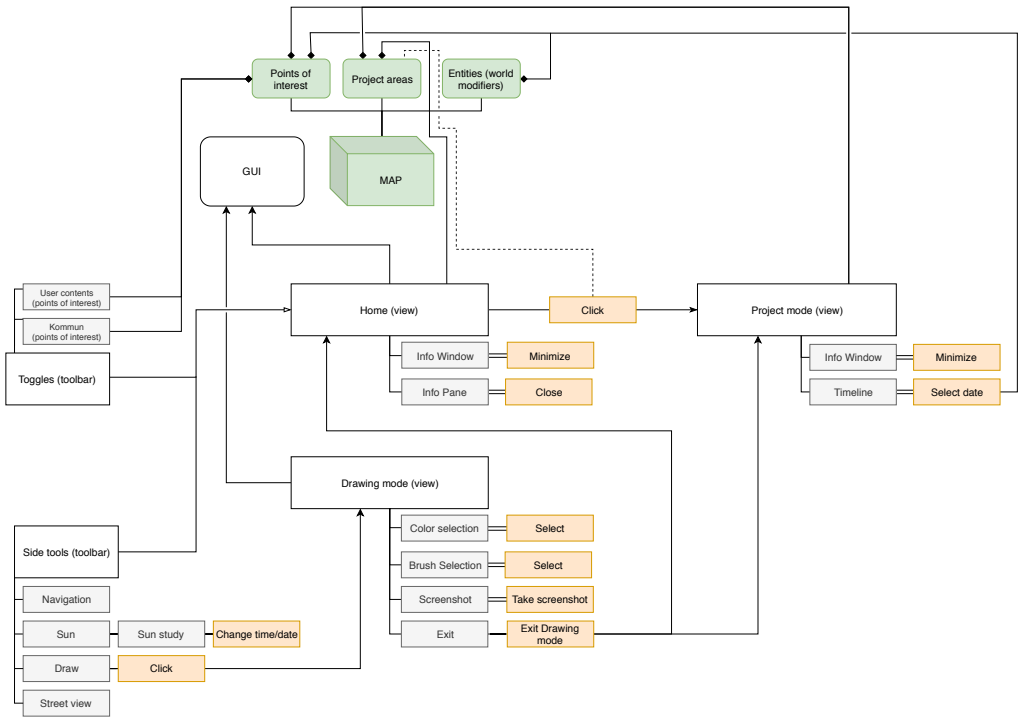

Figure 5.4: A more advanced flowchart describing views/sub views (white), components (grey), functions (orange) and map entities (green). Image made by the authors.

The primary use of the second flowchart (Figure 5.4) was to assist in the creation of the paper prototypes since it may be used as a map of what views are needed and how they are related to each other, as well as giving us a list of the different components needed and what views they should be present at.

5.2.2 First paper prototype

Our first prototype can be seen as part of our ideation, a process of getting our ideas and requirements to a tangible and concrete form. This resulted in a very rapid prototyping process where new ideas of the components are drawn and thrown away in a matter of minutes until a suitable one is found. We applied the method of Sketchstorming to this part of the process, using it for each new component drawn (some examples can be seen in Figure 5.5).

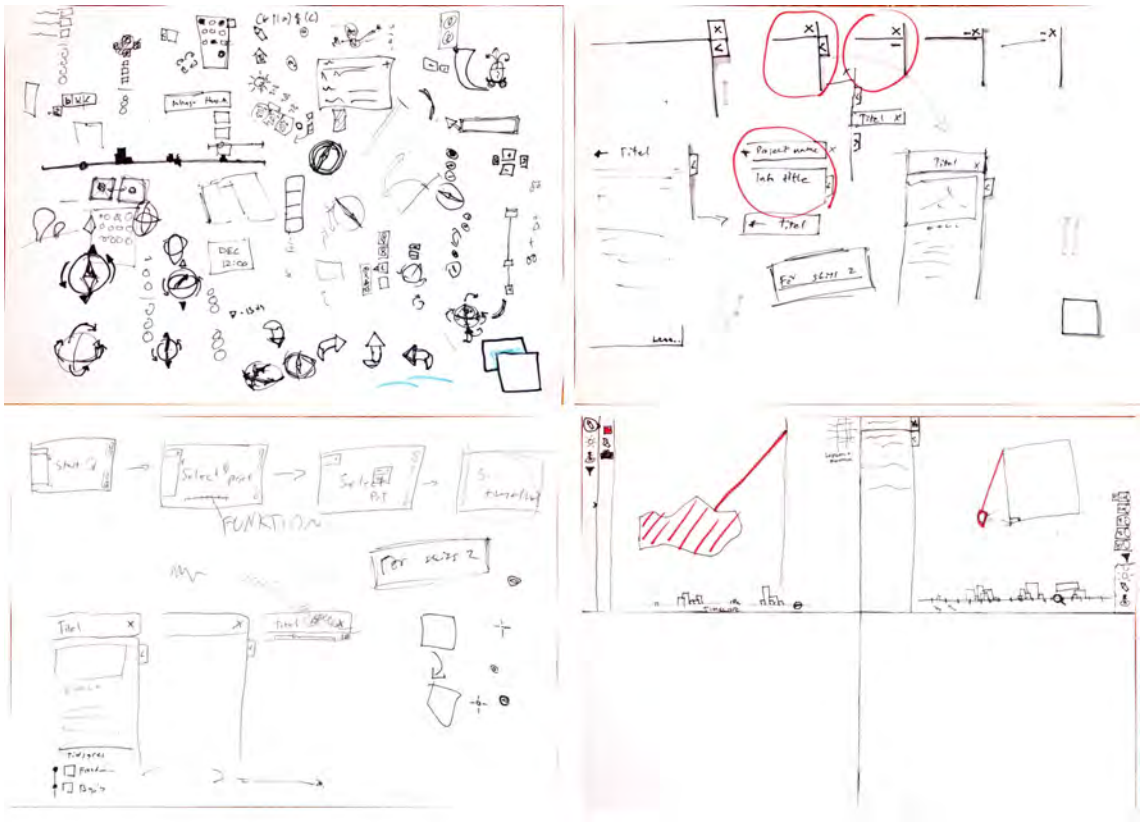

Figure 5.5: Sketches from our Sketchstorming session. Photographs taken by the authors.

The prototyping was started by creating the components derived from the second flowchart (Figure 5.4) and deciding their location, size, and how their functionality was accessed. Focus laid on the components displaying information, mainly the sidebar and movable windows. To allow for better usability and visualization options, especially on smaller screens, we decided to let the sidebar be minimized on demand by the user and thus free up important screen real estate. The main functionality of the sidebar, viewing information and performing specific quick actions from it was inspired by Google Maps (described in section 5.1.2). The difference from Google Maps was that our toolbar would always contain a particular set of information, and having information derived from points of interest display in their own movable windows instead of in the sidebar.

Moving into specific projects were also considered in the prototype, where projects would be marked by special points of interest. Clicking one of the points would move the camera to the project boundaries and replace the information in the sidebar with the project overview. Clicking on the button of the sidebar while in a project would move the user into the full map overview, allowing them to access other projects. This responded to the flow of the second flowchart (Figure 5.4) to navigate between the home and project mode views.

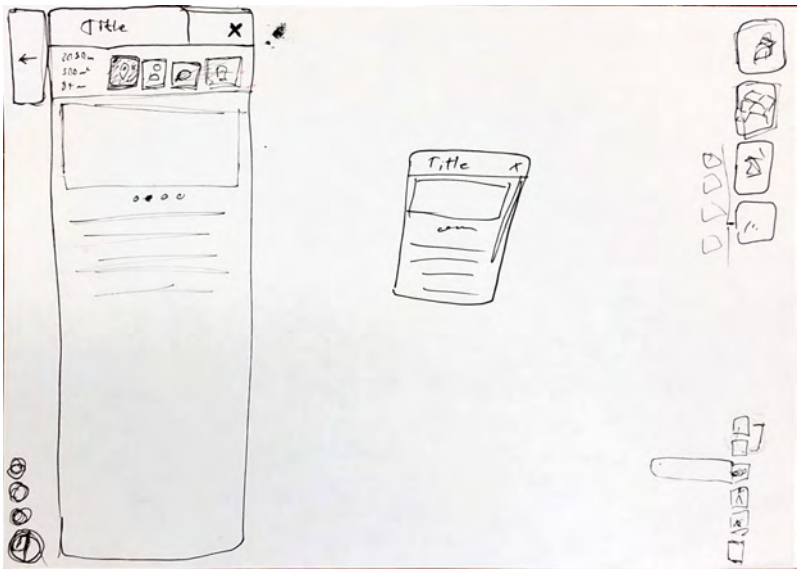

Figure 5.6: A screen from the first set of paper prototyping illustrating the user interface in the project mode view. Photograph taken by the authors.

The result was a set of screens illustrating the user interface at different parts of the application (seen in Figure 5.6). In the sketches, the sidebar takes up most of the height of the left side but leaves a small space to the left for a back button to the home screen as well as navigational tools. In the middle, a floating movable window can be seen. To the top right, a set of toggles for points of interest can be found. These toggles aimed to reduce the clutter from showing to many markers at the same time. At the bottom right, a set of buttons for quick navigation between projects.

5.2.3 Evaluation

The first set of paper prototypes were made quickly and without the necessary detail required to be navigated by a user without help. Instead of performing user testing, we opted to do a quick evaluation ourselves by using Cognitive Walkthrough and Heuristic Evaluation. This allowed us to quickly iterate on the whole design and move on to the next phase where more detailed and complete paper prototypes where to be constructed by the use of our first sketches and the data from our evaluation.

Cognitive Walkthrough
Evaluating the prototype with Cognitive Walkthrough proved some weaknesses in our design. Most of the tasks performed fulfilled all of the demands from the walk-through, but it highlighted the difficulties of enabling user created points of interest and the unclarity of closing the sidebar. A full report of the Cognitive Walkthrough can be found in appendix A.1.3.

Heuristic evaluation
The heuristic evaluation showed generally positive results but was still lacking in many areas. The strong point of the prototype was the heuristic *User control and freedom*. Meaning that the user has freedom when using the tool by always being able to go back to where they were while also having the option to use many of the other functions. The *Help and documentation* and *Aesthetics and minimalist* heuristics scored the lowest. The low score aesthetics was justifiable due to it being an early phase of the project. The help and documentation heuristic, however, means that the user is not given any help at all when using the tool. There is not an option for documentation, and the user has to rely on the interface being intuitive solely. All of the heuristics for the prototype can be found in appendix A.1.6 labeled as *V1*.

Summary
The first iteration of prototyping has resulted in a good base for further work. Our evaluations have pointed out some flaws to mind for the next iteration. We also recognized that the next iteration of our prototype would need a lot more features that we had deemed to detailed to include in this version. Especially more details on what information would be display inside the sidebar and movable windows was needed.

List of improvements to consider for next iteration:

- Reconsider way of minimizing the sidebar.
- Remove the possibility of moving between projects from the project view.
- Format information in more ways, add the possibility for:
  - Contact person
  - Documents
  - Social media sharing
- Add a way for users to create their own points of interest
- Add a way for users to enter street view mode at a specific location
- Add a panel for user and application settings

5.3 Third phase - Completing paper prototyping

After completing the evaluation of the first set of paper prototypes, we moved on to create a new, more refined set based on the data. This phase used the same pattern as the previous generation. We started with the construction of a new paper prototype, evaluated with Cognitive Walkthrough, Heuristic Evaluation, as well as User testing, and went on to perform an analysis highlighting the needs of improvement.

5.3.1 Second paper prototype

The second round of paper prototyping aimed to be more detailed and refined than the previous one. The goal was to make a prototype suitable for basic user testing to evaluate if our desired flow (see Figure 5.4) was translated into our design.

A separate sketch was created (Figure 5.7) with only the sidebar due to the large size would require a scrollable window, something not possible on paper. This sketch contained the new information formats specified in the analysis of the previous prototype (section 5.2.3) in addition to the already thought of in the previous prototype (gallery and description).

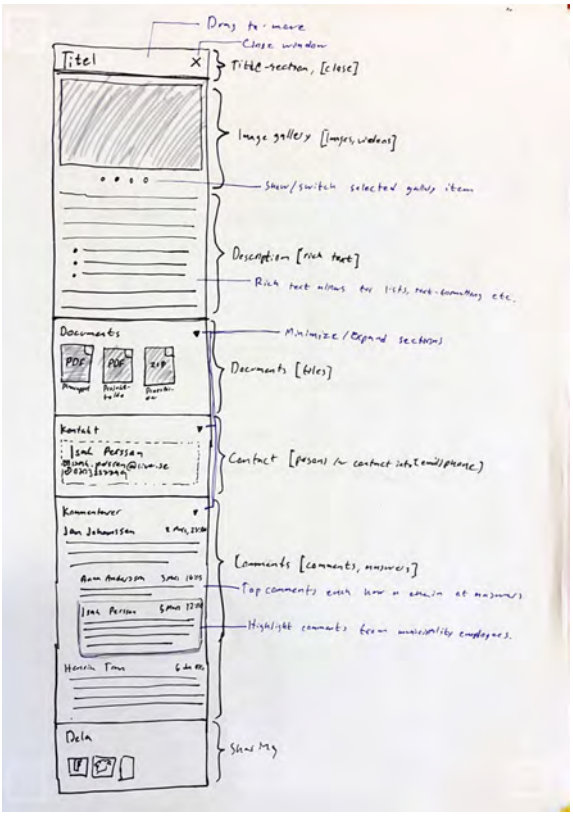

Figure 5.7: The sidebar with all its different sub-sections drawn and annotated on a piece of paper. Photograph taken by the authors.

A set of screens displaying the different views of the application was also created (Figure 5.8). These were based on the second flowchart (Figure 5.4) but contained additions derived from our previous analysis (section 5.2.3). These additions included a panel to create points of interests (markers) and enter street view mode at a position on the map where the user clicked. The toolbar with buttons for navigation and other functionality was moved to the right side of the screen, allowing the sidebar to be placed all the way to the left.

