

Inclusive 3D Campus Map of TU Delft

Final Report

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Synthesis Project 2025 (GEOIT1501)

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Abstract

A campus map serves as the gateway to information about infrastructure, facilities and services a university provides. We critique existing campus maps of TU Delft from an inclusive perspective, and propose a new 3d inclusive campus map targeted at staff and students. The map integrates both 2D and 3D spatial representations, consolidates outdoor and indoor information, and offers interactive map functionalities prioritising the needs of the underrepresented communities of the university. In fulfilment of the GEOIT1501 Synthesis Project course and our client the Diversity and Inclusion Office, our map serves as the foundation upon which future projects may build upon to continually provide a comfortable and socially safe campus grounds for all staff and students.

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1. Introduction

A map in its base form is a source of information. It is a canvas upon which the mapmaker shapes data into a coherent message for viewers. The mapmaking process is therefore an exercise in abstracting reality; the mapmaker makes deliberate choices in simultaneously prioritising certain information and omitting other information. This has implications on who the map serves, and conversely excludes through the missing information.

In the context of education, a campus map is an essential tool for universities to highlight important infrastructure, and support the navigational needs of students, employees and visitors of the campus. Such a map should therefore include information on all the facilities the university offers, to ensure each map viewer is well-equipped to enjoy the campus grounds.

1.1. Context

This report examines whether the current campus map of Delft University of Technology (TU Delft) fulfils this purpose, and proposes a new campus map that caters to a larger, inclusive audience. The overall project – including report, campus map product and relevant documentation – are made in fulfilment of the Master (MSc) in Geomatics GEOIT1501 Synthesis Project requirements.

1.1.1. Strategic agenda

The ‘Strategic Agenda TU Delft 2024-2030’ (TU Delft, 2023) highlights diversity, integrity, and respect as the core principles behind the creation of a socially safe and sustainable campus for both students and staff. To paraphrase, this means to recognise a wide variety of needs by the two largest populations on campus, and cater resources to ensure their wellbeing and safety. The practical implementation of this strategic view is manifested in the provision of high-quality infrastructure and facilities. For instance, neurodiversity can be acknowledged through the designation of rooms or spaces in faculty buildings that create a low-stimuli environment. A socially safe campus is of priority in this discussion: a student who has to travel to another building to use an all-gender bathroom would imply an insufficient distribution of resources towards gender-neutrality in campus.

1.1.2. Diversity and Inclusion Office

As the project client, the Diversity and Inclusion Office (D&I Office) is the department of TU Delft committed to creating and improving an inclusive campus that welcomes diverse identities and abilities. The D&I Office performs several roles in continual pursuit of the abovementioned aims. Raising awareness of the available facilities and services is one such critical task; the high-quality infrastructure built by the university cannot be appropriately utilised if its target group is unaware of the existence of such amenities. Whether through events, open-hour consultations or more, the Office ensures students and staff are equipped with the knowledge of the available facilities to meet their individual needs.

The D&I Office also maintains direct connections to the lived experiences of staff and students across campus. The Office is structured with a small headquarters, and D&I officers attached to each faculty. Each officer therefore serves as the immediate point of contact for assistance and

feedback in their respective faculty. With this structure, policy changes and implementation can be quickly and efficiently disseminated to each faculty, while also enabling pertinent faculty-specific issues to be collated and addressed at the headquarters. Furthermore, the Office works closely with support networks and communities across campus (see [Diversity and Inclusion – Contacts Network](#)) which it has identified as being marginalised due to insufficient resources to meet their needs. Instances include ease of mobility for physical disabilities, gender-inclusive spaces, and more.

As part of the continuous goal of an inclusive campus, the D&I Office seeks to normalise such inclusive considerations in the academic and administrative functions of the university. This process includes celebrating achievements towards improved wellbeing and safety, but also identifying provision gaps and accessibility issues. By tabling such issues of diversity, accessibility and wellbeing to be addressed through policymaking, the Office aims to create a positive feedback cycle that achieves the goals outlined in the Strategic Agenda.

1.2. Problem definition

The university campus map is a key indicator for the fulfilment of the Strategic Agenda. The role of the campus map – to consolidate information on the infrastructure, facilities, amenities and services available in campus and display them to users – directly addresses accessibility to resources that the university provides. The D&I Office also envisions the campus map to play a critical role in creating a more inclusive campus; the types of information in the map, and the users who benefit from such information are therefore of pertinent discussion.

However, the word ‘inclusive’ is a rather ambiguous term; a specific understanding relevant to the project context is necessary, which is discussed in *Chapter 2*. In the meantime, the following subsections evaluate the existing campus maps of TU Delft based on the availability and presentation of information for various groups of users across campus.

1.2.1. Current TU Delft campus map

Currently, TU Delft provides a range of maps to facilitate navigation and information dissemination. The campus map is available in two forms: the online digital map (see Figure 1, available at <https://map.tudelftcampus.nl/nl/>), as well as physical maps displayed in billboards across the campus grounds (Figure 2). Spit (2024) argues that these maps are not aimed at students, employees, or visitors; instead, it is aimed at investors, startups, and entrepreneurs to promote business and innovation. Indeed, the use of building numbers as labels instead of prominent names – such as Building 34 over Faculty of Mechanical Engineering or ME – suggests the map user is expected to be more concerned with navigation rather than the actual function of the location. Another clear example is the prioritisation of main entrances, supplier entrances, roadways and parking in the physical map; these are considerations primarily for one-off deliveries and events rather than information a staff or student requires.

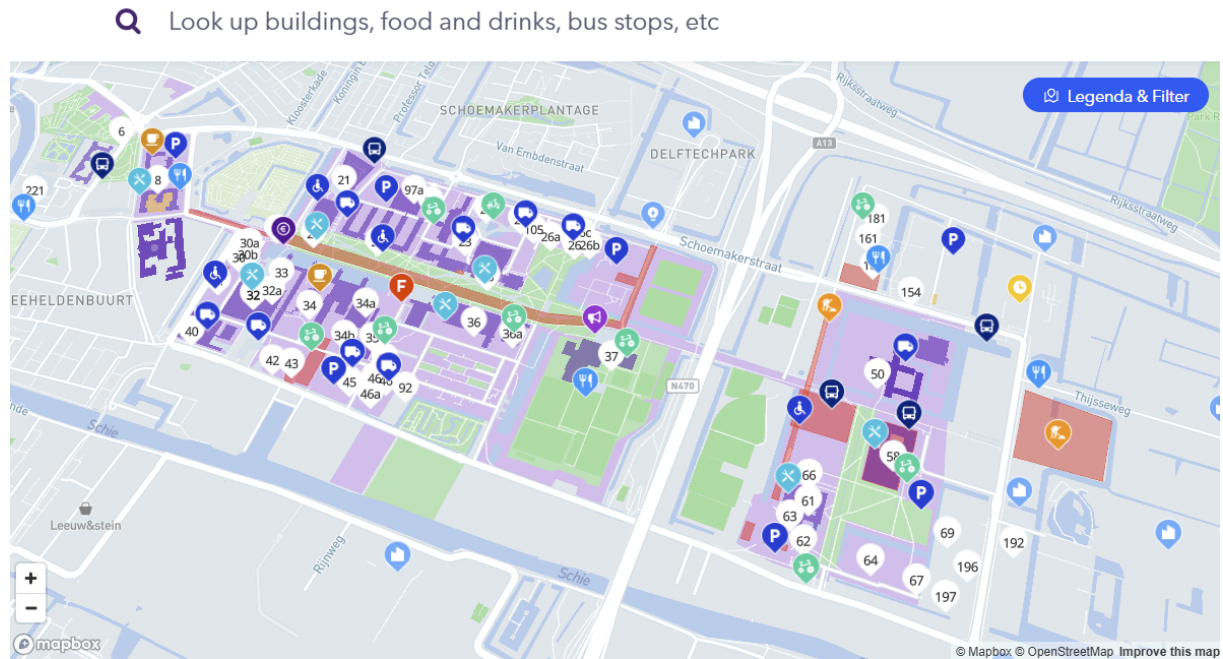


Figure 1: Existing campus web map.

The digital map provides a plethora of thematic information, ranging from dining options to transport information and more. However, from the perspective of the marginalised groups the D&I Office supports, the map provides limited information. Specifically, only the ‘Parking Spaces for the Disabled’ thematic layer minimally caters to mobility issues and physical accessibility. The exclusion of such data in the map is partially due to the incompatibility of the map structure. The campus provides extensive support for the physically disabled. For example, faculty buildings have multiple ramps, accessible entrances, accessible parking, and elevators to ensure wheelchair users are able to traverse the building. However, these facilities are largely indoor, whereas the campus map focuses on exterior facilities; There is minimal thematic information about indoor facilities and services, and what available indoor information – as is the case with the ‘Coffee’ layer – is either outdated or has an inaccurate location. The resultant campus map is therefore a product of different priorities, an emphasis on having interactive functionalities in the online map, additional technical limitations, and an overall lack of an inclusive design mindset (Spit, 2024).

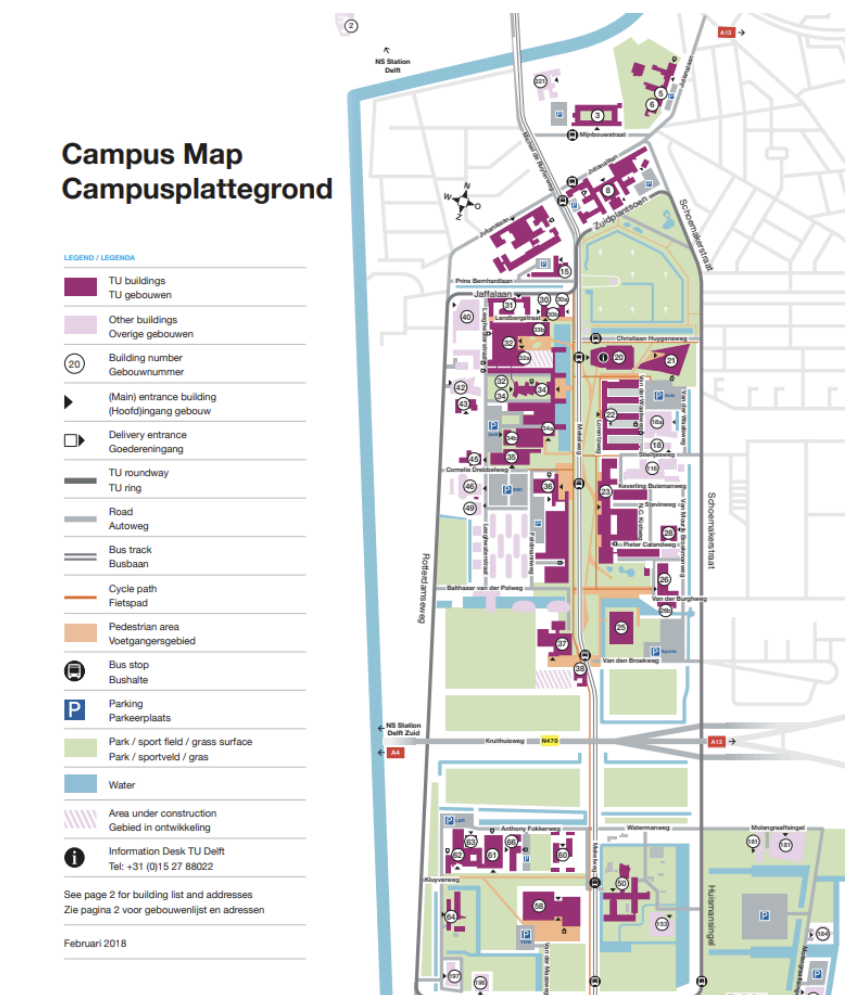


Figure 2: Snippet of physical maps in billboards across campus.

1.2.2. Faculty maps

There are mitigating considerations for the lack of indoor facilities in the campus map. It can be argued that a campus map should focus on the broader outdoor information across the large campus grounds, and the rich indoor details can be better represented via floor plans and interior maps of each building. Furthermore, majority of the support facilities that the university provides are typically indoors. A sample floor plan of the Faculty of Architecture and the Built Environment (BK in Dutch, short for Bouwkunde) does indeed indicate wheelchair-accessible entrances and lifts, indicating a consideration for users with mobility issues during the mapmaking process. However, plenty of other facilities implemented by the university to support marginalised groups remain unmapped. The ground floor (BG) of BK has multiple gender-neutral bathrooms that are not clearly demarcated on the map, or distinguished from the typical male/female bathroom icons. The map thus fails its critical role in information dissemination: despite constructing high-quality infrastructure and facilities, the university cannot be said to achieve a socially safe and inclusive campus if these facilities are not made known to and used by the people in need of them.



Figure 3: Snippet of TU Delft's Faculty of Architecture floor plan.

Another pertinent issue lies in the multiplicity of map referencing for the purpose of navigation. Consider the case of finding a bookshop called 'Waltman's Bouwshop'. The user would first have to check the digital campus map to learn that the bookshop is situated in BK, then search for the faculty floor plans in order to verify its location inside the building. Consider yet another case for a wheelchair user to determine a suitable route for a meeting at BK. This would involve locating the nearest accessible parking space to BK on the digital map, then re-orientate the map and the floor plan to find the closest accessible entrance. The lack of a single source of navigation information forms yet another barrier towards accessible campus resources.

1.2.3. 3D mapping

It is noteworthy that the aforementioned range of maps provided by TU Delft are solely in 2D. Spit (2024) suggests that a 3D map was originally planned, but ultimately reverted to 2D due to financial limitations. This is despite significant benefits in a 3D campus map: Apeh (2024) argues 3D cartography provides superior spatial awareness and contextualisation in complex environments such as the university campus grounds. This is also relevant for the project, since our MSc Geomatics course includes 3D representations as part of the core modules.

Given the intended target of the maps are investors, and the fact that 3D campus maps are rare, this would also have been a significant opportunity to showcase the technical accomplishments of the Delft University of Technology. Indeed, the 3DBAG consisting of 3D building models for the whole of Netherlands was developed within TU Delft's Geomatics department (Peters et al., 2022).

1.2.4. Research objectives

The current (set of) campus maps is argued to have a misaligned aim and target group, thereby conflicting with the goals of the university's Strategic Agenda and the D&I Office. We therefore propose a new campus map that both leverages the enhanced spatial contextualisation of 3D cartography, and provide greater support for the under-represented groups in the university. This involves making information about available facilities easier to find, spreading awareness of diversity, equity and inclusion, and promoting discussions and accountability through the map. These various aspects can be condensed into our main research question:

How can an inclusive 3D campus map be designed that improves the campus experience for students, employees and visitors of TU Delft, particularly in terms of equitable access for marginalised groups?

This main research question can be further broken down into the following sub-questions, each of which defines separate parts of our workflow:

1. *What does inclusivity mean, and what is an appropriate definition of inclusivity for our project?*

Inclusivity is an often-mentioned term, yet its interpretation is typically unique to the individual. We discuss definitions of the term across relevant theories and contexts in *Section 2.1*.

2. *What does inclusivity entail in digital cartography?*

This sub-question – detailed in *Section 2.2* and *Section 2.3* – explores the appropriate data design, input and feedback avenues to ensure an inclusive mapmaking process. Together with the first question, these findings are synthesised in *Section 2.4* into our own definition of inclusivity that is unique to our development of an inclusive campus map.

3. *Who are the marginalised groups in TU Delft, and what additional information do they need in a campus map?*

Under the guidance of the D&I Office, we identify marginalised groups as students and staff whose unfulfilled needs lead to an unsafe or uncomfortable experience in the campus grounds. We then consolidate a list of information and functionalities to be installed in the map that would improve their campus experience. Details are discussed in *Chapter 4*.

4. *How do we create an online map viewer which can be easily updated over time?*

The sub-question implies two aspects: methodology and sustainability. The workflow for creating a digital map is outlined in *Chapter 3* using an AGILE approach. Critical decision points and their rationale are detailed in *Chapter 5* highlighting the conscious effort to ensure the map is reproducible and modifiable to incorporate new needs and expanded functionalities.

2. Literature review

The development of an inclusive 3D campus map requires a theoretical foundation that integrates principles of accessibility, open data, and user-centered design. Therefore, in this literature review we establish the necessary context to define the core concepts for the methodological and design choices made throughout this project.

2.1. The concept of inclusivity

Inclusivity is a multi-dimensional, often ambiguous concept that has significantly evolved in recent decades. A systematic review of the literature by Demirel & Erkiş (2025) highlights a key paradigm shift from the early 2000s approaches, which focused primarily on physical accessibility and the removal of physical barriers. This shift was prompted by growing social, political, and spatial challenges on a global scale, leading to increased recognition and identification of intrinsic sociocultural heterogeneity. This fostered a demand for design approaches grounded in equity, diversity, and accessibility related to themes such as socio-spatial justice. Consequently, inclusivity is now understood *not* as a static, universal outcome, but as an experiential, ever-changing, and relational – described as the “process-of-becoming”. In a similar nature, an inclusive map should not serve as a snapshot of the campus; rather, the map should be refreshed and updated dynamically to reflect the ever-changing campus experience.

This philosophical shift demands a move from a traditional supply-driven design process (what the provider thinks is needed) to a user-driven, co-designed approach that prioritizes users’ experiences (Demirel & Erkiş, 2025).

Inclusion and its antonym are binary oppositions, and their relationship should therefore also be acknowledged. Each can only be defined in opposition to the other, in the same way that including half of a population necessarily implies excluding the remaining half. Therefore, inclusivity is an iterative process of identifying excluded groups, improve their accessibility to resources and information, then re-examining the current situation and re-identifying (new) excluded groups.

2.1.1. Inclusivity in higher education

Demirel & Erkiş (2025) recognise that higher education plays a crucial role in equipping future generations with the necessary skills, tools, and attitudes to foster inclusive approaches.

This complements the recognition of inclusion as a central concept for the development of higher education institutions, often hand-in-hand with diversity and individuality. For example, UNESCO (2009) describes inclusion in education as a continuous process of addressing and responding to diverse needs of learners and emphasising their participation. Within higher education, inclusion has often been addressed in relation to teaching and learning practices. According to Hockings (2010), inclusive learning and teaching should be designed in such a way that the students are engaged in a meaningful way and should be accessible for all. This is done by embracing individuals and their individuality as a source that enriches the lives and learnings of others. However, Gibson (2015) stresses the importance that inclusion in education should not only involve teaching and learning practices but also foster belonging

and changing the system that creates inequality. Inclusion should be part of the institutional transformation, including universities' mission, leadership and strategies at every institutional level (Smith, 2014).

Therefore, an inclusive campus map serves as a practical implementation of these values, extending the concept of inclusive learning and teaching to the physical and digital campus environment by ensuring equitable access and fostering a sense of belonging.

2.1.2. TU Delft diversity and inclusion definition

As an institute of higher education, the TU Delft, has its own dedicated body – the Diversity and Inclusion Office – to foster an inclusive community for all students and staff at the university (Delft University of Technology, Diversity & Inclusion Office, 2025a). From the perspective of the D&I Office, inclusion, diversity and equity are closely related terms. They are defined as follows (Delft University of Technology, Diversity & Inclusion Office, 2025b):

- **Inclusion** is the act of welcoming, supporting, respecting, and valuing all individuals and groups.
- **Diversity** is the representation of different people and acknowledges and encourages individual visual and non-visual differences.
- **Equity** relates to correcting imbalances. Ensuring fair access to opportunities and resources while taking into consideration individual's barriers or privileges and eliminating systemic barriers and privileges.

These three terms are believed to positively improve the well-being of students and staff, thus creating an optimal environment that enhances creativity and productivity. This ultimately leads towards innovation and societal impact of TU Delft.

In practice, the D&I Office understands diversity (and thus inclusion) as a multi-dimensional concept. It prioritises following dimensions of differences (Diversity & Inclusion Office, 2025): age, gender, social class, diverse abilities & well-being, religion & belief, race & ethnicity, sexual orientation and culture. The intersections of these identities create unique differences that shape an individual. By defining diversity and inclusion in this way, the D&I Office and TU Delft acknowledges the presence of various identities and their responsibility to foster a place of belonging and accessibility, ultimately creating an equitable TU Delft community.

Therefore, the project's definition of an inclusive map is a context-specific application of these D&I principles, specifically targeting the identified dimensions of difference through its participatory creation, inclusive content, and accessible representation.

2.2. Accessible cartography: data and access framework

To establish the requirements for the map's success, we framed the map as an *open data resource* that reflects the university's commitment to *open education* and *open science* (Haslinger, 2019). To ensure the map is both accessible and reusable, we adopted the *concentric shell model* (Backx, 2003) that defines the necessary conditions for data re-use based on Known, Attainable, and Usable criteria. This allows us to define success criteria for the inclusive campus map.

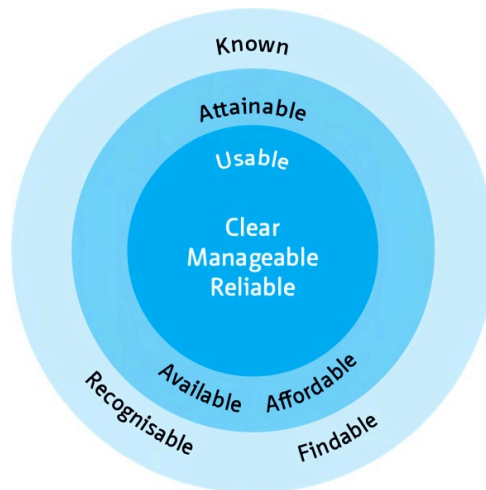


Figure 4: Concentric Shell Model for Open Data Supply (Backx, 2003).

2.2.1. The Known requirement

The first shell mandates that the resource must be *known* to its potential users. For the inclusive campus map, this goes beyond simple technical availability.

The *known* requirement, derived from open data principles (van Loenen & Grothe, 2014), demands the map to be both *recognisable* (clearly identified by its purpose) and *discoverable* (the potential users are aware of its existence). A campus map is an information source and must be therefore easily found and recognised by its intended users: students, staff and visitors.

Recognisable

For a campus map to be trusted and utilised, it requires institutional commitment to actively promote it as an official source of reliable information. This is essential to incentivise users to use this map instead of third-party services like Google Maps. Therefore, the map must offer a Unique Value Proposition (UVP) that clearly differentiates it from general applications.

Discoverable

This requires the inclusive campus map to be on a dedicated, well-integrated platform (such as its own webpage) to fulfil the discoverable criterion. The recognisable criterion should be fulfilled by implementing unique inclusive content that is identified by potential users, ensuring the map is sought out because it provides essential information that is unavailable elsewhere.

2.2.2. The Attainable requirement

The second shell mandates that the resource must be attainable by the users. This addresses the legal, financial and physical barriers to accessing the map and its displayed data. This aligns with open data and equitable access principles.

Legal access

The legal attainability requires the data to be available for re-use. This can be done through open licences (van Loenen & Grothe, 2014). For an open science institution like TU Delft, this

requires adopting a system that allows students, staff, and visitors to re-use the map data for campus/academic activities and allows future developers to maintain and extend the map, ensuring the project's long-term continuity.

Furthermore, by fulfilling the legal access requirement, the map could be re-used beyond its initial scope of TU Delft. It can serve as an incentive for other organisations such as companies or other universities to (re)map their grounds in an inclusive approach benefiting their respective communities.

Financial access

Financial attainability requires that the map is affordable, aligning with the open data principle of being free of charge (van Loenen & Grothe, 2014). Since the map is intended to ensure equitable access for all members of the TU Delft community and visitors, it must be provided without any cost, eliminating financial barriers to essential campus information.

Physical/technical access

Physical attainability requires that the map is available 24/7 with direct access (van Loenen & Grothe, 2014). This necessitates the use of a medium that ensures ubiquitous access for all users. The study by van Loenen & Grothe (2014) also mentions that the data should be in a machine-readable format; the underlying information of a map should otherwise be readable by humans. There is therefore a need to implement some form of translation between the machine-readable raw data and the final visual display for map users.

2.2.3. The Usable requirement

The final shell mandates that the resource must be Usable, meaning it is fit for the user's intended purpose. Usability is broken down into three sub-criteria: Clear, Manageable, and Reliable (Backx, 2003).

Clear

This criterion ensures the map information is comprehensible, addressing the need for intellectual access such that the map is easy to understand, even for non-specialists.

Manageable

The underlying data must be structured to be easily processed, displayed, and queried. For an inclusive map, this is a technical necessity to organise the data, and provide dynamic functions allowing users to navigate and manipulate the map.

Reliable

This criterion ensures the map is consistent, complete, and up-to-date. For an inclusive map, users must be able to trust the displayed data for their needs. This necessitates the implementation of an updatable data structure that can keep pace with the dynamic nature of the campus environment.

2.3. Designing for Inclusivity

While the abovementioned criteria ensures technical and cognitive robustness, achieving true usability for diverse and marginalised communities requires a deeper focus on the experi-

ential dimension of inclusivity (Demirel & Erkiıç, 2025). This necessitates design principles that accommodate a plurality of experiences from non-visual access to socio-spatial safety concerns.

This chapter details the design and methodological principles moving beyond the foundational requirements of data access (*Section 2.2*). We establish the best practices for map representation, ensuring the map is not only technically available but also cognitively, visually, and experientially accessible.

Maps are inherently visual-based means to convey geographical information, which can create a barrier for individuals with visual or cognitive challenges, leading to an information inequality (Jung et al., 2022). To bridge this gap, the design is guided by the four core principles of the Web Content Accessibility Guidelines (WCAG) (W3C Web Accessibility Initiative (WAI), 2018a):

1. **Perceivable:** All information and User Interface (UI) components must be presented in a way that all users can sense.
2. **Operable:** The user UI and navigation must be fully operable by all users, including those who rely on a keyboard for navigation.
3. **Understandable:** Information and the operation of the UI must be understandable. Digital content should work in predictable ways, allowing for all users to comprehend the information and its components.
4. **Robust:** Content must be robust enough to be interpreted reliably by a wide range of user agents, including a variety of standard browsers and assistive technologies like screen readers.

2.3.1. Visual accessibility and cognitive design

The visual design of an inclusive map is primarily guided by the perceivable and understandable WCAG principles to facilitate users with visual and cognitive differences, such as colour-blindness and dyslexia.

Improvement of legibility and readability

For individuals with cognitive differences like dyslexia, specific typographic choices are essential to mitigate difficulties due to language processing and visual crowding (Bachmann & Mengheri, 2018). British Dyslexia Association (2018) suggests using Sans Serif fonts (e.g., Open Sans, Arial, or Verdana) and enhancing legibility through increased spacing (e.g., inter-letter spacing of $\approx 35\%$ and line spacing of 150%). Furthermore, to ensure easy information comprehension, text should be left-aligned with lines no longer than 70 characters, using short, simple sentences in a direct style. Finally, essential information should be also conveyed through additional means like symbols, patterns, and text labels.

Designing for colour and contrast

The Perceivable principle mandates that the map and UI should not rely solely on colour to convey essential information. To ensure sufficient contrast, the background should be a simple, unified colour. While dark text on a light background is preferred, a pure white background should be avoided as it can appear dazzling to some users; therefore, a softer or cream background is recommended (British Dyslexia Association, 2018). The WCAG mandates

a minimum contrast ratio of 4.5:1 for regular-sized text and its background colour. Finally, to accommodate colour-blind users, specific colour pairings (such as green and red/pink) should be avoided near text.

