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Enhancing Inclusive Wayfinding

A strategic framework to support design practitioners in improving wayfinding in Dutch metro stations.

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Master Graduation Thesis

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Preface

First and foremost, I would like to thank my supervisory team for the support you have given me throughout this journey.

To my chair, Achilleas, thank you for guiding me and encouraging me to broaden my perspectives.
To my mentor, Martijn, thank you for helping me reflect on my choices.
And to Anna, thank you for welcoming every question and doubt that I had, and for helping me make sense of my chaotic ideas.

Besides my supervisory team I would love to thank the people I shared this journey with, Alessandra, Ilia, Jack, Kalyani and Roos. It would not be the same without you.

I would also like to thank the entire Fabrique team, who made me feel welcome from the very first day. Thank you for your curiosity and support, even the smallest words of encouragement shared over coffee meant a lot and helped me more than you know.

This project marks the end of two incredible years, filled with countless moments and emotions. There were challenges and moments of discouragement, but also new friendships, great satisfaction, and the awareness that I made the right choice, even though the journey is still long. It was never easy to take this path. The thought of being far from home, from my family, and from the people I love was intimidating.
Yet, along the way, I rediscovered myself. I understood that wherever I am, I can always rely on the unconditional love of my family, something truly essential to me. So I want to thank my loved ones for it.

Grazie mamma e papà, per avermi dato la possibilità di sognare un futuro lontano da casa, ma sempre vicino al cuore. Tutto quello che faccio è grazie a voi, a quello che mi avete insegnato e i valori che mi avete trasmesso, non vi potrò mai ringraziare abbastanza.
Grazie a mio fratello, per essere sempre presente e pronto ad aiutarmi in tutto, per le tue parole mai scontate e piene di affetto, te ne sono grata.
Grazie a Lorenzo, la mia spalla, che ne ha viste di tutti i colori, ogni volta che pensavo di non farcela c'eri tu a tendermi la mano, sei stato fondamentale.
Infine, grazie alle amiche di una vita, che anche da distante mi siete sempre state accanto e gioito dei miei traguardi, vi voglio bene.

Enjoy the reading,
Chiara

Executive Summary

This thesis explores the topic of wayfinding in public transportation in the Netherlands, specifically for metro stations. Within this context, it investigates how designers can be supported in making it more inclusive. Even if there is a growing interest in accessibility for people with recognised disabilities, such as physical impairments, informational barriers persist, hindering independent navigation for many users. In this project, the focus is particularly on people with visual impairments and low-literate users. The thesis approach to inclusivity in navigation is not only from a technical perspective but also as a matter of social responsibility. With this project, the aim is to design for inclusion beyond compliance, promoting environments where everyone can navigate independently and with confidence.
The research followed the Double Diamond framework. During the Discover phase, desk research was conducted on wayfinding theories, accessibility regulations, and analysis of network management in public transportation. This was complemented by stakeholder mapping and preliminary field observations in Dutch metro stations. In the Define phase, the findings were synthesised and opportunity areas were explored. This stage also included expert and user interviews, user observations, and the development of design criteria grounded in Universal and Inclusive Design principles. The Develop phase focused on co-creation and ideation sessions with design practitioners of Fabrique, a leading design agency also involved in user experience in public spaces. In those sessions, iterative prototyping of framework components, and the exploration of inclusive design applications occurred. Finally, in the Deliver phase, the strategic framework was refined through expert evaluations and feedback iteration sessions, leading to the final outcome of the project.

From the research, it came out that in current wayfinding systems in public transport, "invisible" user groups are often overlooked, although they are the ones who face major challenges in navigating metro environments. Accessibility is still mainly framed in physical terms (e.g., ramps, elevators), with limited attention to informational clarity and independent navigation. Metro stations, being high-stress and multisensory spaces, further intensify these issues. In addition, stakeholder responsibilities are fragmented across municipalities, resulting in inconsistent inclusive wayfinding strategies. Together, these findings highlighted that inclusive wayfinding is a systemic challenge, one that extends beyond infrastructure and regulation. The design opportunity lies in developing an adaptable, cross-disciplinary framework that responds to the needs of users with invisible difficulties, ultimately enhancing the wayfinding experience for a broader range of passengers.

To respond to these complex challenges, a strategic framework, *"Finding the Way Together"*, was developed. The resulting framework is not a single "perfect" design, but it is envisioned to guide practitioners through diagnosis, ideation, and implementation. It consists of three main components: the Knowledge Tool, the Participatory Tool, and the Recommendation Cards. Together, they function both as a reference for practitioners and as a participatory instrument for stakeholder engagement. These tools aim to raise awareness, position inclusivity as a design requirement, reduce assumptions, foster collaboration, and embed inclusive perspectives throughout the design process. As convivial and inspiring artefacts, they encourage meaningful participation in co-creation activities, to support a more inclusive and human-centred wayfinding experience.