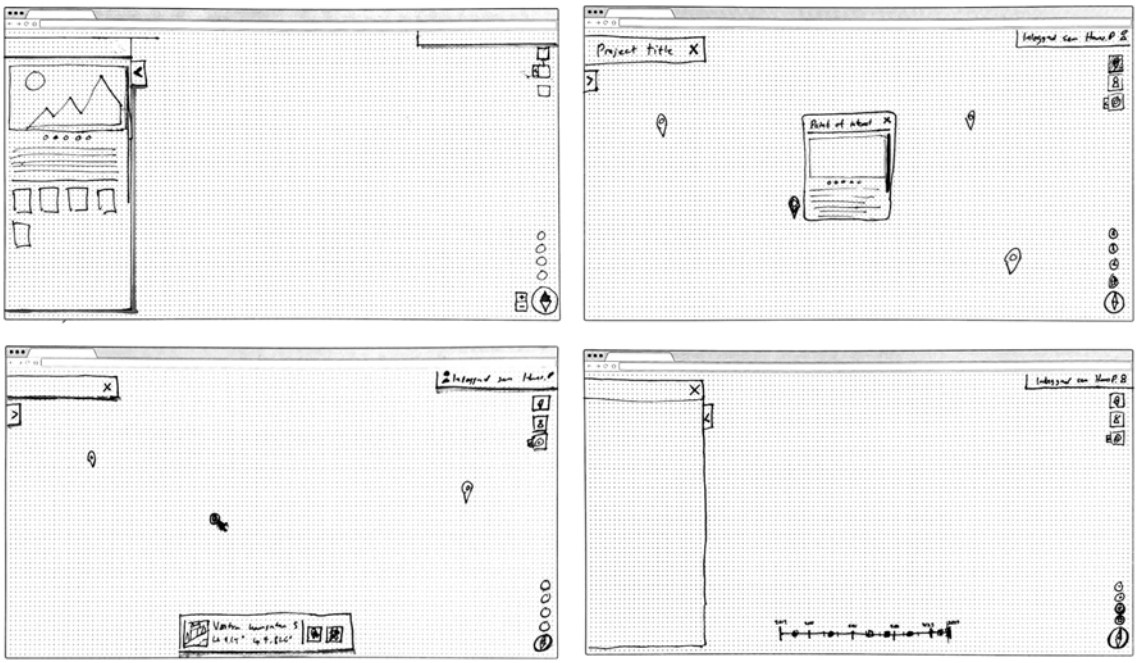

Figure 5.8: A selection of the resulting screens from iteration two of paper prototyping. **Top left:** project view. **Top Right:** project view with a information window. **Bottom left:** project view with pane for position specific actions. **Bottom right:** project view with active timeline. Photograph taken by the authors.

The result of this iteration was a set of views, that together with the sidebar sketch and a printed out 3D view could be used for more conclusive evaluation.

5.3.2 Evaluation

In this round of evaluation, we performed both Cognitive Walkthrough and Heuristic Evaluation as we did in the previous round but also decided to do a small round of User testing.

Cognitive Walkthrough
For our second round of Cognitive Walkthrough (as described in section 4.4.1) we used the tasks from our first round as base while adding some new tasks based on the added features of the prototype. These new tasks were to enter the street view mode, to enable the timeline and set the time to the start of the project.

While the second round of paper prototyping proved to be a bit more clear to use, it still showed a lot of the same problems as the first paper prototype. The difficulties of enabling user markers as well as minimizing the sidebar persisted despite our efforts in making it clearer to use. A full report of the Cognitive Walkthrough can be found in appendix A.1.4.

Heuristic Evaluation
The prototype improved in aesthetics but overall didn't show much progress in terms of usability and instead performed worse than the previous iteration. Reason being that many new functionalities were added which made the prototype more complex. Heuristics that scored highest was *Recognition rather than recall* and *User control and freedom*. Many of the buttons and actions are presented to the users, meaning that they don't need to navigate through menus or perform a long sequence of steps to achieve something, thus eliminating the need for recall while also enabling freedom.

The heuristic *Help user recognize, diagnose, and recover from errors* scored the lowest. As mentioned previously, the additions of functionalities made the prototype complex, but the new additions didn't include any ways to handle errors. The complete table of heuristics can be found in appendix A.1.6 as *V2*.

User testing
The user testing was done with the help of three participants aged 19, 21, and 27 years old. They were each subject of an individual testing session. Testing was carried out by simulating the user interface with the help of our set of paper prototype screens with one of us performing Wizard of Oz (as described in section 4.4.6) while the other provided the user with tasks and took notes. During the testing, the users were encouraged to explain their thought process, utilizing the Think Aloud Protocol (as described in section 4.4.5).

We created a set of tasks for the user to perform, suitable for our pre-made views as well as covering the main use cases (a complete list of tasks and questions can be found in appendix A.1.7). This round of user testing was not developed enough to be conclusive but functioned as a means to give us some insight into user patterns and behaviors. The reason for this was the lack of navigable screens in our prototype, resulting in many actions not resulting in anything. The list of tasks to be performed by the user followed a similar pattern as those performed in our Cognitive Walkthrough, focusing on shallow tasks using the main components. One problem all users encountered was problems with navigating into street view since it required first clicking a point on the ground and then on the street view mode button. This was probably especially hard due to the lack of mouse cues and tooltips, something unavoidable with a paper prototype. Our small list of tasks proved successful overall and solidified our confidence in our design, allowing us to move forward with the next iteration in a digital form.

The user testing and heuristic evaluation showed a disparity in terms of usability and is a clear example that low-scoring evaluation by experts might not directly translate into low-scoring usability test with users.

Summary
List of improvements to consider for next iteration:

- Re-evaluate system of enabling user made points of interest.
- Make the feature to enter street view mode easier to access.
- Make it clearer how to exit the project view and enter the municipality overview.
- Improve the help and documentation through a more intuitive interface or introduce documentation for instructions on usage.

5.4 Fourth phase - From paper to digital

We concluded that we could move on to digital designs in regards to the success of our user testing and the limitations of our paper prototypes explained in section 5.3.2. The result of this phase was to be a high fidelity digital prototype of our design, evaluated by ourselves for a fast iteration. This phase would also contain our first workshop with Lerum municipality. The workshop was initially planned to be positioned earlier in the process, but due to problems with the availability of people would be required to be held in this phase. This required us to re-think and restructure on the initially planned workshop, and rework some elements to be able to draw as much data from us that would be useful in this relatively late stage of our project.

5.4.1 Paper components to basic digital components

The first step of moving to a digitally based prototyping format was to recreate our components previously drawn on paper. This was done by first creating rough drafts of the essential components (side-window, movable window, and action-buttons) and iterate on these to achieve a suitable style that fulfilled our visual requirements. Our tool of choice was Adobe XD (described in section 4.5). We aimed to use the digital components in an upcoming workshop. Therefore we aimed for components made with black outlines and white background. This allowed them to be printed and therefore, easily used and modified in the physical medium (Figure 5.9).

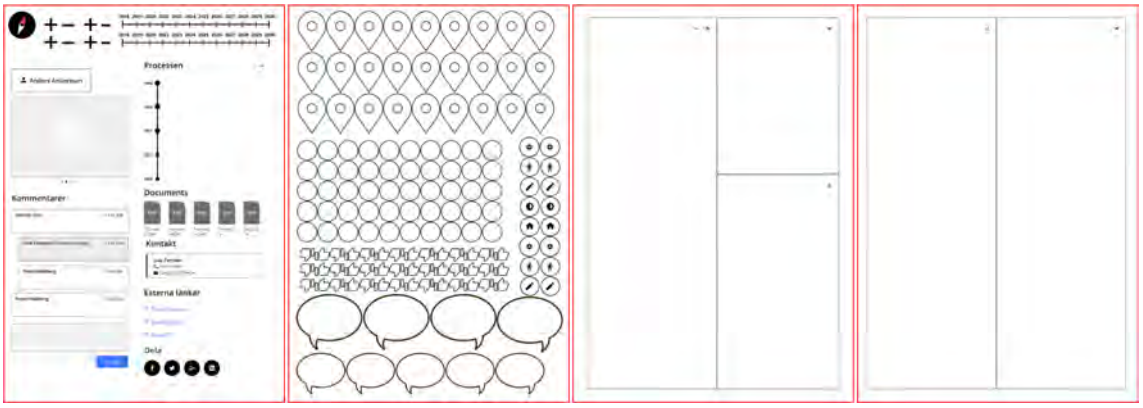

Figure 5.9: Digital components made for printout to use in the upcoming workshop. Image made by the authors.

5.4.2 First workshop with Lerum municipality

Two months into the project, we, together with our advisor from Atvis, organized a small design workshop (as described in section 4.2.3) at Lerum municipality. The goal of the workshop was to discuss different aspects of urban planning as well as ideating and designing a civil dialogue tool. The workshop was held in a small conference room in the town hall building of Lerum. The attendees consisted of two urban planners, one GIS-coordinator, and one organisational developer (verksamhetsutvecklare).

The workshop started with an introduction of everyone in the room and what the agenda of the day was. We began with a short slideshow presenting ATGIS and InPlan, together with a demonstration of some everyday use cases of InPlan. This was followed by a discussion session, where a question asked by us was followed by a couple of minutes of the participant answering the question on their phone using Mentimeter. When everyone had submitted one or two answers, we opened up for discussion to discuss the question in more detail.

List of questions and a summary of the answers by the participants (a complete list of answers can be found in appendix A.1.1):

Question	**Summary of answers**
What pros and cons do you see with civil dialogue?	A lot of different answers are submitted with the common theme that civil dialogue is good for the process in general, but that it's not always the correct people that get involved the most.
What do you reckon citizens find important?	Two of the answers each provide a set of commonly asked questions, most of them revolving around how the citizen gets affected by the new development.
When in the process do you see civil dialogue as most important?	Consensus that early on in the project is the most important place to hold a civil dialogue. The earlier, the better.
How effective do you find civil dialogue to be in Lerum municipality currently?	No one wants to submit an answer due to lack of statistics.

All participants expressed interest in using InPlan, both on the web and with the use of large touch screens at meetings. One of the urban planners pointed out that it may be complicated for the citizen if both smaller comments and opinions and official statements were allowed to be submitted through the application since it might be hard for them to know if a submitted statement will be considered as an official statement or not. A street view function was also promoted due to it being hard to determine the size and impact of a structure from a birds perspective. One of the urban planners had used City Planner at her old workplace, Alingsås municipality[51], and claimed it had reduced the amounts of appeals since people could accurately study the shadows from the new construction and ensure that it would not negatively affect them.

From the discussion, we also gained a lot of insight into the planning process of Lerum. It was explained that they use a central email address as contact and that these were routed by personnel to the urban planner responsible for the project. It was also highlighted that the process in its current state had some weaknesses and space for improvement.

Following the second practical phase of the workshop, where the participants designed their online module of choice, another discussion ensued. This discussion revolved mainly around that the urban planners are very restrained by time and that new tools that added to the process must be sufficient to use while providing a positive effect.

Designs by the participants
The workshop resulted, in addition to the provided answers to our questions and the ensuing discussion, in two designs for civil dialogue in 3D. The first of them is the one designed by the two urban planners (Figure 5.10) with a clear focus on preemptive action where citizens are free to submit points of interest about whatever place they want. They explain that they hope this might lead to a greater base of knowledge among the urban planners, where they can avoid stepping on the toes of the citizens by using this data.

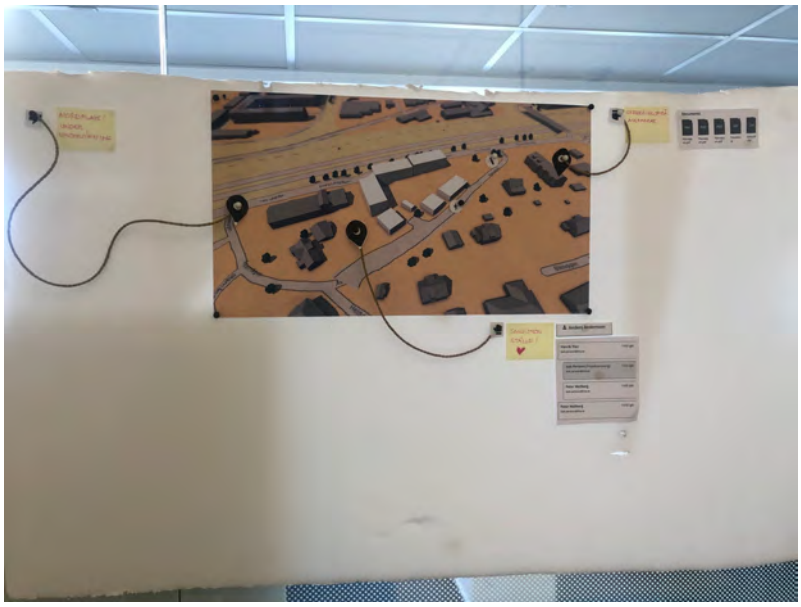

Figure 5.10: The first prototype made by two of the workshop participants. Photograph taken by the authors.

The second design (Figure 5.11) is made by the organizational developer with a completely different focus. This is instead focused on providing as much information to the citizens as possible. Centered the use of timelines, it allows the user to look into the past and see images, documentation, and plans of the past.

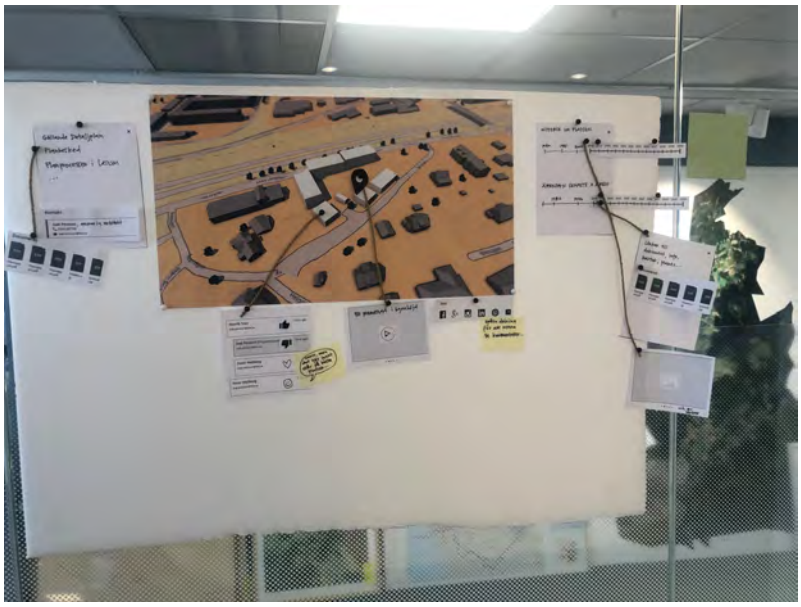

Figure 5.11: The second prototype made by one of the workshop participants. Photograph taken by the authors.

Content Analysis
A content analysis (as described in section 4.4.4) was conducted after the workshop. Common themes and words that were discussed during the workshop are listed below in no particular order.

- There exists two clashing viewpoints within the municipality: providing as much information as possible versus restricting the information available to citizens
- Civil dialogue should be organized early in the process
- 3D visualizations can provide a new perspective and reduce the citizens' concerns
- There is currently a lack of resources and personnel to handle extensive civil dialogue
- Not in my backyard - Citizens are generally positive to new urban projects but only if they are not built in the citizen's metaphorical backyard

Reoccurring words that came up in the workshop: *shadows, sun studies, feedback, effectiveness, comments.*

Takeaways
The workshop provided us with a lot of insights. Mainly from the discussion that followed both our questions as well as the presentation of the prototypes. The pro-

totypes themselves also gave some ideas and thoughts about what to include in our further work and what the urban planners find important. Our takeaways were compiled into a list detailing what we found most important from the workshop.