2.3.2. Multisensory and non-visual access

The non-visual features of the inclusive map are primarily guided by operable and robust WCAG principles to achieve full accessibility and address the needs of users who rely on non-visual navigation.

Non-visual spatial representation

Inclusive cartography emphasises the need for a multisensory and multimodal graphic language to convey spatial information to users with visual impairments (Almeida, 2014). This approach, informed by the principles of tactile cartography and audio-tactile systems, translates spatial data into non-visual cues like sound and text. In a digital environment, this principle is applied by ensuring compatibility with screen readers, which is the core theme for users who are blind or have low vision (Jung et al., 2022).

Designing for operation and robustness

The operable principle requires the map UI to be fully navigable and controllable using only a keyboard (Calle-Jimenez & Luján-Mora, 2016). The robust principle mandates that all non-text content, including the map visualisation, must have a functional alternative text (alt-text) that can be reliably interpreted by assistive technologies (W3C Web Accessibility Initiative (WAI), 2018b). For the inclusive campus map, this means implementing:

- **Alt-Text and ARIA labels:** Implementing functional alt-text that strategically summarises the map's content and visible features (Jung et al., 2022). This is often supported by using technical standards like ARIA labels to explicitly define the role and state of interactive elements for screen readers. Furthermore, designing online maps using Scalable Vector Graphics (SVG) is a recommended practice, as this format can embed information directly readable by screen readers.
- **The Non-Visual Experience:** Map functionality should correspond to a non-visual experience, such as the UI being able to simulate the displayed information (Calle-Jimenez & Luján-Mora, 2016). This is often achieved through a “verbal” feature or “data view” mode that provides clear, sequential, text-based instructions, translating the visual environment into a comprehensible non-visual format.

2.3.3. Participatory mapping for socio-spatial inclusion

While technical standards address universal physical and cognitive needs, achieving a complete definition of inclusivity requires a methodology that addresses the experiential dimension and socio-spatial justice (Demirel & Erkiş, 2025).

The need of co-design

Inclusive design literature emphasises that technical accessibility alone is insufficient, as exclusion is often rooted in complex social and cultural relations. For these reasons, cartography is recommended to adopt new design approaches (Almeida, 2014). Therefore, the recommendation is a shift to a user-driven/co-designed approach, implemented through participatory

mapping. This methodology allows marginalised groups to become co-designers, ensuring that the map's content is relevant to their unique and often overlooked needs, thereby achieving inclusion (Demirel & Erkiş, 2025; Spit, 2024). This reinforces Spit (2024)'s conclusion that maps become more relevant and meaningful when users are actively engaged, especially those whose needs are often overlooked, thereby fostering a participatory culture.

By integrating this participatory methodology, the map can fulfil its role as a tool for social agency, making the institution's commitment to its diverse demographics visible and accountable. This process is essential for identifying the inclusive points related to well-being, safety, and identity that are often absent from traditional maps.

2.4. Project inclusivity definition

2.4.1. An inclusive map as an iterative process

Building on the D&I Office's efforts to foster an inclusive community, the concept of inclusivity for this project is defined through the process of mapping. As campus maps are valuable tools for fostering inclusivity (Spit, 2024), the inclusive campus map is conceptualised across three interconnected aspects: Process, Content, and Representation.

1. **Inclusive Mapping Process:** This aspect defines inclusivity as the continuous, co-designed involvement of the campus community from early-stages onwards. This ensures that diverse voices and opinions are heard, especially those that are often overlooked during 'regular' mapping process. This approach fosters participatory culture ensuring that the map is relevant and meaningful by spotlighting the overlooked needs.
2. **Depiction of Inclusive Content:** In terms of the content of the map, we define an inclusive map as a tool that highlights inclusive facilities on campus that may not be part of the public knowledge of the campus community. This inclusive content serves as a form of social agency (Demirel & Erkiş, 2025), making the TU Delft's commitment (or lack thereof) visible and accountable (Spit, 2024).
3. **Inclusive representation and User Interface:** The campus map should be able to represent the mapped information in ways accessible to everyone, including people with visual difficulties and accessibility needs. This involves informed design choices to ensure information equity for all users. This must satisfy the "Usable" requirements mandated by the WCAG principles. However, it is important to note that there is no one-size fits all solution, as various users have various preferences and experiences (Spit, 2024).

Ultimately, the inclusive campus map implements the broader D&I Office principles into a practical and context-specific definition of inclusivity: a campus map that is participatory in creation, mindful of inclusive spaces and accessible in its representation for all students and staff of the TU Delft community.

2.4.2. Map literacy and cartographic positionality

Based on the literature review, we highlight two final requirements for a truly inclusive map based on the need for Intellectual Access (van Loenen & Grothe, 2014) and the recognition of inclusivity as a "process of becoming" (Demirel & Erkiş, 2025).

To ensure the map is Clear and Usable (*Subsection 2.2.3*), improving map literacy is a necessary component of the mapmaking process. This means clearly explaining the potential users about the map functionalities and the map's creation process, especially first time users of the map. This is achieved by providing clear documentation, such as an "About" page and/or legend, to explain the map's intentions, symbology, and functionalities. This documentation also serves to address our positionality as cartographers and ethical responsibilities, ensuring that the decisions made in the project remain transparent and accountable to the TU Delft community.

The relational and experiential nature of inclusivity means it is "always in the making" and is best understood as a "process of becoming" (Demirel & Erki1i1, 2025). Therefore, this necessitates the need for *iterative refinement* of the map, which can be achieved by allowing for direct user input via a feedback mechanism. This ensures the map remains a reliable and continuously improving source of information that can adapt to the dynamic needs of the campus community.

3. Methodology

The structure of our map development incorporates key findings from the abovementioned literature review in *Chapter 2*. In this chapter, we discuss the scoping and overall design philosophy of the project, before detailing the individual components of the workflow in subsequent sections.

3.1. Project scope

The ideal product of this project is a campus map that:

- Contains both 3D and 2D information on all building exterior and interior geometries within the campus grounds.
- Contains relevant attribute information on each building, as well as for individual rooms, spaces, and units inside the building.
- Serves all users by providing general and core map functionalities.
- Provide additional functionalities that improve the experience for our target groups.
- Prioritises the display of inclusive information for our target groups.

Given the 10-week timeline of the GEOIT1501 course and the 5-member manpower of the team, it was deemed unfeasible in the early weeks to achieve all the abovementioned goals. This is a pragmatic choice especially since – instead of adapting the existing 2D campus map – the new map is intentionally built from scratch to weave in the inclusive design. Therefore, we present a refined scope that creates an achievable proof-of-concept, focusing on the Bouwkunde (BK) faculty building and its interior details.

3.1.1. Target audience

It is important to highlight that our product actually has two target audiences. In a broad sense, the map can be used by any person who accesses the map, beyond the university's students and staff; there is therefore a silent majority of the 'default' or 'generic' map user, whose needs and requirements can be generally be satisfied through the provision of core functionalities, such as panning and zooming the map, providing spatial context using basemaps and building polygons, etc.

Beyond this set of basic functionalities that make a map useable, our primary target group are the networks and communities with underrepresented needs in the campus, as prioritised by the D&I Office in *Subsection 1.1.2*. These needs require greater understanding and incorporation into the map, in addition to the 'basic' needs that the core map functionalities provide.

In *Subsection 3.3.2* and *Chapter 4*, we further refine the context of inclusivity based on the participants of the project. Each individual has unique experiences of both the campus grounds and the campus map. This intrinsic understanding of information is shaped by the overlapping identities of the individual. Teasing out the relevant identities associated with each pain point, or opinion allows us to generalise requirements for the larger community and network, which we then implement functionalities for. Our target groups for inclusivity are therefore determined by the participants of the discussions and interviews, and who they represent. For the rest of this report, we refer to these participants and their larger networks and communities as our main target group.

3.2. Design philosophy

Considering the digital campus map as a product deliverable, the design process took on a software development approach incorporating AGILE principles. Rather than a linear development style, this approach complements the inclusive design elements by allowing quick prototyping, feedback and refinement dynamically throughout the entire timeline.

The overall workflow can be categorised into three main aspects: data collection, data processing and visualisation, as seen in Figure 5. The iterative refinement through feedback sessions with participants enforces the cyclical AGILE style, allowing for incremental improvements to the map display and its functionalities.

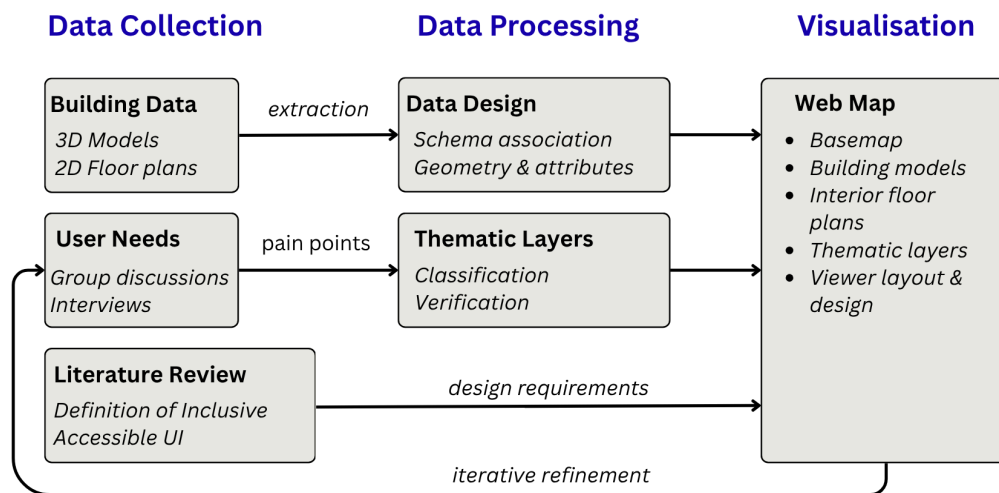


Figure 5: Overall workflow.

3.2.1. Inclusive design process

A key input from the D&I Office can be encapsulated in the phrase:

Nothing about Us without Us.

Designers often make assumptions about what the user wants in a product; this may not necessarily reflect the true requirements of the user. Indeed, the positionality of the designer can often create blindspots in design choices. As a team of 5 members, we are experienced cartographers and therefore may take certain nuances of map usage for granted. For instance, maps controls such as 3D panning, orbiting and zooming come intuitively with practice; these may be significant challenges or even obstacles for map users who have not interacted with 3D objects before.

Furthermore, our personal requirements for map functionalities generally align with what we conceptualise as the ‘default’ user, and thus cannot fully appreciate the struggles and issues that, for instance, a wheelchair user may experience. The viewpoint and input of the people we seek to improve the campus experience for are therefore crucial in every step of the design process. Rather than making our own informed guesses on the facilities, features and information to prioritise, the map can only truly serve our target group if they provide direct input and clarification on their requirements.

However, we also go beyond participatory mapping, to additionally incorporate iterative feedback and refinement. Participant input may reflect the actual requirements and needs of the users, but the functionalities we implement into the map are still subject to our understanding and interpretation. Seeking feedback from the users through prototyping enables confirmation that our implementations actually serve their needs. The recurring interest of participants also serves as an indicator of the intrinsic value of the map in providing information and usability that is appropriate to the participants and target groups.

3.2.2. Extensibility and documentation

Needs, desires, and resources change over time. The campus environment is also subject to constant modification and improvements; the campus map should equivalently serve as a living resource that reflects these dynamic changes. A sustainable development approach is therefore necessary to elevate the map beyond a one-off product, by setting the foundation upon which extensions, updates and maintenance can be carried out beyond the timeline of our project and course.

To achieve this, our methodology incorporates additional steps to ensure modularity and reproducibility. Pattern analysis was conducted on our collected secondary data of the BK building, to structure our data schema such that it can be extrapolated to other campus buildings. In a similar way, our code is designed in modular components, allowing easy expansion to include all other buildings.

Extensive documentation is carried out throughout the entire project. This report serves as a primer for key decision points and their rationale throughout all components of the project. All relevant data are consolidated, and the project code is made available in an open GitHub repository. The intention is to create a complete and documented set for handover, such that future groups can conduct further improvements. This would allow the map to evolve as a living resource that becomes progressively more inclusive and complete through ongoing cycles of community input, development and feedback.

3.3. Data collection

3.3.1. Building data

Physical data is simply information about the urban campus setting that will be represented in the digital map. This encompasses geometries of the campus buildings, their internal rooms, as well as outdoor facilities such as car and bicycle parking lots. Models of the exterior shell of the campus buildings serve as the 3D visualisation in the map, while internal rooms are represented using 2D planes similar to a floor plan. Finally, outdoor facilities are condensed to point markers.

This combination of 3D shells and 2D floor plans is intentionally chosen. From the overview of the campus 3D models of the buildings provide greater spatial contextualisation due to their proximity to the real-world building shapes. On the other hand, 3D models of the rooms in an indoor view adds an additional dimension of complexity, which obfuscates clarity in an information-dense environment. 2D floor plans are instead advantageous in clearly separating individual rooms and hallways, allowing easier navigation and pathfinding by the user.

3D shells of the campus buildings were extracted from the 3DBAG (see Figure 6). 3DBAG models are programmatically generated using aerial LiDAR as a data source. There are therefore some minor issues in the models, such as missing planes in the triangulation, inconsistent normal direction, etc. Specific to our scope, the BK building model was simplified for a cleaner facade representation, which is further discussed in *Subsection 5.4.2*.

On the other hand, the interior geometry of the buildings was extracted from PDF and IFC floor plans provided by the Campus Real Estate & Facility Management department (CREFM department). Individual rooms, staircases, and other prominent features were demarcated into 2D geometric planes. For data and attributes that were not already available, physical verification and modelling were carried out where necessary. These were extensive, ranging from ramp and stair geometry to various attributes of the building, such as opening hours and contact points. All physical data are then further collated and processed in *Section 3.4*.

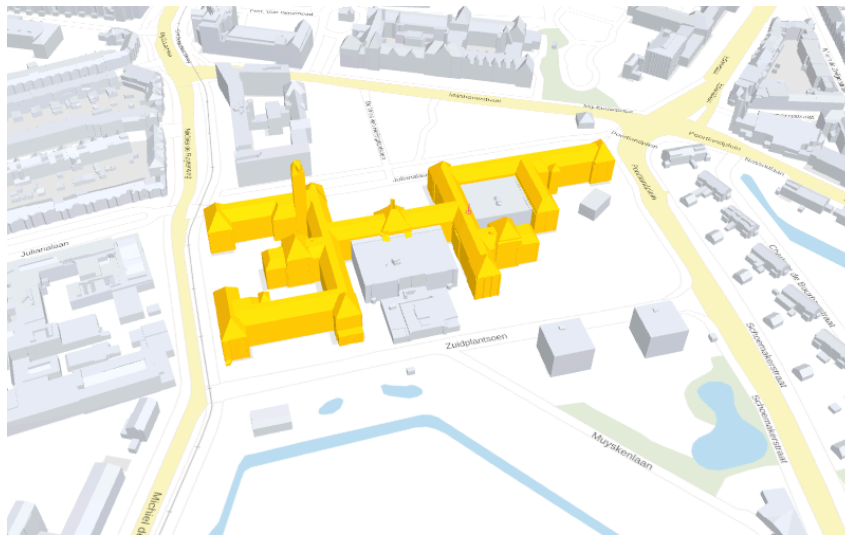


Figure 6: Snippet of 3DBAG viewer with Faculty of Architecture selected.

3.3.2. User Needs

User needs corresponds to the subjective, lived experiences of the university campus. Each individual has multiple identities - for example: gender, nationality, ethnicity, age, among many others. The overlapping of these identities thus creates interpretations of the campus and its facilities that are unique to the individual. Using another example, a Muslim staff might want to know where the prayer room in their faculty is located, whereas a student who bikes to school might prefer to find available bicycle parking lots near the building where their classes are held. We capture these interpretations through two rounds of focus group discussions and interviews. The first round is crafted towards an initial understanding of the map requirements, whereas the subsequent round was held to incorporate feedback and refine our implementations for such requirements.

Requirement modelling

Working with the D&I Office, we obtained contact information of representatives of various inclusive communities at TU Delft. This initial list provided us a broad range of potential target groups representing the diverse staff and student population of TU Delft.

Subsequently, rather than pre-selecting specific target groups, we decided to use an engagement-based approach. We reached out to all contacts provided by the D&I Office, where we proposed multiple meeting times, and for those unable to join, offering one-on-one interviews to accommodate different schedules and preferences. As a result, our target groups were defined by those who responded to our outreach and participated in our first round of focus groups/ interviews, which are listed in greater detail in *Section 4.2*.

The format of this discussion is an open-ended, comparative analysis of the existing campus maps that TU Delft offers, to uncover high-level desires, general thoughts, and suggestions. Participants are encouraged to first think about their own motivations behind using a map, and what features would they need in a map in order to use it comfortably. The current 2D campus map is then shown and used as a reference to discuss facilities, UI design and other functionalities that participants think are useful, or would be good to add. From here, we identify the strengths of the current map to be incorporated in our 3d inclusive campus map, whilst also avoiding its pitfalls and inadequacies.

The discussion is then steered towards the building interiors, with broad guiding questions including - what indoor facilities are important to participants? And what manner of representation would make it intuitive to understand? To conclude the discussion, participants were asked to explore the 3DBAG viewer (refer again to 3DBAG), and compare its ease of use in navigating compared to a 2D map. Key facilities of interest and pain points experienced by participants in their navigation of the campus were recorded and compiled into a list of requirements in *Subsection 4.2.1*.

Feedback and refinement

Following the list of requirements from the initial discussions, we then implemented prioritised functionalities to create a work-in-progress web map. This allowed participants to give their feedback on a tangible product in the subsequent round of discussion. Contrasting with the exploratory nature of the first round of discussions, the format for this discussion was specific and task-oriented to generate detailed, concrete feedback on specific functionalities, interface elements, and user experience/ functionality issues. Participants were asked to focus on and critique individual elements of the map – from ease-of-use of map controls, to the choice of layout, icons and font of the user interface, and lastly to the About and Feedback pages. Following this, task-based questions were given to allow exploration of the map in greater depth. This involved actions with multiple steps, such as searching for a specific room in BK, toggling thematic layers on and off, and navigating between floors in the indoor view. Tasking with minimal guidance was an indicator of whether the map was truly intuitive for participants; buttons and functions that were not immediately obvious were therefore identified for further improvement and reconsideration.

This round of discussion provided structured and targeted feedback which allowed us to identify our misinterpretations and refine functionalities that were greatly appreciated by participants. Simultaneously, participants were able to see how their individual output has shaped our map, and reconfirm their needs are being met.

3.4. Data processing

Both human and physical data were consolidated into a data structure that could then be served into the map viewer. The geometry of buildings and rooms were stored in Graphics Library Transmission Format (glTF) to enable efficient rendering of the models. Attribute information is stored in CityJSON format to take advantage of the flattened hierarchy for querying and grouping operations.

Linking the geometry to thematic attributes is necessary to display and query additional information in the map viewer. Typification and classification of the buildings, rooms and facilities is therefore a crucial step in enabling the association of geometry and functions across the data. User needs was classified into thematic groups, prioritising inclusive data such as locations for assistance and support, wheelchair accessibility, and more. Rooms and geometry features in BK that serve these needs – for instance, a contemplation room for low-stimuli and prayer – were codified accordingly; these codes were then also stored in the CityJSON as attributes. To ensure correct association between the CityJSON attributes and glTF geometry, an appropriate key ID system was designed to uniquely identify an object and its corresponding geometry.

It is also important to note that while room numbers (similar to a unique room ID) are generally available, the actual room functions - using the contemplation room again as an example - were not recorded and thus required manual verification on our part. Similarly, the list didn't distinguish between the type of toilets, all toilets are simply categorised as 'Toilet'.

3.4.1. Thematic prioritisation

The specific features, facilities, and other information included in the final product is then determined from a systematic prioritisation process. All unique needs, pain points, desires, suggestions, etc. from the first round were compiled into a comprehensive list, where items mentioned by multiple respondents were consolidated into single entries, keeping note of the amount of times mentioned. Each item was subsequently evaluated on two dimensions, both on a scale of 1 to 3 (with 3 being the highest):

- **Feasibility:** our capacity to implement the feature. This was assessed based on availability of data, technical constraints based on our knowledge set, and the predicted time-cost for implementation.
- **Impact:** The significance of the feature, as measured from the perspective for the relevant target groups. This is subjectively derived from how much participants value certain information or functionality. For example, the criticality of information relating to wheelchair accessibility on our map, as viewed by someone in a wheelchair themselves.

Features scoring 3-3 were prioritised for implementation first, with other features progressively worked on afterwards. We also determined in this phase certain requested features which were unrealistic to us, and as such placed out of our scope. This is discussed in further detail in *Subsection 4.3.1*. The list is subsequently re-examined and extended based on the feedback gathered during the second round of discussion and interviews.

Thereafter, we translated this list into a structured GitHub Issues list for our internal project management and collaboration. Each feature or task was converted into an individual issue.

Each issue is then labelled according to its type (e.g., bug, enhancement) and assigned a Kanban status in our workflow (to do, in progress, done, future work). All issues were also linked to a milestone or deadline, and allocated to the responsible team member(s). This allowed us to track implementation progress systematically through GitHub and maintain clear documentation of each feature's scope and acceptance criteria. The complete issues list can be found in *Appendix A.3*.

3.5. Visualisation

The most basic prerequisite for inclusivity is simply availability. Making a campus map available to everyone is a fundamental component of the overall workflow. We leverage the ubiquity of the internet to serve a digital map that is compatible with desktop and mobile devices using three.js. A hosting server (managed by TU Delft) is used to deliver the map via HTTP and a static URL. The map viewer contains the basemap, models of campus building shells, their interior floor plans, and thematic layers. Functionalities in the map are developed through a combination of Javascript, supplemented with CSS and HTML to also account for an accessible user interface. The overall design style for inclusivity is elaborated at length in *Section 6.1*.

A digital online campus map is a deliberate choice to ensure the map is accessible by the greatest number of users. We understand this may unfortunately exclude users who may not have internet connection, internet-capable devices, or are not tech-savvy and otherwise have difficulties accessing the internet. However, alternative solutions – in the form of a physical map, for example – would require a different set of cartographic considerations well beyond the scope of this project.

The visualisation container in Figure 5 (*Section 3.2*) showcases some of the functionalities of the map. A compiled list of key functionalities are described in *Section 6.2*.

4. User requirements

4.1. Initial prioritisation

Before speaking with any respondents, we developed an initial prioritisation framework in the form of a MoSCoW board. This preliminary board allowed us to structure our opinions on necessary elements of a web map from the perspective of mapping experts and to establish a general, collective understanding of what might be important for an inclusive campus map.

The board was intentionally kept broad and high-level. Given that we had not conducted any interviews yet, we deliberately kept our target groups and their specific needs vague, expressed as ‘specific facilities/points of interest’, to avoid making assumptions about what our target groups would be and what they would actually require.

While this MoSCoW board provided a useful starting point, it has its limitations. Categories such as ‘Could have’ and ‘Should have’ proved rather vague when making concrete decisions about what we would ultimately implement or exclude. This led us to transition to a more precise prioritisation system: an impact-feasibility matrix.

The complete initial MoSCoW board can be found in *Appendix A.1*.

4.2. Participants

As mentioned in *Subsection 3.3.2*, two rounds of semi-structured focus groups/interviews were conducted with members of the TU Delft community. The first round comprised six sessions involving eight participants. The second round also included six sessions with nine respondents, of which six are recurring participants.

The eleven unique participants hailed from various academic, student and staff roles across several faculties, including Aerospace Engineering (AE), Mechanical Engineering (ME), Architecture and the Built Environment (A+BE) and Electrical Engineering (EEMCS). Their roles encompassed education advisors, assistant professors, faculty D&I Officers/Coordinators, a PhD student, an MSc student, and staff involved in DE&I coordination or team lead functions. The respondents collectively represent several specific communities and perspectives relevant to campus inclusivity: one individual is a board member of TrueU, providing insights from the LGBTQIA+ community; another is a board member of DiversAbility, representing employees with chronic disease, physical or psychological disability, and neurodiversity. Other participants are actively involved in Diversity & Inclusion education and coordination teams within their faculties (AE, ME, A+BE, and EEMCS).

4.2.1. Illustrative example of requirements

The focus groups and interviews resulted in rich, detailed insights into the everyday lived experiences of campus navigation and usage of traditional maps by users with diverse needs and identities. Several themes emerged that profoundly shaped our understanding of what would make our map truly inclusive for these respondents.

Particularly striking was the depth and complexity of challenges faced by wheelchair users when navigating in and around campus buildings. The discussion revealed that accessibility

is much more in-depth and encompasses a multitude of factors that able-bodied individuals (and by extension traditional maps) rarely consider, for example:

- Location of elevators are often hard to find; they are often more tucked away than the staircases and are less prominent on signage around campus. Furthermore, information on whether these elevators are wheelchair accessible, if authorisation is required – and if so, how to obtain this authorisation – is generally not easily available, and only obtainable through trial and error.
- Similarly, determining which building entrances are wheelchair-accessible is a difficult task. Additional details regarding the existence of an intercom to speak to the service desk or whether you will have to call them yourself, are also not provided.
- Disabled parking spots are indicated on the current TU Delft map, yet details regarding whether these spots are free-to-use or require prior authorisation is not available. Furthermore, not knowing whether the nearest building entrance is also wheelchair-accessible diminishes the usefulness of knowing the location of these parking spots.
- The locations of wheelchair-accessible restrooms are often hard to find, which is underscored by the fact that neither the current TU Delft web map nor the interior map of BK displays them.
- Whether emergency exits of buildings are wheelchair accessible is often not indicated, since all emergency exits are indicated using the same icon.

4.3. Impact-feasibility matrix

Based on the input from our participants, we compiled all findings from the first round of interviews into an impact-feasibility matrix, as outlined in our methodology. The complete matrix is extensive and has been included in the appendices for reference (*Appendix A.2*). Here we highlight several frequently mentioned requirements that scored highly on both impact and feasibility and thus became priorities for implementation:

- The location of service desks.
- Comprehensive building information, such as address and contact details, opening hours, wheelchair accessibility, and the facilities available within.
- Information about inclusive spaces, with a special emphasis on contemplation/prayer rooms, all-gender restrooms and lactation rooms (see Table 1).

It is worth noting that the impact-feasibility matrices shown here and in the appendix are shortened versions. In our internal matrix, each item also included a user story specifying the target group(s), the desired functionality, and the underlying goal or reason.

It is also worth noting that some core functionalities do not appear prominently in the matrix or participant feedback, not because they were unimportant, but because of how we structured the discussions. For instance, we started our first round of interviews by informing the respondents that we were developing both a desktop version and a mobile version of the map. Consequently, the respondents often did not express an explicit need for a mobile version. This has two implications: the frequency of mention may not fully represent the significance of a feature to participants; indeed, certain functionalities were developed despite a lack of specific mention by participants.

Table 1: Excerpt of impact-feasibility matrix

Goals	Feature Groups	Features	Mentioned	Feasibility	Impact	Done
Map contents	Target groups	Gender-neutral bathrooms	2	3	3	Yes
		Disabled parking spaces	1	3	3	Yes
		Elevators	2	3	3	Yes
		Contemplation rooms	4	3	3	Yes
		Prayer rooms	0	3	3	Yes
		Lactation rooms	3	3	3	Yes
		Quiet rooms	2	3	3	Yes
		Wheelchair-accessible entrances	4	3	3	Yes
		Supplier/ logistic entrances	1	2	2	Yes
		Outdoor accessibility	1	1	3	No
		Doorway dimensions	2	1	2	Yes
		Pavement material	1	1	2	No

4.3.1. Requirements not implemented

The impact-feasibility analysis also helped us make difficult but necessary decisions about what not to implement. These decisions were based on careful consideration of time and capacity constraints.