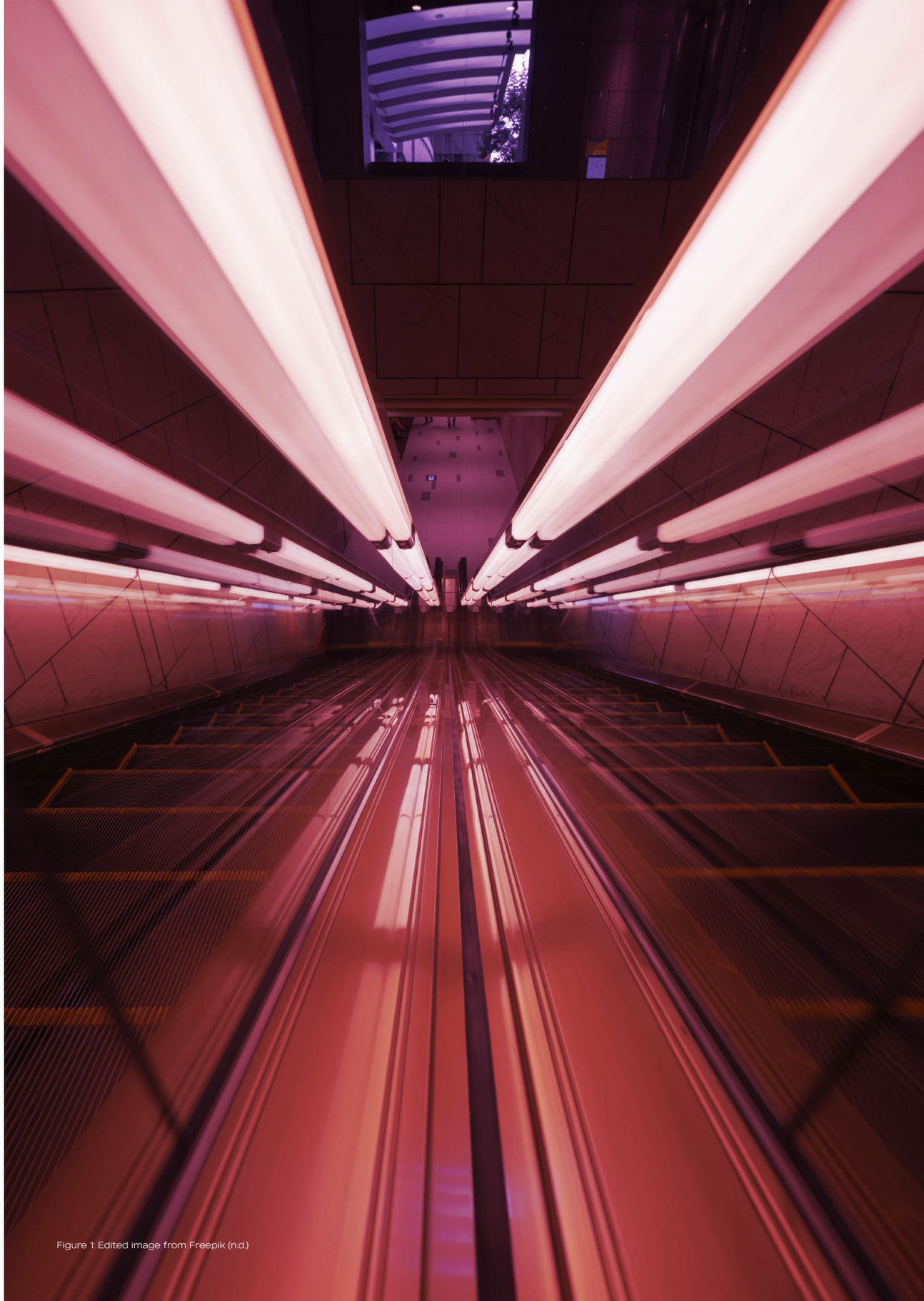

Figure 1: Edited image from Freepik (n.d.)

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↘ Introduction

In this first chapter, a general overview of the project is provided, starting from the project context, the inclusivity within wayfinding, which is the main focus. Following, the design challenge, aim, objective and approach of the project are discussed. The topic of this research project originates from the challenge of accessibility and usability of information, in the context of public transportation. In particular, the analysis focuses on metro station hubs within the Dutch territory.

The core theme under investigation is wayfinding, a term referred to as the process of determining a route from one location to another and its navigation (Chen et al., 2009; Passini, 1981).
Access to information is particularly crucial in public transport environments for individuals with disabilities or difficulties. This is due to the lack of relevant information. When someone needs to navigate and orient itself independently within a space, this can result in significant disadvantages (Maynard, 2009). Therefore, these issues can result in the decision to avoid the use of public transportation altogether (Transport Committee, 2025).

However, avoiding the use of this service can trigger a chain of disadvantages, such as reducing or missing participation in social and working life.
From the transport authorities' perspective, this means that an important demographic segment could potentially remain excluded from their services (Jamshidi et al., 2020).

1.1 Project Context

When addressing accessibility in public transportation, the conversation is often limited to physical barriers, such as being unable to access a particular location due to missing or non-functioning elements (Toegankelijkheid, 2025).
This is reflected in the way transportation authorities, such as GVB and RET, tend to demonstrate and communicate that a location (e.g., a station) is accessible (GVB, 2025a; Travelling with a Physical Impairment, n.d.).
There is often an emphasis on the physical components, focusing on access via escalators, ramps, elevators, and other mobility barriers. It is therefore interesting to observe how their perspective on accessibility also appears to be fixed or limited to physical access alone.
Informational and navigational barriers are considered critical elements, often overlooked in an infrastructure-centric view of accessibility.
Recognising this limitation highlights the importance of expanding the dialogue around the topic, to include cognitive, sensory, and informational dimensions, particularly in environments as complex as transportation hubs.
Many studies have explored the concept of accessibility in public transportation, extending beyond physical infrastructure to include the accessibility of information (Asamoah et al., 2020; Baric et al., 2024; Bęczkowska & Zysk, 2021; Boadi-Kusi et al., 2023; Carlsson, 2004; Creba-Wright et al., 2019; Fiedler & Rupprecht Consult - Forschung & Beratung GmbH, 2007; Mwaka et al., 2024; Park and Chowdhury, 2018; Park and Chowdhury, 2022; Expert Group for Urban Mobility, 2022; Ministry of Transport and Communication, 2022).

Apart from people with reduced mobility, many individuals with sensory and cognitive impairments or depend on clear, usable, and consistent wayfinding information to navigate independently. Despite advances in information, localisation, and communication technologies, traveller information remains very challenging for people with sensory disabilities (visual or auditory) to access during their journeys in urban public transport (Baudoin & Venard, 2010).
According to Mwaka et al. (2024), without them, navigating public spaces becomes a source of stress or even exclusion, ultimately impacting autonomy and participation in social and economic life.
Various studies explore the theme of the "journey trip chain", and as explained by Park and Chowdhury (2018), this chain requires a seamless connection between the built environment and transportation systems. While physical barriers are often considered as accessibility requirement in the built environment, informational barriers are less visible but equally limiting, since they hinder individuals with sensory and cognitive impairments or difficulties from accessing information and fully participating in daily life.

This research specifically focuses on metro stations in the Netherlands. The choice has been made because metro hubs are often high-paced and complex, with multiple decision points, which make navigation particularly difficult. Moreover, metro stations are central nodes in urban travel chains, therefore improving wayfinding here could positively affect the accessibility of a wider transportation network.
Another reason for this focus is that metro systems in the Netherlands are managed locally by each municipality (e.g., GVB in Amsterdam, RET in Rotterdam). Consequently, there is no unified national standard for wayfinding in metro environments. This highlights the need for a strategic yet adaptable framework

even more relevant, one that design practitioners and teams can apply flexibly across different cities while aligning with overarching accessibility goals, as the European Accessibility Act (2025).

Therefore, the most impactful intervention is not a new product, but a new process. In this context, to carry out the thesis project, the targeted users are: design practitioners who are the primary users of the framework, and people with visual impairment and low literate as secondary targeted group.
The role of designer, and the need for a solution for them, relies on the fact that they often lack the tools to bridge the gap between regulations and real user needs. They work with assumptions and find it hard to advocate for deeper inclusivity with clients.
This decision was made to be able to provide different needs perspectives for the framework. Regarding the final structure, the components of the framework are the following: a Knowledge Tool, which provide a systemic and evidence-based overview of the metro travel journey, to be used as strategic reference document; and a Participatory Tool, designed for use in co-creation sessions with clients and stakeholders. Both these tools are supported by a set of Recommendation Cards.

In this way, it is possible to ensure a tool for design practitioners with a structured resource in the design and its implementation, and a practical instrument for engagement with clients and stakeholders, creating space for reflection and discussion.

1.2 Design Challenge

The main design challenge in this project is the insufficiency of an inclusive and, therefore, accessible wayfinding system in public transportation hubs (Park & Chowdhury, 2018) in the Netherlands, although there is a growing interest in accessibility for people with recognised disabilities, such as physical disability, informational barriers still exist and hinder independent navigation for many people.