List of takeaways from the workshop:

- Usual questions asked by the citizens that the application should manage to answer are:
  - How high?
  - How dark?
  - How close?
  - How does it feel?
- Urban planners are often pressured by time constraints and might reject new solutions that are requiring them to invest a lot of time.
- Using graphic timelines allow urban planners to present old studies relevant to the project in an intuitive way.
- Allowing users to place their own point of interests allows the urban planners to get a quick overview of how areas are viewed by the citizens before moving forward with a project.
- Using similar tools have led to fewer appeals by the citizens of neighboring municipality Alingsås.
- It's important to visualize if structures are decided in size/appearance or not. If the urban planners present the public with material that is probably due to change without the public understanding, they will have to spend more time explaining the process.

5.4.3 First digital high fidelity prototype

The aim of the first digital prototype was to have a single screen with the layout present in the previous paper prototype and with the use of some of the components previously prototype. This means that a lot of our effort was focused on creating a compelling visual language.

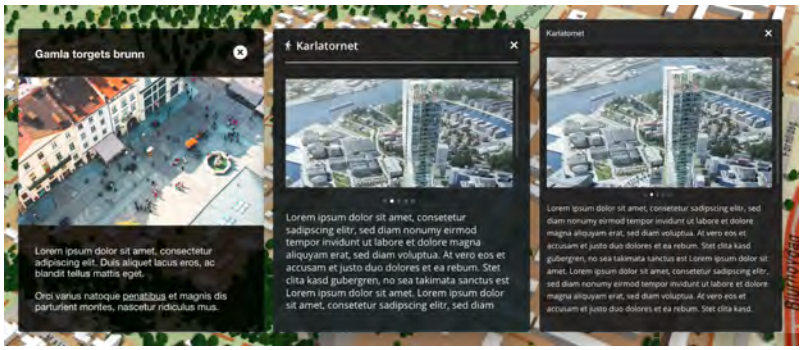

Figure 5.12: Style iterations of first digital prototype. Image made by the authors.

We started by creating a basic layout, following the same rules set by the design language of InPlan. This meant that the layout was following the structure of a 24-pixel large square grid with a general border radius of most panels set to 4 pixels. Text sizes and style was also inherited from the InPlan design system. Diverging from the design system, we choose a darker theme with dark panels and light text to fit better with the rendered environment and give the application a, according to us, more compelling look to users while also providing the benefits of a dark theme as reduced eye strain[52]. Deciding on the theme and style of the process was an iterative process with a lot of different versions to enable us deciding the correct look of the application.

Figure 5.13: Main view of the first version of our digital high fidelity prototype. Image made by the authors.

We went on and used this style to create the essential layout elements of the paper prototype: the sidebar, navigation buttons, settings panel, and the floating window. The smaller components residing within the sidebar and floating window were also created.

5.4.4 Evaluation of high fidelity prototype

As with the first paper prototype, we decided to do a quick round of evaluation ourselves to find the most glaring problems. We performed a Cognitive Walkthrough as well as a Heuristic evaluation of the prototype, combining the results of these into a list of possible improvements.

Cognitive Walkthrough
The Cognitive Walkthrough used a modified set of the tasks used for the previous round. The task of using the timeline was removed due to our decision to re-evaluate the timeline feature, and the tasks of downloading documents, reading comments, and accessing the settings menu were added.

This round of Cognitive Walkthrough produced a better result than the previous round. It provided overall good results, with some exceptions like the issue of enabling user points of interests. This task was failed simply because the feature was not implemented yet into the prototype, making it impossible to perform. A full report of the Cognitive Walkthrough can be found in appendix A.1.3.

Heuristic Evaluation
The prototype is overall better than the previous iteration in terms of intuitiveness and aesthetics. The language and symbols introduced in this prototype displayed an improvement in the heuristic *Match between system and the real world*. The prototype, however, still lacks assisting the users in handling errors, option for help, and documentation. The specific scores and heuristics can be found in appendix A.1.6 labeled as *V3*.

Summary
List of improvements to consider for next iteration:

- Implement a way to enable user points of interest.
- Re-design the exiting and minimizing of the sidebar.
- Make it more clear that documents are downloadable.
- Improve the consistency of user interface elements.

5.5 Fifth phase - Finalizing the design

Our final design phase revolved around getting the digital prototype to a completed state with the end goal of getting it ready for implementation. The phase started with a workshop at Lerum municipality, our second one. This one followed a similar pattern to the previous one and therefore only managed to provide a limited amount of useful takeaways for our prototype. Following the workshop, we con-

tinued with the work to complete our high fidelity digital prototype. Work in this phase included not only visual changes but also the work of implementing faked functionality through Adobe XD's prototyping system. The phase was finished with a round of user testing where fixes to the observed issued were incorporated into the final design.

5.5.1 Second workshop with Lerum municipality

The second design workshop took place two weeks after the first one, and therefore in the fifth and final design phase. This meant that while all of the data gathered from it would be useful for us, it could not affect a too large part of the already set design. Instead, we tried to get as much feedback of our already designed components and therefore decided to include all of our newly developed components to observe what the participants would use and what would be left untouched. The structure of the rest of the workshop was left pretty much intact following the same structure of an introduction, followed by discussion and ending with the attendees designing an online tool for civil dialogue. Instead of changing the main parts of the workshop, we instead refined them to try and get better use of the time, as well as to get more and better data. The workshop this time had a larger crowd of six participants from different areas related to urban planning.

The workshop started in the same fashion as the previous one with a small presentation about civil dialogue in general and an introduction of InPlan. Following was a set of questions for our participants. At each question, participants were required to take a couple of minutes to answer the question by the use of Mentimeter on their phones. After everyone had submitted an answer or two, we moved on to an open discussion about the question.

List of the second set of questions and summaries of answers by the participants (a complete list of all the answers can be found in appendix A.1.2)

Question	Summary of answers
What pros and cons do you see with civil dialogue?	An overall positive response with some cons as time-consuming and often excluding of certain groups.
Do you reckon citizens currently get their opinions heard?	Most agree that certain groups are definitely heard, often those that live closest and have enough time and money to engage.
What do you reckon citizens find important?	A multitude of different aspects centered around what the city stands to win or lose from the development. How is my area affected? How does my properties value change? How do shadows from new developments affect me?
When in the process do you see civil dialogue as most important?	Answers ranges from before to during to after the planning process.
How effectively do you find civil dialogue to be in Lerum municipality currently?	Answers are agreeing on that the current state of the civil dialogue can be improved.

The discussions around each question were dominated by the notion that some individuals have a disproportionate amount of influence over the planning process. These people, referred to as strong individuals, were said to be followed by a group of yes-sayers, agreeing with their statements and skewing the debate in their favor. It was also highlighted that it is often hard for the public to understand what is going on at the planning office and how the process as a whole is being implemented. The importance of keeping everything up to date to avoid unnecessary confusion was pointed out as well.

After the discussion phase was completed, it was time for the practical part of the workshop where the participants could create their own designs of an online module for InPlan. This was followed by a short presentation for each group and another set of questions and discussions.

List of the second set of questions and summaries of answers by the participants (a complete list of all the answers can be found in appendix A.1.2):

Question	Summary of answers
What is the most important function of your design?	A common theme is information delivery. That the citizen using their solution is given correct, relevant, and up to date information.
Was there something you wanted to work more with during the workshop?	Participants want to work more with the process of informing citizen about the new tool, how the real world process is going to be performed and want to involve more parts of the organization.

The discussion about their designs proved to be more fragmented than the previous one with two main sides. On one side, the possibility of dialogue through the online module was preferred, while the other wanted the only purpose to be that of information delivery. The main argument of those opposed to dialogue through the module was that people are unable to hold civilized discussions online, something they had observed through sites like Facebook. The direction those debates often took was described as "mass psychosis" and explained as a process where the involved citizens only focused on a few aspects of the projects and blew them out of proportions. Both of the urban planners urged to instead speak to people eye to eye to avoid their fears of skewed online discussions. One proposed solution was to use the Swedish *Bank Identification system*[53] to get everyone identified and in that way not allow anyone to be anonymous. The opposed reasoning was that the problem might not be that people are more anonymous on the internet, but that the relationship between individual and organization was the problem.

Designs by the participants

The practical part of the workshop resulted in four different prototypes (figure 5.14) made by the participants. Common for all of them was a focus on delivering information over that of providing a space for dialogue. One of the prototypes went all the way on this aspect and prevented any form of dialogue at all, acting simply as an information delivery system while redirecting all contact to different channels.

Figure 5.14: Four prototypes made by the participants of the second workshop. Photograph taken by the authors.

Components provided by us were heavily used by the prototypes, especially the two types of timeline-components available. Components for contact, links, social media sharing, and image galleries were also used in one or more of the prototypes. Among the people implementing a dialogue system, a simple solution of thumbs up or down was preferred due to it is simplicity and expected to engage more people. Extended functionality like VR-mode and indoor simulations were also proposed.

Content Analysis
A content analysis (as described in section 4.4.4) was also conducted after this workshop. Common themes and words that were discussed during the workshop are listed below in no particular order.

- Internet comments can quickly deteriorate, resulting in useless data
- Citizens must provide identification when commenting online
- Provide the possibility to like/dislike a different kind of content
- There should be continuous updates on maps/projects

- Disable commenting
- There are currently well-attended physical meetings organized by the municipality of Lerum

Reoccurring words that came up in the workshop: *Infected debates, comments, meetings, events, developers, reactions, updates, virtual reality.*

Takeaways
When the workshop was finished, we moved on to transcribe our recording of the discussions. The most important parts of the transcribed recording, together with the answers from Mentimeter and the aspects of the prototypes, were all compiled into a list of takeaways:

- It's important not to let the already strong individuals get more influence over the planning process.
- The process is continuously ongoing and changing, requiring the project in InPlan also to be easily maintained and up to date with the process.
- Urban planners do rather not get into discussions online, and instead, prefer meeting eye to eye.
- Solutions like identification through Sweden's official system Bank Identification should be considered as a mean to decrease unacceptable behaviours and make people take more responsibility when commenting on the projects online.
- Simple ways of stating opinions like a thumbs up/down system may engage more people to the process.
- If people understand the amount of knowledge the urban planners have gathered about the project, they are less likely to question their competence and decisions.
- The earlier in the process changes are made to the plan, the cheaper it is. After a certain limit, most of the feedback from citizens is not considered since it's not economically sustainable to perform these changes.

5.5.2 Second digital high fidelity prototype

The second high fidelity prototype was to be as close to a finished representation as possible within our prototyping tools. This meant that we needed to produce all the missing views and connect them with the use of Adobe XD's prototyping tool.

The first step was to fix the previous noticed issues from our testing. We increased

the text size slightly, making it easier to read. To fix the issue with the minimization of the sidebar, we decided to remove the arrow to the left of the sidebar and instead use the more conventional solution of a minimizing line and a maximizing box, similar to that present on many operating systems such as Windows.

We also removed the rounded corners and removed unnecessary margins below and above the sidebar to improve the use of screen real estate (Figure 5.15).

Figure 5.15: Project view of the second version of our digital high fidelity prototype. Image made by the authors.

Next step for added functionality was to add a lot more screens and allow navigation between them. We decided on three different backgrounds for the screens representing different modes of the application. The first background was a view of the map far from above with different project areas highlighted. This background was used for the home view, where the user is able to select different projects or see markers and comments for the overall plan. The second background was the same one used for the previous digital prototype. This background was zoomed in further than the previous, focusing on a city block and was used for the project view. Third and last of the backgrounds where a view of a street at eye level, used for the street view mode.

Together the backgrounds were used to create eleven different views. These were interconnected along with a set of separate panels and windows (figure 5.16). The panels and windows were able to be incorporated by the use of Adobe XD's overlay functionality. This meant that we could enable the same panel from different views, making for a theoretical unique view count of hundreds.

Figure 5.16: Structure and flow of the prototype made in Adobe XD. Screenshot taken by the authors.

The result was a prototype with limited functionality such as scrolling, minimizing and expanding, activating floating windows, enable/disable points of interest, enter street view mode, and submitting user made points of interest.

5.5.3 Evaluation of high fidelity prototype

This was our last planned evaluation of our design, instead of just doing our usual evaluation process, we decided to instead focus on a larger and more conclusive user testing.

Heuristic Evaluation
This prototype had the best score overall so far, which is a sign of progress. The heuristics that scored the highest were *Match between system and the real world*, *User control and freedom*, *Recognition, rather than recall*, and *Aesthetic and minimalist design*. In other words, the prototype is intuitive and grants the user much freedom to navigate back and forth. The language used in the interface is familiar to the users. The aesthetics of the tool has improved, but this is within expectations.

The prototype did not show any distinct weaknesses and had an average score on the rest of the heuristics. It could still be significantly improved in some areas such as help and documentation. The prototype could also do better to give feedback to the user on what is going on. The specific scores and heuristics can be found in appendix A.1.6 labeled as *V4*.

User testing
The user testing was held in five separate sessions, with a single participant at a time, spanning in the ages of 21 to 81 years old. The participants consisted of a mix

of other students and relatives, picked to represent a wide age span. Each session featured a set of tasks carried out by the user in our design prototype (running in Adobe XD, described in section 4.5) while utilizing the Think Aloud Protocol (as described in section 4.4.5). After completing all of the tasks, users were asked a set of questions to evaluate their experience in full. Each test had a running time of around 20-30 minutes, including the questions ending the session. The complete list of tasks and questions can be found in appendix A.1.8.

Most of the users had no major problem with understanding the primary navigation of the application, even though they were unable to perform any 3D-navigation due to it being a non-functioning prototype. Navigating through the interface was quickly done by all at participants since most of the navigational difficulties were solved by simply reading the texts describing available actions. The younger crowd performed by far better than the older (60 and 81 years old) in terms of time where they spent an average of five minutes completing all the tasks compared to the almost double of the older two participants. The most significant issue found where the difficulty of all participants except one to find the toggle for user comments, required for task two. In the end, all except one succeeded in finding the toggle but in some cases due to trial and error.

In the interviews, none of the participants answered that they had used a tool for urban planning similar to this before. What everyone except one person answered though, was that our design shared similarities to Google Earth[54] and Google Maps making it intuitive to use. All of them were positive in using a tool like this, mainly in the purpose to get more information about new projects nearby to their home. The two youngest participants (age 19 and 21) all said their preferred medium of submitting comments and discussing issues related to ongoing projects where the digital medium. The three older subjects all claimed their preferred way was human contact, but agreed that it was more comfortable and more viable to submit their comments in an online tool.

Overall, the user testing session was a success and left us with much confidence in our design while also providing us with a couple of issues to fix. The most pressing of these issues was to make it more apparent how and why to use the toggles.

Usability report
Not many problems were found; the most severe problem was difficulty in finding the button to toggle buildings and comments on and off. Low amount of problem is a positive result and can be due to the tool being shallow meaning that there are not many places to navigate to. As a result, shallow navigation and limited tools don't allow much room for mistakes. The complete usability report can be found in appendix A.1.9.