One example is routing and general navigation. While we recognize this as important and believe it would be a valuable feature, implementing it would constitute a project in itself. Building navigation functionality is already challenging, but adding interiors, various floors, the ability for users to indicate wheelchair use and have the route adapt accordingly, and providing accurate paths with estimated times (which was mentioned as very important by several participants) was simply unrealistic within our timeframe.

Another example is a colour-blind mode. While this was something we wanted to implement and recognized as valuable, none of our interview participants identified as colour-blind. Without direct user input, we could have implemented a generalist solution based on existing accessibility literature, but we found it difficult to justify the effectiveness of such an approach without being able to validate it with actual users.

5. Creation of the map

In this chapter we detail all the implementations and considerations made when developing the first version of the inclusive campus map. It serves as the practical execution of the methodology outlined in *Chapter 3*, translating the theoretical requirements established in the *Chapter 2* and *Chapter 4* into a functional web application.

5.1. Web map

5.1.1. The choice of three.js

First, since we had to make an interactive online map that would be as accessible as possible (based on the *Attainable shell* criteria in *Subsection 2.2.3*.) Therefore, we decided to make a web application, as they can easily run on different types of device with few prerequisites. Then, we decided to use the most common tools to make websites – Hypertext Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript (JS) – and to look for specific libraries allowing to display and manipulate 3D objects.

The first option that we encountered was CesiumJS, a JS library that is often used to display 3D geo-referenced data. However, then we discovered three.js, another JS library allowing to render, style and interact with 3D scenes. Finally, we also considered a third library called iTowns, which is based on three.js and adds support for geo-referenced data and more file formats used in the geographic data domain.

To choose between the three, our main criteria were:

1. The ability to use and get results swiftly without extensive prior JS experience. This was crucial because being able to implement feedback rapidly from our target groups was an important part of the process.
2. Dynamic and precise styling of the displayed objects. This was important for us as the control on the appearance is crucial for accessibility, and the ability to dynamically change it is necessary to cater to diverse user needs fulfilling the *usable* requirement (*Subsection 2.2.3*).
3. Integration of features corresponding to requirements of our map. Such as being able to create perspective and orthographic cameras, supported controls for mobile and computer devices, and more.

On the other hand, the ability to load georeferenced data was not crucial for us, for two main reasons:

1. Our data uses EPSG:28992, a coordinate reference system where the values are already in metres.
2. We are only making a map for TU Delft campus, which is only a few kilometres long.

Therefore, we did not need any powerful tool to handle conversions between different coordinate systems.

Based on these criteria, we rejected CesiumJS mostly because customising the appearance of objects seemed difficult compared to three.js. This would not allow us to deliver a map

accessible in terms of user experience, prioritising users' needs and tailoring the visual design for diverse audiences. This assessment was based mostly on the examples provided by both libraries, and is also linked to the target audience of both libraries — three.js is a general-purpose viewer for 3D scenes and applications while CesiumJS focuses on easily visualising large amounts of geographic data.

Then, we opted for three.js rather than iTowns because we considered that the added layer provided by iTowns would only add more unnecessary complexity to the project, as we did not really need the geographic component.

5.1.2. Development of the web-app

Without diving into the implementation details, this section will present some of the key choices that we made to be able to incrementally upgrade the app without compromising our ability to all contribute efficiently.

Firstly, the web app was structured to have each component be handled by one specific JS class — often in a dedicated file — that is instantiated by the main component, and can be used and called by the other components. This was very beneficial to be able to successively add new features without breaking previous features.

To avoid conflicts, we also developed the app in a git environment, with every feature and every team member having their own branches. This allowed the main branch to always contain the latest stable version of the app, which was crucial for us to be able to gather feedback from our target groups in a convenient context. Moreover, with every feature having mostly one or two people designated to develop it, this allowed us to always have a main point of contact to propose improvements or ask for help to integrate it with other features.

Finally, to assign tasks and keep track of the issues that arose during development, we used GitHub issues. This allowed us to have one place to store the problems and new features to implement, making it easier to:

- Know individually what tasks each team member was responsible for,
- Know if something is already tackled by someone, and thus avoid duplicate efforts,
- Add small bugs to the backlog without the risk of forgetting about it,
- Assign deadlines, priorities, and labels to structure our efforts,
- Discuss solutions directly in context through comments and linked commits,
- Track the history and resolution (or not) of issues.

5.1.3. Development for web-app robustness

We developed the web-app to satisfy the *robust* WCAG principle (*Section 2.3*) and the *physical/technical access* requirement from the *attainable shell* (*Subsection 2.2.2*). This allowed us to ensure the map could be reliably accessed and used by wide range of users on different devices.

Mobile version

Since smartphones are the most convenient and likely the most-used devices for on-campus navigation, we ensured that our map is accessible on smartphones. We recognised the importance of a mobile-first development approach; the reduced resolution of a mobile phone

meant there was less screen space to add design elements without creating visual clutter. It is therefore easier to design the mobile UI first, then scale it up for desktop resolutions. However, technical difficulties in connecting the mobile devices to the local development server restricted our ability to perform real-time testing. Consequently, we first proceeded with the desktop development and then adapted and optimised it for mobile version later in the project once our issue was resolved.

The mobile version version required adjustment, primarily in its layout, to ensure our map remained *operable* and *clear* (WCAG principles) despite the smaller screen size. We re-adjusted the key map functionalities to be touch-friendly and to prevent visual clutter.

We simplified the layout utilising responsive CSS to dynamically adjust the placements and size of the UI elements. The interactive elements such as buttons were scaled such that they remained easily selectable despite the smaller screen size. Lastly, the complex information such as drop-down menu of toggle-able buttons and information panels were designed as slide bars that appear from screen sides once the corresponding element was clicked on activating a focus mode. We also designed it in such way that the user can easily exit the focus mode with a click outside of the focus area.

Cross-browser compatibility

To further ensure *robustness*, we needed the map to function and render consistently across different web browsers. This also ensured prevention of information inequality caused by the discrepancies.

During the development of the web-app, we realised the discrepancies where the UI elements would be positioned/rendered inconsistently across different web browsers. This highlighted the importance of ensuring consistent user experience regardless of the used web browser.

Therefore, we developed and tested the map for most commonly used Chromium and non-Chromium-based browsers (that we also used on a daily basis): Chrome, Mozilla Firefox and Safari. This involved targeted adjustments to the CSS properties by trial-and-error method which allowed us to proceed more swiftly since we were inexperienced with cross-browser development.

5.1.4. The server

For the web app to be actually *accessible* and *usable* (*Subsection 2.2.2*), it had to run on a dedicated server. A server was provided to us by TU Delft for this purpose. We initially considered using the server as a central part of the project, but this had to be reconsidered due to the issues we encountered. These issues were mostly due to our lack of experience with running and handling servers – especially to host a web app – and to the limitations and restrictions imposed by TU Delft – which hosted the server.

We used nginx to run the app on the server and have it accessible at the correct web address. Setting up nginx is not a complex process in theory, but it was new to us and required some time to find the correct pipeline to be able to quickly update the server with the latest version of the app whenever needed.

We also encountered difficulties when trying to use more than the few ports that were open in the server. It was especially problematic when implementing the feedback feature, which required us to run another app through another process while still only using a few ports. This process may also not be very complex theoretically, but our lack of experience with the web in general made it a difficult task.

5.1.5. Sharing data between members

Because of the issues we had with the server, it took us more time than expected to get it running and enable every member of the team to connect to it and download/upload data from/into it. In the meantime, we had to come up with a simpler solution; enabling every team member to work with the latest data and run locally a fully-functioning version of the app. Ultimately, this was crucial to be able to develop the app.

Our solution was therefore to use one SharePoint environment, provided to every student by TU Delft. By storing all the data there with a fixed structure, we allowed anyone in the team to simply copy all necessary assets to a local directory to run the app. This also had the effect of simplifying the process of uploading the updated data to the server, as most of the input data was in one of these situations:

1. Stored and managed with Excel, allowing simultaneous editing. Which through using OneDrive or the web-version provides excellent support for simultaneous editing.
2. Processed only by one specific member of the team and therefore not prone to version conflicts
3. Never or almost never edited.

Therefore, having this fixed structure of data on a cloud server was sufficient for the project.

5.2. Data formats

5.2.1. JSON

JavaScript Object Notation (JSON) is a format for the storage of key-value pairs, arrays and other serialisable values. JSON objects can be nested arbitrarily allowing for the creation of complex hierarchies. JSON has many derivative data formats that build on its strengths, and it sees use across a large number of different programming languages and applications. We make use of JSON extensively when rendering the map.

5.2.2. glTF

glTF is a relatively modern format for the storage of 3D scenes and meshes that is an extension of JSON. One of the reasons we opted to use glTF is the high compatibility with three.js, which is the JS library we use to render our map. It is even the recommended data format for this library, as it was specifically designed for the exchange on the web of complex 3D scenes, such as our map. Furthermore, the format is also supported by Blender, which is a tool we used extensively to manipulate 3D data. Another reason to choose glTF instead of an older format such as OBJ, is its support for object hierarchies, meaning that we can directly import the models with a convenient structure.

5.2.3. CityJSON

CityJSON is an extension of JSON intended for encoding 3D city models. The decision to use CityJSON was motivated by its lightweight nature and high compatibility with JS. Since CityJSON is essentially JSON, traversing and processing the data can happen without intermediary in both Python or JS.

Moreover, it is based on the CityGML standard which is very convenient for structuring our data. But compared to CityGML, CityJSON is more compact and less verbose, making it faster to load and process. It is also easier to read and understand both for machine and humans, and easier to write. This thus addressed the *manageable* and *clear* criteria (*Subsection 2.2.3*).

5.2.4. CSV

Comma-separated values (CSV) is a format for the storage of tabular data. It can almost universally be imported and exported by spreadsheet applications and most programming languages.

We make use of CSV to export the data we have collected in a spreadsheet, so that it can be processed and integrated into our CityJSON files.

5.2.5. IFC

Industry Foundation Classes (IFC) is a data format for the exchange of architectural, building and construction data.

Commonly used in the Building Information Modelling domain, it can provide rich descriptions of buildings due to its large amount of object classes. This ensures that the displayed underlying information aligns with the *reliable* criterion (*Reliable*) as IFC provides detailed description of building's internal structure. Interior data used in the creation of the map was made available to us in this format.

5.3. Output data

5.3.1. Data structure

Driven by the *manageable* and *reliable* requirements (*Subsection 2.2.3*), we needed to structure our data in a meaningful way. Therefore, we decided to use mainly 5 classes from CityGML 3.0:

- **Building**: containing the outer shell of the buildings.
- **BuildingPart**: to separate the large buildings in multiple parts.
- **BuildingStorey**: to separate each building part between its different storeys.
- **BuildingRoom**: containing the rooms.
- **BuildingUnit**: to arbitrarily group the above objects into meaningful spaces.

Before going into the details for each type, every object in our data model stores as an attribute the 3D position of its icon on the map. This position can then be used in the map when needed to emphasise the object with a visible and meaningful icon. Even objects which have geometry associated to them have a specific icon position.

The structure was chosen to be aligned with the numbering used by the CREFM department which defines each room with a code similar to this one: `08.02.00.600`. In this code, the four parts correspond in this order to the building (08 → Bouwkunde), the wing of the building (02 → East, Dutch: *Oost*), the storey (00 → ground floor) and the room number (600). This example is located in the Bouwkunde building, but the same structure is used for the rooms of all buildings: `<Building>.<Part>.<Storey>.<Room>`.

Then, we use `BuildingUnit` to store every piece of information that does not fully fit in the standard division of `Building`, `BuildingPart`, `BuildingStorey` and `BuildingRoom`. In essence, units are a way to divide a building into arbitrary sections. The simplest example is a part of a building that consists of multiple rooms, such as a library or a hall. These units will have a single name that refers to a group of rooms, and we therefore use units to add this semantic information to our data. This structure would also efficiently serve the case where a single building is subdivided between multiple faculties; it is desirable to group the rooms belonging to a single faculty together into a single unit for visual distinguishing. This allows for easier access and makes it possible to visualise highly specific subsets of rooms.

We also use units in two different ways. The first one is to represent objects that do not have an associated geometry. Examples could include locations of events, food stands or trees. For these objects, we only use the icon position, which is an attribute that every object has — even the ones that have geometry or are associated to geometry — to be able to show it on the map. The other situation relates to entities that require or contain geometry that were not available in the floor plan. In BK, this referred to ramps and smaller stairs (with only a few steps), which we found necessary to model and include to better facilitate decision making for users with mobility issues. In this case only, the units do not reference any existing room, but have instead their own 2D geometry, that is rendered on top of the floor plan when necessary.

Finally, we use a structure similar to units to represent outdoor objects. This includes bike parkings, car parkings, bus stops, food trucks or even automated external defibrillators (AED). Currently, they are all represented only with the position of their icon, but similarly to building units, they could simply be extended to have geometry.

To be able to use `BuildingRoom`, `BuildingStorey` and `BuildingUnit`, we had to use CityGML 3.0 instead of a previous version, as these classes were introduced in this version of CityGML. However, using `BuildingRoom` to store every lowest-level object does not necessarily fully conform to CityGML 3.0 specifications (Open Geospatial Consortium, 2021). The documentation specifies for example that stairs should be stored using `BuildingInstallation` instead. For hallways it is however unclear, as it does not really fit in either of `BuildingRoom` or `BuildingInstallation`.

Therefore, our whole structure takes inspiration from CityGML and CityJSON, but slightly adapts the schema for better compatibility with our data. This was a deliberate choice, as this data is not meant to be shared but instead to fit our needs for the map and thus better support the project's inclusive content goal (*Section 2.4*). Even though it is not fully compliant with CityGML, it should still make it easier for anyone to inspect and manipulate the files using the tools that support CityJSON. Moreover, the possibilities provided by using a predefined standard like CityJSON are very beneficial for the project as it makes the data handling easier to expand. That could be the case for example if this project was expanded to add navigation

data — roads, bike paths, sidewalks — in which case the Transportation module of CityGML could be used.

Finally, we use the support for Level of Detail (LoD) to store for each building a 3D version (LoD 1 or 2) and a 2D version (LoD 0). This support for multiple LoDs is once again very beneficial for potential further work. For instance, while we use 2D floor plans as a deliberate design choice, the schema can be easily adapted to render 3D rooms instead.

5.3.2. Data modelling

We modelled building meshes as closed 3D objects with volume, whilst rooms are only represented as flat 2D planes. Although 3D data for rooms is available, early testing indicated that viewing floor plans in three dimensions made for a worse experience. Despite the fact that the rooms are only ever visible in the 2D map mode, the meshes do retain their appropriate 3D height values. This data was left in as it has a negligible impact on file size and might be useful in the future.

Usually, floor plans are often visualised as planar partitions, wherein the walls between rooms are represented as edges without thickness. However, due to the underlying data of our room meshes, they do not form such a partition in our map. Instead rooms are modelled exactly as their true counterparts, meaning that walls are visible on the map as empty spaces between adjacent rooms. Although technically more accurate than a planar partition, this level of detail is unnecessary for the purposes of our map, and simply results in more visual clutter. Unfortunately, converting the existing meshes into a planar partition is complex and was deemed beyond the scope of the project.

Aside from buildings and rooms, a number of other objects are also stored as meshes in the glTF file. These include ramps, entrances, stairs and emergency exits. Although the existence of such features could also have been signified using icons, we opted for 2D planes instead. The primary reasoning behind this decision was that meshes bring a better understanding of the size of these objects, as well as how they interface with nearby spatial features. For a person in a wheelchair, knowing exactly where a ramp starts or how large an entrance is can be crucial information which would otherwise be lost in a more abstract representation.

5.3.3. glTF

The mesh data that we use to visualise the buildings, rooms and other spatial objects of the map are stored in a glTF file. In the glTF file each building is represented as a hierarchy of objects that eventually terminate into meshes. The top-level building object can therefore contain all of its LoD mesh representations as well as the meshes for the rooms that the building contains. Intermediate steps of this hierarchy represent concepts such as building parts or building storeys.

Building and room mesh data are connected to their respective attributes by manner of common unique identifiers. The JSON object name for a room mesh can therefore be used to retrieve the linked attributes from our CityJSON file, and vice versa.

5.3.4. CityJSON

The non-mesh data that our map requires is stored in a large CityJSON file. This file contains all the information associated with the shown map elements. Examples include names, nicknames, addresses, room codes, opening hours, etc. Each building, room, storey and other map object is represented by a CityJSON object. These objects form a hierarchy by linking to each other using parent-child relationships.

It is important to note that we do not store the geometry of buildings and other objects inside of the CityJSON file, even though this is one of the intended uses of the format.

The attributes that a CityJSON object possesses depend on the physical or abstract element that it represents. Building objects will have an address and opening hours, whilst room objects will contain a room code and surface area. Included attributes either provide information about the associated space, make the object easier to search for, or both. Objects can also be provided the icon position attribute, which stores a position on the map and is used to determine where associated icons need to be placed.

As mentioned previously, CityJSON entries are linked to their corresponding meshes by virtue of identical JSON object names. This means that if a mesh is selected by the user on the map, the corresponding attributes of that mesh can be retrieved by querying the CityJSON for the appropriate name. And vice versa, if a user searches the name of a building or room the required mesh can be found by querying the glTF object. The correspondence between both files is shown with a simple example in Figure 7.

(a) The glTF structure.

(b) The CityJSON structure.

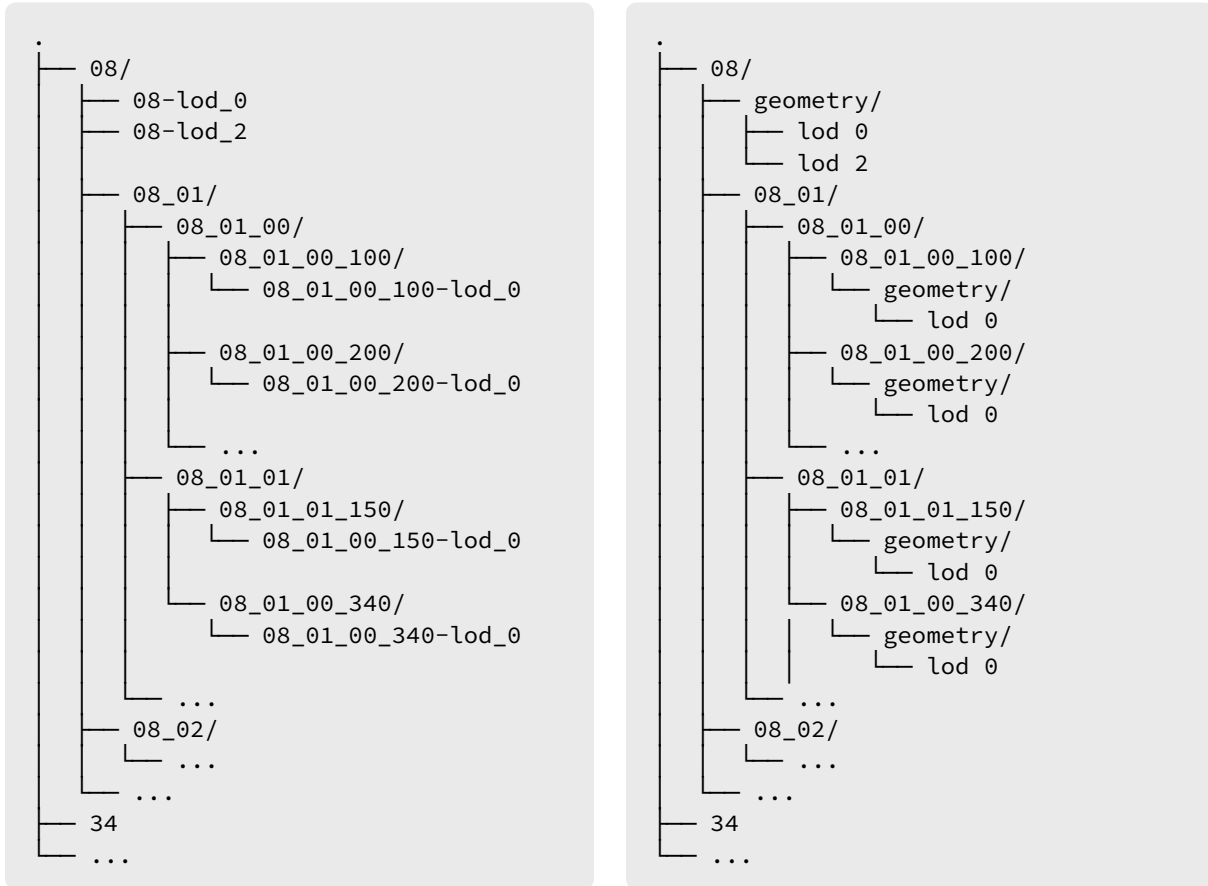


Figure 7: The corresponding glTF and CityJSON structures to store the geometry and the attributes.

Although all CityJSON objects provide information and context necessary to generate the map, many of them do not have corresponding meshes. Building parts and storeys are examples of objects that are not directly linked to any geometry. Instead they link to child objects that eventually terminate into meshes. This way it is possible to recover all of the rooms associated with a given storey, without having to store duplicate data.

5.4. Input data

Converting input data into the necessary output data is not a one time occurrence. As the reality of the campus shifts and evolves the map will be expected to conform to these changes and reflect them accurately. Because of this, the files and formats that we chose to represent the campus need to be easy to edit and convert into their respective outputs.

These adaptable inputs are derived from external sources, and these conversions generally only need to happen once. As an example, after a 3D model of a building is available in Blender as a glTF, it is no longer necessary to interact with the original data from the 3DBAG. Any changes that need to be made are done in Blender, which produces a new glTF file that is then used in the data processing step.

We decided not to include any height information in the terrain, effectively placing all map objects on a flat plane. This decision was made due to how flat the campus already is. Overlaying a Digital Terrain Model (DTM) onto the map would provide almost no additional

information and only serve to clutter the map and make it less coherent. Consequent to this, the reference height of all meshes are set to 0m.

5.4.1. IFC to 2D input glTF

Geometry data for the interiors can be extracted in two distinct manners:

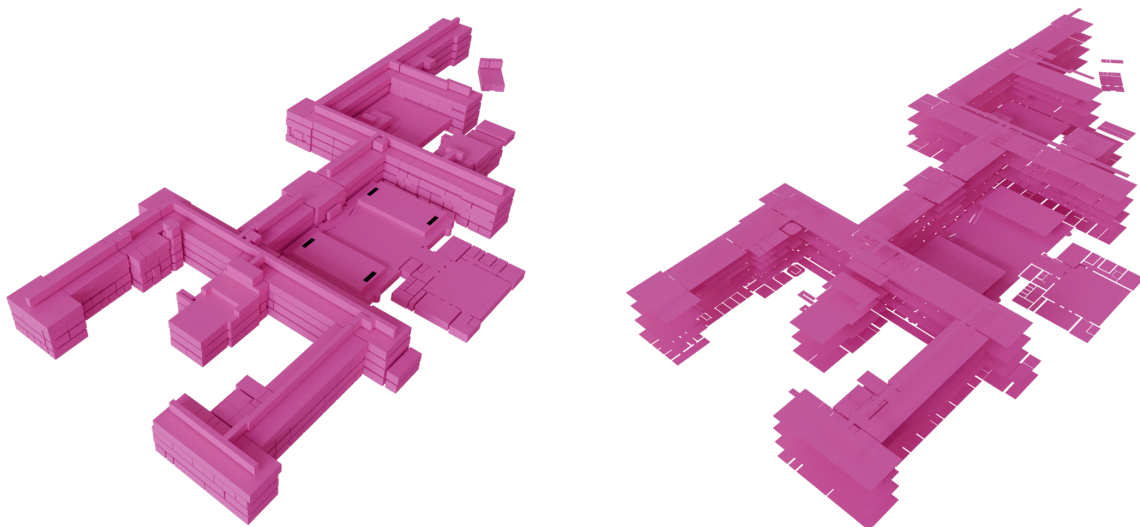
- The first option is to make use of IFC files, which are distributed by the CREFM department. In these files each room, hallway, staircase and elevator have separate geometry and, critically, are labelled with their room codes. As interiors will only be displayed in 2D, the room geometry is flattened before exporting. The result of this operation can be seen in Figure 8. After exporting the geometry, it can be linked to the appropriate database entry by using its label.
- The second method uses the PDF floor plan documents, which are also made available through the CREFM department. By using a program that can manipulate vector documents these PDFs can be converted into SVG files. Next the SVG files are opened in Blender and converted from spline objects into mesh objects. The main downside of this method is that each room geometry needs to be labelled by hand, as the original PDF vector objects do not contain any identifying information. Due to this drawback, this method serves as a backup for when IFC files are not available.

5.4.2. 3DBAG to 3D input glTF

The 3D buildings used in the map fall into one of two categories:

- Building models taken directly from the 3DBAG.
- Building models that are modelled by hand using their 3DBAG counterparts as a guide.

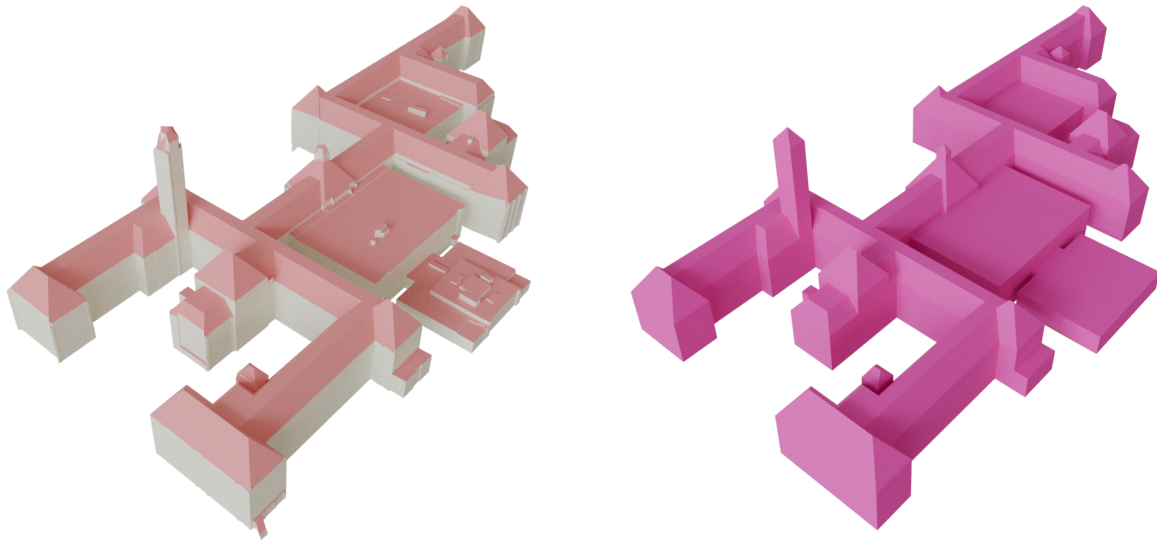
Due to how time consuming the remodelling process is, this has currently only been done for a small subset of the buildings. Although the 3DBAG buildings are good representations of their real-world counterparts, they can contain geometric errors such as holes, offshoots



(a) Render of the BK IFC spaces.