In 2023, 27% of the EU population over the age of 16 had some form of disability. That equals 101 million people or 1 in 4 adults in the EU (Disability in the EU: Facts and Figures, 2025). As of 2024, approximately 6 million people aged 15 to 65 in the Netherlands are classified as having a disability (ABN AMRO Bank, 2024).
According to the Oogvereniging (the Dutch association for people with eye conditions), the estimated numbers are approximately 300,000 people are blind or have some degree of visual impairment (Van Der Heijden et al., 2024). This number is expected to grow due to the ageing population. This group is broken down into:

- **Partially Sighted**: Approximately 220,000 people. This is generally defined as having a visual acuity between 5% and 30%.
- **Blind:** Approximately 80,000 people. This is defined as having a visual acuity of less than 5% or a very limited field of vision.

This thesis adopts an "expanded" view of accessibility. It not only considers the needs of individuals with formal impairments but also includes those people facing difficulties (in navigation and access to information) due to other conditions, such as low literacy.
Based on the most recent PIAAC (Programme for the International Assessment of Adult Competencies) survey data, shared by the Stichting Lezen & Schrijven (Reading & Writing Foundation), shows that in the Netherlands the total low-literate adults (16-65 years) is 3 million people (Stichting Lezen & Schrijven, 2025). These individuals often fall outside regulatory definitions of disability and, consequently, they are less visible, receiving lower design attention and support from existing policies. For this reason, they represent a substantial and particularly vulnerable group, especially in high-stress, complex environments as public transportation metro stations. By addressing the needs of both legally recognised disabled individuals and people with difficulties, this project identifies an opportunity: **to design for inclusion beyond compliance.**
Thus, improving wayfinding is not just a compliance issue; it's a matter of equity, dignity, and inclusive urban mobility.

The challenge extends beyond identifying what to change, but it mainly involves helping design practitioners understand how to change within real-world constraints.
Finally, the goal is to create a resource that bridges user needs, strategic thinking, and design implementation, contributing to more inclusive and human-centred public environments. This results in the development of a strategic framework with actionable recommendations that enhance accessibility and demonstrate its potential social impact.

1.3 Aim and Objectives

This master's thesis aims to enable design practitioners to improve information access and independent mobility for people with visual impairments and low-literate individuals. The objectives of this project are:

- Explore the wayfinding needs of targeted individuals
- Map out informational barriers across the travel journey chain
- Identify strategic design principles and prioritisation criteria
- Create a strategic framework that supports design practitioners in the decision-making of wayfinding in Dutch metro stations.

The developed outcome is a strategic design framework that establishes the foundation, values, and understanding of what inclusivity means in this context, identifies the key dimensions to consider, and explores how wayfinding intersects with regulations, user needs, and design principles. In this way, progress can be made in enhancing the execution of inclusive wayfinding systems in Dutch metro hubs.

1.4 Research Questions

Based on the project context and the design challenge, the following main and sub research questions have been derived:
How can inclusive design be strategically implemented to improve wayfinding in Dutch metro stations for people with visual impairments (VI) and low literacy (LL)?

To answer the main research question, three sub-questions are developed:
1. *What are the key accessibility barriers that these different user groups face across the travel journey?*
2. *How can inclusive design principles be applied to improve wayfinding in the Dutch metro stations beyond legal compliance?*
3. *What strategic approaches can support design practitioners in designing and implementing inclusive wayfinding systems that address a broader spectrum of needs?*

1.5 Project Approach

This thesis adopts a qualitative, human-centred design approach grounded in the Double Diamond framework. This was chosen for its capacity to navigate elaborate, multi-stakeholder design challenges, which encompass the complexities of inclusive wayfinding.
Since wayfinding is a natural human experience, shaped by cognitive, emotional and physical factors (Passini, 1996), a purely technical or regulatory-based analysis would be insufficient.
For this reason, this research employs a qualitative methodology to reveal the lived experiences of users and the practical realities faced by design practitioners. Specifically, semi-structured interviews were carried out, followed by a thematic analysis.
The reason for choosing a qualitative research approach lies in the intention to explore the topic in greater depth. Indeed, it is important to emphasise that qualitative methods do not allow for generalisation to an entire population. Even though, they provide a rich and in-depth understanding of specific targeted groups and situations, something that cannot be captured through quantitative research (Clarke & Braun, 2013).
This study aims to understand personal knowledge gained through direct life events, first and foremost those of individuals who face difficulties in navigating a space, and secondly those of designers tasked with improving the navigation of such environments. A qualitative approach is considered the most effective method for this purpose, as it prioritises participants' voices and perspectives.

The research starts with a broad review of accessibility in public transportation to map the full landscape of barriers across diverse user groups (see Appendix B). This wider lens ensured a holistic understanding of the accessibility context. However, to make the research feasible within the 100 working days of this project, the focus was intentionally narrowed to two specific user groups: people with Visual Impairments (VI) and people with Low Literacy (LL). These two groups were selected because they face persistent informational barriers in complex

[1] Note: the project does not address vehicle design, in-depth ticketing systems or emergency wayfinding systems. Instead, it centres on informational navigation within public transit hubs. Due to time constraints, the project emphasises conceptual development and design, rather than full-scale implementation of the solution.

transit environments, yet are often addressed indirectly or inconsistently in existing design practice and regulation (Cushley et al., 2022; Anna Newey, 2020). Studying them in detail provided a meaningful test case for developing a strategic framework that can later be adapted to broader accessibility needs.

The Double Diamond structure (see Figure 2) was applied as follows:
- **Discover:** desk research into wayfinding theory, accessibility regulations, and analysis of network management in public transportation; stakeholder mapping; and preliminary field observations in Dutch metro stations.
- **Define:** synthesis of findings into key problem statements, opportunity areas, expert and user interviews, user observation and development of design criteria (within universal and inclusive design).
- **Develop:** co-creation and ideation with design practitioners, iterative prototyping of framework design components, and exploration of inclusive design applications.
- **Deliver:** refinement of the strategic framework, expert evaluation and feedback iteration sessions[1].

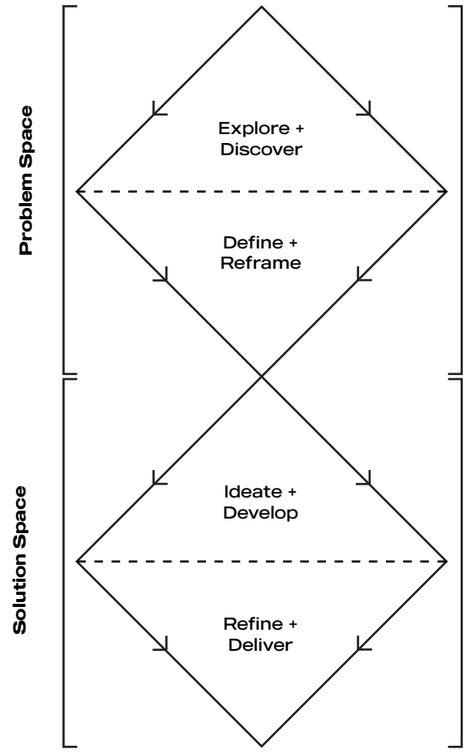


Figure 2: The adapted Double Diamond (Design Council, n.d.).