5.5.4 Final changes

For our final changes to the prototype, we focused on the problems highlighted by our user testing. The first step to fix the toggles issue was to make them more prevalent to catch the user's attention by changing their color to blue (Figure 5.17). Performing this change also led to the increased contrast between the symbol and the toggle background, making it easier to see the purpose of each switch. However, it still was not evident what each switch's purpose was since there was no describing text for them available anywhere. To address this issue, we decided to add tooltips when hovering over the mouse over the toggle. Binding elements to mouse hover functionality like tooltips are impossible in Adobe XD. Therefore we were only able to create a mockup of their supposed look. Further design and functionality testing would have to be saved for later when implemented within Unity during the next phase.

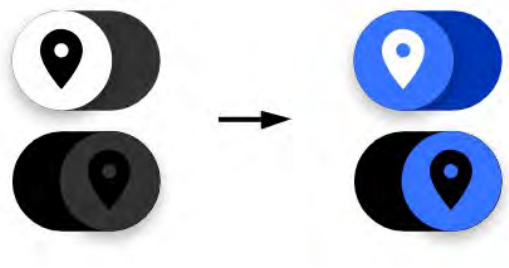

Figure 5.17: Change to toggle appearance for greater visibility when toggled off. Image made by the authors.

5.6 Sixth phase - Implementing the design

The sixth phase was the last phase of the project and concluded in an attempt at implementing our design into the Unity project of InPlan. The goal was to develop a prototype, using mock data, to be able to evaluate the features that were impossible to develop in Adobe XD, as well as making sure everything of our design were possible to develop.

5.6.1 Converting our design into a Unity user interface

Our first step in the implementation process was to construct the user interface in a self-contained project. This meant that we, in this stage, could focus on the layout, visuals, and functionality of the user interface (UI) without having to do any integration into the larger InPlan project. We opted only to use Unity's integrated components and UI system to avoid any compatibility issue with the InPlan project. Google's Material Design Icon's[55] were imported into the project as a folder of

individual sprites as well as a couple of placeholder images.

Base resolution of the user interface was set to match the one used in Adobe XD, allowing us to use the same values for margins and text sizes as our digital prototypes. Enabling UI-scaling made it usable for screens of a smaller resolution. The primary interface layout was built up in the unity scene, using a system of layered vertical and horizontal layout groups to provide a robust and expandable layout system. In this layout, the components from the digital prototype were recreated and adapted to fit any amount of information, allowing it to use whatever content provided for it.

A small data handling system was also created, mainly to prove the possibility of modular content creation. The primary data object was the information view, containing a list of components. The information views purpose was to provide a side panel or floating window with a set of information-rich components depending on which projector point of interest was activated. Using the same structure for both the sidebar as well as the points of interest allowed us to save much time while at the same time provide as much choice to the urban planners as possible. Functionality to apply data from the data structures to the sidebar and a floating window was added, along with other functions for UI-features such as minimizing information categories and moving as well as closing the floating windows.

5.6.2 Applying the interface to the InPlan project

After completing the primary functionality of the user interface, it was imported into the InPlan project. We aimed to perform a semi-functional implementation of the interface, where the actual information displayed was static while still utilizing the functionality of InPlan. This meant binding the different events of the application to invoke the functions of our interface, instead of their standard functionality. Replacing the old interface ultimately was impossible since some parts were still required for the creation mode that was active on startup. Therefore we opted for a keybinding to switch between the two user interfaces, allowing us to log into the application by the use of the regular interface and then switch over to our own by a key-press.

Binding events to the new interface proved to be a more laborious task than expected. A number of the different events and functionality of InPlan we had planned to use was intertwined with other functionality, making it hard to redirect them without having to rewrite significant amounts of code. In the end, we resided to the most basic functionality of our implementation were only a handful of our UI-elements were bound to the environment.

6

Results

In this chapter, we display our set of final results. Because of the complex issue given by our problem definition, the result is split into many parts. First, a summary of our research and our concluded guidelines are presented. Second, our three different sets of high fidelity digital prototypes are presented, each handling varied cases and users. At last, the result of our implementation is presented as a combination of visual and technical characteristics.

6.1 Guidelines to consider when designing for civil dialogue

To answer our established research question, *What should be considered when designing a city building tool to generate valuable dialogue between urban planners and citizens, to better support on-going urban planning projects?*, we have composed a list of guidelines we accounted as most important. These should not be used without consideration due to the limited amount of research that lies behind them. However, they might be of value to designers getting started with designing for urban planning and helping them understand what is relevant to the stakeholders of the process.

List of guidelines to consider, in no specific order:

- **Prioritize urban planners before citizens.** Designing for urban development means that there are two stakeholders: the city and the citizens. Designing to cater to both of them would be preferred, but since the urban planners have actual requirements to fulfill it is preferable to create a design that enables them to do this. These requirements may stem from either law, the guidelines of their municipality or from themselves in terms of preferences. Not fulfilling the requirements of the urban planners may, therefore, result in an application unused by them, and as a result of that not available for the citizens.

- **Enable effective communication handling for the municipalities.** The urban planners and responsible communication managers should be able to manage and respond to large volumes of feedback quickly and easily. Achieving this may be done by a separate interface used by the municipality for handling user comments, separate from the civil dialogue application itself. Options to effectively answer people can include preset responses or mass messaging.

- **Design for an efficient workflow when creating and managing content.** Urban planners are often busy, and any application used is probably only a small part of their entire workflow. Design for an efficient process for the urban planners, make it feel like it is worth the time they put into it.

- **Support input from citizens, despite not being official statements.** Feedback and input from users do not have to be regarded as official statements to be considered by the urban planners. Therefore there is no need to verify that users who comment are living in the affected area. Adding options for users to post official statements should be handled separately from the normal process of commenting and adding suggestions since this will need to be processed separately and in the end connected to an identified person.

- **Allow urban planners to provide diverse information.** Urban planners are not a unified set of people; they belong to different organizations with different rules and prefers different ways of communicating their plans. Instead of designing a limited set of possibilities that caters to a particular group, allow them to choose their structures for information. Allow for free text, galleries, timelines, lists of lists and document, and more as long as they can choose not to use it as well.

- **Prioritize visual content hierarchically to avoid clutter.** Visual content should be sorted and prioritized to enable a valuable dialogue. A system for how different kinds of data is prioritized on a visual level should be implemented, ranking the information by author and content. Municipality should be ranked higher than a citizen. An entry describing for example how the traffic will be affected should be ranked higher than a picture of how the place looked like 50 years ago. Performing this and sorting them using toggles and proximity based solutions may help prevent cluttered spaces like Min Stad (see Figure 2.8).

6.2 High fidelity digital prototyopes

What follows are the three digital prototypes created for the project. Each contains a set of screens displaying different views and functions of the product. The graphical user interfaces are all created in Adobe XD. The 3D-environments have been captured from inside the InPlan application and in some cases altered in Adobe Photoshop to fit our design.

6.2.1 InPlan module

Entering the InPlan home view provides users with an overview of the entire municipality (Figure 6.1). Projects are marked on the map as well as in the side menu. At the bottom right corner, a compass indicating the direction of the 3D-view and a set of buttons and toggles are located. The buttons control certain functionality of the application; navigate home, sun studies, drawing mode and street view. Above them, three toggles are present with functionality toggle the visibility of new construction, points of interests, and user-submitted points of interest. At the top right, a small pane is located indicating if the user is currently logged into the application as well as a button where the user can access a drop-down menu displaying the different settings of the application.

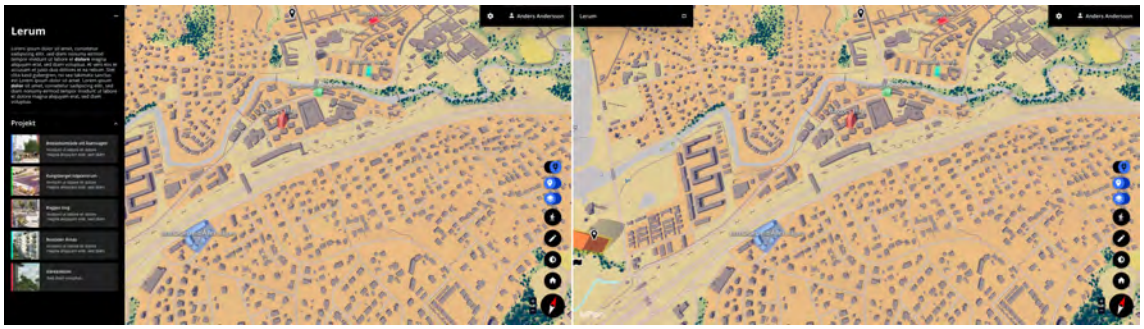

Figure 6.1: **Overview of all projects in the Municipality**. Left: Home view with active sidebar. Right: Home view with minimized sidebar
Full sized images can be found in appendix A.2.1. Image made by the authors.

When the user enters a specific project, the camera moves close to the project area, and the colored highlighting around all projects is hidden (Figure 6.2). The sidebar has its contents replaced by a project overview containing information like a gallery, description, process timeline, contact, external links, social media sharing, and comments. Project-specific points of interest are shown on the ground.

Figure 6.2: **Project view**. Top left: Start view. Top right: Side bar scrolled down. Bottom left: Side bar scrolled down to comments. Bottom right: Side bar minimized.
Full sized images can be found in appendix A.2.1. Image made by the authors.

Clicking a point of interest activates a movable window (Figure 6.3), presenting a set of information following the same structure as the sidebar. The window can be moved by dragging it by its top bar and may be closed at any time by clicking the close symbol. User-submitted points of interest can be read by toggling the corresponding toggle, activating the clickable blue and white markers. The user can submit a new point of interest by clicking on a position of their choice, where a small pane presents them at the bottom center. This displays some information about the position and provides buttons to create a new point of interest at the location or to enter the street view mode (Figure 6.4). Creating a new marker is done within a new movable window, allowing the user to enter a title and a description as well as adding up to five images.

Figure 6.3: **Project view**. Top left: Active point of interest, displaying in a floating window. Top right: Marked position, positional options pane active. Bottom left: Create new point of interest on position. Bottom right: User made point of interest, displaying in floating window.
Full sized images can be found in appendix A.2.1. Image made by the authors.

While in the street view mode (Figure 6.4) the user is able to move around freely on the ground. Points of interest are automatically toggled off to not block any sight lines. The position-pane is available at the button of the screen allowing the user to exit street view mode at any time. Toggles are also available to control visibility of structures and markers.

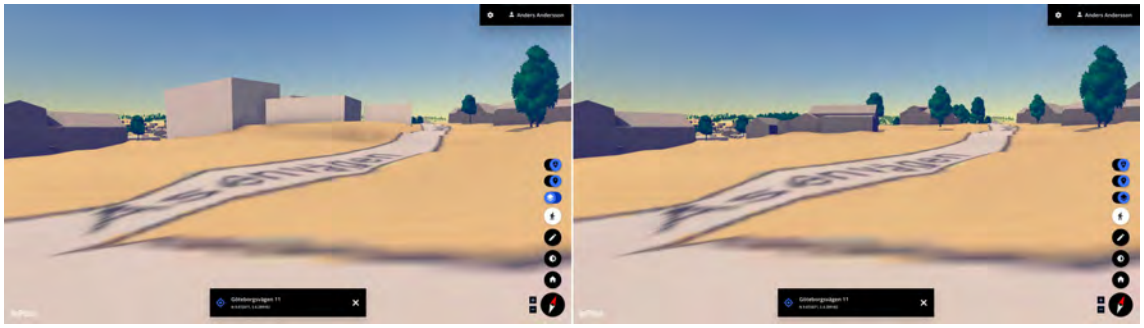

Figure 6.4: **Street view**. Left: New construction toggled on. Right: New construction toggled off, displaying original environment.
Full sized images can be found in appendix A.2.1. Image made by the authors.

6.2.2 Web interface for communication handling

A separate web interface handling the communication within InPlan is available to the municipality (Figure 6.5). The interface mainly consists of three panels, a menu, a list of new comments, and a view of the currently selected comment. Comments can be filtered on a project basis, and further sorting and filtering are possible by the button beside the title or the project. Comments already read are sorted at the bottom, with a greyed out appearance. The currently selected comment is highlighted with a blue border.

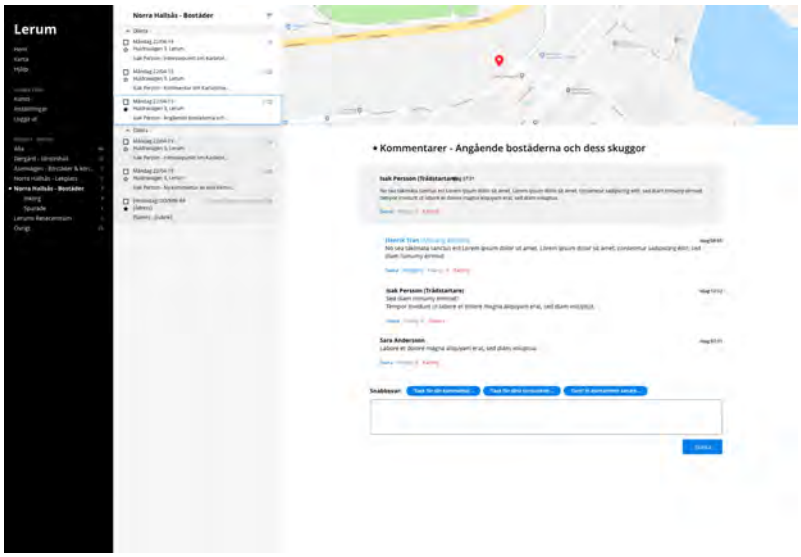

Figure 6.5: **Mock-up of the web interface for handling of user input. Image made by the authors.**

When a comment is selected, the complete list of comments on that point of interest are displayed in the rightmost pane (Figure 6.5). A map view, utilizing Google Maps open API, shows the position of the point of interest. Comments can be edited, removed, or answered. Answering is done from the text field located below the comments. A list of quick answers are provided that when clicked will automatically fill the text field with a pre-made response.

6.2.3 InPlan workflow for creating new content

Creating a point of interest within InPlan now presents the user with a new modular component-based system (Figure 6.6). Two fields are available at creation: the title and description. The title is always located at the top and users are unable to move or delete it, since it is a required property of a point of interest. The description, as well as all other components, can be reordered amongst the different components by dragging it by the handle next to its title. Deleting a component is done by the close symbol to the far right of the title. Residing to the right of the delete button

is a small toggle that determines whether the component will be minimized or not when the window is opened.