(b) Render of the flattened BK IFC spaces.

Figure 8: Comparison between the IFC spaces and their flattened counterparts.



(a) Render of the 3DBAG version of BK.

(b) Render of our remodelled version of BK.

Figure 9: Comparison between the 3DBAG and our remodelled BK versions.

and jagged sections, and are often more complicated than strictly necessary. Creating a new version from scratch whilst using the 3DBAG model as a guide allows us to create models that are geometrically sound, sufficiently simplified and accurate. Another upside of utilising the 3DBAG data is that the position of modelled geometry within the space will conform to real-world coordinates of the underlying building. Simplifying buildings has a number of benefits, such as reducing their file size and making them easier to texture. An example of this remodelling process is visible in Figure 9.

Creating simplified building shells was done using Blender. We used two distinct methods:

- Tracing the footprint of a 3DBAG building, and then extruding to the appropriate height. This option was suitable for buildings with simple shapes in the two horizontal directions but with unnecessary vertical details, such as air ducts.
- The other method involved starting with a simple geometric primitive such as a cube, and then extruding and manipulating the geometry to achieve the desired shape. We made use of snapping tools to enable easier conformity to the 3DBAG shells. Modelling in this way costs more time and effort but enables recreating buildings that have a higher complexity.

5.4.3. CSV

All non-mesh map data is stored and maintained inside of an online spreadsheet. Each building, room, unit and other spatial object is described by a series of identifying attributes (name, space-id, code etc) and a series of descriptive attributes (room type, surface area, address etc). Whether or not specific attributes are present for any given record depends on what that record represents. Buildings will have addresses, whilst rooms will not.

The identifying attributes serve a dual purpose. The first is to make the resulting CityJSON objects searchable. Nearly all records have both an id and a name. Important objects such as faculty buildings are also given a list of nicknames, which often include the shorthand versions of names that people familiar with campus often make use of. The second purpose of the

identifiers is to create relationships between objects and to link them with their accompanying meshes. Objects connected via a parent-child relationship will contain a reference to each others id. Linking meshes and objects is done by ensuring that both maintain identical names.

When a new version of the CityJSON file is required, the spreadsheet is exported to CSV and inserted into the data processing pipeline. Editing the spreadsheet is made easy due to the collaborative nature of the editor we used. Unlike the other files that had to be managed by dedicated team members, everyone was free to add to and edit the spreadsheet.

5.4.4. GeoJSON point data

Objects that are on the campus but outside of any of the faculty buildings are tracked using GeoJSON point data. GeoJSON is a good format for this kind of data as it can easily be edited using programs such as Quantum GIS (QGIS). Instead of having to manually edit lists of coordinates, points can instead be placed and moved using the cursor, which allows for a much more intuitive and user friendly process.

5.5. Data processing pipeline

The pipeline that we have to go through from the raw input data to the data actually used in the map is slightly complex. The main reason for this is the constraints that we had at the different steps of the pipeline:

- Being able to ingest:
 - CityJSON data for the 3DBAG
 - glTF data for our custom geometry
 - CSV data for the attributes about buildings, rooms, etc stored in a human-readable format (spreadsheets)
 - GeoJSON data for outdoor elements represented as simple points
- Being able to output in three.js:
 - CityJSON data for the attributes with proper hierarchy and links between objects
 - glTF data for the geometry with a hierarchy following the one of the CityJSON file

Our current pipeline is shown in Figure 10. It can be split in two phases: everything before the `cjio` step is data collection, preparation and structuring, while everything after the database is data formatting for the actual usage in the map. Before giving more details, the diagram also displays the main softwares that we are using:

- Blender for initial data processing,
- Python for data processing and translation between the different formats,
- JS for the web map.

5.5.1. The Python scripts

First, Python was chosen to process the geometry mostly because it is a versatile language that we are all familiar with in the team. The language is widely used and had many libraries that we could use to accelerate the development of the scripts. Moreover, potential performance issues for the data processing should not be a problem for us, because we will not process huge amounts of data. For example, the current size of all geometries – indoor for BK, and all 3D building shells of the campus – are around 80MB in total.

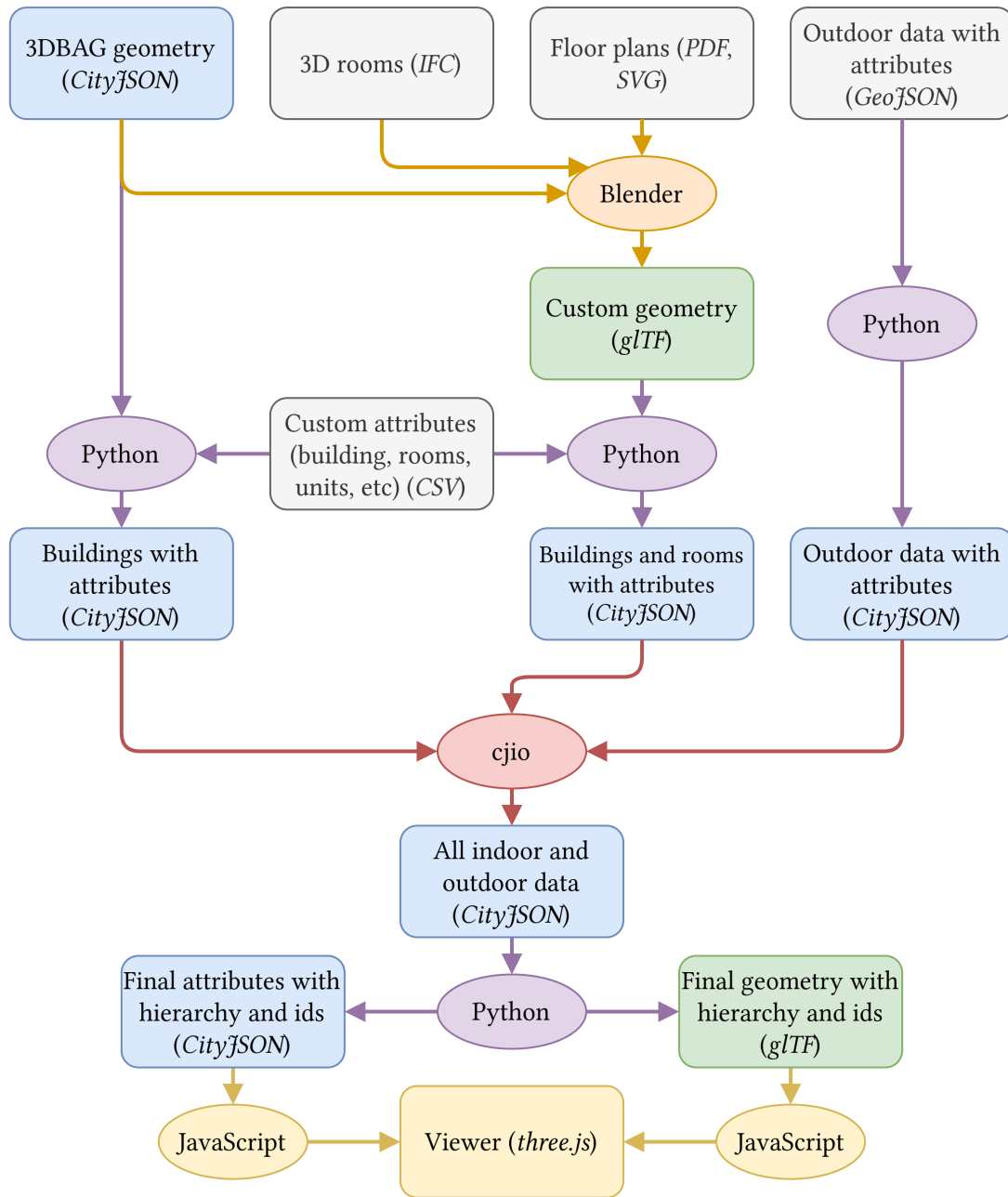


Figure 10: Our data pipeline.

To have a fine control over the hierarchy of the objects and the association of the attributes, we implemented several functions to read and write data in CityJSON, glTF and GeoJSON. This also has the benefit of enabling code reusability for when the project will be continued. Scripts were then organised into a command-line interface (CLI) with multiple separate commands. Therefore, each of the purple Python oval blocks in Figure 10 (Section 5.5) correspond to a script that can be run in one single line by providing the correct input files. This means that the current process to update the online map with the new data is the following:

1. Download the latest versions of the input files that were edited. This can include exporting the spreadsheets to CSV.

2. Run 5 CLI commands corresponding to the 4 Python oval blocks and the cjoy oval block in Figure 10 (*Section 5.5*). These commands take in total approximately 90 seconds. Most of the time can be explained by the processing of the 3D geometry that is done every time but could be avoided by saving intermediate results and reusing it if it ever became an issue.
3. Upload these new files to the server. This takes a few seconds, as the files are not very large.
4. Rebuild the map with the new data. This takes approximately 15 seconds.

These steps are documented and can be run by anyone capable of running the necessary commands, which also require to install the necessary tools. This means that the only prerequisites to produce the datasets and update the online map are:

- An access to the input data
- The capacity to install software and run CLI commands
- Access to the server

5.5.2. Database

For a large portion of the project, we considered and tried to use a database to store our data. This database would have become the main data storage and could have allowed every member of the group to access and edit data simultaneously without creating conflicts, thanks to databases handling multiple simultaneous connections. However, multiple obstacles prevented us from setting up a database and actually using it, and ended up convincing us that it was not necessary in our pipeline.

The first and most basic reason is the difficulty we had to simply get the database running on the server and accessible to everyone. Due to limitations on the server that was provided to us, it took us a lot of time and effort to have a database on the server and figure out a convenient way to access it from our local computers.

Then, the decision that we took to use CityJSON as our central file format and inspiration for the data structure meant that we needed a database that was compatible with it. The database was initially supposed to be in the place where the red cjoy block currently is in Figure 10 (*Section 5.5*), meaning that it would be a central place from which the data used in the map could be extracted and formatted with one command. We therefore considered two different database schemas. The first one is 3D City Database (3DCityDB), a complex database schema that is developed to fully support the CityGML standard. The second one is cjdb, a simpler database schema that handles importing and exporting CityJSON files.

However, both of them raised issues that would have required a lot of investment to tackle them. The complexity of 3DCityDB made it difficult to directly edit the data, even simply the attributes of a given object. This would have required to identify the most common modifications that we would like to apply, and prepare simple usable functionalities to edit them. As for cjdb, it was simpler to use and edit, but it lacked fine control over deciding which objects to keep and which ones to remove when updating the data. Eventually, the simplest solution to update the content of the database became to wipe it out and load all the data again, even for small changes — therefore losing many of the benefits of the database.

Finally, the last obstacle that prevented us from using these tools was the incompatibility between our desired data structure and these tools. It is still unclear to us today if our data structure is breaking any of the rules of CityJSON, because we could not identify any conflict with its specifications. But it is clear that when trying to import the data and then exporting it from any of 3DCityDB or cjdb, the output was missing data. Even with the help from people more knowledgeable about CityJSON, we could not fix it. The summation of the above issues resulted in our decision to avoid the usage of a database on the server.

5.5.3. Some technical considerations

In this section, we explain the most significant challenges that we had to overcome to make this pipeline work and produce a robust and clean output, with enough flexibility.

Regarding the geometry, the step that required the most significant work was the triangulation of the objects provided in CityJSON. CityJSON is a geographic standard supporting for example polygons and multi-polygons. In contrast, glTF is a format focussed on quick and efficient 3D rendering. Therefore, glTF only supports triangles, and converting from CityJSON to glTF requires the triangulation of all polygons contained in the CityJSON buildings. This was not an easy process, because most triangulating packages in Python support 2D polygons only, and the 3DBAG data is not always geometrically correct.

Another significant issue was to be able to add attributes to the geometry in a simple and expandable way. CityJSON is very convenient for this, as it supports attaching any attribute to any object that it contains. However, to make these attributes easy to edit, we used shared spreadsheets that we exported to CSV. This came with the limitations of CSV being a basic format without support for type consistency. To resolve this, we had to come up with simple conventions to enforce the type of data. We also had to make sure that each element has its own unique identifier that is the same in the geometry and in the attributes. This is to enable attaching attributes to the geometry, or even group geometry based on the attributes.

Moreover, as can be seen in Figure 10 (*Section 5.5*), there are three different pipelines that were each developed for a different sort of input – one for the 3DBAG building shells, one for the rooms and one for the outdoor data. But even though these pipelines use different processes and take different sources of data, they have to produce coherent and compatible data that can be merged into one final CityJSON file. This made the development of the pipelines more difficult and more time-consuming, to ensure that similar objects or attributes use similar names and conventions, without adding more complexity to the project.

6. Results

This chapter presents the results of the project, demonstrating a working, inclusive 3D campus map that is available online on the web. The results are presented in two parts. First the overall structure and design of the web app, and second, the key functionalities of the map.

The web app can be viewed at <https://inclusivecampusmap.bk.tudelft.nl/>.

The GitHub repository is available at <https://github.com/tudelft3d/Inclusive-TU-Delft-Map>.

6.1. Structure of the website

The web app and the overall layout were designed to meet the requirements stated by both literature (*Chapter 2*) and users (*Chapter 4*) as much as possible despite project time limitations. However, it is important to note that, due to the scope and timeline, the current version of the map does not fully implement all established requirements. The website is composed of three main pages: the Map page, the About page, and the Feedback page, all of which share a consistent header.

6.1.1. Header

The header on the whole website stays consistent for all three pages (see Figure 11). It has two main purposes: navigation and identity association. The consistent layout ensures the map is easy to operate and comprehend.

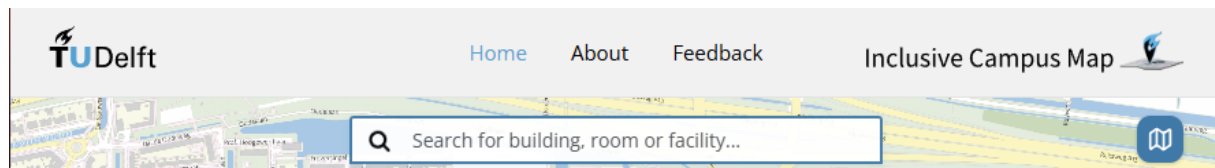


Figure 11: Header bar.

Navigation

The navigation links in the middle allow the user to easily switch between the Map, About, and Feedback pages at any point of time. The active webpage link is highlighted in the TU Delft blue colour, and links provide responsive highlighting upon hover. This ensures that even users with cognitive differences can easily track their actions within the header.

Identity association

The left and right sides of the header are dedicated to establishing the map's identity and the institutional trust. The left side contains the standard TU Delft logo, which provides immediate association with the institution. This is vital as we want the intended users to view the map as an official and reliable source of information.

The right side features the custom-designed map logo. This provides a visual identity to the whole project, making it recognisable from other general map applications, supporting the map's UVP as the inclusive campus map.

Mobile version adaptation

To maintain operability and prevent clutter on smaller screens, the header layout is dynamically adjusted for the mobile version. The navigation links and the custom map logo are removed from the main header view. The header is reduced to two elements: TU Delft logo (top left) and a “menu” button (top right), as seen in Figure 12.



Figure 12: Header bar in mobile version.

When the user taps the menu button, the navigation links temporarily appear as a slide-out side bar. This ensures that the website remains operable by providing touch-screen friendly access to all pages while minimising visual distractions of the main view. The side bar disappears when a navigation link is selected or when the user taps outside of it.

Visual accessibility

The background colour of the entire webpage utilises an off-white colour, as it prevents the dazzling effect of pure white while maintaining the high contrast with the text required for legibility.

6.1.2. Map page

The Map Page (See Figure 13) is the primary interface, designed to ensure the map is immediately discoverable and the information is perceivable for all users. The default view consists of rendered building models on a base map, UI control buttons and a search bar.

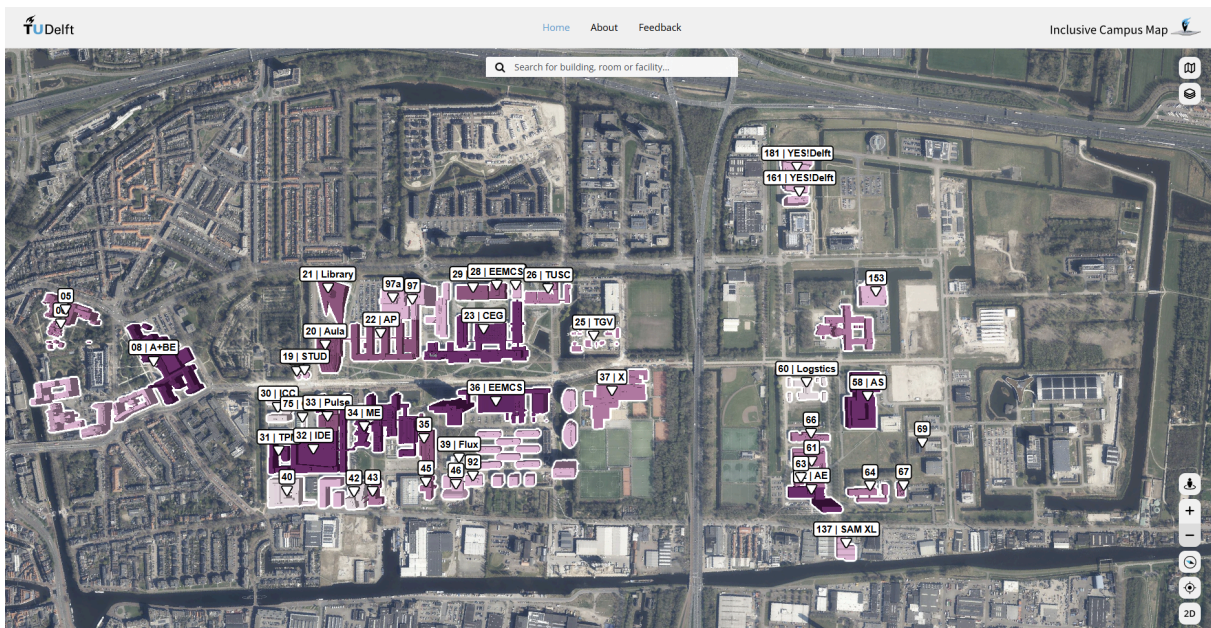


Figure 13: Main map page.

Building models

The default map view of are 3D building models that are displayed in deliberate way to provide information hierarchy:

- **Building hierarchy:** Buildings are rendered in a hierarchical colour palette using various shades of purple. This colour scheme is a deliberate design choice to convey the buildings' importance at a glance:
 - Darkest Purple: Main faculty buildings.
 - Light Dark Purple: Supporting educational buildings (e.g., Echo or Library).
 - Medium Purple: TU Delft-operated, non-educational buildings (e.g., Labs or Botanical Garden).
 - Dark Light Purple: Buildings on campus operated by closely related external institutions (e.g. TNO).
 - Lightest Purple: Buildings not related to TU Delft (e.g. Haagse Hogeschool).
- **Building labelling:** The building short names and their corresponding numbers are displayed as labels above their models to make sure the buildings are immediately recognisable.

UI controls

The UI controls are placed on the right and allow the users to change what is rendered on the map or manipulate the view of the map. The top right UI controls consists of three buttons all utilising a drop down menu style. This prevents initial clutter and maintains a clear interface. The buttons enable the following functionality:

- Change base map: Allows the user to select alternative base layer based on personal preferences and needs.
- Toggle layers: Enables the user to select individual facilities or groups of thematic layers (e.g., wheelchair accessibility, quiet rooms) to be displayed, which is essential for the map's UVP.
- Legend: Explains the colour hierarchy of the buildings.

The bottom right UI controls consist of standard map controls including:

- Reset view.
- Zoom-in/Zoom-out.
- North arrow.
- Find my position.
- 3D/2D view toggle.

Search bar

The search bar is located at the top and central portion of the map for immediate notice. It allows users to query for buildings or rooms. The search bar also provides intermediate results list when writing the desired search object. This is to ease the search process for the users. Upon selection, the corresponding object is highlighted in yellow (contrast colour to purple) and an information panel is displayed on the left side (see Figure 14).

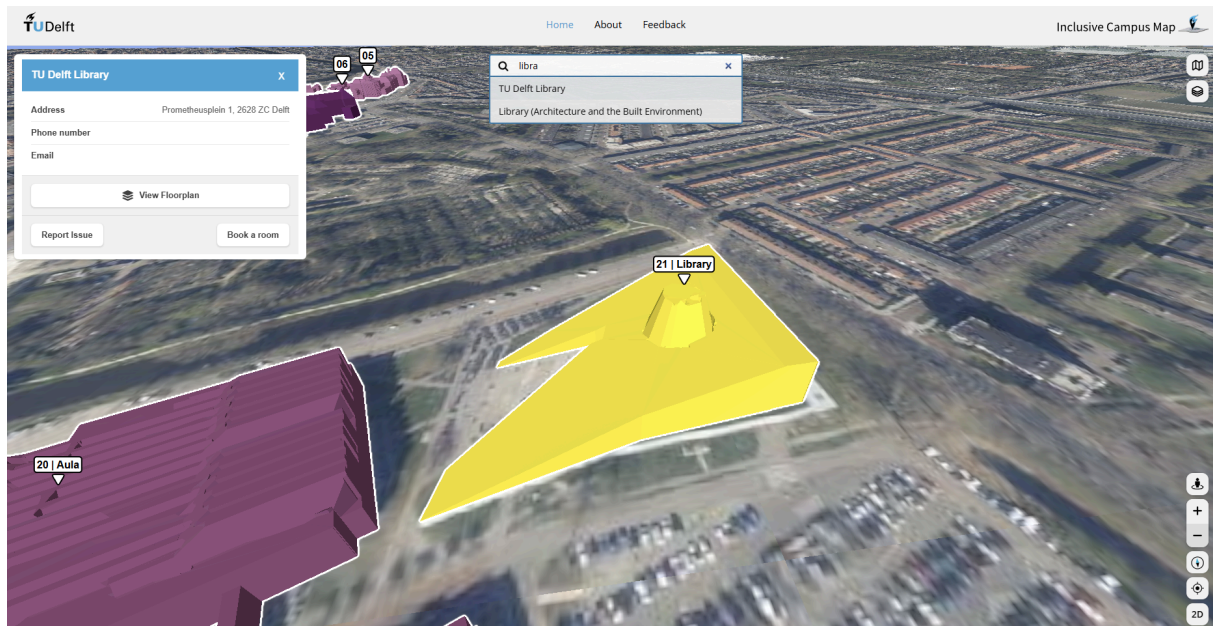


Figure 14: Search bar with closest matches and highlight on click.

Information panel

The information panel provides building details and enables further actions that are building-specific: view floor plans, report an issue or book a room.

Floor plan view

Once in the floor plan view, three navigation buttons appear: up, down and select floor. These allow focused manipulation of the viewed floor within a building.

Visual accessibility and mobile adaptation

All buttons and the search bar dynamically adjust their appearance based on the chosen base map to ensure the contrast ratio between the colour and icon remains sufficient for visibility. The specific colours were chosen from on a generated accessible colour palette that displayed the contrast ratio, derived from the initial TU Delft colour, ensuring compliance with WCAG principles (*Section 2.3*). The colour palette was generated from here: <https://venngage.com/tools/accessible-color-palette-generator>.

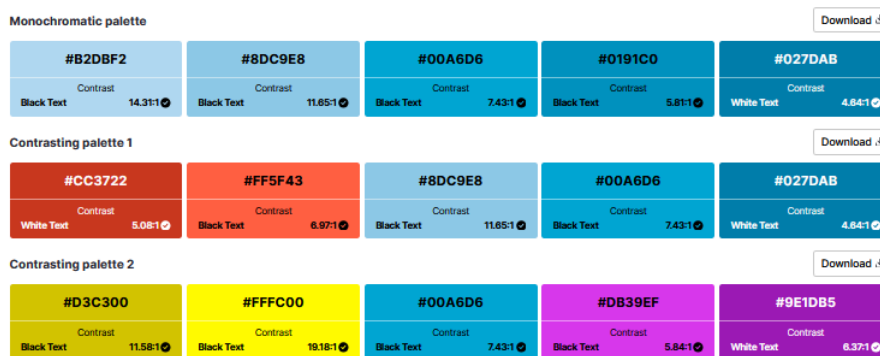


Figure 15: The colour options from the generated colour palette.

For the mobile version, the drop down menus and search bar are adapted into slide-out panels from the bottom of the screen. This design prevents overcrowding of the small screen while still providing full operability of the map.

6.1.3. About page

The about page is a critical component that transforms the web app beyond its simple technical functionality, satisfying the *clear* criterion (*Clear*). It addresses the users of the map and improves their map literacy by providing a clear documentation of the project, especially for the first-time users (see Figure 16).

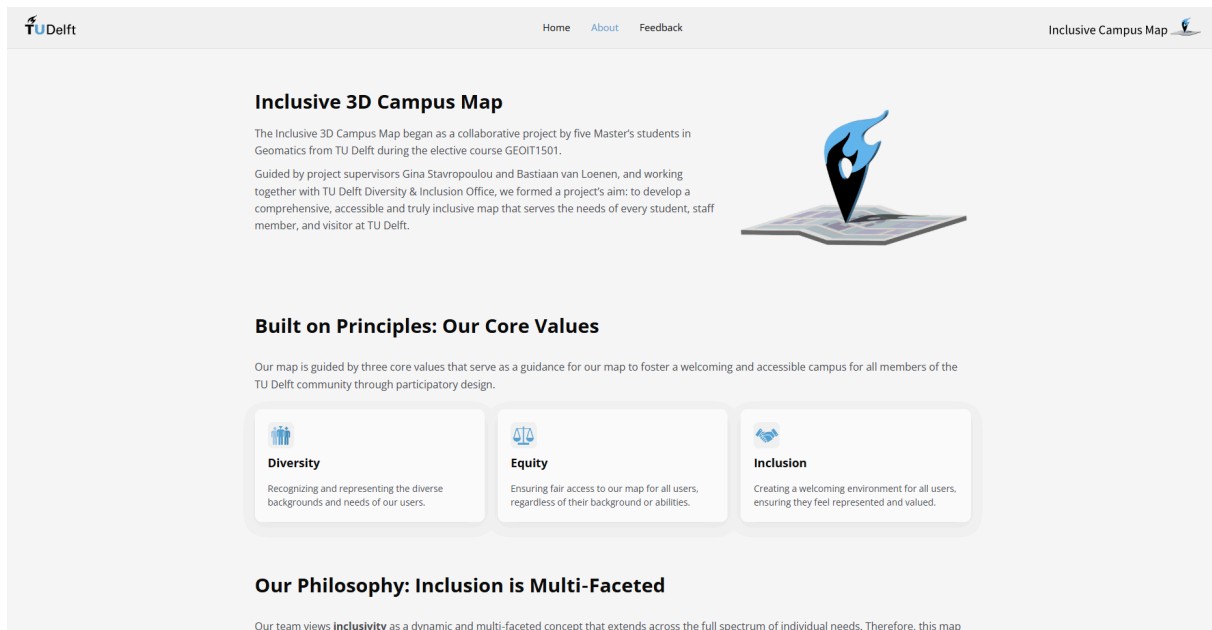


Figure 16: Snippet of the About page.