↘ Theoretical Background

This chapter lays the foundation of the research, by examining the relevant literature on wayfinding and the public transportation domain.
The first part begins with an overview of the wayfinding theories and all the relevant elements connected to them.
Subsequently, a review of the Travel Chain was done to better understand the components and the importance of a seamless journey.
Lastly, principles of universal and inclusive design were analysed to gain insight into how they can affect access to information.

The second part concerns public transportation analysis, which included an overview of the main stakeholders and their role, the existing policies and regulations across Europe and the Netherlands.

A final section reveals some of the most interesting aspects of current assistive technologies.
This theoretical overview helps to formulate the problem space of the research, in order to take further steps to narrow down the focus of the project.

2.1 Wayfinding Theory and Spatial Cognition

Definition and Relevance in the Built Environment

Navigating environments, whether indoors or outdoors, is a fundamental human activity known as wayfinding. This process is vital for determining a route from one place to another and for its navigation (Chen et al., 2009). Wayfinding is a lesser-known field of design that spans several disciplines, including urban design and planning, product design, graphic design, information design, and behavioural psychology (Dewar et al., 2022).
Disorientation and getting lost are often very frustrating experiences for travellers or visitors trying to reach a specific destination. Wayfinding difficulties are usually worse for people with impairments, especially those with sensory impairments. These challenges can become psychological barriers, which, in terms of reducing accessibility, are just as obstructive as physical barriers (Passini, 1996).

Wayfinding involves a set of cognitive processes (Delgrange et al., 2020). During wayfinding, individuals select information relevant to their task from the environment (Chang et al., 2010). Environmental information includes all relevant available evidence to a person when completing a wayfinding task (Passini, 1981). The public transit wayfinding system has a distinct look and feel, and users are required to intuitively understand the transit culture of the system the moment they step foot into the network, regardless of experience (Mollerup, 2013).
The effectiveness of a public transit wayfinding system lies in the interaction of structural design principles and the users' basic understandings of the system itself (Ferri & Popp, 2023).

The main stages of wayfinding, as described by Klimek (2025), can be divided into four, which are:

1. **Orientation:** this phase is essential to figure out where you are in space, in relation to landmarks and the eventual goal.
2. **Route decision:** based on the orientation, route decision is for choosing the best direction to take to reach the desired destination.
3. **Route monitoring:** as a person moves, it is usually common to check and use different orientation points to ensure that they are still heading towards the destination.
4. **Destination recognition:** this is the final step, in which you recognise when you have reached the intended location.

These four stages can be seen as a cyclic process. As soon as you reach your destination, the process begins again as you orient yourself for the next part of your journey or to find the final destination.

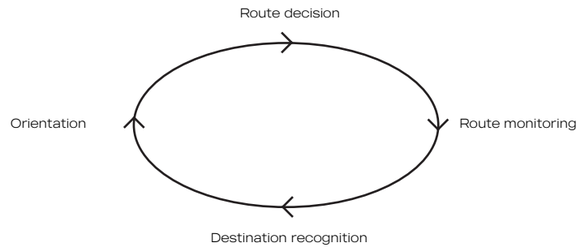


Figure 3: Visual representation of the four stages of wayfinding of Klimek (2025).

According to Gibson (2009), four main types of signs can be found in wayfinding design:

- **Identification:** identification signs often provide the first impression of a destination, helping people figuring out where they are. They provide a sense of place and context within a wider environment. Examples are building names, train and metro station names, department signs or room numbers (see Figure 4).
- **Directional:** these signs have the role of guiding people, routing them between main entrances, key decision points, destinations and exit points. Usually, this happens by displaying graphic prompts as symbols, arrows or other visual cues (see Figure 5).
- **Informational (or orientational):** informational signs offer people an overview of the surroundings in the form of comprehensive site maps and directories, or explanations about services. This helps users understand the available resources and the space layout (see Figure 6).

Figure 4: Identification sign, Nieuwmarkt Amsterdam Metro Station (photo taken by the author).

Figure 5: Directional sign, Pok Oi Hospital in Hong Kong (Long, 2017).

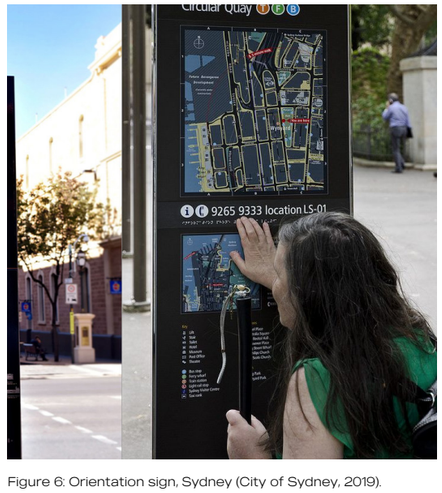


Figure 6: Orientation sign, Sydney (City of Sydney, 2019).

Figure 7: Regulatory sign, London, UK (Shone, 2025).

- **Regulatory:** these signs establish rules and guidelines to follow within a space, such as safety instructions or restrictions. Some regulatory signs need to comply with legal codes. They are important since they promote safety and order within the environment (see Figure 7).

Cognitive Processes Involved in Spatial Navigation

Various cognitive processes, including memory, attention, spatial updating, mental planning, and problem-solving skills, play a vital role in navigation. Additionally, numerous internal and external factors, such as age, familiarity with the environment, landmark characteristics, and environmental complexity, can influence spatial navigation (Piccardi et al., 2024).
According to Lynch (1960), cognitive mapping is defined as the internal and external mental representation of the surrounding environment. As part of cognitive processes, cognitive maps are the result of an information processing ability by which we are able to obtain, accumulate and structure information. They are essentially a source of environmental information to be used in solving environmental problems (Passini, 1981).

Sensory-impaired users, especially those who are visually impaired, face challenges with wayfinding in public environments. A notable issue concerns congenitally blind individuals. Do people who have never seen and cannot form visual mental images of space still grasp spatial concepts and develop cognitive maps? Extensive research has addressed this question, and most experts agree that even those born blind possess some form of spatial representation.

According to Passini (1996), it has been demonstrated that they are capable not only of understanding sequences but also of comprehending spatial coordinates. In his research, it was confirmed that congenitally blind individuals are capable of cognitive mapping, and they can perform all spatio-cognitive operations necessary for wayfinding. Their difficulties derive not from their own cognitive limitations but from limited access to relevant information.
For example, Lynch (1960) emphasised the relevance of legibility, and how easily a space can be understood and organised mentally, as a core quality of well-designed environments. A highly legible space is essential to support strong cognitive mapping. It can help individuals structure the space in their mind and feel confident and oriented.

Role of Landmarks, Signage and Environmental Cues

The capacity to structure and identify the environment is fundamental for all animals.
The types of cues that can be used are many: the visual sensation of colour, shape, movement, light, and other senses as smell, sound and touch, also play an important role. Lynch (1960) highlights that the necessity of recognising and patterning the surroundings is crucial, since it is a core human and animal vital ability from the beginning of their existence.