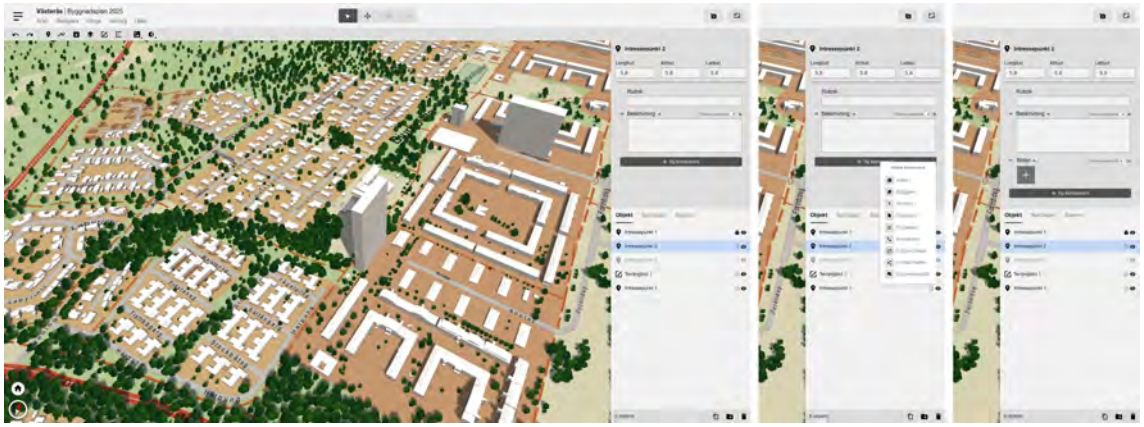

Figure 6.6: **Mock-up of the modular point of interest system in creation mode**. Left: A point of interest with no added modules. Middle: Drop down menu for adding a new module. Right: New module added.
Full sized images can be found in appendix A.2.2. Image made by the authors.

Adding a new component is done by clicking the large "Add component"-button below the list of components (Figure 6.6). This enables a small floating menu where the user selects what type of component to add. The new components are added to the bottom of the list.

6.3 Implementation of the user interface in Unity

The implementation of the user interface (UI) was made in Unity using the game engine's native components[56] as well as our own script written in C#. In addition to our own work is the base implementation of InPlan developed by ATGIS.

Figure 6.7: **Unity implementation**. Top left: Project view. Top right: Sidebar scrolled down, expanded subsections. Bottom left: Sidebar scrolled down, comment field. Bottom right: Highlighted point of interest, displaying in a floating window. Full sized images can be found in appenix A.2.3. Screenshot taken by the authors.

Available in the implementation is the project view (Figure 6.7). The sidebar is present on the left side and contains all of the modules listed in 6.2.1. The modules can be minimized or expanded by clicking on the arrow to the left of its name, which also changes the direction of the arrow to indicate its current state. The sidebar is scrollable to reveal more content. Scrolling also activates a smaller title on the always visible title bar. The title bar also contains buttons for minimizing the sidebar and exiting the project, with the latter not being functional. Present on the bottom right side of the screen is a compass, accompanied by two buttons to allow the users to zoom in and out. Above the compass is a set of buttons responsible for actions: navigate home, drawing mode, sun position (Figure 6.8), and street view mode. To the top right of the screen is the pane responsible for settings and user login. Clicking on the cogwheel-button presents the user with a small menu containing the settings: graphic fidelity (low, medium high), interface scaling (small, normal, large) and high contrast mode (on, off). Clicking on a marker activates a small movable window presenting some information in a structure like that of the sidebar.

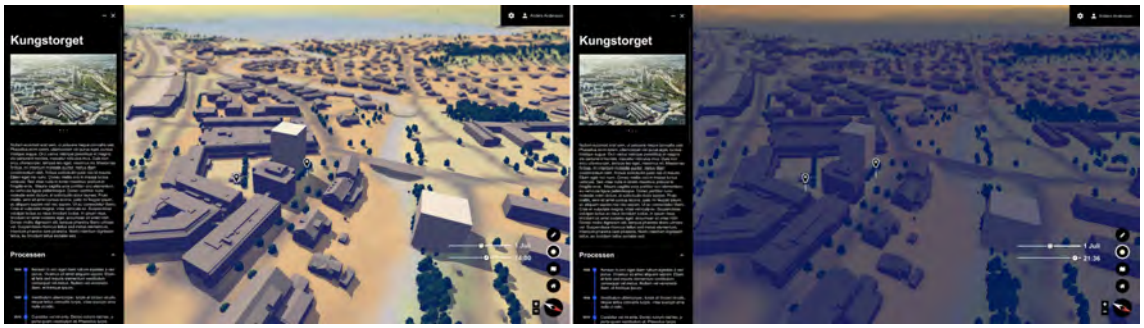

Figure 6.8: **Unity implementation - Sun and shadow studies**. Right: Sun studies panel active. Left: Sun studies set to night time.
Full sized images can be found in appendix A.2.3. Screenshot taken by the authors.

The implementation does only contain a limited amount of functionality, mostly contained within the user interface itself without interacting with the application at large. The information displayed by the sidebar and movable window is retrieved from data objects, but these data objects are static and not bound to the project in any way. The functionality of moving between different projects as well as submitting points of interests and comments is not implemented.

List of significant implemented functionality

- **Expandable sidebar.** Functionality to minimize and expand the sidebar. Accessed by clicking the button with a line or square symbol, next to the close-button at the top right corner of the sidebar. Calling the function de-activates the scrollable part of the window, activates the smaller title present in the title bar, and changes the symbol of the button to a line or a square corresponding to its new state.

- **Expandable section.** Functionality for minimizing and expanding a module in an information window. Accessed by clicking the button with a downward or upward pointing arrow symbol, next to the title of the module. Calling the function de-activates the content area of the module and changes the direction of the arrow symbol corresponding to its new state.

- **Title scrolling.** Functionality for the sidebar, allowing a large title to be displayed above the gallery and other components. When the sidebar is scrolled up, the large title fades out based on scrolling distance and a smaller title appears in the title bar.

- **Image gallery.** A module for the information window, displaying a set of images one at a time. The displaying image can be changed by clicking on the left or right side of the gallery. Hovering the mouse over one of these sides reveals a semi-transparent arrow symbol pointing in the corresponding

direction. A set of circles, each representing one image, is present beneath the image. The currently viewed image has its circle displaying in full opacity while the other is displayed as semi-transparent.

- **Process timeline.** A module for the information window, displaying a vertical timeline of connected timestamps (year-based) and a corresponding description. Each timestamp can be fulfilled which colors it and the connecting line above to the primary color, marking it as completed.

- **Comment system.** A module for the information window for displaying and handling user comments. Comments can be up or downvoted as well as replied. Chains of comments based on answers are linked to each other.

- **Re-sizable user interface.** A system controlling the scaling of the complete user interface. Can be scaled to small, medium and large. Setting one of these scales sets the base resolution of the auto scaling base canvas (where all of the user interface resides). The resolution is set to either 2560x1440 pixels (small), 1920x1080 pixels (medium) or 1600x900 pixels (large).

- **Tooltip system.** A system for providing tooltips to components of the user interface. Tooltips are activated by adding a tooltip-component to an interface element and entering a description. Hovering on an element with an added tooltip calls the system that generates a tooltip-box at mouse position until the user stops hovering the element.

- **Color system.** A system for handling colors for the user interface. Contains a list of colors, each corresponding to a string ("primary", "secondary", "grey1", etc.). Calling the system with a string then returns the corresponding color. A component with a string variable can be added to UI-elements, setting their color to the one specified by the variable on startup.

- **Information window data system.** A system for handling data of information windows. A data object contains a list of smaller data components such as galleries, descriptions, and lists of links. Components can be reordered and are able to be initiated with correct functionality in a information window.

7

Discussion

In this chapter we discuss our findings, problems and results. The chapter begins with a discussion regarding our insights into the clash that exists within the urban planning community, something we learned about from our design workshops. Following is analyzes about our process and result, what could have been done better and how our result would have changed. During the process and result discussion, we also consider how the process could have been modified to not have ended in the sixth incomplete phase. Generalizability and future work is introduced at the end of the chapter, describing processes of moving forward with this project as well as what can be of use by other similar projects.

7.1 The challenges of empowering citizens and providing transparency in urban planning

A reoccurring topic of discussion that came up during the interviews and workshops was how much control a citizen should have when interacting with the dialogue tool. There were two contrasting opinions if citizens should be able to interact with other citizens and the municipality.

One side argued to limit the capabilities of how much a citizen can interact with other people in the dialogue tool. This means disabling any chat functionality and strictly keeping the tool as a way to convey information. There are several reasons behind these comments. Some argued that the dialogue between citizen most often deteriorates to a lower level of communication that does not result in any valuable discussion. The argument to why the quality of discussions always descended was because of the veil of anonymity. The citizens leaving the comments did not feel the need to upkeep quality and responsible discussions if it could not be traced back to them.

This argument also applied when the dialogue was directed to the relevant people working in the municipalities as some found that the dialogue online did not give any results worth working with. Some in the municipality instead argued for physical meetings. They spoke from experience and knowledge that the physical meetings

have had a more positive feeling and resulted in more meaningful discussions because there was no veil of anonymity.

The arguments are reasonable and understandable but come at a price. Having physical meetings means that the accessibility will be limited. The physical meetings would require citizens to be available at that time and place. There is also the questionable ethics of limiting the citizens by presenting fewer opportunities to get involved. Another factor in the whole argument is the availability of resources. Municipalities with more resources have more opportunities they can present to the citizens.

Another reoccurring theme was transparency and how much information the municipality should give to its citizens. One side argued that, by holding back information, citizens would have less to ask about which will save both time and energy for the municipalities. Essential to keep in mind is that this does not necessarily mean that the time and energy will be used for their self-interest but will instead be focused into another priority at hand since most of those we discussed with had a shortage of staff in the municipalities.

The other side argued for the municipalities to share as much information as possible to keep the citizens informed since they will most likely get a hint of the ongoing projects anyway and that its best to keep the root of information from the municipalities themselves. Transparency and giving more information could also instead improve the quality of discussion by informing and giving citizens more to work with. Above all else, informing and keeping it transparent could prevent many unnecessary debates by answering the citizens' issues before they come up.

The study by Golobič (section 3.3) is relevant to this discussion. In her study, she describes the importance of involving the public early on while also including them in the process as much as possible as well as keeping the process as transparent as possible. Golobič also states that the validity of the decision-making involving the public is compromised if these objectives (found in section 3.3) are not fulfilled.

We have tried to make the dialogue tool as efficient as possible for the municipalities to administrate. We have included the option to provide a wide variety of information types, to facilitate transparency by making it easy for the municipalities to publish information.

Ultimately both sides have one shared goal, and that is to have a smooth process as possible with the citizens' interests at the top. Both these sides are different solutions to one issue. What we hope to achieve is a solution that provides a civil dialogue valuable enough to be used even by those on the side that oppose transparency.

7.2 Design process

After concluding the project, we had performed six phases of work, four of them iterative prototyping cycles. One of the most significant benefits of working in fast iteration cycles is the amount of flexibility it provides to not only the project, but to the product as a whole. While our design did not go through substantial changes in the basic layout, functionality was continuously updated and sometimes scrapped altogether. This process of fast iterative work has resulted in a good structure in the workflow, mainly due to the uncertainty and scattered dates we have had to use to work with Kungälv and Lerum. Especially the two workshops held at Lerum's town hall was held far later than scheduled in our planning, something that was in part saved by our iterative process. The iterative process has led to us being able to accustom our workshop structures by applying our latest design components and in turn use the resulting thoughts and ideas in a more relevant fashion. The two interviews, held at the start of the project, also gave us a lot of relevant data. In the end, we managed to use the interviews for two purposes, to get an insight into the work of our stakeholders and also provide data for a requirement specification. Working in pairs in the format of a semi-structured interview worked out great, especially our process of transcribing the audio by ourselves first and then combining the data. The transcription process allowed us to quickly highlight the data we both deemed to be necessary, and discard what did not.

Even though the timing of the workshops was a bit out of sync with our process, the resulting insights from our side, and hopefully theirs, have been of great value to the project. Spending four hours with groups of urban planners and other people of relevance has allowed us to put ourselves in their positions and design with them in mind. The drawback of this is that it might have led to a process too focused on one group of stakeholders, while down prioritizing the other group, the citizen. The problems stem mainly from the fact that the urban planners have specific standards and information they need to provide, both by their preference and by law. This resulted in us focusing on the planners because a lacking product by their standards would not be used by the citizen nevertheless. While it might not have been possible for us to skip much of our data gathering process for urban planners, we should have worked to get more data from the citizen. Notably lacking in our data gathering from citizens was early on in the process where a questionnaire to gather quantitative data would have been advantageous for our design work.

Our process of original design and implementation worked decently well throughout the whole process, except for the failed implementation at the last phase. Throughout the project, we have been hindered by our desire to focus on details that may not have been of great importance to the phase. Lengthy discussions about icon choices and margins were held at the early parts of the prototyping, something not relevant until the later stages of high fidelity prototyping. Nonetheless, our work moved on at a steady pace of progress until the last phase. The implementation of a functioning prototype proved to be too ambitious and left us with an unfinished and untestable Unity prototype. A solution to this would have been to have looked more

into the codebase of InPlan early on in the project and evaluated the possibilities of a semi-functioning prototype. This would have led us to either tighten up our design process to allow us more time for implementation or scrapped the implementation entirely in favor of a more advanced Adobe XD prototype.

7.3 Research result

Our research result was compiled into a list of six guidelines we consider essential for our design work that applies to other projects within the urban planning context. The underlying aspects of the guidelines were mostly achieved by the discussions held at the workshops and the two interviews. All of the guidelines apply to our final design since they are based on the same underlying data. Overall, the guidelines aim to point out what needs to be considered when explicitly designing for urban planning. Therefore, guidelines applicable to other types of interaction design should still be considered valid if not strictly contradict ours.

We decided to focus on broad general guidelines due to the diverse field we conceive urban planning to be. Most of them govern the overall design of an application, aiming to achieve an efficient workflow for urban planners. The exception to this is the guideline *Prioritize visual content hierarchically to avoid clutter* that aims to improve the user experience for the citizens by avoiding cluttered interfaces as seen in tools like Min Stad. The guideline *Prioritize urban planners before citizen* may be considered as our most general, and perhaps also the most controversial out of the six. Determining on the wording of this guideline was hard, but we decided to put it as straight forward as possible to reflect how it actually works.

We could probably have continued adding guidelines in the same fashion, targeting problems often occurring within similar tools, but we wanted to focus our guidelines towards the dialogue between the urban planners and citizens. Doing this meant our guidelines assume that the underlying application itself is of sufficient usability and, as mentioned above, adheres to already established guidelines within interaction design. We chose not to reflect on some aspects of our work in the guidelines such as our methodology and process. The motivation behind this decision is because we did not perform any conclusive research on how different methods performed in our context, but instead used the methods as a means to reach a result.

7.4 Design result

Due to our issues with the implementation, our final design result should mainly be considered as the set of screens designed in Adobe XD. These screens do hold up to our expectations and the solutions implemented should be seen as the answer to our initial problem description and question. While they might lack certain functionality that was only possible to implement in the Unity prototype, they provide

the functional cues (like symbol choice) to enable implementation. An example of this is the minimization and expansion of subsections found in a project or point of interest description. This is hard to implement through a prototyping application like XD without creating multitudes of new screens. Instead, the button to expand and minimize, an upward pointing arrowhead icon, should to some degree be enough for designers and stakeholders to conclude the intended functionality.