Positionality and accountability

The page therefore acts as a formal mechanism for addressing our cartographic positionality. The page includes a section detailing the project's background, the client (TU Delft D&I Office), and the participatory mapping process used to gather requirements. This transparency ensures users understand why certain features were prioritised and how the inclusive content was defined.

Management of expectations

By documenting the project's goals and limitations, we ensure that our decisions remain transparent to the TU Delft community, manage user expectations, and establish a clear direction for future development.

Point of Contact

The page also includes links to the participants and client for further information, acknowledging the collaborative nature of the project. If the users wish to participate, contribute or share their thoughts about the project, this page also serves as a direct point of contact to the web app team.

Mobile adaptation

To ensure the page's clarity, the mobile version was optimised for a vertical flow. The content that would typically be displayed horizontally on wider screens (e.g. parallel blocks) were condensed into a vertical system. This system ensures easy-to-read, sequential flow preventing the need for horizontal scrolling (see Figure 17).

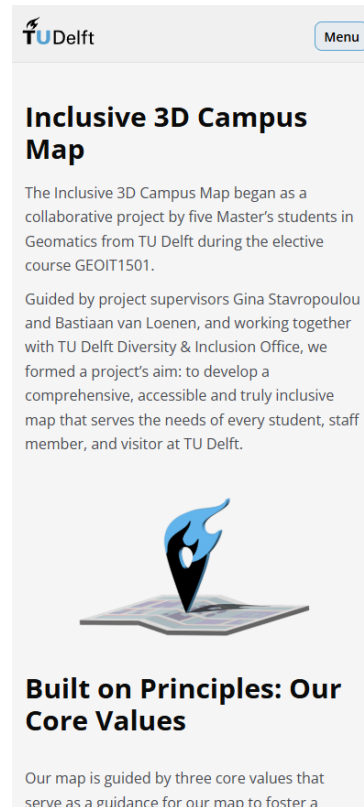


Figure 17: About page in mobile view.

6.1.4. Feedback page

The feedback page serves as a direct manifestation of the co-creating inclusive design process and the commitment to the continuous improvement. It is designed to satisfy the *reliable* criterion (*Reliable*) and the concept of inclusivity as a *process of becoming* (Demirel & Erkılıç, 2025).

The aim of this page is to engage the users to become an active participant in the map's maintenance, transforming them into co-designers and thus increasing the map's UVP.

The feedback ensures that the participatory process extends beyond its initial development stage. By allowing for direct user input, the map remains a tool for social agency, making the institution's commitment to its diverse demographics diverse and accountable. This is crucial for the map to remain reliable throughout its lifetime and adaptable to the dynamic TU Delft environment.

The structure of the feedback page consists of a feedback form that collects the user's input (see Figure 18). The form first asks to describe the feedback the user wants to give. Additionally, to make the gathered data location-specific and action-specific we also ask the users to provide the location of the described matter as well as categorising the matter (e.g. Incorrect

information provided in the map). Lastly, we ask the users to leave their email address. This allows the development team to establish contact with the particular users and to inform them about the status of their feedback processing. This allows us to stay transparent and accountable.

Figure 18: Feedback page.

Mobile adaptation

Similarly to the About page adaptation of the feedback form was optimised for vertical flow by narrowing down the feedback form and adjusting the font sizings. This was adapted such that the need for horizontal scrolling is minimised.

6.2. Map functionalities

This section will present the different functionalities that were implemented in the map. We will first start with general map features that many maps offer, before presenting features that really show the added value of our map. Some of them are specific inclusive features that target specific user groups, while some are more common but fill gaps in the currently available information about the TU Delft campus.

6.2.1. General map features

Our map presents features that are often considered as prerequisites for any map, including physical ones. This includes:

- A north arrow, which is especially useful in an interactive map to prevent the user from getting lost when rotating the view.
- A legend to understand what the colours and the icons correspond to.
- A title giving more information about the goal pursued by the map (with many more details in the About page).

Then, it also presents some features that are specific to interactive maps but are still very common for this type of maps:

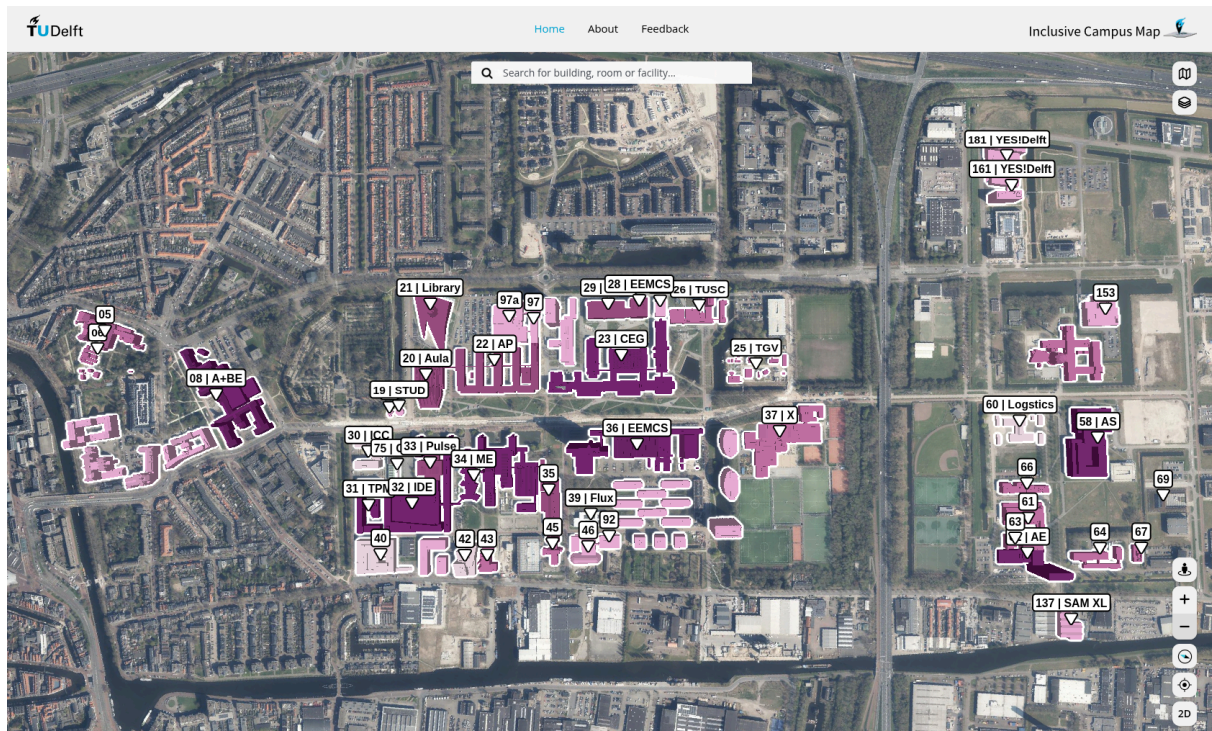


Figure 19: Screenshot of the first view when loading the web map.

- The ability to zoom in and out and pan the map to focus on specific locations or get a broader view.
- The ability to reset the view or the orientation of the map in case the user gets lost.
- Positioning allowing the user to know where they are in the displayed map.
- The choice between multiple basemaps, which are the background layers that serve as a basis for the map.

All these features are not particularly new or innovative, but they were necessary to make a map that would be usable and ensure that users do not have to start from scratch when attempting to use our map. It is worth noting that with all these features and the potential information provided by the basemaps — which include aerial photos and more abstract representation of the campus — the result is already a functional map, even if a very generic one. Everything that is mentioned in the next sections builds on top of this to achieve goals that are not usually achieved by maps, or at least not by the maps covering the TU Delft campus.

Nonetheless, we put great effort in making these general features as intuitive as possible based on the interview input we received. For example, the buttons that change the camera's position and/or rotation are accommodated using animations. With the intention the user is less likely to lose their sense of direction, since they see the camera move/rotate from A to B instead of snapping there immediately.

6.2.2. Inclusive map features

Many of the needs emphasised by the target groups were related to indoor facilities and the lack of information about what can be found in the buildings of the campus, as well as their exact location. But this lack of information is there for a reason: indoor data about the buildings

on the TU Delft campus is difficult to find, and rarely contains information about the facilities that users actually need, especially marginalised groups.

Therefore, our map contains indoor data only for the building of the Faculty of Architecture and the Built Environment (see Figure 20 and Figure 21). In this building, we made sure to collect and present information about as many as possible of the facilities that were queried by our target groups. This includes:

- The official and unofficial names of the rooms and places in the building
- The necessary information for wheelchair users to navigate the building (such as accessible parkings, entrances and emergency exits, elevators and ramps)
- Care facilities for parents (day care and lactation rooms)
- Contemplation rooms
- Restrooms categorised between the different users

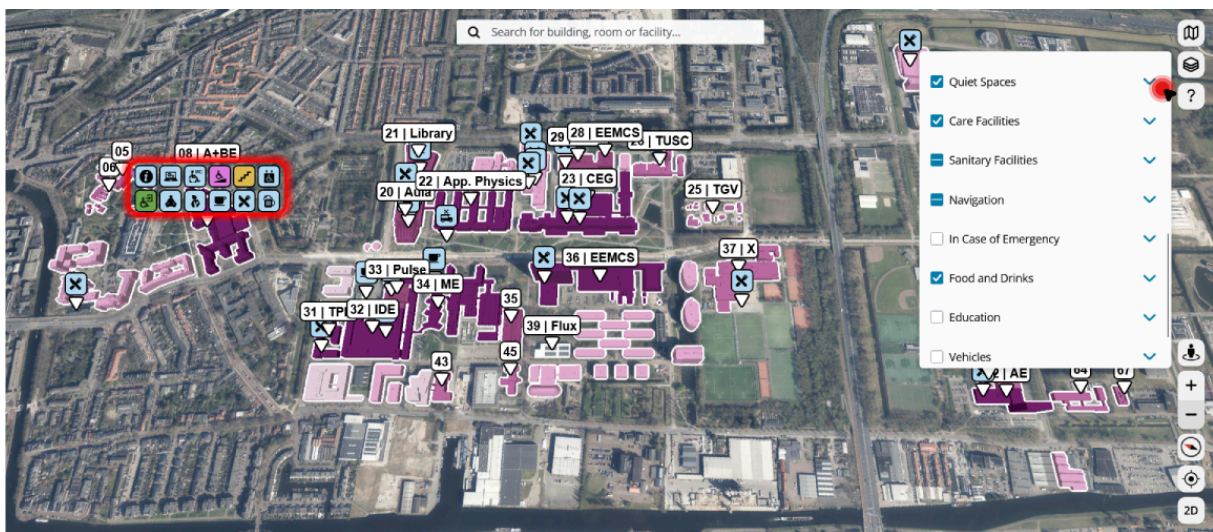


Figure 20: Toggling thematic layers in 3D view.

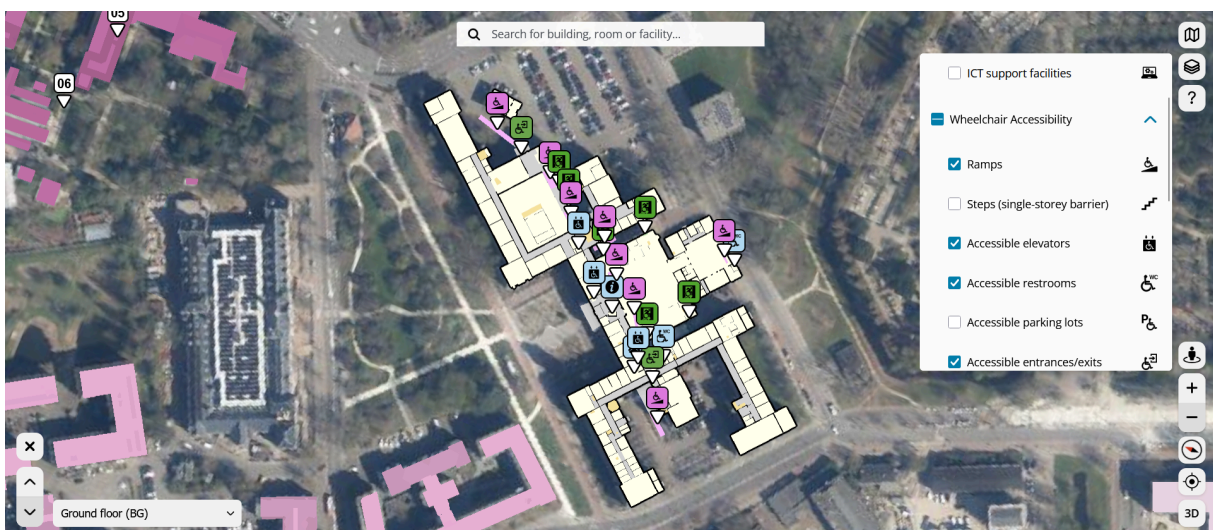


Figure 21: Thematic icons in indoor view.

Moreover, more general indoor information was also widely requested among the different interviewees, and mapping the whole building also made it possible to collect more generic information useful to all campus users. It is crucial to recognise that a user with specific needs,

such as a mobility impairment, still requires the full range of universal functionalities (e.g., finding a lecture hall, locating a food stand) in addition to their specialised requirements. Adopting this perspective, we ensure that the map addresses the complete requirements of every student, staff member, and visitor. Therefore, the following general needs were also included in the scope of inclusivity:

This includes:

- Education and work spaces
- Food and beverages
- More generic navigation elements, such as:
 - Public transports
 - Parkings for cars, scooters and bikes
 - Stairs and elevators

6.2.3. 3D and 2D integration

On top of targeting marginalised groups to attempt to fulfil their needs, one of the main specificities of our map is the integration in a single map of both 2D and 3D information. Almost every building that is part of the TU Delft campus is displayed in the map as a 3D model. This should enable users to get a better understanding of the organisation and the structure of the campus, as well as making the building more recognisable. However, we also received mixed feedback about the 3D view, due to difficulties in the added dimension for panning and orbiting as well as the added visual information. As a result, we also implemented a 2D orthographic view from the top, such that the map is still easily usable by users with either preference. This 2D view is very similar to what other interactive web maps use, therefore offering a more familiar and easier interface to users who could be uncomfortable with the 3D controls. Moreover, this 2D view is used to display the floor plans of the buildings with a simpler interface, since the floor plans do not require a 3D view.

Finally, to ensure a nice and comfortable experience in the different views, we made sure to implement smooth animations for the different views and between them. The main goal was to provide a clear, smooth and convenient navigation without disorienting them every time the camera changes or moves to a different location that the user is looking for. To achieve this, we made sure to avoid as much as possible any automatic rotation of the camera, and to balance the speed of animations between getting quickly to the point of interest and allowing the user to understand the path taken by the camera.

6.2.4. Information accessibility

One of the highest priorities of this map was to make the collected data about the campus accessible to users in simple ways. This is partly the consequence of trying to cater to the needs of several different target groups, as this implies having to collect a lot more data and making sure that each user can select what they want to know about. To overcome this issue, we implemented three main features that are complementary and beneficial in different situations.

Icons

The first solution to make facilities discoverable on the map is the use of icons. Icons enable the user to get an idea of what is available in a given area, without any prior knowledge other than knowing what they are looking for. They can also be convenient to get an idea of the amount of facilities that the campus contains, and how they are distributed. To prevent the view from being cluttered with icons, we made sure that icons referring to spaces inside of buildings are only shown when the user is in the building view, but gathered on the building otherwise. This allows users to identify which buildings contain which facilities, and then select a specific building to find their precise location.

Filtering

Another feature that was implemented to avoid cluttering the view with icons is the ability to filter the displayed layers. Users can select precisely which layers to activate or not, and layers are grouped and categorised to make them easily accessible and discoverable. This feature was mentioned a lot due to the previous experience that many interviewees had with other TU Delft campus maps, which displayed too much information at once, making it difficult for them to find what they were really looking for. Such a hierarchical organisation also makes it easier for new users to discover the content of the map depending on their needs. This should reduce the likelihood of users not knowing that a map had a feature they would appreciate — a situation that we observed when requesting feedback about the current maps.

Information panel

To make detailed information accessible without overwhelming the main view, we implemented an information panel (infopane) that appears when a user clicks on a building or a specific unit (see Figure 22). The infopane provides detailed and context-dependent information while maintaining a consistent layout across all entries. For buildings, it includes its' name and number, an image of its' main entrance, a list of key facilities with an emphasis on those that are not universally available (such as gender-neutral restrooms), and practical details such as the address, contact information, and opening hours.

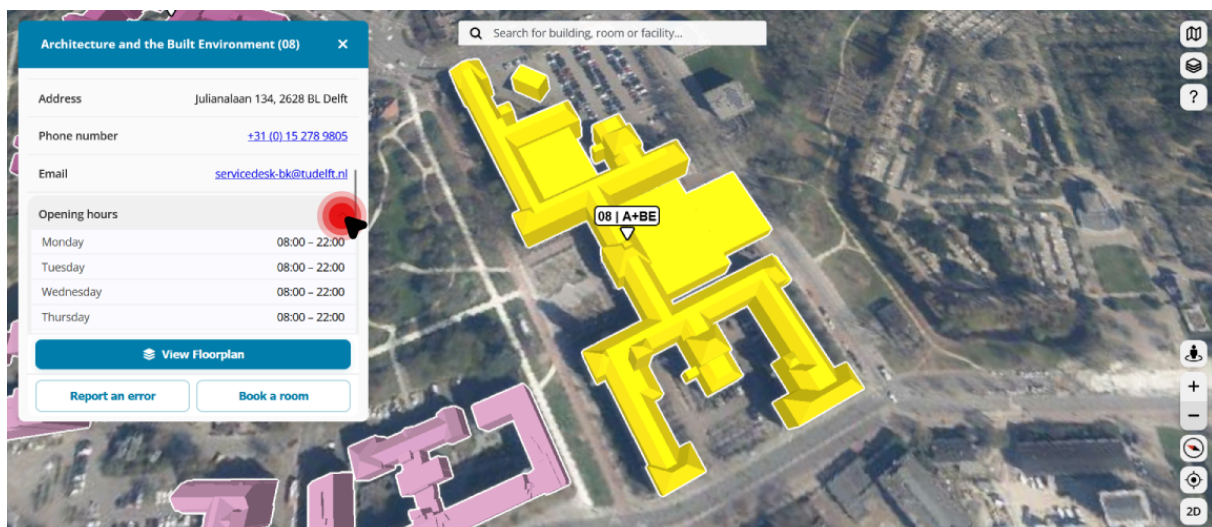


Figure 22: Infopane of BK faculty building.

Special attention was given to wheelchair accessibility, which is often difficult to find, such as information about parking, entrances, elevators, and restrooms for wheelchair users. The infopane also allows users to access the floorplan view and to navigate to external websites, such as TU Delft's faculty page. For individual rooms or units, the same structure is used, with slightly different content since other information is relevant. Each infopane also includes a "Report an error" button that redirects to the feedback page with the corresponding location prefilled, making user contributions and continuous improvement of the information easier.

Search

Finally, we implemented a search bar to allow users to find specific places that they are looking for (refer back to Figure 14 (*Search bar*)). Since there are many situations in which users may be looking for a place in different situations, we tried to gather a variety of information about places and make all of them accessible through the search bar. Here are a few examples of what can be found in the current map, with a concrete example for each:

- Buildings (example of Bouwkunde):
 - By their TU Delft number (08)
 - By their full name (Architecture and the Built Environment)
 - By their nicknames (Bouwkunde or BK)
- Indoor spaces (example of the Geolab):
 - By their official CREFM department number (such as 08.02.00.600)
 - By their displayed number (BG.00st.630)
 - By their name (Geolab)

This flexibility allows the search bar to support the various situations in location a place in campus. Room codes in calendar invitations can be used to find the appropriate meeting room, while casual nicknames can also be used to confirm the location of a meetup or event.

7. Conclusion

The report concludes by revisiting the research question(s).

1. *What does inclusivity mean, and what is an appropriate definition of inclusivity for our project?*
2. *What does inclusivity entail in digital cartography?*

We answer the two above sub-questions through a comprehensive literature review. Despite the ambiguous and multi-dimensional nature of the term ‘inclusive’, we situate our understanding through relevant contexts – the TU Delft’s inclusivity objectives, inclusive cartography, and inclusive design – and develop a unique definition of ‘inclusive’ specific to the project. This involves a continuous and user-involved mapping process which delivers information on inclusive facilities for diverse needs, all presented in a visually accessible style.

3. *Who are the marginalised groups in TU Delft, and what additional information do they need in a campus map?*

As defined by the D&I office as the dimensions of difference, each individual is different in age, gender, social class, diverse abilities & well being, religion & belief, race & ethnicity, sexual orientation and culture. This underlines that for our web map there is no ‘the user’, and similarly there is no ‘the underrepresented/ marginalised target group’.

The marginalised groups we worked with are specific communities and support networks that our client, the D&I Office has been working with and supporting. From our focus group discussions and interviews, participants shared their struggles in navigating the campus based on a diverse variety of needs – such as mobility issues and neurodivergent needs – which were codified into a list of requirements to be built into our map. Examples of such requirements are information on the location of specific rooms – such as the contemplation room for meditation, prayer and a low-stimuli environment – or certain functionalities that help in using the map – such as a search bar.

4. *How do we create an online map viewer which can be easily updated over time?*

This sub-question instead became a core principle throughout the map development process, to ensure all components of the project are well-documented, explained, and modular. This extends to our report, code and the map itself. Reproducibility is therefore a significant outcome of our project.

7.1. Unique value proposition

Our project delivers a 3D inclusive campus map of the TU Delft in a digital online format. The map is designed to serve staff and students, with further prioritisation and availability of information that serves the needs of under-represented communities across the campus. The project serves both as a proof-of-concept and as a foundational piece upon which future synthesis projects and research assignments can build upon to further increase the inclusive aspect of the map. To this effect, extensive and detailed documentation has also been recorded to justify key decision points, and record the overall process for reproducibility.

The map design itself is also noteworthy for incorporating 2D and 3D, as well as indoor and outdoor details, into a single viewing experience. This not only greatly improves accessibility to information by consolidating relevant campus information into a single coherent source, but also reaffirms the possibility of bridging the interior-exterior cartographic divide. Critically, the map centralises information that is typically scattered, incomplete, or entirely absent from existing resources. Through the map users can access comprehensive accessibility details, such as wheelchair accessibility, steps (single-storey barriers), and accessible toilet locations, that would otherwise require consulting multiple sources or even physical reconnaissance. Buildings, units and rooms are enriched with detailed attributes, such as contact details, opening hours, and textual information on wheelchair accessibility, all immediately visible through the infopane. This approach to information presentation makes that essential information, often buried in (internal) PDFs or institutional knowledge, is discoverable, up-to-date, and presented in a consistent format across all campus locations.

Beyond the original intention of the project, the map also possesses added significance for the client D&I Office. Mapping inclusive spaces in the campus contributes to the Strategic Agenda by increasing awareness of the existing facilities and support TU Delft has provided for staff and students. Map users with access to these information and facilities are then able to utilise these facilities and improve their campus experience. The mapping process also has the appropriate effect of exposing 'exclusive' areas, or otherwise zones where inclusive facilities are lacking.

The map and project in and of themselves are valuable statements of a successful and impactful story of enhancing university resources through the use of an inclusive lens. These can then be used as showcases by the D&I Office to spur discussions of inclusivity in greater academic and administrative contexts. Examples include incorporating inclusive mapmaking as core materials for cartography lectures, and exploring avenues with the Campus Real Estate & Facility Management department to further liberalise campus data towards inclusive purposes.

7.2. Limitations

Our project focuses on exposing existing inclusive facilities, enhancing the information surrounding them, then spreading awareness and increasing accessibility to these facilities through the map. In a broader scale, the priority is therefore on the current status of the campus; the map does not seek to enact changes in the physical infrastructure, institutional policies or broader campus accessibility interventions. Instead, the map acts as a reflection of the existing situation, with the possibility of sparking and triggering discussions along these topics. In the event that such changes do occur, the map can then be updated to reflect such improvements to the campus grounds.

7.2.1. Time constraints

Specific to the overall workflow of our project, the main limiting factor was time. Meeting dates and times were only able to be proposed on short notice. These timings also necessarily coincided with the start of a new academic year. Many potential participants therefore found these dates and times unsuitable, resulting in a lower response rate than anticipated. We

adapted by arranging ad-hoc meetings, which often meant speaking with individual respondents rather than facilitating group discussions.

While the individual feedback we gathered remained invaluable, this approach resulted in lost opportunities for facilitating discussion and cross-examination among participants with diverse backgrounds and identities. Group settings can spark insights as participants respond to and build upon each other's experiences—something that individual interviews, no matter how thorough, cannot replicate. We also recognize that a larger participant pool would likely have provided richer, more diverse insights, potentially uncovering needs and use cases we did not identify.

An alternative interpretation of our participant engagement is equally valid: the number of respondents we spoke with and the depth of insight they provided may well have been more than sufficient for this project's scope. We successfully uncovered and documented more requirements, desires, and accessibility issues than we could implement within our timeframe. This perspective is particularly relevant when considering our project's positioning as a proof-of-concept toward a new, comprehensive inclusive campus map. In this light, our research phase has established a solid foundation of user needs and validated core design decisions, while also identifying clear directions for future development.

7.2.2. Risks

The two-round, engagement-based methodology employed means that the depth and specificity of features is directly dependent on direct community input. For example, if we did not connect with a wheelchair user during either interview/focus group round, we would still likely include wheelchair accessibility information based on general best practices and existing knowledge. However, the nuance, detail, and user-centred design of these features would be more limited compared to features informed by direct consultation with wheelchair users themselves. Conversely, target groups who actively participated in both consultation phases are represented with greater depth and specificity in both the features implemented and the information prioritised on the map.

There is also a risk that due to a relatively small sample size of 11 participants, the requirement modelling results could be too specific to the individual, and therefore not necessarily representative of the needs of the larger community. We mitigate this possibility through the mentioned frequency of each requirement. Aggregating similar requirements indicate a common need across participants, which can then be extended to reflect a common need across the larger communities.

7.3. Future Work

Many of the limitations identified above are resolvable simply given a longer timeframe for implementation. Our project sought to extract the most important needs and provide functionality across a broader scale, on top of developing a functional map viewer. Indeed, future extensions to the project are likely to have broader options for scope and implementation due to having an existing working map product as a basis. There is therefore the opportunity to reference our impact-feasibility matrix, and implement high-impact but complex functionalities.

An obvious example would be to implement support for accurate navigation and routing within campus, with dedicated considerations for physical accessibility. This would also involve narrowing the target group to campus users with some form of permanent or temporary physical disability, and provide in-depth solutions towards a seamless end-to-end routing function.

Another possible alternative is to improve inclusiveness from the perspective of enhancing the dynamic delivery of information. Introducing up-to-date information can be an effective way of making the map feel more active and informative. This could take the form of updating the current crossing points along the tram construction work as they shift, or sourcing information from event organisers to highlight upcoming events – such as a bar activity, open-to-all guest lectures and showcases, etc.

To conclude, it is important to reiterate the cyclical nature of inclusive work. Needs do not have an end; the campus map should therefore be dynamically reviewed to address contemporary needs.