External environmental factors that greatly affect spatial navigation involve landmark features and environmental cues, especially their salience. Characteristics like shape, size, distance to the goal, and brightness enhance landmarks' prominence, boosting their usefulness for navigation (Piccardi et al., 2024). Landmarks are recognised as vital elements in both virtual and real environments during wayfinding tasks. They are characterised by two main aspects: visibility and salience. They should contrast with their background or possess a distinct shape or other specific feature that makes them stand out. Depending on their visibility during a wayfinding process, landmarks can be categorised as either global or local.

Lynch (1960) described global landmarks as elements visible from many angles and distances, including those seen above smaller features. Conversely, local landmarks are only visible at close range. In particular, the ones that are also visually, cognitively, or structurally salient can reduce the number of wayfinding errors. Additionally, making routes more attractive with urban features, such as statues, buildings, or other aesthetically appealing facilities, can enhance the experience (Yesiltepe et al., 2021).

Design Principles of Wayfinding

Even if there is no official standardised principles, from the literature (Gibson, 2009; Lynch, 1960; Passini, 1996; Design Principles for Wayfinding, n.d.) it was possible to define and combine the main factors to considers, in order to design good wayfinding:

Create an identity at each location, different from all others	Use landmarks to provide orientation cues and memorable locations
Create well-structured paths	Create regions of differing visual character
Don't give the user too many choices in navigation	Use survey views (give navigators a vista or map)
Provide signs at decision points to help wayfinding decisions	Use sight lines to show what's ahead.

2.2 Travel Chain

Definition and Components

The "travel chain" refers to the entire sequence of activities and movements that a person undertakes to complete a journey, from their starting point to their final destination. This concept shifts the focus from the act of travel itself to the numerous interconnected links that form the complete experience [2].
Each link, from planning the trip to navigating the station and boarding the vehicle, can present potential barriers, and a failure in one can compromise the entire journey. Adopting a travel chain perspective provides a holistic, system-oriented view, helping to identify and address usability problems that can occur at any stage (Carlsson, 2004).
The successful use of public transport, particularly for people with disabilities, hinges on what Park & Chowdhury (2018) names an "accessible journey chain" (see Figure 8). This framework highlights that a journey is a series of elements that must be seamlessly connected. Whenever one small part of the journey is inaccessible, the entire chain is broken, rendering the trip impossible (Maynard, 2009).

[2] Note: For the practical purposes of this analysis, the travel chain is considered to begin when a person arrives at the station and end when they exit the destination station, representing a partial rather than a complete door-to-door journey.

An accessible travel chain consists of several critical stages (see Figure 8), which encompass both digital and physical interactions:

- **Stage 1 -** Planning and Information: the journey begins not with movement, but with information. people with disabilities need reliable, comprehensive information to be certain the entire route is accessible before they depart, as they may find it difficult to adapt to unexpected barriers (Boadi-Kusi et al., 2023; Saarela & Partanen, 2024).
- **Stages 2,3,4 -** The Full Journey: this includes the initial journey through the built environment to the station, the main journey on the public transport network, and the final journey from the destination stop to the end point (Park & Chowdhury, 2018; Saarela & Partanen, 2024).

By analysing each of these stages, it becomes possible to design more flexible and adaptable solutions that support smooth transitions between links, making public transport more inclusive for everyone.

Vulnerable Touchpoints and Systemic Challenges

While the travel chain concept provides a clear framework, its implementation has some important challenges. Vulnerable touchpoints, stages where the chain is most likely to break, prevent a safe, smooth, and seamless experience for people with impairments or difficulties. These issues arise from fragmented information systems, inadequate physical design, and a lack of user-centred planning.

The planning phase is often the first point of failure. Research indicates a significant lack of coordination between signage, printed materials, and web-based information, resulting in confusing navigation experiences (Jost et al., 2024). This fragmentation is particularly challenging for vulnerable individuals, who may struggle with low digital literacy or require assistive technologies to access online information and purchase tickets. The increasing dependency on online services for booking and real-time updates leaves many individuals behind (Saarela & Partanen, 2024).

The built environment leading to and from transport hubs often presents the first barrier, making it difficult for users to even reach the network (Park & Chowdhury, 2018). Within the transport system, challenges include:

Fragmented Governance
Public transit systems are often controlled by multiple regional authorities, leading to fragmented and inconsistent wayfinding information and accessibility standards across a single journey (Ferri & Popp, 2023).

Complex Spatial Design
Large transit networks create intricate navigational environments, with constant transitions between inside and outside, and aboveground and belowground spaces. Poorly structured spaces with unclear topological relations contribute to disorientation and chaos, hindering effective wayfinding (Hillier & Hanson, 1984; Ferri & Popp, 2023).

Lack of Real-Time Guidance
Inconsistently marked accessible routes at junctions and a near-total lack of advance information about malfunctioning infrastructure, such as out-of-order elevators, leave passengers without guidance to alternative routes (Saarela & Partanen, 2024).

Beyond physical and informational barriers, the travel environment itself can be overwhelming. For individuals with cognitive impairments, as ASD and ADHD, executive functioning difficulties can lead to missing scheduled transport or getting lost. Furthermore, hypersensitivity to noise, crowded environments, and a lack of personal space can create significant stress and anxiety, making public transport use extremely challenging (Baric et al., 2024).
In conclusion, while individual technical fixes are important, a Swedish research highlights that qualitative measures, such as service quality, information availability, and a holistically accessible environment, are equally crucial throughout the entire travel process (Transport Analysis, 2019). Ensuring a truly seamless journey requires a coordinated effort to address weaknesses at every link in the chain.

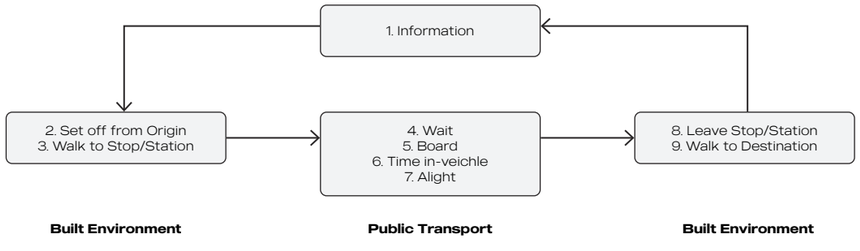


Figure 8: The adapted accessible journey chain (Park & Chowdhury, 2018).

2.3 Universal and Inclusive Design

While Universal and Inclusive Design share the common goal of creating more accessible and usable products, environments, and services, they represent distinct approaches with different philosophies, methodologies, and outcomes. Understanding these differences is crucial for designers, architects, and organisations seeking to implement more equitable design practices.

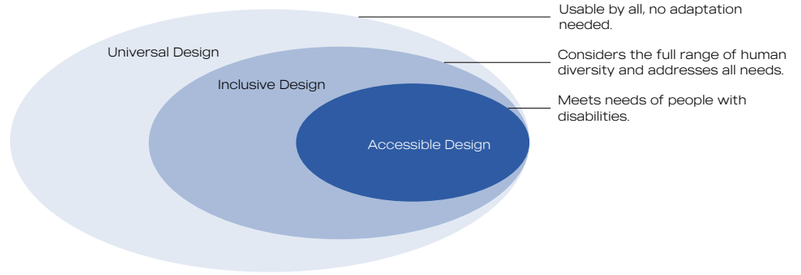


Figure 9: Adapted image from Continual Engine (2025).