We would probably have arrived at a more conclusive final design if we had managed the implementation of the interface. A lot of the functionality of the application resides outside of our user interface, which suggests that users of our final testing might have acted differently if the tests were performed with a semi-functional prototype. Although the implementation was unfit for user testing, it does still hold a lot of production value for continued work, since a lot of the implemented functionality and structures are usable for the continued work of InPlan. The implementation also proved some of our uncertain functionality to be possible and therefore solidified our design.

7.5 Generalizability

Even though this thesis is aimed towards the design of a module for a specific application, a lot of it should also apply to civil dialogue in other contexts, using other tools and methods as well as other parts of the planning process. The list of guidelines to consider when designing (described in section 6.1) covers some parts of how interaction design in urban planning at large may be approached. The correctness of these guidelines are hard to determine, but due to our results from our interviews and workshops spanning two different municipalities, we can be relatively secure to state that this extends into other places.

Our technological issues and solutions from implementing our design can also be applied to other development, especially game and application development done in Unity. They are also an indicator of difficulties encountered when applying a new interface to an already completed application with a large codebase.

7.6 Future work

Moving forward, the next step is completing the sixth phase of our project. This includes finishing the semi-functional prototype in Unity and performing the consecutive user testing. This would then give way for completing the implementation, along with back end functionality needed for our solution. Preferably, this should follow the same kind of iterative workflow as used by us and involve more municipalities for further testing and evaluation.

Further on , we hope our design is used in the next version of InPlan and be well

received by all stakeholders. Some parts of the design might have to be reconsidered when exposing them to real-world scenarios, especially the color choices that currently are set by the municipalities themselves. These colors might need some adjustment to fit with our dark color choices while also maximizing accessibility[52]. Individual municipalities other than the ones we have worked together with might also have other needs of functionality to be implemented. This would, of course, require further design work and maybe even restructuring of the current design. That should not be of concern, because it is the life of a continuously developed product where changes to already completed work should be seen as improvement.

8

Conclusion

This thesis aimed to answer the question: *What should be considered when designing a city building tool to generate dialogue between urban planners and citizens?* To achieve this, we have held interviews and workshops with participants involved in the urban planning process at Kungälv and Lerum municipality, examined existing solutions, and studied other work of related subjects. To put theory into practice, we created a design of an online module for InPlan intending to promote sustainable civil dialogue regarding urban planning between a municipality and its citizen. An iterative design process was utilized, resulting in a prototype covering use cases of both our stakeholders. Finally, we attempted to implement our new design into InPlan that in the end, did not reach a high enough functionality for user testing.

From our theoretical and practical work, a list of guidelines was compiled. These six guidelines are what we recommend following when designing for civil dialogue within urban development (a complete list can be found in 6.1):

- Prioritize urban planners before citizens.
- Enable effective communication handling for the municipalities.
- Design for an efficient workflow when creating and managing content.
- Support input from citizens, despite not being official statements.
- Allow urban planners to provide diverse information.
- Prioritize visual content hierarchically to avoid clutter.

This list is not a definitive set of guidelines, merely what we recommend following. In conclusion, urban planning is a complicated process, but despite that, many urban planners and municipalities are willing to put in the energy for improving the civil dialogue, which is evident in this thesis. While there is room for additional guidelines and improvements, this thesis provides a well-grounded foundation for future work.

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A

Appendix

A.1 Lists and tables

A.1.1 Complete list of answers from first workshop

Question	Answer
What pros and cons do you see with civil dialogue?	• Con: People only care about who they are affected. • Citizen may get their opinions heard. • A con is that people does not have a lot of knowledge about urban planning. • Con: may take time and is not always profitable. • Pro: citizens often know things about their nearby area that the urban planners are not aware of. • A disadvantage with today's civil dialogue is that it does not engage the correct people at the correct phase. • Clarifies the area conditions, support for developing discussion, may lead to citizen believing in limitless ability to affect the process and be a conflicting democracy. • Clearer picture of the project. Less appeals. Shorter and cheaper process. We get ideas and tips. • May become violent.
What do you reckon citizens find important?	• Lisa answered those questions. • Promote democracy. • How high, how dark, how close, how does it feel? • Shadows, view, insight, availability, over exploitation, increasing traffic, safety.

When in the process do you see civil dialogue as most important?	• At an early point for the zoning and other strategic work. • Early! Let the citizens join and provide ideas and engage in how they want their city to be shaped. • Relative, but in most cases early on. • As early as possible. • It differs from plan to plan. But in most cases at the start.
How effective do you find civil dialogue to be in Lerum municipality currently?	• Don't know... • Don't know. • I lack information or statistics. • May be able to answer in a year.

A.1.2 Complete list of answers from second workshop

Question	Answer
What pros and cons do you see with civil dialogue?	• Fun for the citizens to get a chance to voice their opinons • Not involved in the planning process • Con: Time consuming • Citizen often know more about their local area • There often exists good intentions that municipalities do not have energy to deal with, that may be contraproductive from a democratic perspective and for trust. • Pros: Its accessible. You have a chance to influence decisions. Cons: How are you supposed to reach people about [InPlan]? There are a lot of elderly who are inable to use [InPlan] that wants to influence the decisions. • Pros: To early be able to take part in important opinions of a project to take into consideration. Maybe [urban planners] have not thought of everything. • It might create a rewarding communication and meetings between citizens that wouldn't have met otherwise. • pro: Catches thoughts and ideas that might otherwise have been overlooked. Con: It's hard to get a good overview, since it's often the same people who are engaged. • The municipality risks to give more influence to already strong individuals. • Do the voice of the citizen reach the politicians? Do they see what the citizen want? They are after all in charge.

Question	Answer
What pros and cons do you see with civil dialogue?	• Complex questions require sophisticated methods and extreme amounts of preparation time, is it worth it? • Young people might get involved and get a enticed to work with urban planning in the future. • A way to give the citizens opportunity to affect the society and for themselves to feel safe about the future. • In one way the opportunities exist. Practically, it might not be as simple. • If we use the residents we include more people. • Yes and no. Which citizens?
Do you reckon citizens currently get their opinions heard?	• Do not know. • The ones who shout the loudest. • Yes and no. Which citizen are meant? • If we use the notion of residents instead we include people who do not have Swedish citizenship. • Both. It is about the fact that those who are already interested can take to much space. • Those who have time to go to meetings and engage themselves. • Yes and no. It's important that the information about what exists reaches the citizen. • Depends how we define "get their opinions heard". Higher levels of influence that consultation requires an amount of money. • Even if the citizen get their voice heard, it feels like they get a bit disregarded because someone in a higher position of power gets to decide in the end.

Question	Answer
What do you reckon citizens find important?	• Vested interest. • If new houses are supposed to be built: Noise, light and height. • Shadows. • That information reach me in the channels i use. For example that a meeting is not only announced in a news paper I'm not reading. • To get to hold the municipality accountable. • How is the price of property affected? • Venues. • Fear of change, fear of economy, fear of integrity. • What do I win or lose from this. Hard to see the whole picture.
When in the process do you see civil dialogue as most important?	• Early on. • Before. To have general knowledge before the process is initiated. • During the whole process. Transparency. • When new project are planned. • During consultation. But also earlier if possible and time is available. • At consultation. When you can show what's going on. • After, we evaluate too little. • Before, during and after consultation. • Do not know.

Question	Answer
How effective do you find civil dialogue to be in Lerum municipality currently?	• Do not know. • It can most probably be improved. • Have not tested it as a citizen. • Does it exist? • It is quire uneven and maybe a bit governing. • Not that effective, otherwise we wouldn't have to buy this system.
What is the most important functionality of your design?	• Feedback and that you provide the correct information about what is being planned and that you can explain more about why it is cheap that the citizen are engaging with it. • To be able to give quick simple expressions in the shape of thumbs up or thumbs down so that everybody are able to express themselves. This should be possible on all different parts of the plan! • That it works, is updated and that the resident/citizen gets feedback. • Clickability of map. Possibility to use layers. Continuous updating (week wise). • That the municipality delivers correct information to those who lives and work in Lerum. • To make the object interesting to activate thoughts from the user.

Question	Answer
Was there something you wanted to work more with during the workshop?	• I don't know. • Would have wanted that more from different parts of the organization participated. For example the communications unity and KomIn (customer service). • Hard to say. Feasability maybe? • How do we build upp the knowledge about the 3D-tool among the citizen.

A.1.3 Cognitive walkthrough, first paper prototype

Tasks for the participating user to perform:

1. Locate the information about the current project
2. Enable user markers
   (a) Click on a Points of interests (a marker)
   (b) Read the description of the selected point of interest
3. Close the selected point of interest
4. Minimize the sidebar
5. Exit the project view

Questions asked for each task:

- **Q.1** Will, the user, want to produce whatever effect the action has?
- **Q.2** Will users see the control (button, menu, label and other components) for the action?
- **Q.3** Once the user finds the control, will they recognize that it will produce the effect they want?
- **Q.4** After the action is taken, will users understand the feedback they get, so they can confidently
  continue on the next action?

Task	**Q.1**	**Q.2**	**Q.3**	**Q.4**
Locate the information about the current project	Y	Y	Y	Y
Enable user markers	Y	N	N	Y
Click on a Points of interests (a marker)	Y	Y	Y	Y
Read the description of the selected point of interest	Y	Y	Y	Y
Close the selected point of interest	Y	Y	Y	Y
Minimize the sidebar	Y	Y	N	Y
Exit the project view	Y	Y	N	Y

A.1.4 Cognitive walkthrough, second paper prototype

Tasks for the participating user to perform:

1. Locate the information about the current project and download a document
2. Enable user markers
3. Click on a Points of interests (a marker)
   (a) Read the description of the selected point of interest
   (b) Close the selected point of interest
4. Enter street view at a position of choice
5. Enable the timeline
   (a) Set the timeline to the start of the project
6. Minimize the sidebar
7. Exit the project view

Questions asked for each task:

- **Q.1** Will, the user, want to produce whatever effect the action has?
- **Q.2** Will users see the control (button, menu, label and other components) for the action?
- **Q.3** Once the user finds the control, will they recognize that it will produce the effect they want?
- **Q.4** After the action is taken, will users understand the feedback they get, so they can confidently
  continue on the next action?

Task	**Q.1**	**Q.2**	**Q.3**	**Q.4**
Locate the information about the current project and download a document	Y	Y	Y	Y
Enable user markers	Y	Y	N	Y
Click on a Points of interests (a marker)	Y	Y	Y	Y
Read the description of the selected point of interest	Y	Y	Y	Y
Close the selected point of interest	Y	Y	Y	Y
Enter street view mode at a position of choice	Y	N	Y	Y
Enable the timeline	Y	N	N	Y
Set the timeline to the start of the project	N	Y	Y	Y
Minimize the sidebar	Y	Y	Y	Y
Exit the project view	Y	Y	N	Y

A.1.5 Cognitive walkthrough, first digital prototype

Tasks for the participating user to perform:

1. Locate the information about the current project
   (a) Download a document
   (b) Read user submitted comments
2. Enable user markers
3. Click on a Points of interests (a marker)
   (a) Read the description of the selected point of interest
   (b) Close the selected point of interest
4. Enter street view at a position of choice
5. Access the settings menu
6. Minimize the sidebar
7. Exit the project view

Questions asked for each task:

- **Q.1** Will, the user, want to produce whatever effect the action has?
- **Q.2** Will users see the control (button, menu, label and other components) for the action?
- **Q.3** Once the user finds the control, will they recognize that it will produce the effect they want?
- **Q.4** After the action is taken, will users understand the feedback they get, so they can confidently
  continue on the next action?

Task	**Q.1**	**Q.2**	**Q.3**	**Q.4**
Locate the information about the current project and download a document	Y	Y	Y	Y
Download a document	Y	Y	N	Y
Read user submitted comments	Y	Y	Y	Y
Enable user markers	Y	N	N	N
Click on a Points of interests (a marker)	Y	Y	Y	Y
Read the description of the selected point of interest	Y	Y	Y	Y
Close the selected point of interest	Y	Y	Y	Y
Enter street view mode at a position of choice	Y	Y	Y	Y
Access the settings menu	Y	Y	Y	Y
Minimize the sidebar	Y	Y	Y	Y
Exit the project view	Y	Y	N	Y

A.1.6 Heuristic evaluation

Question	**V1 (1-5)**	**V2 (1-5)**	**V3 (1-5)**	**V4 (1-5)**
Visibility of system status	4	3	3	3
Match between system and the real world	3	4	5	5
User control and freedom	5	5	5	5
Consistency and standards	2	3	3	4
Error prevention	3	2	2	3
Recognition rather than recall	4	5	5	5
Flexibility and efficiency of use	4	3	3	4
Aesthetic and minimalist design	1	3	4	5
Help user recognize, diagnose, and recover from errors	2	1	2	3
Help and documentation	1	2	2	3
Total points	**29**	**31**	**34**	**40**

A.1.7 List of tasks and questions from the first round of user testing

1. Enter a project
    (a) Find more information about the project
    (b) Download a document from the project description
    (c) Find the user submitted comments on the project
2. Minimize the side bar
3. Click on a *Points of interests* (a marker)
    (a) Read the description of the selected point of interest
    (b) Close the selected point of interest
4. Enter street view mode at a street of your choice

A.1.8 List of tasks and questions from the final round of user testing

Tasks for the participating user to perform

1. Browse to the project view of the project "Housing at Åsenvägen"
   (a) Find more information about the project in question
   (b) Find the link to the project website
   (c) Find the user submitted comments on the project
   (d) Up-vote a comment you agree with
   (e) Respond to a comment you don't agree with
   (f) Find more information about the town hall
2. Activate user submitted *Points of interests*
   (a) Read the user submitted *Points of interest* about the dangerous crossing
   (b) Click the ground at the junction Göteborgsvägen Brogårdsvägen
   (c) Enter the *Street view* mode at the junction
   (d) Toggle the view mode between the old structures and the ones to be built
   (e) Exit the *Street view* mode
   (f) Create your own *Point of interest* at the junction
3. Find the *Sun and shadows* -tool
   (a) Change the sun position to that of December 6th, 14:00
4. Find the settings menu
   (a) Change the user interface scaling to be larger
   (b) Enable the high-contrast mode
   (c) Log off the application

Questions to the participant

- What is your age?
- Have you used a tool similar to this before?
- Have you voiced your opinions about a urban development project before?
- How would you currently proceed if you wanted to voice your opinions about a current development that would affect you?
- In what medium (physical meeting, phone, mail, etc.) would you prefer to voice your opinions about a project through?
- How would you describe your overall impression of the tool?
- Was there any information that you couldn't find about the project in question while using the tool?
- Would you consider using a tool like this in real life?
- In what purpose, if any, would you use this tool?
- As a citizen, do you think there is a possibility to affect the outcome of a on-going urban development project with a tool like this?
- Do you think anything was missing from the tool, like an important feature for example?