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Glossary

3DBAG – An open 3D building data set that is generated fully automatically based on LiDAR data and covers the whole of the Netherlands. More information at https://docs.3dbag.nl/en/ .	5, 18, 19, 33, 34, 35, 36, 39
3DCityDB (3D City Database) – A free and open source package consisting of a database schema and a set of software tools to import, export, manage, analyse, and visualise virtual 3D city models on top of a spatial database system. More information at https://docs.3dcitydb.org/1.1/ .	38, 39
AGILE – Product development approach that emphasises flexibility, collaboration, user feedback, and iterative progress rather than rigid planning. More information at https://agilemanifesto.org/ .	6, 16
Blender – A program for the creation, processing and rendering of 3D information. It has support for all common data formats, and is completely free and open-source. More information at https://www.blender.org/ .	33, 34, 35, 36
CesiumJS – An open-source JS library for creating 3D globes and maps. It allows to create interactive web apps for sharing dynamic geospatial data. More information at https://cesium.com/platform/cesiumjs/ .	25, 26
CityGML – An open standardised data model and exchange format developed by the Open Geospatial Consortium (OGC) for storing and exchanging 3D city models with semantic information. More information at https://www.ogc.org/standards/citygml/ .	29, 30, 31, 38, 58
CityJSON – A JSON-based encoding for storing 3D city models based on the CityGML standard. More information at https://www.cityjson.org/ .	iv, 20, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 58
cjdb – A Python-based importer/exporter of CityJSONL files (CityJSON Lines) to and from a PostgreSQL database. More information at https://github.com/cityjson/cjdb .	38, 39
CLI (command-line interface) – A means of interacting with software via commands – each formatted as a line of text. More information at https://en.wikipedia.org/wiki/Command-line_interface .	37, 38
CREFM department (Campus Real Estate & Facility Management department) – A department of the University Corporate Office which develops and manages the real estate and grounds of TU Delft. This includes lecture halls, offices, laboratories, infrastructure and parks on the campus. More information at https://www.tudelft.nl/en/about-tu-delft/organisation/university-corporate-office .	18, 30, 34, 51, 53
CSS (Cascading Style Sheets) – A stylesheet language used to describe the presentation of a document written in HTML or XML (including XML dialects such as SVG, MathML or XHTML). CSS describes how elements should be rendered on screen, on paper, in speech, or on other media. More information at https://developer.mozilla.org/en-US/docs/Web/CSS .	25

CSV (Comma-separated values) – A data format that stores tabular data (numbers and text) in plain text, using commas to separate delimiter-separated values, and new lines to separate records.	29, 35, 36, 37, 39
D&I Office (Diversity and Inclusion Office) – TU Delft’s office aiming at nurturing and promoting a respectful, accessible, diverse and inclusive TU Delft community for all staff, students and guests. More information at https://www.tudelft.nl/over-tu-delft/strategie/diversiteit-en-inclusie/contactpersonen-netwerk .	i, ii, 1, 2, 3, 5, 6, 8, 13, 15, 16, 52, 53
DTM (Digital Terrain Model) – A digital representation of the bare-earth surface, excluding all natural and man-made features such as vegetation, buildings, and other above-ground objects.	33
GeoJSON – A JSON-based open format for encoding a variety of geographic data structures. More information at https://geojson.org/ .	36, 37
glTF (Graphics Library Transmission Format) – A standard file format for three-dimensional scenes and models, with a focus on the efficient transmission and loading by engines and applications. More information at https://www.khronos.org/glTF/ .	iv, 20, 28, 31, 32, 33, 34, 36, 37, 39
HTML (Hypertext Markup Language) – The standard markup language for documents designed to be displayed in a web browser. It defines the content and structure of web content. More information at https://html.spec.whatwg.org/ .	25
IFC (Industry Foundation Classes) – An open data model used in the Building-information modelling (BIM) domain for the exchange of construction models, including 3D models of buildings. More information at https://www.buildingsmart.org/standards/bsi-standards/industry-foundation-classes/ .	29, 34
iTowns – An open-source framework designed for the efficient visualisation, navigation, and interaction with 2D and 3D geospatial data on the web. More information at https://www.itowns-project.org/ .	25, 26
JS (JavaScript) – A programming language used most often for dynamic client-side scripts on webpages, but it is also often used on the server-side, using a runtime such as Node.js, Deno, and Bun. More information at https://developer.mozilla.org/en-US/docs/Glossary/JavaScript .	25, 26, 28, 29, 36, 58, 60
JSON (JavaScript Object Notation) – A format for the storage of key-value pairs, arrays and other serialisable values, where objects can be nested arbitrarily allowing for the creation of complex hierarchies.	28, 29, 31, 32, 58, 59
LoD (Level of Detail) – A concept to differentiate multi-scale representations of semantic 3D city models. It is in practice principally used to indicate the geometric detail of a model, primarily of buildings. More information at https://3d.bk.tudelft.nl/lod/ .	31
Python – A widely used, high-level, general-purpose programming language, featuring many libraries in the domain of geospatial and geometric data processing. More information at https://www.python.org/ .	29, 36, 37, 38, 39, 58
QGIS (Quantum GIS) – An open source GIS program that allows for creating maps and performing spatial operations. More information at https://qgis.org/ .	36

SVG (Scalable Vector Graphics) – An open standard based on XML for defining two-dimensional vector graphics, having support for interactivity and animation. More information at https://www.w3.org/TR/SVG/ .	12, 34, 58
three.js – An open-source, easy-to-use, lightweight, cross-browser, general-purpose 3D library for JS. More information at https://github.com/mrdoob/three.js .	21, 25, 26, 28, 36
TU Delft (Delft University of Technology) – The Dutch university in which this project was carried on. More information at https://www.tudelft.nl/en/ .	ii, 1, 2, 5, 6, 8, 9, 10, 13, 14, 19, 25, 27, 28, 46, 47, 48, 49, 50, 51, 52, 53, 58, 59
UI (User Interface) – Communication tool between the user and the map consisting of all the visual and tactile elements presented in the map.	11, 12, 27, 41, 42
UVP (Unique Value Proposition) – Defined value that the users receive from using the product, differentiating it from other competitors.	9, 40, 42, 45
WCAG (Web Content Accessibility Guidelines) – International standard that documents how to make web content more accessible to people with disabilities. More information at https://www.w3.org/WAI/standards-guidelines/wcag/ .	11, 12, 13, 26, 27

Appendix A

Detailed requirements

A.1. Initial MoSCoW

The initial MoSCoW categorisation of the map specifications, about three-four week into the project. The filling of each cell specifies whether the objective was achieved (filled in), partially achieved (hatched/striped) or not achieved (white) at the end of our project.

Table 2: The initial MoSCoW categorisation of the map specifications

Must Have	Should Have	Could Have	Won't Have
Thematic layers: <i>For different emphasis/target groups.</i>	Parking facilities for bikes and cars	Printable map: <i>To use as a physical map.</i>	Navigation
2D view for the map			Show GPS position on the map
3D building outer shell: <i>For all campus buildings.</i>	Multiple languages: <i>Dutch and English. The structure should allow for additional languages.</i>	Offline map: <i>That can be downloaded or used offline.</i>	User editing data directly
Search bar: <i>To access specific elements.</i>			'Immediate Help' button: <i>Shows where are the closest points of help like security guards/help desk etc.</i>
Frontdesk/helpdesk: <i>In case of emergency.</i>			
Universal icons: <i>For language-free access.</i>	Camera reset: <i>When you get lost for the 3D map.</i>	Details about history for rooms and/or buildings	
Legend, north arrow			Trees, foliage, additional aesthetics
Infrastructure, paths, sidewalks: <i>For the whole campus.</i>		Dynamic Event Updates: <i>Eg: There's a bar event this Thursday, come here!</i>	
Buildings entrances: <i>For at least a few buildings, including accessibility.</i>			
Updatable database: <i>For future maintenance/work.</i>			
Floor plans: <i>At least for a few buildings.</i>			
Mobile phone support			
Specific facilities / points of interest: <i>For at least a few buildings, to define specifically with our user groups.</i>			
Colorblind mode			
Dyslexic-friendly interface: <i>Typography, layout, contrast.</i>			
Documentation of the process: <i>Decisions, user groups.</i>			
Feedback : <i>General feedback form and feedback about specific locations.</i>			

A.2. Impact-feasibility matrix

Table 3 displays our priorities for the project at about 6 weeks into the project, after the first round of interviews. We grouped all the requests we received with the features we were already planning to do, and grouped them depending on the goal they would help to achieve. Then, we assessed for each feature:

- “Mentioned”: how many time it was mentioned by interviewees
- “Feasibility”: how feasible the feature seemed to be, on a scale from 1 (difficult and/or requires a significant amount of time) to 3 (seems achievable in a decent amount of time)
- “Impact”: how impactful would this feature be towards the goal that it corresponds to, on a scale from 1 (bonus feature) to 3 (necessary)

Finally, the “Done” column shows what we ended up implementing by the end of the project. It is worth mentioning that the evaluation of feasibility was very subjective to our skills, our impressions and the quick research we could do on each topic. It may not be completely accurate, but it helped us to prioritise what we were the most certain to be able to achieve. Similarly, the impact was very difficult to assess, and we tried to consider the number of people who mentioned each feature as a indicator of the impact it could have. However, it is biased by the course of each interview, and therefore we also had to assess, based on our opinions, our expectations and our understanding from the discussions with the target groups, how impactful each feature could be.

Table 3: Impact-feasibility matrix

Goals	Feature Groups	Features	Mentioned	Feasibility	Impact	Done
Product design	Map formats	Laptop browser version	0	3	3	Yes
		Mobile browser version	1	3	3	Yes
		Printable map	1	1	2	No
		Offline map	0	2	1	No
		Screen print of customised map	1	2	1	No
	Views & controls	Camera reset	0	3	3	Yes
		2D view	0	3	3	Yes
		3D view	1	3	3	Yes
		Map interaction	1	3	3	Yes
		Icons	0	3	3	Yes

<i>Goals</i>	<i>Feature Groups</i>	<i>Features</i>	<i>Mentioned</i>	<i>Feasibility</i>	<i>Impact</i>	<i>Done</i>	
		Detailed building information	2	3	3	Yes	
		Satellite image map	1	3	3	Yes	
		Being able to rotate the map	1	3	3	Yes	
		Brief building information	2	3	2	No	
		2.5D view	0	2	1	No	
	Accessible UI	Universal icons	1	3	3	Yes	
		Minimal startup design	3	3	3	Yes	
		Highlighting	3	3	3	Yes	
		Colorblind mode	0	2	3	No	
		Dyslexic-friendly interface	0	2	3	No	
		Multiple languages	0	3	2	No	
		Building abbreviations	1	3	1	Yes	
		More campus context	3	2	1	Yes	
		Actual colours of buildings	3	1	2	No	
		Guide/tutorial for map use	2	1	2	No	
	Map contents	General users	Car parking facilities	3	3	3	Yes
			Bathrooms	3	3	3	Yes
			Opening hours	3	3	3	Yes
			Food and beverages	2	3	3	Yes
All room locations			2	3	3	Yes	
Building numbers and names			4	3	3	Yes	
Bike parking facilities			5	2	3	Yes	
Meeting rooms			1	3	1	Yes	
Study spaces			2	1	2	No	
Authorised coffee machines			1	2	1	No	
Venue visual			1	1	2	No	
Facility authorisation			3	1	2	No	
Historical significance			0	1	1	No	

<i>Goals</i>	<i>Feature Groups</i>	<i>Features</i>	<i>Mentioned</i>	<i>Feasibility</i>	<i>Impact</i>	<i>Done</i>
		Culture POIs	0	1	1	No
		Campus navigation chatbot	1	1	1	No
		Services/facilities in-room	1	1	1	No
	Target groups	Gender-neutral bathrooms	2	3	3	Yes
		Disabled parking spaces	1	3	3	Yes
		Elevators	2	3	3	Yes
		Contemplation rooms	4	3	3	Yes
		Prayer rooms	0	3	3	Yes
		Lactation rooms	3	3	3	Yes
		Quiet rooms	2	3	3	Yes
		Wheelchair-accessible entrances	4	3	3	Yes
		Supplier/ logistic entrances	1	2	2	Yes
		Outdoor accessibility	1	1	3	No
		Doorway dimensions	2	1	2	Yes
Pavement material	1	1	2	No		
Map features & functions	Orientation/navigation	Building entrances	4	3	3	Yes
		3D building shells	0	3	2	Yes
		Positioning	5	3	3	Yes
		North arrow	0	3	2	Yes
		Travel time estimation	2	1	3	No
		Routing	5	1	3	No
		Accessible routing	1	1	3	No
		Landscape features	0	1	2	No
		Paths	0	1	2	No
		Nearest facility	3	1	2	No
	Helpdesk	4	3	3	Yes	

<i>Goals</i>	<i>Feature Groups</i>	<i>Features</i>	<i>Mentioned</i>	<i>Feasibility</i>	<i>Impact</i>	<i>Done</i>	
	Help or emergencies	Immediate help button	0	1	2	No	
	Map query	Search bar	4	3	3	Yes	
		Filter function	6	3	3	Yes	
	User contributions	General feedback	0	3	3	Yes	
		Specific feedback	0	3	3	No	
		Dynamic campus events	1	2	3	No	
		Construction/obstruction	2	1	3	No	
		User editing	0	1	2	No	
	Sharing	Share position	4	3	2	No	
		Share single map object	2	2	2	No	
		Map QR code	1	3	1	No	
		Share map state	2	1	2	No	
	Documentation	Design choices	Interviews & discussions	0	3	3	Yes
			Key workflow decisions	0	3	3	Yes
			Tools used	0	3	3	Yes
About Page			0	3	3	Yes	
		Data structure	0	3	3	Yes	
		Data pipeline	0	3	3	Yes	
		Viewer	0	3	3	Yes	

<i>Goals</i>	<i>Feature Groups</i>	<i>Features</i>	<i>Mentioned</i>	<i>Feasibility</i>	<i>Impact</i>	<i>Done</i>
	Development guide	Server	0	3	3	Yes
	Further work	Non-implemented features	0	3	3	Yes

A.3. Final, complete GitHub Issues list

Table 4: List of Issues in our GitHub repository at the end of our project

#	Title	Description	Label(s)
1	Prevent getting lost in the map	So we don't lose the map and don't allow people to get out of the bounding box to lose the map.	enhancement javascript
2	Background in 2D map view	Fix the black background that happens when switching to 2D view of the map.	enhancement javascript
3	Fix the visibility of floorplans and buildings		enhancement javascript
4	Apply appropriate CSS to the buttons.		
5	Fix resizing the three.js window when the screen size changes		bug javascript
6	Camera snaps to north in certain circumstances	When you are in ortho view, and you click on a building or room, the camera snaps to north being up.	bug javascript
7	Exported data has incorrectly oriented triangles	This may be a problem that arises when triangulating the geometry, if the order of the vertices is not properly handled.	enhancement data pipeline future work
8	Colour/Pattern the buildings		enhancement modelling
9	Increase zoom speed	Can the zoom speed be increased? Having to scroll a lot now to get to my desired zoom level(s)	question javascript
10	Replace dots in objects keys by hyphens for three.js compatibility		bug data pipeline
11	No tooltips	Currently no tooltips on button hover	javascript
12	reset view button doesn't work, actually makes it worse		bug javascript

#	Title	Description	Label(s)
13	north-arrow / compass, when already pointing north, makes view wrong		bug javascript
14	Outline disappear	When opening the map, and clicking on the bottom left button to view the floorplan highlighted, the other highlights disappear, which I assume is intentional, however when then clicking this button again, all highlighting disappears and none remain.	bug javascript
15	Choose a license	[Help](https://docs.github.com/en/repositories/managing-your-repositorys-settings-and-features/customizing-your-repository/licensing-a-repository).	documentation
16	Make a citation file?	[Help](https://docs.github.com/en/repositories/managing-your-repositorys-settings-and-features/customizing-your-repository/about-citation-files).	documentation
17	Update the main README	The main README should contain or link to: - The purpose of the project, what the code is for, - Installation instructions - Example usage - API documentation (if this applies)	documentation
18	Clicking on search result while something is selected	Clicking on a search result while a building is selected keeps the previously selected building as highlighted	bug javascript
19	The command `load_3dbag` seems to fail randomly	This is related to the use of `Path2D.triangulate` in `flatten_trimesh` in `geometry_utils.py`.	bug data pipeline

#	Title	Description	Label(s)
20	Awkward rotation when switching between selected objects in orthographic view		bug
21	Orthographic view background is black	Visible when zooming out far enough - consider if we need to make the skybox visible	bug
22	Limited zoom out when selecting object		bug
23	User location tracks beyond basemap	Would be good to limit location tracking to show only if user is within the bounds of the basemap	enhancement javascript
24	User location symbol prevents clicks through to buildings/map underneath	Still an issue for 2D view because the inaccuracy circle has higher Z-position	bug javascript
25	User location button needs to be togglable + Add boundary whether the position can be even showed		bug javascript
26	Search bar should directly enter building view of corresponding floor when searching a room		javascript
27	Search bar intermediate results should return legible terms/ words instead of backend keys		javascript
28	Search bar needs a prompt/error if no action can be done with the search string		javascript
29	Multiple highlights remain when searching objects with an existing highlighted object		bug javascript
30	Thematic layers to be toggleable in dropdown	This includes refactoring the layer.js code to incorporate visibility of icons and outlines.	javascript
31	Thematic layers should have a search bar/filter in dropdown		javascript
32	Icons of building label (in 3D view) should enter building		javascript

#	Title	Description	Label(s)
	view with thematic layer toggled on click		
33	Baemap loading can be faster	This includes - Speed of loading - Preloading - Keeping tiles in memory to prevent re-requesting tiles on basemap change	javascript
34	Basement floors should be made visible	Option: push basemap down by x metres	javascript
35	Double click building in 3D view should also enter building view		javascript
36	Info pane close button doesn't close		javascript
37	Info pane - Include button that links to feedback page with selected object pre-filled		enhancement javascript
38	Header of About and Feedback page scrolls away (disappears) when scrolling down	Not sure if this is a mobile or desktop issue	bug
39	3D building models are not up-to-date	Some buildings have already been removed (eg: construction site next to AE building, already visible in satellite basemap)	modelling
40	Color blindness mode to be implemented		enhancement future work
41	Additional information for database and info pane	- Data about buildings - address, phone numbers, internal facilities, departments, opening hours, etc - Data about specific rooms/objects - service desk phone number and email, elevators, etc - Data about entrances - height, width, wheelchair accessible, supplier entrances, etc	data pipeline

#	Title	Description	Label(s)
		- Data about outdoor locations - see Daan's GIS data	
42	Entrances of buildings and how they should be represented	3D model vs point - how to store in DB structure	enhancement
43	UI - Dutch language mode to be added in future		enhancement future work
44	2nd group discussion summaries and findings	To populate github issues with new findings from 2nd group discussion. These will likely be future work due to time constraints	documentation
45	Mobile version layout	- Choice of button layout, hiding excessive buttons in sidebar - How to show info pane in the mobile version	
46	Report - elaborate on literature and background	- Explain more about accessibility and inclusivity in the larger/broader context	documentation
47	Report - redo midterm report portions that were WIP/ current status		documentation
48	Technical Presentation		documentation
49	Geomatics Day presentation		documentation
50	About page - enhancements	- Concretely state target groups - Add timeline of our project - Add links to D&I Office webpage - Add our names (?) - Update descriptions - Add contacts (not for feedback, but for learning more about the map, open conversation, etc)	
51	Blender - documentation of modelling process		documentation

#	Title	Description	Label(s)
52	Outdoor facilities - to be verified and updated with physical check		
53	Info Pane - Selected object - include link to TUD room finder/booking system		enhancement
54	Info Pane - Routing - add button that links to Google Map pin	Not entirely sure how this works	enhancement question future work
55	give feedback from room/building that would redirect to feedback page with pre-filled location		bug javascript
57	Make transition between buildings better in 3D view	No unnecessary rotation.	enhancement javascript
58	add tool-tips for zoom-in and zoom-out		bug
59	Floorplan viewer doesn't hide the 3D model of the building anymore	<p>As per the title, when clicking on the 3D model of BK, and then the floorplan viewer button, it does highlight the floorplan of 00, but the 3D model of BK is not hidden and is shown simultaneously.</p> <p>In 2D this is a bit odd, but when viewing the floorplan in 3D (if we want to allow that) it is actually kinda nice, except that then clicking on a room will click on the building instead.</p>	bug javascript
60	When in floorplan mode, you should not be able to close the infopane, since then you cannot access the buttons to leave floorplan/ change floor anymore		enhancement javascript
61	The order of the floor plan, when changing floor, is now		bug javascript

#	Title	Description	Label(s)
	seemingly random, should be ordered by Z		
62	The floor selector should not only have the 00, 01, T1, etc. but also recognisable names since T0, T1 is unclear by itself		enhancement javascript
63	Include the custom-made 3D shells of buildings	Requires to format them properly in Blender and export to glTF	enhancement data pipeline
64	Fix the UI so it looks the same on Chrome and Mozilla + Safari		bug
65	Clearly define our scope and what elements of inclusivity we are targeting	- to put in about page + report	documentation
66	Mobile - header should be fixed at top, even with scrolling		
67	UI - remove the language buttons		
68	UI - Header - add title: Inclusive Campus Map with icon	Suggestion: Put TU Delft logo and link to TUD website on the right, and our logo + 'Inclusive Campus Map' on the left.	
69	UI - Change colour of buttons based on the active basemap	Blue colour buttons not immediately obvious in satellite imagery basemap. Suggestion: trigger HTML colour changes based on the javascript Map class' active basemap. Only for satellite basemap	
70	UI - Search Bar - clear text 'X' button overlaps with the search icon	Suggestion: - shift either button to the left/right	
71	UI - Basemap - Extent of basemap should be extended	User feedback: especially in Safari, the reset view (initial view as well) shows the edge of the basemap tiles, which is distracting. Suggestions:	enhancement future work

#	Title	Description	Label(s)
		- Extend maximum extents of basemap to a reasonable size (consider the storage and network traffic) - recommended by MJ - Or set a maximum zoom-out and pan so that the view will never have the basemap edge visible	
72	Report - Draft skeleton for final report	To be discussed in next week's meeting on Monday. To show the outline in supervisor's meeting on Tuesday	
73	Handle conflicts between animations and user controls input		enhancement javascript future work
74	Add something to better display icons positions	Like a triangle or a better shape	enhancement javascript
75	Support buildings without geometry	Just don't try to zoom to the building	bug javascript
76	Fix layers menu in place when opening dropdown sections	Currently the layers menu will grow in both vertical directions when opening a sub menu, causing the buttons to shift around. Fixing them in place would better the user experience.	enhancement
77	New necessary icons	We need new icons for: - Stairs that go from one storey to another - Stairs that connect different parts of the same storey	bug javascript
78	Add support for outdoor elements		enhancement data pipeline
79	(If desired) For on the InfoPane, to have images of all main TU Delft buildings (from the outside) we'd need some		enhancement javascript

#	Title	Description	Label(s)
	sort of repository/ storage to host these.		
80	Add all the buildings on the map to the buildings list	Also need to add support for buildings without number	enhancement data pipeline
81	improve infopane css		enhancement
82	All the building names should have a recognisable name, instead of NL.IMBAG.PAND.xxx...		
83	Building labels should also have the name of the building in there, instead of only the number		bug
84	List of outdoor objects partly overlaps with the already added objects in BK, e.g. retail		bug
85	Rooms belonging to bigger whole, e.g. the library in BK (per floor) should be joined.	If they are clicked, they all should be selected. This will likely also now fix the bug that there are multiple icons even though there is only 1 retail, 1 library, etc.	bug
86	Some icons don't show up, e.g. shower on T0, accessible restrooms in 00/01/02, even whilst they are enabled.		bug
87	If one clicks on an icon in the layers menu, only the icons background becomes green, not the whole label		bug
88	Enabling the study room/area label in the dropdown menu makes most of the other icons disappear into white blocks within the map icon		bug
89	Data about entrances - height, width, wheelchair accessible, etc.		enhancement future work

#	Title	Description	Label(s)
90	Data about specifically the elevators, e.g. height, width, max. weight, key-card necessary?		enhancement future work
91	Outdoor data needs to be verified/ updated to be complete		enhancement future work
92	Separate the building label icon from the layers icons shown underneath	I am thinking whether the building labels (now including number) can be in teardrop shape while the other icons showing facilities (in a row above each building) be as they are in rounded rectangle. @alexandre-bry could you maybe look at this since you did the icons?	enhancement
93	Improve the search bar	- Decide what should be put between parenthesis (full name, shorter name, number?) - Should the search bar be wider on laptop? - Make the results appear when clicking on the search bar if some text is already there	javascript
94	North arrow points south instead of north.		bug
95	Map becomes extremely laggy after dismissing user's position due to it being outside the map boundaries		bug javascript
96	2D/3D button doesn't immediately update after clicking on it when going from 3D view to 2D view.	It only updates after the animation is finished and you then move/pan/rotate. I'd expect that it would immediately update after clicking on it, even already during its animation from 3D to 2D.	bug

#	Title	Description	Label(s)
97	FG request: some way to show what the boundary is of the TU Campus	For example, by showing this with a shaded area/ a border, or with the addition of paths, roads, etc. only within the campus	enhancement future work
98	FG request: the possibility to export/print the map to a proper format		enhancement future work
99	FG request: clicking on the compass / Öÿorient north button would either go back to the previous orientation, or to the main axis of the map		enhancement
100	FG request: the aerospace building is incorrectly split currently.		enhancement future work
101	FG request: on the about/ feedback page, in some browser you can only scroll when first clicking		bug wontfix
102	FG request: Floor plans of the buildings should have some distinguishing in colours, e.g. hallways/ lecture halls, etc.		enhancement
103	FG request: the combination of 2D/3D should be put more forward in the definition of our project, and the things that it brings		enhancement
104	FG request: when leaving the page, your last viewpoint/ settings are remembered, so you can go continue where you left off.	This is not only handy for when you open it again, but this would also be valuable when you go to the About/ Feedback page (e.g. when clicking on 'Report Issue') that you can go back to where you were.	enhancement future work
105	FG Request: In the infopane, it should also display the number		bug enhancement

#	Title	Description	Label(s)
		of the building, instead of only the name.	
106	'Reset view' button / / 'Home' location to where it zooms to needs to be updated since most buildings in the south are removed		enhancement
107	FG request: TU Delft logo should redirect towards TU Delft's (english) homepage, instead of map		bug
108	Map guide/ tutorial	<p>An example regarding its importance:</p> <p>When using the map, it is not entirely clear for the respondent that once you have selected a building, that the map locks on this building and goes into orbit mode. As such, the respondent wanted to move away, but was locked. The ability to click on nothing didn't occur and as such Daan had to help.</p>	enhancement
109	FG request: the types of exterior surfaces and areas, and whether they are accessible by someone in a wheelchair		enhancement future work
110	FG request: a functionality to find a quiet space to study		enhancement future work
111	FG request: navigation/ routing from building to building/ room to room		enhancement future work
112	Floor plan view is bugged, when clicking on room in floorplan view it goes back into 3D orbit, selects the building but shows 'undefined' in infopane		bug javascript