Definition and Principles of Universal Design

Universal Design is the design of products and environments that can be used by all people, without the need for adaptation or specialised design. Its philosophy works around the one-size-fits-all approach, seeking solutions that work for the broadest range possible of users without adapting or making specialised design versions.
The 20th Century brought about major social changes with respect to civil and human rights. Medical advances during this period meant that the likelihood of surviving an injury or illness was far greater. People were living longer and the average life expectancy of people with severe impairments was increasing.

The concept was coined by architect Ronald Mace in the mid-1980s, who envisioned creating solutions that would be accessible to everyone regardless of age, ability, or other characteristics.
Universal design is guided by seven fundamental principles (The 7 Principles - Centre for Excellence in Universal Design, n.d.), established in 1997 by a working group led by Ronald Mace at North Carolina State University:

1. **Equitable Use:** the design is useful and marketable to people with diverse abilities.
2. **Flexibility in Use**: the design accommodates a wide range of individual preferences and abilities.
3. **Simple and Intuitive Use:** use is easy to understand, regardless of experience or language skills.
4. **Perceptible Information:** the design communicates necessary information

effectively to all users.

5. **Tolerance for Error:** the design minimizes hazards and adverse consequences of accidents.
6. **Low Physical Effort**: the design can be used efficiently and comfortably with minimal fatigue.
7. **Size and Space for Approach and Use:** appropriate size and space is provided for approach and use.

During the social movements in the 20th century, increasing laws contributed to the promotion of social inclusion and discrimination prevention. The design industry as well faced important pressure to meet the demand of creating accessible and usable products, services and environments. New terms appeared, such as barrier-free design, to remove barriers for people with disabilities. In particular, the concept of " accessible design" emerged around the 1970s, promoting the integration of accessible solutions into the general design of products, services and environments. (History of Universal Design - Centre for Excellence in Universal Design, n.d.).
Nowadays, The Disability Act 2005 (Definition and Overview of Universal Design (UD) - Centre for Excellence in Universal Design, n.d.) defines Universal Design, as *"The design and composition of an environment so that it may be accessed, understood and used:*

- *To the greatest possible extent;*
- *In the most independent and natural manner possible;*
- *In the widest possible range of situations;*
- *Without the need for adaptation, modification, assistive devices or specialised solutions, by any persons of any age or size or having any particular physical, sensory, mental health or intellectual ability or disability".*

When an environment is easily accessible and usable, it becomes a pleasure to use, and everyone can benefit from it. By considering the diversity of needs and abilities of people throughout the entire design process, it is possible to meet people's needs for physical products, environments, and systems. (About Universal Design - Centre for Excellence in Universal Design, n.d.).
Regarding the digital product and services, some qualities should be followed to adhere to Universal Design. These qualities are the following:
Perceivable: users must be able to clearly perceive the content, regardless of the device or configuration they are using.
Operable: Individuals must be able to use the controls, buttons, sliders, menu, etc., despite the device they are using.
Understandable: users must be able to understand the context and the interface of the digital product or service.
Robust: the content must be built in compliance with relevant coding standards.

This is essential to ensure it is interpreted with accuracy and meaning by devices, browsers and assistive technologies (Burgstahler, 2021).
In the 1980s, disability was described, from the World Health Organization, as a personal attribute.
"In the context of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being" (Microsoft Design, 2016).

Today, disability is seen as context-dependent, as it states the World Health Organization:
"Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives." (World Health Organization, 2025).

Definition and Elements of Inclusive Design

The inclusive design approach encourages designers to employ a variety of designs rather than a single one, to accommodate different user segments. The Design for All philosophy is closely related to inclusive design. This is because it focuses on including accessible features in products and services from early on in the design process. This approach is in contrast to the traditional way in which a mainstream design has to be adapted to have options for users with disabilities later (Interaction Design Foundation - IxDF, 2016).
The Inclusive Design Research Centre (OCSD University) has defined Inclusive Design as:
"Design that considers the full range of human diversity with respect to ability, language, culture, gender, age and other forms of human difference".
Unlike universal design's focus on creating one solution for all, inclusive design focuses on fulfilling as many users' needs as possible, not just as many users as possible (Inclusive Design Research Centre, n.d.).
The principles of Inclusive Design are:

Recognise exclusion
Exclusion happens when we solve problems using our own biases. It can be understood as being left out or rejected by an environment, a service, a product or people. For the Microsoft Design team, exclusion usually happens when a "mismatch" occurs. The term is used to describe the gap between the design of a product, service or environment, and the needs or abilities of a user.
This means that exclusion is a consequence of design decisions, which are mostly made unconsciously.
The Inclusive Design Guidebook (Microsoft Design, 2016) also highlights that points of exclusion that may arise can help designers generate new ideas and create inclusive design solutions.

Learn from diversity
Human beings are the real experts in adapting to diversity. This principle remarks that our differences are not obstacles to overcome, but rather sources of creativity and innovation. Microsoft Design (2016) emphasises that people who can't use services as they should become experts at adapting. Their experiences are crucial because they detect where design fails and make it easier to identify points for improvement. Therefore, the true value is in understanding the experiences of people with different abilities through listening, observing, and co-creating with individuals who have to adapt.

Solve for one, extend to many
A common worry across designers is that, when designing for a smaller group, it will make the outcome less useful (and appealing) for everyone else. The truth

is that, often, it happens the opposite. When we design something for individuals with more specific needs, the resulting design could benefit a greater number of people. By designing for someone with permanent impairment, other individuals with temporary impairment can also take advantage of it.

To better explain this concept, a Persona Spectrum was developed by them (see Figure 10). By incorporating the Persona Spectrum in the process, the aim is to encourage design teams to shift their perception to inclusiveness, where difference is a resource and not a problem.

Accessible Design

Accessibility can be described as the practice of designing products, services and environments that are easily usable for people, regardless of disability or other needs. Within the accessibility word, it is possible to cluster different dimensions. We can consider accessibility in the physical environment, but also in the information or services. Most of the time, the physical environment represents the most considered dimension, with the other are often neglected (Iwarsson & Stahl, 2003).

In recent years, more rigorous constraints have been applied to accessible design in the digital sphere, setting standards to follow, such as the Web Content Accessibility Guidelines (WCAG) developed by the Web Accessibility Initiative of the World Wide Web Consortium (Web Content Accessibility Guidelines (WCAG) 2.1, 2025).
Despite its goal of inclusion, there is a tendency within accessibility practices to develop solutions that generate isolated experiences for users, rather than allowing them to feel more integrated. This mainly occurs as a result of "compliance-driven" products that follow the so-called "bolt-on" approach. It means that accessibility is addressed once the product or service is already built. With isolated user experiences, even if they are accessible per se, we keep fostering exclusion. The critical issue underlying the prevailing vision of accessible design is the assumption that society is divided into two groups: those considered 'typical' and those perceived as 'different,' such as people with disabilities. This dichotomy reinforces isolation and stigmatization (Iwarsson & Stahl, 2003).
For this reason is crucial to have a "built-in" accessibility approach. This imply integrating it from the beginning of a design process, in order to ensure that a product, service or environment can be truly inclusive and works for everyone, empowering all users (Torre, 2022).