A.1.9 Usability report on user testing

Not many problems were found, the most severe problem was difficulty in finding the button to toggle buildings and comments on and off. Low amount of problem is a positive result and can be due to the tool being shallow meaning that there are not many places to navigate to. As a result, shallow navigation and limited tools don't allow much room for mistakes.

Problems found	Frequency	Impact	Persistance
Unclear toggles	High	Medium	High
Missing tooltip	Low	Low	Low
Unclear how to place points of interest	Low	Low	Low

List of problems that will be fixed

- Unclear toggles

Reports on positive findings

- Great that so much information is available (documents, contact information, etc)
- Option to view the process timeline and contact information is valuable
- Overall intuitive interface

Detailed task and scenario descriptions

1. View the information and contents of a ongoing project (images, comments, etc)
2. Place a comment on a ongoing project
3. Find further documents and information about a project
4. Place a point of interest on the map
5. Lower the graphics settings
6. Check out the sun study function and how the sun affects the ongoing projects
7. Contact someone responsible for the project
8. Look at a project from ground level
9. Toggle a building on/off

A.2 Gallery

A.2.1 Result mockups

Figure A.1: Mockup showing the home view. Image by the authors.

Figure A.2: Mockup showing the home view with the sidebar minimized. Image by the authors.

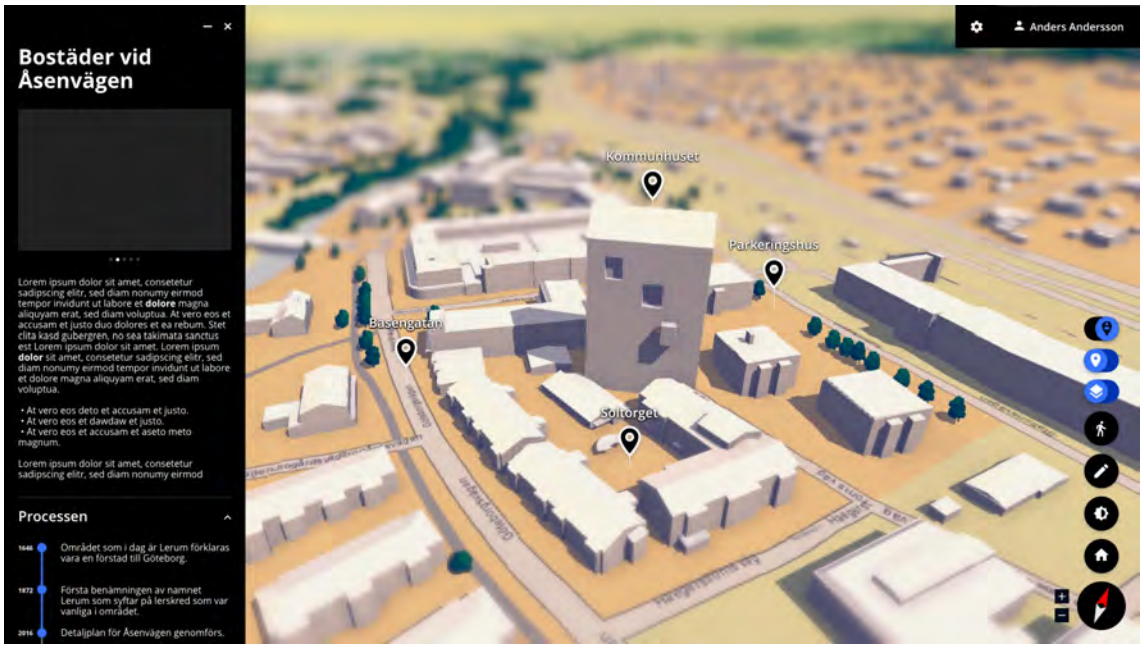

Figure A.3: Mockup showing the project view. Image by the authors.

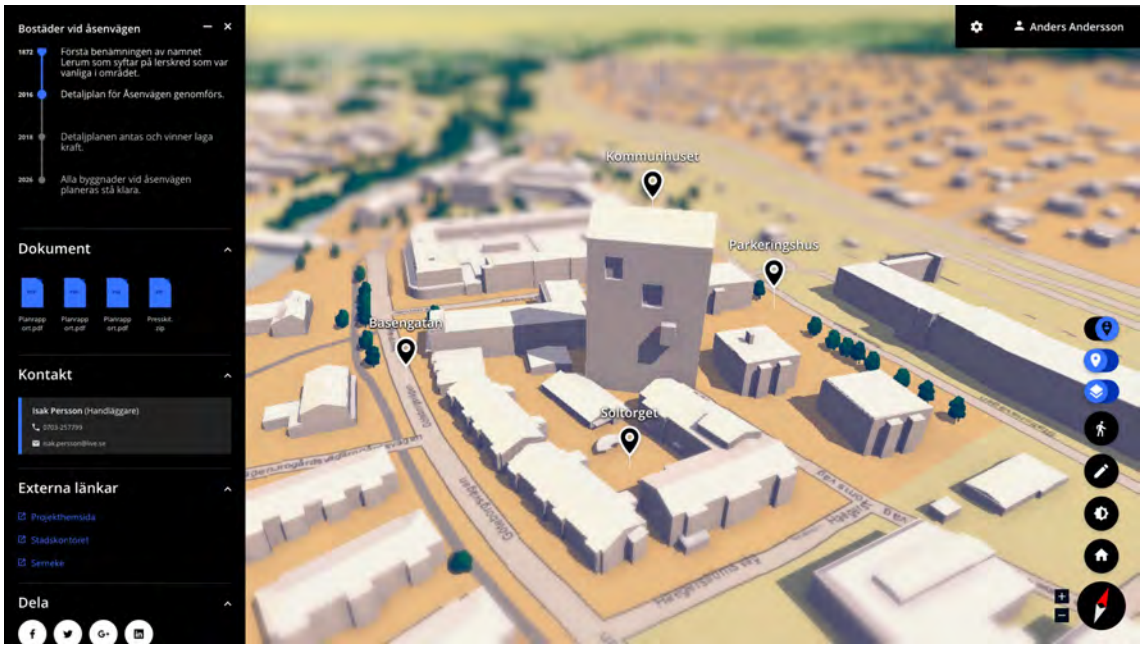

Figure A.4: Mockup showing the project view with the side bar scrolled down, displaying documents, contacts, external links, and social media sharing. Image by the authors.

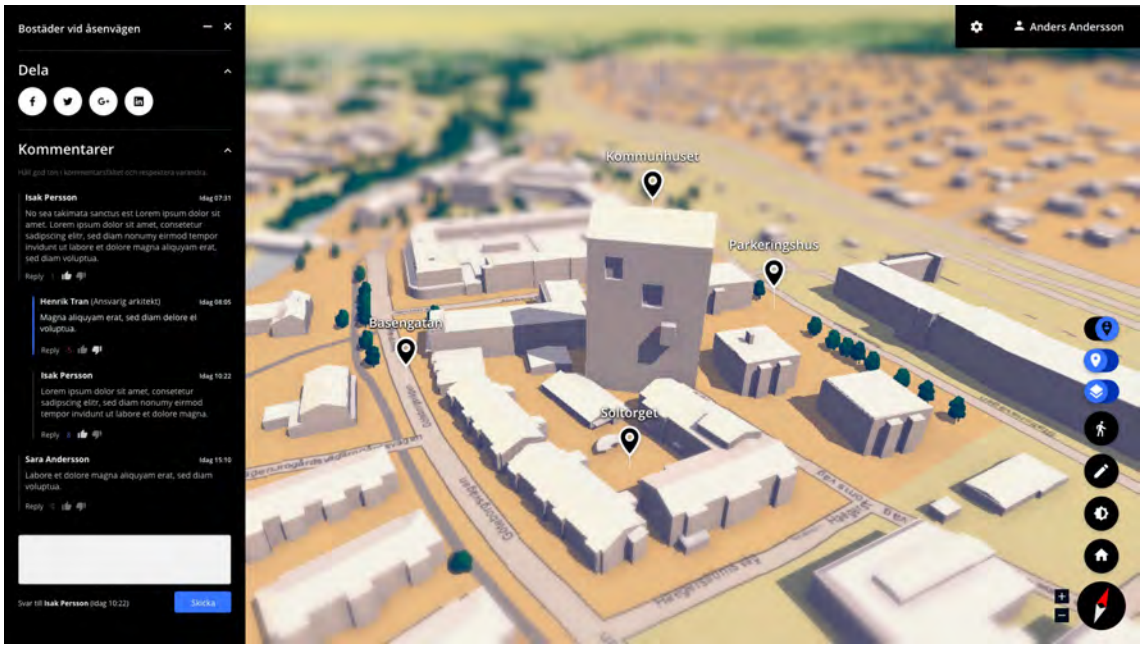

Figure A.5: Mockup showing the project view with the side bar scrolled down, displaying user comments. Image by the authors.

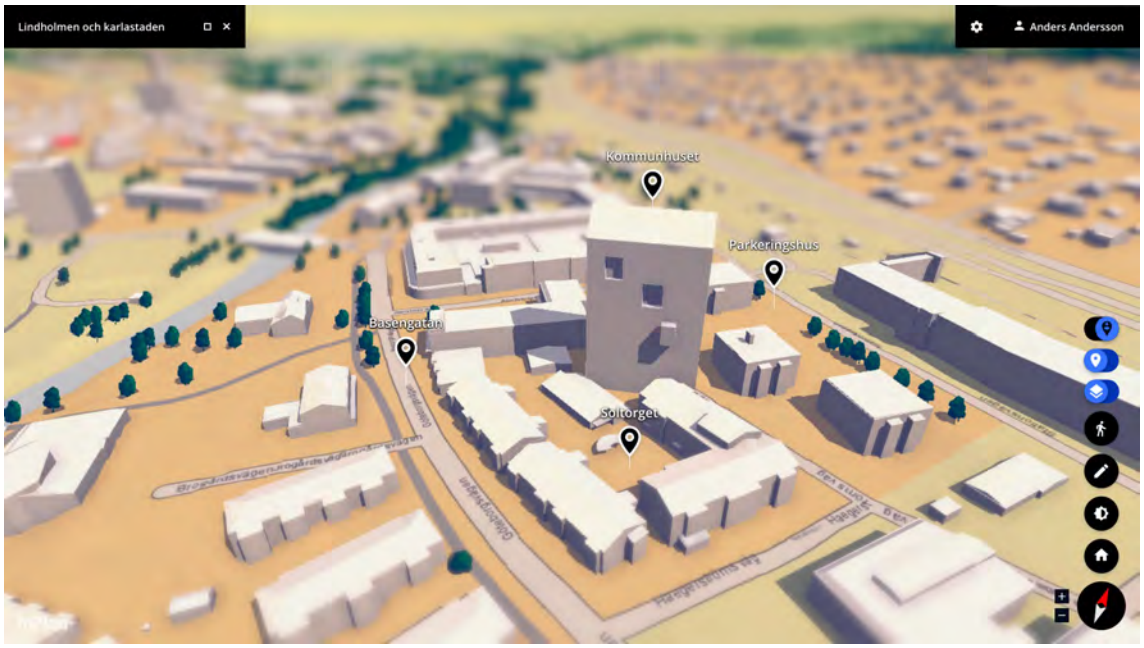

Figure A.6: Mockup showing the project view with the sidebar minimized. Image by the authors.

Figure A.7: Mockup showing the project view with a point of interest active, enabling a movable window with information. Image by the authors.

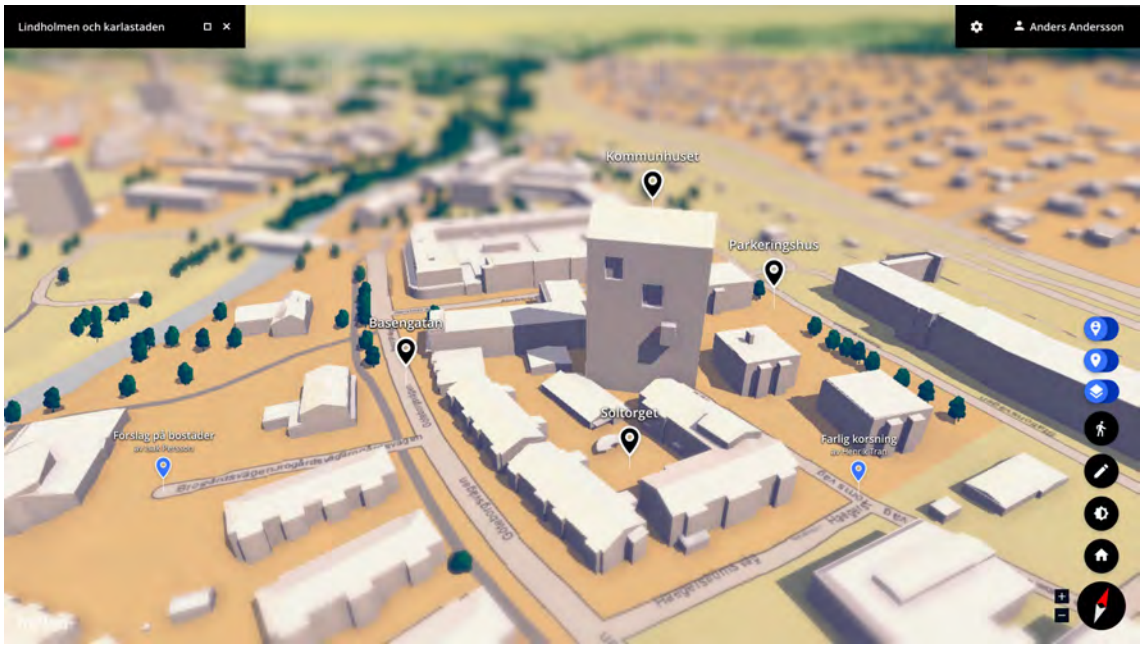

Figure A.8: Mockup showing the project view with user points of interest activated. Image by the authors.