#	Title	Description	Label(s)
113	Minimal Start-up: Limit the labelling of buildings to only Primary, Secondary, Tertriary	the other labels should be on a certain zoom/ or on hover?	enhancement javascript
114	Add button to show legend of colouring building on click		duplicate
115	Make icons below building name stackable		bug
116	Layers dropdown - add search bar and clear all functions inside the layer-dropdown		future work
117	Remove the rows that don't have icons in layer - dropdown		bug
118	Bottom right buttons update		enhancement
119	Fix typo in Building 60 Logistics (missing 'i')		bug
120	Change default map to satellite		enhancement
121	Change compass icon to original		enhancement
122	Add a button for floorplan navigation		enhancement
123	Fix the default map view (center it more)		bug
124	Add support for clicking on everything that can be searched	Requires to add support for: - Units with geometry instead of space IDs - Storeys - Building subdivisions	enhancement javascript
125	Store the feedback in a database	The feedback is currently sent to a `feedback.log` file, but it would be better if it was properly stored in a database instead.	enhancement future work
126	Translate the 3D building shells to an elevation of 0	Can be done in Blender, then export the files to glTF. Requires to modify the loading scripts slightly.	enhancement data pipeline future work

#	Title	Description	Label(s)
127	FG request: Info pane, also include facilities of the building	<p>It would be valuable to have the facilities, which the building contains, shown in the infopane, such as:</p> <ul style="list-style-type: none"> - Gender-neutral restrooms, quiet rooms, lactation room - Specifically, within the wheelchair accessibility details menu, information regarding accessible restrooms would be valuable <p>How this would be show, e.g. in text, or with icons below the header, I do not know yet.</p>	enhancement
128	The purple building colours don't always load, and it seems sometimes the grey buildings get loaded in as well		bug
129	FG request: Would it be possible to filter out certain buildings?	<p>Now all buildings are always shown. What about letting users disable them (e.g., based on their category (primary, secondary, etc.)).</p> <p>In general, is this something we want to let users do? I think this also depends on how we do the showing/hiding of building labels in general.</p>	enhancement future work
130	FG request: Being able to enable/disable thematic layers through searching them in the search bar	<p>Resulting in a similar functionality as if you would open the thematic layers dropdown menu, and click on a layer.</p> <p>A respondent suggested that enabling them by searching them, e.g. searching for 'Wheelchair accessible restrooms', 'toilets', etc. would also be a nice functionality</p>	enhancement future work

#	Title	Description	Label(s)
131	Overlapping icons is undesirable and needs a method to make overlapping icons appear next to each other.		enhancement javascript future work
132	rename Home to Map in navbar in header		enhancement
133	Add a button for legend	Under top right buttons add another one. Once it is clicked a legend explaining the colouring of the buildings	
134	Layers: Each room of a buildingUnit displays an icon instead of one icon for the whole buildingUnit		bug javascript
135	Building icons appear at different distances depending on their category		enhancement javascript
136	Wheelchair Accessible doesn't untoggle when clicking on the whole group		bug
137	Performance issues, seems to be related to the base layers		enhancement future work
138	Closing an Infopane (be it building, facility, room, etc.) closes building view, it shouldn't do that		bug
139	Clicking on a room/an icon corresponding to said room, should show the same (details in the) infopane	When I clicked on the room of an elevator I would see some info, e.g. the room number, etc., and when I clicked on the icon of that elevator, it only showed me 'elevator', meaning the content shown is different, yet I am clicking on the same 'thing'	enhancement future work
140	The K1 floor is below the base layer	Likely similar for all floors below the base layer, we did fix this before, but seems to have unfixed itself.	bug

#	Title	Description	Label(s)
141	Clicking on (some of the) icons for stairs, it brings you to another level	Is this intentional behaviour? To me it feels random when it happens, and to which floor it moves me / In general not intuitive.	javascript
142	Issues with ramps, entrances (extra geometries)		enhancement future work
143	Extra geometry doesn't have outlines		bug future work
144	Geometry of entrances, ramps, etc. is hidden when not enabled (intentional?)		enhancement future work
145	After entering building view, enabling/disabling thematic layers completely breaks the building view	When you go into building view, and then enable/disable any layers, the following issues occur: <ul style="list-style-type: none"> - Subsequently switching to other floors, doesn't hide the icons from the original floor, and doesn't display icons related to the new floor - The outlines of the other floors are not being shown - New icons, when trying to enable/disable more layers doesn't enable/disable them, only for the original floor - Closing the infopane doesn't close the infopane, yet it leaves the building view. However, the icons of the interior remain in their exact room positions, instead of being below the building label (which also doesn't appear) 	bug
146	Prevent some objects from being searchable using the search bar	Units could have a "Searchable" attribute, and if it is false, then the units should not appear in the search bar.	enhancement javascript

#	Title	Description	Label(s)
147	Remove the `CityObjectGroup` objects		
148	Support a `Searchable` attribute for units		
149	Handle the storeys appearing multiple times		
150	Infopane needs update in terms of the order of contents, and what is actually shown vs. hidden	Now the order is random, and a lot of internal, not perse information that should be shown, is being shown. This could potentially be organised using a JSON file that specifies the order and what is included, similar to the layers.	enhancement
151	Mobile view - Scene does not take the full screen	It seems that once the mobile window smaller than a certain size, the scene resizes itself smaller than the screen size. This results in empty white spaces in the view 	bug
152	Layer dropdown menu order/ what is in each bucket needs to be updated	Some layers do not fit in the bucket they are in right now, and the order should be changed. See the notes from the meeting with Stavroula.	enhancement
153	Layer dropdown issues	See sub-issues	bug
154	Layer dropdown closing issue	Currently, the layer dropdown menu only closes when you click the button that opened it. For other menus, clicking outside the menu or clicking another button closes them which works well.	bug

#	Title	Description	Label(s)
		We intentionally didn't implement this behaviour for the layer menu because clicking inside it (to toggle layers) would close it, which is annoying. This needs to be revisited: ideally, clicking outside the layer menu should close it, but clicking inside the menu to interact with layers should keep it open.	
155	Layer dropdown checkbox sync issue	When a layer is enabled/disabled from one location (in the layer dropdown menu), the checkbox in other locations where that same layer appears doesn't update to reflect the change.	bug
156	Layer dropdown opening bucket issue	Clicking the name of a container does not open the container, only when using the dropdown caret. We disabled clicking on the text to open the container because this would also trigger the checkbox, which is not intended. Users should be able to click the text to expand/collapse the dropdown.	bug
157	Layer dropdown inconsistent naming	Some items in the layer dropdown represent the same thing but are displayed with different text labels. This should not be and should always be the same label.	bug
158	Layer dropdown issue -> AED length	The length of the AED (...) is too long and makes the menu become bigger/ smaller, I suggest removing the full text since AED is known universally what it does + we also have its icon.	bug

#	Title	Description	Label(s)
159	Icons/geometries of ramps, entrances (extra geometries) are not clickable/ interactable		bug
160	Going up/down in the storey selector should update the dropdown text too	<p>When using the up/down controls in the storey selector, the visible storey changes, but the dropdown label (displayed text) does not update accordingly. This causes a mismatch between the actual active storey and what the textual dropdown shows.</p> <p>I'd expect that navigating through storeys using the up/down controls should update both the selection and the displayed text in the dropdown.</p> <p>I would also expect that this value would update when you go into the building view through the search, e.g. when you go to floor '01', it should also update to match the correct floor.</p>	bug
161	Final Report - update based on feedback from Bastiaan and Gina		documentation
162	Floor Selector - Change the Floor text when clicking on Floor Up/Down buttons	<p>Currently, changing floors with the Up/Down buttons in building view changes the floors as expected. However, the text description of the drop-down bar (and the corresponding tick symbol) does not update when the user clicks on these buttons.</p> <p>The text description should reflect the correct current floor.</p>	bug

#	Title	Description	Label(s)
		This provides good and accurate context, since we do not show anywhere else what the current floor is.	
163	Ramps (and thematic information with geometry) do not have outlines in Building View		
164	Add a license to the actual map	The actual map could be CC-BY-NC for example, it has to be NC.	documentation
165	The wheelchair accessible text and title within the infopane doesn't match	<code></code>	bug
166	Improve the documentation		documentation
167	Update the existing Markdown documentation		documentation
168	Document the data structure		documentation
169	Document the Python functions with docstring		documentation
170	Document the JavaScript functions with docstring		documentation
171	Order of the floors in the storey dropdown selector is reversed	Now at the top, is the lowest floor (K1), and at the bottom is the highest floor (03). This should be the other way around.	bug
172	Some information regarding wheelchair accessible restrooms should also be in infopane		enhancement
173	"View Floorplan" in infopane, when already in floorplan, doesn't hide the storey selector	When you are in the campus view, and have the infopane of BK open, and click on "View Floorplan" it correctly opens the floorplan & the storey selector buttons in the bottom	bug

#	Title	Description	Label(s)
		<p>left. However, when clicking on "View Floorplan" again, it closes the buildingview, but it doesn't also disable the bottom left buttons (instead of when you'd click on the X button of the storey selector). This results in being in the campus/orbit view, whilst the floorplan UI buttons are still there.</p> <p>The solution would be when you click on "View Floorplan" to exit the floorplan, that the storey buttons are also hidden again.</p>	
174	The function `flatten_trimesh` sometimes crashes	<p>This seems to be related to the input of the triangulation not corresponding exactly to what the `triangulate` function expects, and instead of raising an error cleanly it just crashes. This has no impact on the pipeline anymore since we removed the automatic computation of LoD 0 for buildings in `load_3dbag`, but this is still not fixed.</p>	<p>bug</p> <p>future work</p>

Appendix B

Interviews

B.1. First round of interviews

B.1.a. Interview 1

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Alexandre Bry	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Background

[Redacted]

Inclusiveness encompasses many domains of the university, such as student affairs, education, employees, and research. An inclusive campus can be viewed as both accessible and hospitable, where accessibility refers to both physical and non-physical aspects, such as ICT or other multimedia equipment used in the faculty.

Desire and the three overall scenarios/situations a map is used

A product that is useable, not just another report/thesis that ends up in some repository without an actual tangible improvement.

According to the respondent, a map is used mostly in three scenarios:

1. On-boarding employees, students or visitors before they start/come to TU Delft.
2. Orientating yourself on the campus; ‘where am I?’ or ‘where is the nearest X?’
3. Managing expectations; supporting users who are not part of the norm by allowing them to prepare for their visit or work in advance, such as planning their route or parking by using map elements that help them with this.

On-boarding

Firstly, on-boarding: for example, when an employee, student, or guest prepares before starting. In this stage, it is important to be able to visualise a map to better understand where you are and locate the most important facilities you may need. When entering a community, you want to know where you are, what the key facilities are, and where to find them.

Most of the time, buildings are designed for the “norm”, and many buildings look alike. For people who fit this norm, creating a mental map is easier. For instance, they may not need to use an elevator, while stairs are often located near the entrance, such as next to the service

desk. Elevators, however, are not always nearby, making it harder to form a mental map. A map that emphasises these facilities can help everyone orient themselves more easily.

People who don't fit the norm often need additional facilities, such as ramps, elevators, or accessible doors and corridors. It would be very useful if these could be highlighted. For example, when using a map to locate elevators, the user could press a button, and the system would highlight all elevator locations within the map.

Another concrete example involves the doors between the ME and Pulse buildings, which can only be opened with an authorised keycard. Information like this ("Is this door accessible/openable to/by me?") is very important but often difficult to find.

It would also be nice to see/know where you are currently, and what the easiest way is to get to your desired destination. Both for indoors and outdoors.

Orientating yourself on the campus

Secondly, another use of a map is to orientate yourself, e.g. 'where am I on the campus?' or 'where am I in the current building?'. This can potentially (also) be solved by a low-tech solution, such as including a 'you are here' marker on the physical signs around the campus and inside buildings. Again, so that you can mentalise your surroundings and where you are.

Such a system could potentially also be extended to find the nearest elevator, accessible toilets, ramps, or other facilities a user might need.

Managing expectations

Thirdly, maps are important for managing expectations. For example, it is essential to know in advance if a building is not accessible from the front for someone in a wheelchair. Having this information beforehand helps set expectations and reduce frustration. Additionally, it is not always possible to ring a reception bell from the front door; sometimes you have to make a call instead. A map that clearly shows which doors are accessible and which facilities or areas are (not) available would therefore be very valuable.

These features are not only useful for expectation management but can also highlight areas where TU Delft needs to improve or develop. Such information addresses existing gaps and creates accountability, because "No" is now also an answer.

The respondent also mentioned an "accessibility and hospitality expedition" they had organised. Together with a group of stakeholders, they walked through a TU Delft building to identify low-hanging fruit for making the building more accessible and hospitable. They checked entrances, toilet blocks, signage, and other facilities.

Thoughts on the current TU Delft campus map

It's great that there is a map, however currently there is just too much information at start-up. Additionally, a guide/instruction on how to use the map, e.g. how to toggle certain layers on or off, is currently missing but valuable.

There are also a lot of different symbols with wheelchairs on the map, but their meaning is unclear, are they parking, corridors, entrances? After closer inspection together it seems to be the disabled parking spaces, other wheelchair accessible information is not available. But that

would also be very useful to have, because that would also help someone to decide where to park and where to approach the building from.

Other issues, general thoughts and missing features that were discussed

Another issue mentioned is that at [Faculty], for example, there are two disabled parking spaces, but these are not accessible for guests or students, access/authorisation is only available to employees, and obtaining this access requires going through significant bureaucracy.

Routing instructions are also missing but could also be valuable, such as: “Turn right twice, then you will arrive at an accessible door.”

Information on pavement types (Dutch: verharding / bestrating) is also desired but not included, as well as general terrain and slope information about exterior walkways. For example, a colleague of the respondent with a visual impairment suffered a serious injury after falling at a construction site where barriers were missing. Communicating such information is important. Currently, you have to find this out by ‘learning by doing’, which is not ideal. Knowing what kind of pavement to expect in advance would be very valuable.

One proposed option is to highlight pavement types on the map using a green-to-red colour scale, with green meaning easy to traverse and flat (like asphalt). Such features could potentially also provide policymakers with insights into the consequences of road closures or maintenance, especially for people who do not fit the norm.

User interface options for people with difficulties focusing or with colour blindness were also briefly discussed.

Additionally, many outdoor areas are not inclusive. For example, some seating areas on campus are simply unreachable by wheelchair users, such as the outdoor seating near IDE/Pulse by the water, or the grass on top of the library and even the main entrance is not accessible by wheelchair.

Thoughts on a 3D map

The discussion also covered digital literacy regarding 3D maps, specifically the 3DBAG. The respondent was not familiar with the 3DBAG but felt that a 3D addition to the map would be valuable. It helps to have a good overview of the campus, and to find for example logical places for backdoor entrances and other facilities. The respondent also tried out the navigation abilities of the 3DBAG on his phone, which needs a bit of time to get into, but he got the hang of it.

Extra notes on documents/events/other to-dos

- MSc thesis from an IDE student regarding the accessibility of buildings. From a design perspective.
- The discussed report/summary of the accessibility and hospitality expedition.
- An upcoming ‘uncomfortable journey’ through the TU Delft campus.
- The faculty DE&I officer of BK / Health, Safety & Environment advisor of BK / Ambassadors from StudAble / Ambassadors from Diversability were discussed as potential other candidates for further interviews/focus groups.

B.1.b. Interview 2

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Alexandre Bry	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	Phuong Anh Ho (Alena)	MSc Geomatics student
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Background

[Redacted]

Using maps in general

The respondent notes that she mostly uses a (campus) map when trying to find an exam hall. This is especially useful in AE, where the student population is large and a single exam often takes place in multiple locations, which may be quite far apart. Sometimes a 10-minute walk or more.

Additionally, she uses a map to find an appropriate study place, usually through the dedicated “[Spaces on the campus • TU Delft Space finder](#)” website. She expressed that combining these two functions into one map would be more beneficial than having them on separate sites.

Lastly, especially for newer students, maps are also used to decide on meeting places, such as cafés. She mentioned that having options to filter the map to only specific functions (e.g., cafés) would be valuable.

The respondent also mentioned a confusing element: several buildings are labelled “Applied Sciences,” but it is not always clear which one she needs. She suggested that giving these buildings distinct names (on the map) would make it easier to immediately identify the correct one.

Another idea she proposed was integration with the “My TU Delft” app. For example, when the app lists the location of an exam, lecture, or event, the user could click the location and be forwarded directly to the map, showing exactly where the room is. This would help prevent confusion when trying to find a space.

Another functionality discussed stems from difficulties navigating certain buildings. For example, some exam halls on the top floor of the Applied Sciences building are only accessible from specific entrances. Entering through another entrance may force you to take a detour, additional stairs, or longer routes; If you manage not to get lost, even with all the signage). Ideally, a map could provide routing options, showing the “best route” or multiple alternatives with estimated walking times.

The existing campus map

The respondent is familiar with the current TU Delft campus map, though some of her peers were not. Some used the older static TU Delft map with a similar style and colour scheme. She finds the existing interactive map overwhelming at first glance, with too much information displayed, making it confusing to use.

We also discussed the functionality of being able to rotate a digital map. For her sense of direction, this is essential. She noted that being able to rotate the map automatically (using a phone's sensor) or manually would both be useful.

She also mentioned that certain rooms require authorisation to access. While not discussed, this could be an interesting addition potentially for us.

In terms of other maps, she mainly uses Google Maps because it is very convenient to check how long walking, biking, or travelling somewhere will take by simply entering a destination.

She further mentioned that the current TU Delft campus map is not well advertised or marketed, which may be why many people do not use it.

When asked about missing functionalities, she initially struggled to think of one. After some reflection, she suggested including information about campus events. For example, bars, cafés, or student free zones where events take place. She felt this could improve interaction and engagement between students.

We further discussed the current TU Delft map, specifically the numerical building labels. For the respondent, these are not intuitive; she remembers buildings by their names but not their numbers. She suggested using building (nick)names instead, as they are more recognisable.

She found the colours of the map okay and understood the design choices for the colours but would like a building to change colour when clicked or searched, so it is emphasised more clearly.

Regarding facilities, she mentioned the example of the currently closed bicycle parking in front of ME. Quite a few people she knows complained about its closure, and she suggested that information about closures (e.g., bike parking, roads) could be added to the map. However, she was unsure whether many people would use the map for this purpose.

Thoughts on the 3D BAG

We asked the respondent to test the 3D BAG viewer on her phone. This was her first time seeing such a 3D map. She was undecided on whether a 3D map is better or more convenient than a 2D one, noting that it likely depends on the user, some people have a stronger sense of space in 2D, while others benefit more from 3D.

She again emphasised that the current TU Delft campus map is overwhelming because it displays all information simultaneously at start-up. In her view, Google Maps shows an acceptable amount of information (less is more). She also emphasised the value of Google Maps' search bar and dedicated buttons for categories like restaurants and cafés.

More on map information and usage

The respondent again stressed that indoor information, bicycle parking, campus information, and campus events are elements Google Maps does not provide, but which the TU Delft map could. She suggested user input might be valuable here, for example allowing users to share event information directly on the map. Currently, such information is mostly shared via addresses, which often leads back to Google Maps. If users could instead link directly to rooms or places on the campus map, it would help prevent mistakes caused by misreading small details, such as room numbers.

She also noted that the 3D BAG's search bar on mobile is too small and hard to find. When shown a barebones version of our work-in-progress TU Delft map, she emphasised again the importance of a search function that accepts building names, nicknames, and room names.

Regarding languages, she felt that English and Dutch are sufficient. Since studying or working at TU Delft requires knowledge of one of these, she did not see added value in supporting additional languages.

Some last takeaways discussed

When opening the map, show less information by default; display more only when users search for or select specific elements.

A guide for using the map could be helpful.

Including QR codes on or near physical maps around campus that link directly to a "you are here" location on the digital map would add value.

B.1.c. Interview 3

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Alexandre Bry	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Phuong Ahn Ho (Alena)	MSc Geomatics student
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Background

[Redacted]

‘When do you use a map’?

The respondent is relatively new to TU Delft, which has prompted her to use maps more often to find her way around. She also noted that, for mentorship purposes, particularly with first-year students, a map is essential. In these cases, the focus is mostly on showing the key buildings where classes are held, what these buildings look like, and what kind of classrooms they hold.

She also mentioned a kind of campus “bingo” gamification activity, where students use the current TU Delft campus map to find facilities such as cafeterias, and then navigate to them.

The respondent uses Google Maps when navigating to other campus buildings, since it provides clear routes, navigation guidance, and approximate travel times.

Thoughts on the current TU Delft campus map

Overall, the respondent appreciates the current map. She finds the use of multiple colours for distinguishing buildings, greenery, and roads to be helpful. As a car user, she also values the inclusion of parking locations.

What she misses, however, are interior building details and information on facilities that campus users might need, such as prayer or contemplation rooms and lactation rooms. She emphasised the importance of gender-neutral bathrooms on maps, noting that this is a pressing issue, particularly for transgender students, who sometimes need to go to another building to find them. She also underscored that gender-neutral bathrooms should be available in every building (not necessarily a mapping issue in itself), but including this information could help hold the university accountable for such gaps.

The respondent also highlighted the importance of showing locations for disabled parking spots, wheelchair-accessible entrances, and elevators. Having this information available beforehand would make planning and navigating much easier for those who rely on these facilities.

Thoughts on using a 3D map, specifically the 3DBAG

As a self-described “visual” person, the respondent appreciated that in the 3DBAG viewer a building lights up when clicked. However, she found navigation difficult since all the buildings are rendered in grey. She suggested that allowing buildings to appear in different colours, or even with their real-life colours and textures, would make the map much more intuitive.

Describing positionality by the respondent

The respondent often describes buildings using relative terms such as “behind us,” “in front of the office,” or “on the other side of the road.” She also commonly uses building nicknames, but not building numbers, which she finds confusing and un intuitive. Based on her experience, most people use nicknames over numbers, or sometimes both. After further discussion, she suggested that building labels having both the number and the nickname would be the most helpful.

She has not yet needed information on parking availability, as this has not been an issue at her regular parking spot near her office.

How the respondent got to the current meeting room

The respondent had not visited BK before today, so she used Google to find it. She searched the full room code from the agenda invite (Room-08.BG.West.640), which at least helped her find the correct building. She also found a layered floor plan of BK online, which guided her toward the West Wing. Her plan was to figure out the exact room location upon arrival, but this proved difficult since no clear information on room locations/exact codes is available. Ultimately, she went to the reception desk to ask for directions.

Other important elements discussed

The respondent also mentioned a case where a student using a wheelchair was unable to use a lift due to its 200 kg weight limit. She suggested that including such information (e.g., lift capacity) on the map would be very valuable.

Extra notes on documents/events/other to-dos

- The respondent mentioned contacts in her community/network who may also be interested in or valuable to this research. She will send information later.
- We also asked the respondent if she is aware of existing literature about the discussed topics, which could help us in our map making, which she would ask around for in her network/department.

B.1.d. Interview 4

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Lars van Blokland	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	Phuong Ahn Ho (Alena)	MSc Geomatics student
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Background

[Redacted]

From her own experiences, as well as through the [Redacted Community], the respondent underscores the importance of having a clear and accessible map. Such a map should indicate, for example, the location of quiet rooms where individuals can rest. She explained that many members of the [Redacted Community] often become overstimulated by their environment, and therefore, maps that facilitate orientation and access to suitable spaces are particularly valuable.

“When do you use a map?”

In her daily life, the respondent primarily relies on Google Maps for navigation. She noted, however, that Google Maps lacks interior building information, which she considers would be very useful. She also uses it to familiarise herself with unfamiliar locations.

When navigating to the meeting space, she understood from the room code that the room was located in the West wing of the building. However, she was uncertain about which parts of the building were designated as ‘West’ and initially walked in the wrong direction. Fortunately, our meeting room was close to the West entrance, so finding it was easier.

The respondent added that she usually attempts to identify the main entrance of a campus building, since this is often where the Service Desk is located, where one can ask for directions if necessary. She emphasised that knowing the location of the Service Desk is particularly important. In addition, she uses maps to locate nearby toilets, and places to buy food and drinks.

Thoughts on the current TU Delft campus web-map

The respondent likes the interactive elements of the map, particularly the ability to move, zoom in and out, and click on a building number to view more information, such as its name and address. She suggested that it could also be useful to display which lecture halls or study spaces are available within the respective buildings.

She values that buildings are identified by their (Real Estate) numbers, as these are also used in agendas and meeting invitations. However, she emphasised that colleagues in the [Redacted

Community] often use building names instead, which makes it difficult to match invitations that list only a number. She deems the current map cluttered, as such to avoid further visual clutter, she proposed that hovering over a building could display additional information, such as its name.

The respondent observed that the online map appears crowded, though zooming in helps preventing this to some extent. She mentioned again that the map loses clarity due to the overlapping icons. This highlights the usefulness of filters by layer (e.g. viewing only cafeterias), though she had not previously been aware that this functionality already exists. Since this functionality already exists, though she wasn't aware, we asked whether a guide would be useful, she agreed.

She also noted the absence of information on silent or contemplation spaces on campus. Additionally, she would like to see the locations of all-gender restrooms included. She further suggested that information on the accessibility of crossings, especially relevant since the introduction of the new tramline, should be provided, as road closures influence navigation across campus, particularly for those unable to walk long distances. Similarly, within buildings, it would be valuable to know whether certain elements, such as lifts, are out of service, especially for those who cannot (easily) climb stairs.

Thoughts on 3D maps, using the 3DBAG

The respondent was asked to open the 3DBAG viewer on her smartphone and navigate to the TU Delft campus. She appreciated the 3D aspect, particularly for visually oriented users who can recognise buildings by their shapes. She reiterated that knowing the locations of building entrances is valuable and suggested that arrows could be used for this purpose. Less is more; too many details/information may make it harder to understand/ use a (3D) map.

When a building is clicked, it is highlighted in a different colour, which she considered sufficient from a visualisation perspective. However, she added that using the actual colours of buildings could also be useful, for example, representing EWI in blue and red. The highlighting of buildings, in her view, helps to better understand their extent. She found the 2D underlayer satisfactory, since it uses universally recognisable colours (e.g. blue for water, green for greenery). She mentioned that she occasionally uses Google Street View before visiting unfamiliar places, as it helps her gain a better understanding of the surroundings. Additionally, she suggested that distinguishing between TU Delft campus buildings and non-campus buildings could provide a clearer sense of the scale and boundaries of the campus.

Other/Final topics

Based on her internal discussions within the [Redacted Community], the respondent emphasised that clear floor plans are considered highly valuable, both for navigation and for locating specific facilities (e.g. cafés, study psychologists, faculty graduate schools, department secretariats, etc.). Some buildings display fire escape maps near lifts, whereas others either do not or do so less prominently. She emphasised again that access to interior layouts would be very useful.

She also noted the importance of being able to locate meeting rooms. In discussing the idea of a search bar, she agreed that highlighting the relevant location and floor based on search

results would be valuable. Furthermore, she supported the inclusion of a “find the nearest X” function, which could be filtered by inclusive facilities, such as all-gender restrooms.

She also mentioned that she primarily uses navigation tools, such as Google Maps, on her phone, and therefore emphasised that the map should fully support mobile users.

Extra notes on documents/events/other to-dos:

- The respondent mentioned screens placed at EWI containing map information relating to the main lecture halls. She will share an image of these with us.

B.1.e. Interview 5

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Lars van Blokland	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Background

[Redacted]

‘When do you use a map’?

The respondent primarily uses maps, mainly Google Maps, for navigation, planning ahead, obtaining ETAs and finding the quickest routes.