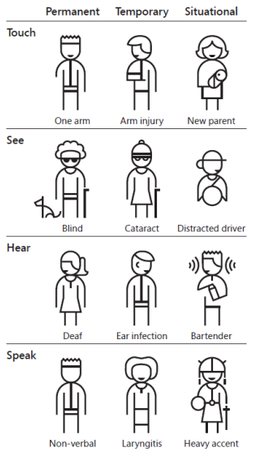


Figure 10: The Persona Spectrum by Microsoft Design (2016).

Relevance for Wayfinding

When it comes to orientation in public transport, both universal and inclusive design are highly relevant factors. They ensure that transit environments and navigation systems are understandable, usable, and accessible to the greatest number of people. This also includes those with cognitive difficulties, language barriers, and disabilities (Jost et al., 2024).

As previously mentioned, inclusive design creates solutions that promote accessibility and usability, allowing individuals to carry out activities or use products independently. Independence is a vital aspect of daily life, and a person's ability, affected by how accessible and usable products, services, and environments are.
Proposing solutions that guarantee people's independence offers significant benefits, including enhancing the experiences of individuals with greater difficulties. This is another positive outcome of expanding market reach.
A product, service, or environment becomes accessible to a broader range of potential customers, including a wider demographic (Ostroff, 2001).
In conclusion, as stated in Jost et al. (2024) research:
"to accommodate diverse user needs and abilities, wayfinding systems must be designed with inclusivity and continuity in mind".

2.4 Wayfinding Frameworks in Dutch Public Transport

The Netherlands has a comprehensive and highly efficient public transport system consisting of urban transport, regional transport, and rail transport. (Ministerie van Infrastructuur en Waterstaat, 2011).
The data, gathered from CBS Statline (2024), regarding the total transport performance in the Netherlands shows that in 2023, 19.8 billion of people (above 12 years old) used the train and 5.0 billion people used the bus/tram/metro as a transport mode.
In particular if we focus on bigger cities, Amsterdam, for example, has the busiest public transportation network in the country. In 2021, the transit operator GVB (for tram, bus and metro) registered 155 million passengers, generating 478.4 million euros in revenue (Majidi, 2024).
For the city of Rotterdam, the estimated number of travellers using the RET (transit operator for tram, bus and metro) in a year is around 190 million of passengers (Dijkstra, 2019).

A recent development highlighted the growing awareness of inclusive information design in the Dutch public transport landscape. The decision by the Nederlandse Spoorwegen (NS) is to transition all its digital information screens to a "dark mode" format starting in October 2025. This change is designed to enhance readability for people with visual impairments, colorblind people, and dyslexia, while also reducing eye strain and light pollution for all travellers (NOS News, 2025). The significance of this initiative lies in its system-wide application; as a national operator, NS can implement this change consistently across all 400 of its stations, creating a predictable and reliable experience for travellers nationwide.

This national consistency, however, underscore a contrast to the situation in the Dutch metro systems. Because metro hubs are managed by different municipalities, each with its own standards and priorities, such a unified and beneficial change is significantly harder to achieve. This fragmentation, which often results in inconsistent and confusing experience for travellers, emphasise the urgent need for a seamless, comprehensive strategy, like the one proposed in this framework, to ensure that improvements in accessibility are implemented fairly across the entire public transport network.

Figure 11: NS dark-mode screens (NOS News, 2025).

2.4.1 Stakeholders Overview

To better understand the context of public transportation in the Netherlands, it is essential to have a broader overview of the actors involved and their roles. The various organisations can be divided in National and Regional level.

National Organisations

ProRail
ProRail is a private limited liability company, for which the Dutch state is the only shareholder. On behalf of the Ministry of Infrastructure and Water Management (which performs all shareholder functions), ProRail main responsabilites are:

- Constructing, managing and maintaining railway infrastructure, including tunnels, level crossings, overhead lines, signs and points.
- Managing and maintaining railway facilities, such as stations.
- Allocating network capacity and runs railway capacity control centre.

Nederlandse Spoorwegen (NS)
Dutch Railways (NS) is the largest railway company in the Netherlands, where the Dutch state is the sole shareholder and the Ministry of Finance performs all shareholder functions.
Their responsabilities concerns the level of service provided to stations in the network, accessibility and assistance for disabled passengers, and bicycle parking facility opening hours. NS is also involved in developing and managing stations and their surroundings (Ministerie van Infrastructuur en Waterstaat, 2018).

R-NET
R-net is the Randstad's public transport network. It is an initiativeacross various municipalieties, such as the Amsterdam, the Rotterdam, The Hague regions. R-NET is responsible to connect a network of routes with high frequency, reliability, speed, comfort, and accessibility, all identified by a consistent red and grey design (Reizen Met De Zekerheid Van R-net, n.d.).

Regional Organisations

Gemeente Vervoerbedrijf (GVB)
It's the municipal public transport operator for Amsterdam, operating metro, tram, bus and ferry services.
The Municipality of Amsterdam is the sole shareholder of GVB (GVB, 2025b).

Vervoerregio Amsterdam
The Amsterdam Transport Region (english translation) is a regional authority responsible for transport planning and policy in the Amsterdam metropolitan area, comprising 14 municipalities in the province of North Holland connects municipalities. They are the client for public transport by bus, tram, and metro. Vervoerregio Amsterdam grant concessions to transport companies and subsidize their operation (Vervoerregio Amsterdam, n.d.)

Rotterdamse Elektrische Tram (RET)
RET is the regional transport operator that is responsible of metro, tram, and bus services in Rotterdam and surrounding areas (Convenient and Comfortable Travel in the Southern Part of the Randstad. - RET, n.d.).

2.4.2 Policies and Regulations

Public transportation systems are shaped not only by technological and operational factors, but they are also strongly influenced by policy decisions and regulatory foundations. In the European Union, as well as in the Netherlands, a dense framework of legislation governs accessibility in public transportation.

Rooted in the UN Convention on the Rights of Persons with Disabilities (UNCRPD) and reinforced by directives like the European Accessibility Act (EAA), the legal foundation for an inclusive society appears strong.

The Netherlands has various legal and policy frameworks that support inclusivity and accessibility, including in the area of public transportation. The Passenger Transport Act (Wet personenvervoer 2020) aims to ensure that public transport services are safe, reliable, and accessible. It establishes a foundation for physical and communicative accessibility for people with disabilities (Wet Personenvervoer 2000, 2024).
Similarly, the Equal Treatment Act (AWGB) and the UN Convention on the Rights of Persons with Disabilities (CRPD), ratified by the Netherlands, prohibit discrimination based on disability and require public transport to accommodate users with disabilities (United Nations Convention on the Rights of Persons With Disabilities, 2025)

However, some sensory and cognitive difficulties, such as low literacy, are not recognised as a disability, and thus these group are often only indirectly supported through policies promoting plain language or simplified design.
In this context, the recently introduced NEN-ISO 24495-1:2023 standard on plain language provides an internationally recognised framework to ensure texts are clear, concise, and accessible to diverse audiences, including low-literate and second-language users (Schindler, 2024). However, because this standard is not mandatory, its uptake remains inconsistent, which hinders systematic implementation across public transport communication.
Laws such as the General Administrative Law Act (Awb) and the Digital Accessibility Law (EN 301 549/WCAG 2.1) require government and public service communication, including digital transport apps and websites, to be understandable and accessible, which promotes the use of plain and understandable language.