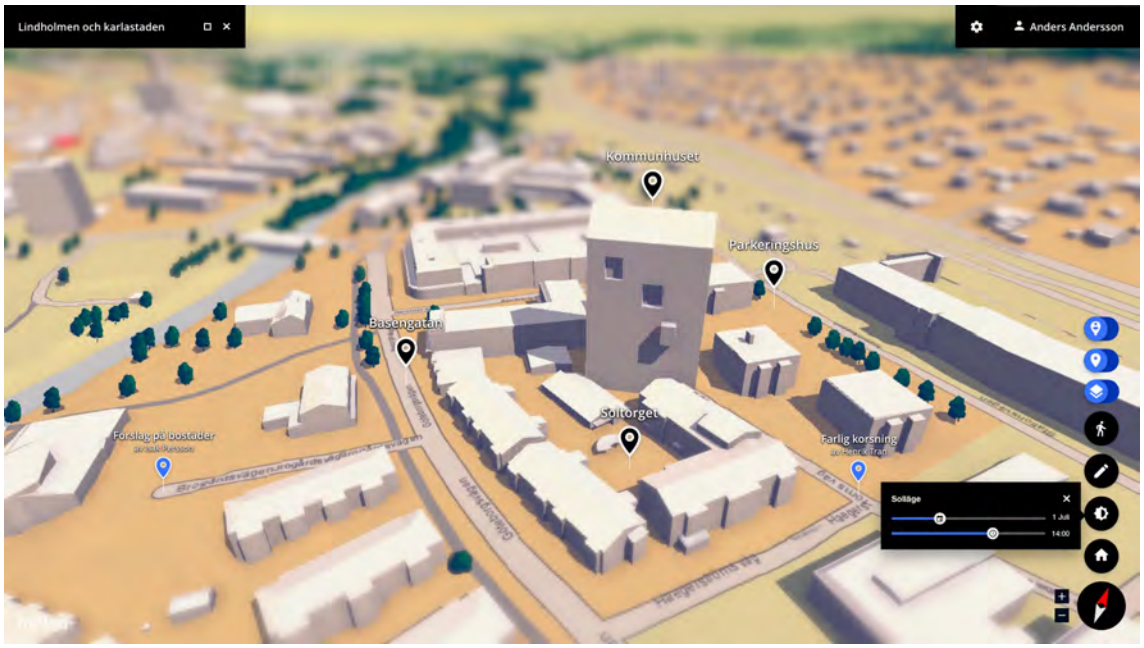

Figure A.9: Mockup showing the project view with the sun settings pane enabled. Image by the authors.

Figure A.10: Mockup showing the project view with a point on the ground clicked, enabling the position pane. Image by the authors.

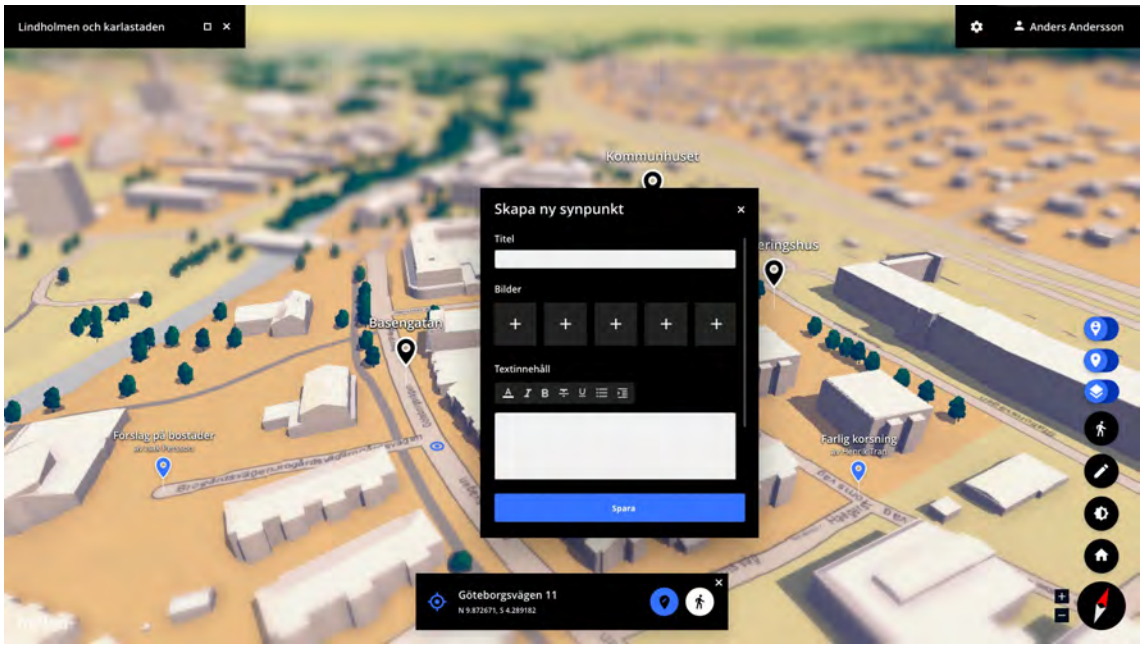

Figure A.11: Mockup showing the project view, displaying a new user submitted point of interest being created in a movable window. Image by the authors.

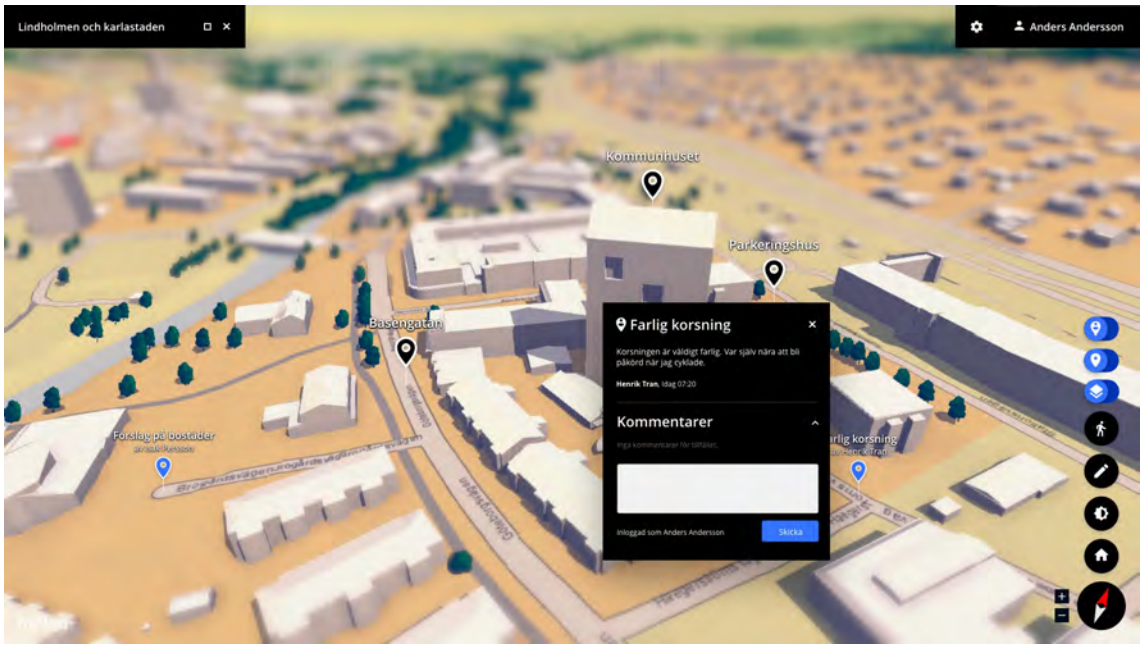

Figure A.12: Mockup showing the project view displaying the information of a user submitted point of interest. Image by the authors.

A.2.2 Interface for creating points of interest

Figure A.13: Mockup showing the creative mode of InPlan, with a point of interest being inspected. Screenshot by the authors.

Figure A.14: Mockup showing the creative mode of InPlan, displaying a menu for adding new modules to a point of interest. Screenshot by the authors.

Figure A.15: Mockup showing the creative mode of InPlan, displaying the inspector of a point of interest with a gallery module. Screenshot by the authors.

A.2.3 Resulting implementation

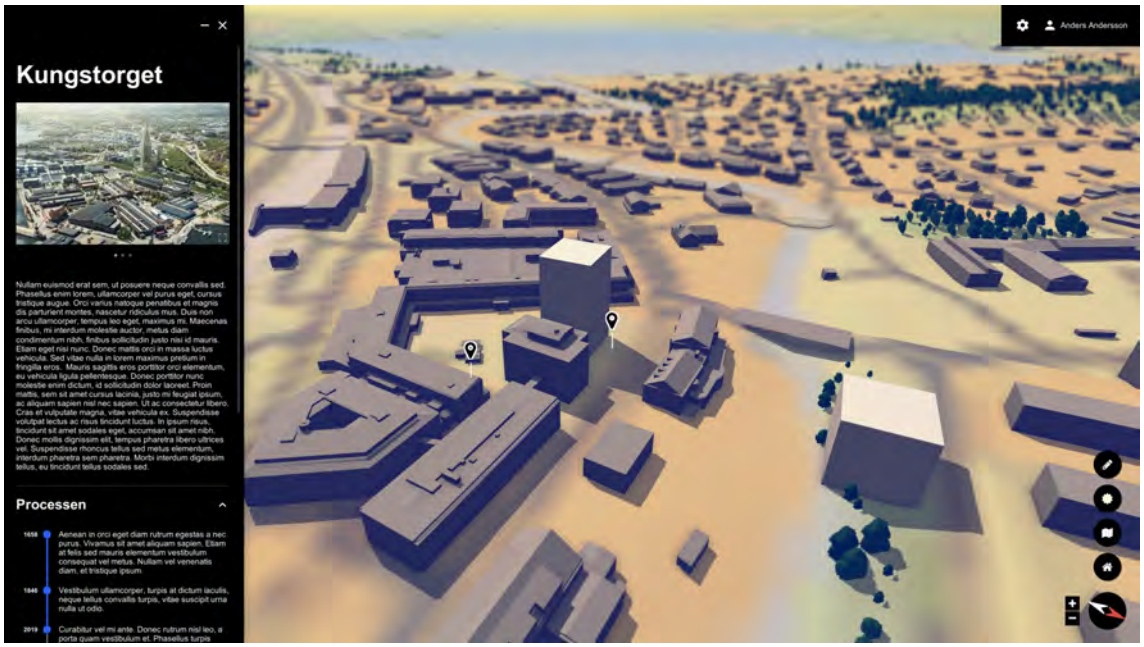

Figure A.16: Screenshot of the implementation, displaying the project view. Screenshot by the authors.

Figure A.17: Screenshot of the implementation, displaying the project view with the sidebar scrolled down showing documents, contact information, external links and social media sharing. Screenshot by the authors.

Figure A.18: Screenshot of the implementation, displaying the project view with the sidebar scrolled down showing user submitted comments. Screenshot by the authors.

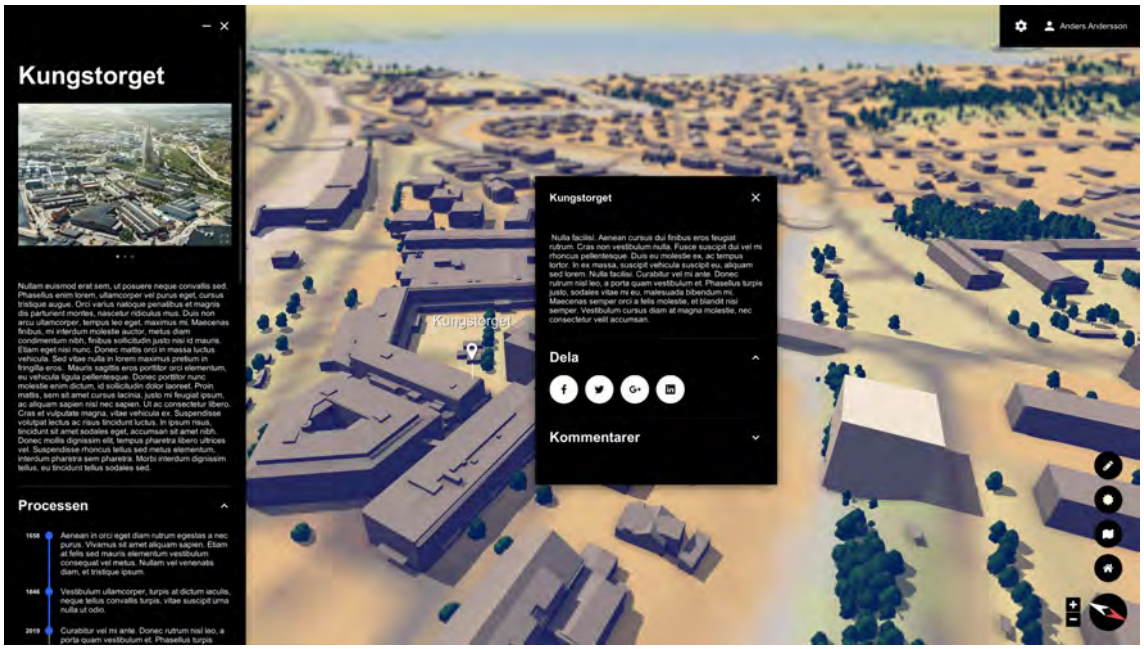

Figure A.19: Screenshot of the implementation, displaying the project view with a point of interest being inspected in a movable window. Screenshot by the authors.

Figure A.20: Screenshot of the implementation, displaying the project view with the sun settings pane enabled. Screenshot by the authors.

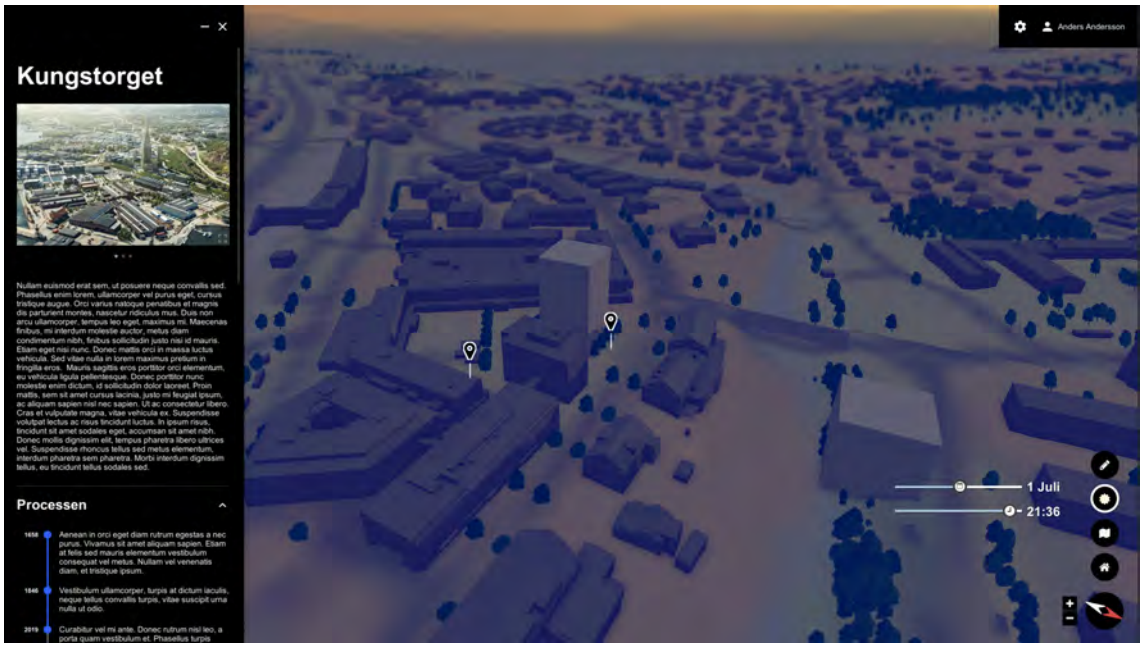

Figure A.21: Screenshot of the implementation, displaying the project view with the sun settings pane enabled and the time changed to 21:36. Screenshot by the authors.