On campus, he typically uses maps when planning events. For example, for the upcoming [Community] event on [Date] at [Location], he needs to understand what the venue looks like and what facilities are available in each room. He notes that such information is often inaccurate or incomplete. He would also like to be able to generate/get a clear picture or floor plan of a building, such that he can make (or generate) directions on how to reach specific rooms.

For instance, whilst navigating to our meeting room, he knew from the room code that it was in the west wing of the Architecture building but had no clue which floor it was on or how to find it. He noted that while the room codes contain some information, for someone who is not familiar with these codes/the building, it remains confusing to find.

He underscored the added value of maps that show general entrances, accessibility ramps, and suitable access points for large objects or equipment. For example, TrueU often transports a large pink closet across campus, and it is important to know in advance which entrances and doors are suitable, as well as the availability and dimensions of (freight) elevators. Doorway heights, particularly in older buildings (often only 1.9–2 metres tall), were also mentioned as important. Such information would make maps more useful for planning and managing expectations, since it is currently unavailable online.

Another key point raised was the impact of construction work. Knowing the location of works and how they affect routes would save time and hassle. Currently organisers have to walk routes in advance to check feasibility. Similarly, he sees value in shortest path routing between specific rooms or even buildings, as well as in knowing where parking facilities for bicycles and cars are located.

As a lecturer, he could also see himself using a map to estimate travel times (by students) between buildings, whether walking, cycling, or using public transport. He thinks that this could also be valuable for employees responsible for scheduling.

Thoughts on the current TU Delft campus map

The respondent finds the current TU Delft campus map not very user-friendly: it is cluttered, and he does not like that icons overlap. He defines it as an issue that some icons disappear when you zoom out, because he would also like to have an overview of such locations from a zoomed-out, whole-campus view.

When planning an event, he often has to take screenshots of the map in order to annotate it himself, rather than having access to a downloadable PDF (from the map itself) with basic information and the option to highlight specific facilities or buildings before printing.

He also noted that buildings are currently only labelled with numbers. He suggested a functionality where hovering over a building number would show its name, with an option to toggle names on or off. Furthermore, he would like a clearer distinction between main campus buildings, supporting buildings, and non-TU Delft buildings. The ability to highlight all facilities of a certain type across campus (e.g. all car parks or bicycle storage facilities) would also be valuable.

Another feature the respondent described is the ability to mark/highlight certain elements and/or locations on the map, which could then be sent to someone else so that those settings are already applied and immediately visible when the link is opened.

He finds some icons ambiguous. For example, the ‘coffee’ icon is not entirely clear. Apparently, it only represents staffed coffee counters. However, there are many other coffee options on campus, such as regular coffee-machines, those only usable by someone with an employee card, and the more luxurious self-service machines, often found in cafeterias.

Similarly, the current wheelchair icon is unclear: does it indicate entrances, parking, or something else? At present, it marks disabled parking spaces, but since there is no “P” on the icon, it could easily be mistaken for a wheelchair-accessible toilet. For the respondent, the wheelchair symbol is more commonly associated with toilets than with parking.

He also mentioned the need for all-gender toilet locations to be included on the map (since these are harder to find and less common), as well as contemplation rooms, lactation rooms, and service desks. He also highlighted the importance of displaying building opening hours. For example, some buildings are always closed to the public, and entry is only possible by ringing the doorbell.

B.1.f. Interview 6

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Lars van Blokland	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]
	[Redacted]	[Redacted]
	[Redacted]	[Redacted]

Note: Underlined words/sentences are concrete issues/desires discussed.

Backgrounds

[Redacted]

‘When do you use a map’?

Respondent 1 mentioned that she uses maps to find out the opening hours of buildings.

Respondent 2 uses a map when visiting a place never visited before, but also in general to get to the place where you need to go to, including additional information you may need for that, such as car or bike parking locations.

Respondent 3 agrees but highlights that it also depends on the nature of the visit, e.g. a shorter vs. a longer stop, whether it’s an intermediate or final destination. Additionally, he uses a map to get an estimate of how long it takes to walk from where you parked your bike or car to where your destination is. He also uses Google Maps’ Streetview to get a better understanding of the destination, a sort of reconnaissance, especially when trying to find a suitable (and ideally allowed) place to park a motorbike.

Thoughts/discussion on the current TU Delft campus map

Respondent 2 mentioned that they use the TU Delft campus map to find the location of a given building number, since that information is not present on Google Maps, which only has the nicknames or faculty names. However, when located, they switch back to Google Maps to check everything else, for example the closest car or bike parking, since they are sometimes not as easy to find. Similarly, to find (all) the entrances of a building.

They highlighted that not always parking lots are next to the building, sometimes across the street, and that the main entrance is also not always the best/most suitable entrance. Since the map now only contains the building number, having additional POIs for the separate building entrances would be valuable. Respondent 1 agrees, and adds that Google Maps, when navigating, often leads you to a random place of a building, yet it would be nicer if it would show you exactly the way to an entrance.

Respondent 2 followed up with highlighting the need for knowing where the Service Desk is located, since their strategy is ‘when in doubt’, ask the Service Desk for navigation instructions

to find the required room. Especially since the Service Desk is always not as easy to find as you might expect/want.

Respondent 1 mentioned that a search function, where you can search for specific room numbers, would be really valuable. Ideally also combined with navigation functions where there would be a pin of your current location and a path/route to the destination. She also mentioned that simply knowing where you are, a 'you are here' pin would be useful and also helps with navigation by seeing which way you are moving in relative direction to where you need/want to go.

Respondent 2 continued by mentioning that (after us showing the interior maps hung up around the campus, that) even though there is some information on there, that locations of lecture halls is not on them. Especially since a lot of AE students have classes all over campus and are having a hard time finding their lectures.

I, Daan, would like to note whilst writing this summary that on all the indoor, stacked maps we found within the TU Delft campus, the locations of lecture halls are always included. However, not all faculties have such floorplan maps.

Respondent 2 also highlighted the usefulness of being able to toggle on/off certain layers based on user-need. For example, if going to a meeting, knowing the locations of lecture halls is not necessary. Yet, being able to search and find rooms by their code would be even better.

Respondent 2 also remarked that they find the current TU Delft web map cluttered, and that an option to filter or hide certain pins would be useful. As this feature is already available, we demonstrated how it can be used. We therefore suggested including a short guide or set of instructions on our website to explain this functionality, or, ideally, designing the map in such a way that no guide would be necessary.

The joint response essentially concluded that not having such a guide would be preferable, as an effective map should be self-explanatory. In addition, users are unlikely to read a guide when in a hurry; instead, they expect to be able to search the map and immediately see the relevant information.

Respondent 3 discussed the gap/misalignment between sometimes the use of the faculty or building names in agendas, and other times the building numbers. For example, he didn't know where TPM was located. We showed that the current TU Delft map already contains search and filtering functions, however the respondents noted that these options are not as clear as they could and should be.

Respondent 2 discussed a potential feature in which the map user can indicate, for example, if they are in a wheelchair/ not very mobile, which would then keep that in mind, for example whilst trying to find a suitable parking space, which would then be nearby a wheelchair accessible entrance. They also mentioned the lack of information regarding the on-going construction site(s) on campus. Currently the web map doesn't give any information whatsoever, just the general area of the building site. Information about which roads/bike paths are closed, or open, would be valuable. In terms of expectation management, how it will affect your journey, does it now fall short. Even a simple description describing 'there are crossing in this construction site' would help.

Respondent 3 underscores that a map could also be a great medium for displaying all the cool experiences visiting the campus could bring, for example Architecture students working on their models in the Model Hall at BK. Similarly, the map could be used to get a better understanding of the extent of the TU Delft campus grounds.

Both respondent 1 and 2 underscore that the current TU Delft map is too cluttered and crowded with icons at start-up and that they should be off by default. Respondent 1 also wonders why the map does not show the building/faculty names, but the numbers. She also mentioned that building abbreviations could be used on smaller screens. Respondent 2 followed up that, in building 62 and 63, which are adjacent, and basically the same building/style, have different codes which is confusing.

Respondent 3 then suggested a map that could be tweaked and setup by individual users. For example, that you can turn certain layers on/off, save that state and potentially even share it with others such that only your active layers are also seen by the receiving party.

Both respondent 1 and 2 discussed that the locations + floors, of cafeterias on campus, and knowing their opening hours, especially during summer, would be valuable.

Respondent 2 also noted that in some buildings, coffee machines are not as abundant as in other buildings, so including these as well could be valuable. Potentially with the added information of whether these are employee-only, or the regular machines.

Respondent 1 highlighted that the locations of contemplation rooms and lactation rooms is important.

Thoughts on a 3D map, specifically the 3DBAG

Respondent 1 finds the 2D map useful yet doesn't see value in having a 3D map. However, retracted this statement at the end of the focus group when viewing an individual building, noting that having a 3D map to get a better understanding of where to find the building entrances is useful. Respondent 2 also, again underscored the added value of the inclusion of building entrances.

Respondent 2 mentions that for their orientation and getting to know their surroundings, a satellite image map is very useful. Since these images show the actual colours of the buildings and surroundings. However, which colours the buildings should be coloured, when not in satellite image mode, is the respondent not entirely sure on.

Supplier/ logistic entrances were also noted as useful, e.g. for bringing large items in.

Respondent 3 asked if we considered a 'campus navigation chatbot'. We have not, but it could be an interesting addition/ tool to navigate.

B.2. Second round of interviews

B.2.a. Interview 7

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Lars van Blokland	MSc Geomatics student
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]
	[Redacted]	[Redacted]

Backgrounds

[Redacted]

User interface

Respondent 1 found the button for the location finder unclear and proposed to use a pin icon instead, while respondent 2 found it clear as-is. The icon to switch between 2D and 3D view (a cube) was also considered unclear, and respondent 2 proposed to use a plane instead when in 3D view.

Respondent 2 found the search bar too transparent. They liked the combination of 3D models with the flat base layer and thought that adding the 3D models of other buildings around campus could make the map too busy. However, they both would like the boundaries of the TU Delft campus to be clearer and proposed to solve this by showing it with a shaded area or with the addition of paths and roads only on the campus. Moreover, they agreed that the basemaps are too slow to load and some of them lack contrast, especially the grey scale one.

Respondent 1 would also like the possibility to export/print the map as an image to be able to share it.

Regarding the compass / ‘orient north’ button, respondent 2 proposed that clicking on it, a second time could either go back to the previous orientation or orient the map based on the main axis of the campus.

Finally, respondent 1 found the highlight of a building too bright, making it harder to see the details/shading of the building, losing identifiability.

Map Controls

Respondent 1 found phone navigation difficult at first, requiring some time to get used to it, especially when trying to zoom in and out and to pan the map. A button to reset the view would be especially useful.

Respondent 2 pointed out that navigation based on right-click can be problematic with a trackpad. Moreover, he found that the rotation of the camera when moving to a clicked element makes it hard to understand how the map is oriented at the end.

Other feedback

The two respondents pointed out that some of the buildings were incorrectly merged and named, such as building 61 missing a part and some buildings next to Aerospace which were demolished.

Both respondents also found issues with the “about” page. Respondent 1 was using Safari and the icons on the page were not at their correct size and taking the whole page. Respondent 2 could only scroll on the page after clicking on it.

Tasking

The first task was to find the TU Delft library. Both respondents succeeded using the search bar but would like the result of the search to be highlighted. Moreover, respondent 1 would also prefer to have the building number visible above the building. Respondent 1 also figured out that clicking on the same building again would make the camera move and zoom slightly, which is not desired.

Regarding the indoor navigation in BK, respondent 1 would prefer other colours for the floor plans as well and suggested using anti-aliasing (note: we are already doing that). Respondent 1 also found that the compass button did not work in this mode and that calling the underground K1 can be confusing for non-Dutch-speaking users. Respondent 2 argued that the names used should be the ones that are used in practice in the building (such as BG for the ground floor). Respondent 2 also would like more colours on the floor plan and labels and did not want the hallways to be highlightable.

Finally respondent 2 had an issue where they could not click on things that were inside the location circle.

B.2.b. Interview 8

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]

Background

[Redacted]

Map Controls

The respondent liked the controls of the map and found them natural to use, because they are similar to controls used by Google Maps. She also liked that the map starts by showing an overview of the whole campus.

User Interface

The respondent used a mobile phone. They pointed out that the info panel is too big and the basemaps load too slow. They liked the icons because they are mostly standard and recognisable, and the colour use to highlight is distinguishable. A good addition to the map could be colours for the buildings to distinguish them, but with a small number of categories to avoid having too many colours. Adding non-campus buildings could be interesting if they bring real benefits, but could also add more complexity, so we need to think about the purpose before doing it.

Other pages

The “About” page is interesting, but it needs to define better what the map tries to achieve and how inclusivity is defined in the context of this map. For example, the respondent mentioned blind people, which are not the target of our map. The “Feedback” page is also good but allowing for anonymous feedback (instead of forcing the person to give an email address), could help gathering more feedback, so a decision must be taken there.

Tasking

The first task was to find the TU Delft Library and the respondent managed to do it quickly using the search bar but mentioned that the results are hard to read. Also, searching for “Building 21” instead of “21” only puts the library as the fourth result.

Other feedback

The respondent mentioned that the combination of 2D and 3D views in one map is something that should be put forward more in the definition of our project and the new things that it brings. On another note, the respondent also mentioned that a synthesis project worked in 2023 on indoor navigation for blind people, which is a target group for inclusivity that our map does not consider.

They also mentioned an experience they had with a visitor in a wheelchair in Bouwkunde. They entered by the west entrance using the ramp and then wanted to go to the library on the second floor. However, to use the elevator they had to borrow a card to the service desk to get access to it, and inside the library, the elevator to go to the half-storey did not work. It can also be necessary to call the service desk to enter through some of the accessible doors of the building.

B.2.c. Interview 9

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Daan Schlosser	MSc Geomatics student
	Mingjie Teo	MSc Geomatics student
	[Redacted]	[Redacted]
	[Redacted]	[Redacted]
	[Redacted]	[Redacted]

Backgrounds

[Redacted]

Introduction

We started the focus group session by recapping what the previous interviews were about, who our respondent population was and how we used these interviews to further shape our project and how we prioritised what will be, and what won't be in our project scope.

Feedback on the map

Map controls (the 2D/3D moving, orbiting, etc.)

Respondent 3 mentioned that when on a building view, the zoom out function has a maximum distance, respondent 2 added that this also seems to be the case for the normal 3D orbit view.

Respondent 3 likes the functionality of the 'reset view' button. He also mentioned that being able to save the map state for a later moment would be a nice functionality, so you can pick-up where you left-off the previous day.

Both respondent 2 and 3 note that the new base layer loads really slow when choosing a new base layer (even after our initial improvements on this).

Respondent 2 mentions that, on mobile, zooming in/out also triggers changes in angles. And in a more general sense the, seemingly random, changes in view angle are confusing and annoying.

Respondent 3 likes that clicking on a building moves the camera to said objects, that it highlights the object and that you are orbiting around it.

The rotating compass button functionality is appreciated.

User interface

Respondent 2 and 3 both agree that the accessibility icon now feels more like Google's 'drag and drop' feature to go into StreetView. Similarly, the 2D/3D 'Cube' button is not great. Both do like the overall map feel though, it feels like a game!

Respondent 2 would like to also have the building number in the info pane shown. She also suggests that the Aula could be where the 'Home' button points you towards, since this is where first years often head to.

Respondent 3 mentions that the TU Delft button in the header should point to the TU Delft website, instead of the map.

When prompted about the placement and usage of the icons, respondent 1 mentioned that he finds them logical in both location on the website and in terms of what they represent.

The about & feedback pages

The about page was discussed, and this discussion underscored the importance of describing very clearly who is, and who is not in our current target groups. For example, assume a blind employee or student, currently there are no elements to facilitate them. Respondent 1 also mentioned that he likes the idea of having a timeline of our progress and future work on the about page.

We also found that the feedback form doesn't seem to work, it raises an error: 'Feedback failed to send, please try again later'.

Other topics discussed whilst trying out the map

Daan and respondent 1 discussed navigation and routing, respondent 1 then highlighted that for someone in a wheelchair, it would be very valuable if there is an option to 'enable' this such that the routing could keep this in mind whilst planning a route. Daan also explained some of the work in progress elements, such as the names of the buildings being highlighted over them.

Respondent 1 emphasises that for someone in a wheelchair, knowing where the wheelchair accessible emergency exits are, in case of a calamity, is very important (similar to the regular (non-)accessible entrances). Often, they are not and as such not useable. Similarly, some faculties have different protocols and meeting places for people in a wheelchair. We will put this on the list, but Daan also emphasised that we are unsure whether we will be able to implement this as well.

Tasking (and the corresponding discussion notes)

Whilst discussing the tasking, it was asked whether our map will show if, for example the Aula, has a shop inside there.

Searching, the search bar, and how people identify campus elements:

- The background of the search bar is missing and thus can't be used nicely.
- Whilst the search bar is still Work in Progress, the respondent note that it already works quite well, in terms of finding what a user searches for.
- Internally, most employees, do not use the addresses of buildings, building names and their numbers are almost always used instead. Addresses are almost exclusive used for communication with external parties, e.g. taxi companies.
- Whilst trying out the search bar, we found that using the nicknames works well, but the current list of nicknames is very sparse and should be extended. E.g. TPM vs TBM. Similarly, when searching using room names, e.g. 08.BG.West.640, doesn't find anything.

Respondent 1 noted that another base layer, one with street names, works better for him. We explained that there are many different preferences, and therefore we have various base layers that can be toggled and changed. Besides the slow loading, this works well.

When asked about the inclusion of TU Delft buildings, and the exclusion of all other buildings, it seems that the respondents like this since our map is after all a TU Delft campus map. However, it is important to note that currently the included buildings also include some non-TU Delft or related buildings, and as such should be removed.

Getting the user's location doesn't work seamless yet, gives some errors and doesn't always work as one would expect.

B.2.d. Interview 10

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Daan Schlosser	MSc Geomatics student
	[Redacted]	[Redacted]

Background

[Redacted]

Introduction

Daan started the interview by recapping and summarising what about project is about, since this was our first meeting. During this summary, questions, remarks, etc. by respondent 1 are noted below, before going into our current Work in Progress map. This included, among other things a recap of what the previous interviews were about, who our respondent population was and how we used these interviews to further shape our project and how we prioritised what will be, and what won't be in our project scope. And Daan also showed the midterm presentation which gives a broader context to the project.

Respondent 1 finds the current TU Delft campus map not very accessible; the previous map was better. She finds the current map hard to use and navigate in.

Respondent 1 asks whether we considered a dyslexic specific font. Daan then explained that we have, but that having an accessible UI for someone with dyslexia, having a different font is just one piece of the solution.

Map feedback

Orbiting, moving, etc.

When the respondent used the map herself, she finds it distracting that in the view of the camera, the border of the base layer is very prominent, and as such very distracting. The respondent would have preferred that it is screen-filling, a map for the whole Netherlands is not necessary.

When using the map, it is not entirely clear for the respondent that once you have selected a building, that the map locks on this building and goes into orbit mode. As such, the respondent wanted to move away but was locked. The ability to click on 'nothing' didn't occur and as such Daan had to help.

The respondent would like it that if you have selected a building, that double clicking on this building would also open the floor plan viewer. The same as in using the 'View floor plan' button. That both actions would do that.

The respondent notes that currently the bottom left two buttons are very contra intuitive since the icons do not relate to the action and also do not have tooltips.

Some buildings currently on the map, are not in ownership/ relate to TU Delft (anymore). Therefore, these should be removed. The respondent does find it logical that only TU Delft buildings are included on the map, since after all this is TU Delft's campus map.

The respondent emphasises the importance of being able to use the map to view which exterior surfaces and areas are and are not accessible by someone in a wheelchair.

The respondent thinks that it would be a nice functionality that, similar to other potential buttons on the info pane, that the room booking website of TU Delft is linked to, for relevant buildings in which students can book rooms. And also, where one can find a quiet space to study.

The respondent underscores the importance of being able to use the map to find wheelchair accessible restrooms. She also can imagine that a routing/ navigation functionality would be a great addition. Especially with an option to let the program know you are in a wheelchair, and as such change the most suitable route.

The respondent would like to see an image of the building after clicking on it, similar to how Google Maps has photos. Since names and numbers can be abstract.

The blue circle of the 'my location' pin overlaps with the floor plan and thus makes rooms under it not accessible to click on.

The respondent tries multiple times to click on the icons, yet they are not clickable in our version, they should be.

User interface

The respondent likes the buttons as they are, they are logical and the tooltips are sufficient, no extra text is necessary.

We discussed the building colours, it is suggested to give the D&I office's location another colour, since there is our client. She isn't too fond of the grey colour, since it disappears into the background on certain layers, e.g. TU Delft blue would maybe be a better option. Regarding the floor plans, she finds the colours of those better than the same grey we now have.

Whilst searching, 'Building 21' does not find the library. The results are also currently not really visible. And in general, sometimes the search bar just doesn't do what one expects it to do.

The about & feedback page

On the about page, the respondent suggests that our names should definitely be there. Since after all we are the ones who built the site. Similarly links to the relevant parties, such as the D&I office, since now one has to manually search it if interested.

The respondent also raised some questions about the feedback page, who receives this/ where is this sent to? Privacy concerns are also discussed. We should also think about the hand-over, who will be the point of contact for technical questions? Contact details would also be valuable, if one would like to give more feedback and/or open a broader conversation regarding the map.

B.2.e. Interview 11

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Daan Schlosser	MSc Geomatics student
	[Redacted]	[Redacted]

Background

[Redacted]

Introduction / Recap

Daan started the interview by summarising the previous interview round; how many people we interviewed, who they are and represent and what we have done with their input (including our Excel list, with the desires/issues mentioned, how often and or subsequent feasibility-impact matrix ranking, which guides our further prioritisation), and similarly what our ideas are for this interview round.

General thoughts on our map

The respondent likes that our map opens with the Satellite image as the default base layer, since this is how it actually looks, and therefore not (too) abstract, helping to better identify/understand where you are. Similarly, the outlines of the buildings are very useful.

The respondent appreciates that when you click on a building, both the info pane is shown and that the building changes colour, as a feedback mechanism.

Regarding the labels of the buildings, the respondent suggests that they should contain both the building numbers and the building names, since various people use either the number or the name.

Whilst using the map we found that the building label (name + icons) remains when you have clicked on the building, I think that this maybe should disappear since now it blocks the building view, and this information could/will also be included in the info pane.

Whilst discussing the length of the building names, since some of the official names are very long, we discussed using abbreviations instead, such as EEMCS. Most people already use/know these abbreviations anyway. Potentially a good source for these abbreviations would be the graduate school email addresses of the various faculties, since these already use these abbreviations.

The respondent finds it important that on a first glance when using the map, e.g. when you have enabled restaurants, that you can immediately identify from the campus map, which locations/buildings contain restaurants.

Map feedback

Map controls

The respondent finds the map control nice, it is also appreciated that when moving between selected objects, that the camera has a brief animation, with smooth zoom and panning so that you keep your understanding of movement and localisation.

However, we did find that for some very small buildings and rooms, the zooming is too much zoomed-in, and the whole building takes up the screen. Perhaps a maximum zoom-in level would be a good addition to have so that you keep the context/surrounding details.

UI: Layout, icons, font, colour, etc.

We found that the outlines of the buildings were missing after using the map for a bit. This is caused by going in- & out of the floor plan viewer, which hides, but not unhides outlines.

(After Daan asked about the inclusion of non-TU Delft buildings) The respondent thinks that, since it is the TU Delft campus map, that only TU Delft-related buildings should be included, however this is a bit nuanced, since for example student housing is also a typology the respondent suggested keeping (and other student-life related facilities). However, there should be a distinguishing between primary TU Delft buildings, and supporting/non-directly TU Delft buildings, the respondent suggested potentially changing the outline colour (e.g. TU Delft blue) for this. Other buildings/facilities shouldn't be included, since those can be found/ searched about/navigated to in Google Maps.

The respondent appreciates it that when you open the map initially, that the map is quite easy on the eyes, without too many icons or different colours. She can imagine that the colours could be not of enough contrast to some, but to her it is no problem now.

The respondent finds the building label now not ideal to read. The 'Bouwkunde' text only has a small boundary, but a whole text box so there is more contrast would be better.

The respondent also emphasised once again that she likes that the map, as is now, is quite easy on the eyes, doesn't have a lot of clutter and in general is quite simple in terms of look. She also emphasised once more that, using the base layer that it is easy to distinguish between the greenery, water, streets, etc. due to it being a satellite image.

The respondent notes that having the TU Delft logo makes the website more recognisable and trustworthy, yet the name of the project/ website is missing and would be a good addition. Especially since our project is not just a campus map, but there is a strong emphasis on inclusivity.

The respondent likes the tooltips of the buttons on the right side of the map. Most buttons in terms of their icon and corresponding function are already what is expected, but these texts help additionally with finding what each button does. She also likes the colour of these buttons, since it is TU Delft blue (It actually is not though). However, when comparing these buttons to the temporary buttons on the button left, she agrees that in terms of contrast and visibility, with a satellite image base layer, black text on white background buttons is better.

After going through the buttons on the right side, when using the base layer function, she likes that there are multiple options, for various users with other preference options.

When using the location button, it doesn't work on the respondent's laptop, likely due to some sort of system setting blocking this. Our website handling this error/ non-availability should be improved. After showing it on Dana's laptop/phone, she likes the functionality and discusses how this would definitely help in finding where you are, and which facilities are nearby you/ which are the closest.

When doing some of the tasks, e.g. the searching 'Building 21' task, it becomes apparent that the search bar is definitely not complete yet in both how it searches and is used and in terms of the names of the search results. However, the respondent likes it very much that even using a part of a search string, e.g. only 640 out of 08.00.03.640 will find results, because she often only remembers the last part of these codes.

About & Feedback pages

See notes below.

Notes

- The respondent will also share the website with other members in her community/ network to also gather feedback from them.
- Since the meeting was already over, yet the About/Feedback pages were only discussed briefly, will the respondent check the About and Feedback pages in her own time and let us know what she thinks of them.
- The respondent will also try the website on her Smartphone and let us know how that goes and what is working nicely vs. what is working not so nicely on mobile.

B.2.f. Interview 12

Location	[Redacted]	
Date & Time	[Redacted]	
Attendance	Name	Role/Function
	Daan Schlosser	MSc Geomatics student
	[Redacted]	[Redacted]

Note: instead of recording and using the recording together with notes taken during the interview, only the notes taken by Daan are included, resulting in a shorter overall summary.

Background

[Redacted]

Feedback regarding the info pane

- It would be valuable to have the facilities shown in the info pane, such as:
 - Gender-neutral restrooms, quiet rooms, lactation room
 - Within the wheelchair accessibility details menu, information regarding accessible restrooms would be valuable

Questions/ other feedback:

- Would it be possible to filter out certain buildings? Now all buildings are always shown. What about letting users disable them (e.g., based on their category)
- A guide on how to use the map would be valuable, especially for those not as tech savvy. This guide could then also explain that in the campus view, indoor facilities are stacked under the rooms, yet in the building/ floor plan view, they show the exact locations of the facilities.\
- Being able to enable/disable thematic layers through searching them in the search bar would be a useful function.

Other issues found when the respondent checked the map

- The purple building colours don't always load, and it seems the grey buildings get loaded in too -> needs fixing.
- In the search bar results, buildings are only displayed using their name, the numbers should also be shown there.
- There is a lot of overlap regarding building labels, which is undesirable