Since 2024, the European Accessibility Act (EAA) has established that all ticket machines, mobile apps, and service platforms be accessible under EU law, fostering the design of key services to accommodate people with disabilities, and encouraging the use of intuitive design. This can also be indirectly beneficial for low-literate users (European Accessibility Act, 2025).
To conclude, the Dutch public transport (DPT) policy demonstrates great effort in supporting people with disabilities, through mandates and practical services, even if they are mainly focused on mobility disabilities, for example, NS's Reisassistentie service in assistance (Nederlandse Spoorwegen, 2023).
Despite this effort, the DPT falls short in systematically addressing the needs of people with literacy difficulties. Although plain language initiatives promote B1-level Dutch, they often do not account for migrants or second-language speakers with functional illiteracy. Moreover, app-based transport services increasingly exclude users without digital skills or screen reader compatibility, exacerbating the digital divide (Vonk, 2025).

Dutch accessibility regulations increasingly emphasise the digital world; nonetheless, challenges persist in both realms: not all physical infrastructure is uniformly accessible, and many digital systems still assume high literacy or digital literacy skills.
This dual focus highlights a growing recognition that true inclusivity requires both an accessible environment and digital services, as they are increasingly interdependent in the public transportation experience.
Despite the existence of numerous laws, their translation into a seamless and truly accessible travel experience is hindered by a complex web of structural, financial, and practical challenges.

Even with an extensive regulatory framework, what most impacts the user experience are the digital accessibility law and the recent European Accessibility Act. It is interesting to notice that both these regulations are focused more on the digital environment, such as websites, apps and ticketing systems.
Nevertheless, the growing connection between the digital and physical worlds indicates that principles from the digital sphere, such as intuitive interaction, multimodal access, and plain language, should also be applied to the physical environment and wayfinding system. Therefore, policies that emphasise digital accessibility can be both a strength and a weakness: they encourage digital inclusive design but risk neglecting important spatial aspects of physical navigation.
For this reason, it is necessary to consider the expertise of UX designers in this context. They are positioned in between technology, communication and human behaviour, being able to translate accessibility requirements into integrated solutions that exceed the differences between physical and digital. With the application of human-centred approaches, UX designers can transform abstract legal obligations into more concrete, inclusive travel experiences.

Policy/Regulations	Mandatory	Description
Passenger Transport Act (Wet personenvervoer 2000)	Yes	National law governing safe, reliable, and accessible public transport. Require physical and communicative accessibility for passengers with disabilities.
UN Convention on the Rights of Persons with Disabilities (CRPD)	Yes	International agreement requiring accessible environments, including public transport, to promote full partecipation of people with disabilities.
European Accessibility Act (EAA)	Yes (phased)	Requires key services (e.g. transport ticketing machines, apps, websites) to be accessible to people with disabilities across the EU.
General Administrative Law Act (Awb)	Yes	Governs how public authorities communicate; requires comprehensibility and fairness. Affects signage and communication in transport.
Digital Accessibility Law (EN 301 549 / WCAG 2.1)	Yes	Dutch implementation of EU accessibility rules for government websites and apps, including public transport.
National Accessibility Agenda (National Agenda Toegankelijkheid)	No (non-binding)	Strategic policy promoting inclusivity in various sectors, including mobility. Provides guidance and vision.
NS Reisassistentie	No (mandatory only as a NS policy)	NS (Dutch Railways) provides travel assistance, accessible infrastructure, and station improvements for people with disabilities.
NEN-ISO 24495-1-2023 Plain Language	No (voluntary, promoted)	International standard for writing clear, user-friendly information for diverse audiences. Adopted by NEN (Dutch Standards Institute) to improve public communication.

Table 1: Summary of EU and Dutch relevant policies.

2.4.3 Assistive Technologies

While policies and regulations establish the foundation for accessible and inclusive public transportation, their effectiveness is reinforced by the adoption of assistive technologies. These technologies, play a crucial role in enabling independent mobility for passengers with diverse needs.
By complementing regulatory frameworks, assistive technologies translate policy objectives into practical solutions that improve the daily travel experience for all users. They can be categorised into four main areas:

Foundational and Low-Tech solutions are the non-digital, often mandatory, building blocks of an accessible environment:

- Tactile Ground Surface Indicators (TGSIs): also known as tactile paving, these textured surfaces provide essential information to long cane users. Attention patterns, such as blisters and domes, warn of hazards like platform edges or stairs, while guidance patterns (parallel bars) indicate a safe path to follow (Tactile Ground Surface Indicators, TGSI, Tactile Surface Indicator, n.d.).
- Braille and tactile signage: Braille on signage for room numbers, platform identifiers and handrails provides direct textual access for braille readers. Tactile maps of the station can offer an important mental model of space (Jenkins et al., 2015)

Infrastructure-based digital technologies are built into the station's environment and transmit information to users:

- Audible Announcement: automated public address systems announcing train arrivals, departures, delays, and next-stop information are essential. These must be clear, concise, and timed to not overlap with other critical sounds.
- Audible beacons and pedestrian signals: by emitting distinct sounds, these devices can help a user locate key points like an entrance, an information kiosk, the correct use of the turnstile at check-in, or a pedestrian crossing.
- Bluetooth Low Energy (BLE) Beacons: small, low-power transmitters that can be placed in a physical space (e.g., a subway station) to send location-specific information to a user's smartphone app. The beacon triggers the app to provide location-specific, contextual information, such as "You are near the elevator to platforms 3 and 4" (Vlasova, 2024).
- NFC technology: short-range wireless technology that enables communication between two devices when they are near to each other (within few centimetres). This technology facilitate data exchange and various studies discuss the employment of NFC technology in the development of assistive tools, especially for people with visual impairments (AlZuhair et al., 2014).
- NaviLens System: new-generation technology using proprietary high-density colour codes. Through the NaviLens app, a smartphone camera can detect these codes from a great distance and at wide angles, providing audio information about the object (e.g., a sign's content, a bus stop's schedule) (Neosistec, n.d.).

Personal Device-Based Technologies leverage the user's own device, typically a smartphone:

- Aira: connects blind and low-vision users with live, human agents via smartphone camera to assist with navigation and description. (Aira, 2025)
- BeMyEyes: free app connecting users with volunteers for visual assistance. (Accessibility Technology for Blind & Low Vision People - Be My Eyes, 2025)
- Microsoft Seeing AI: Uses the phone's camera to read text, describe scenes, identify currency, and recognize people. (Seeing AI | Microsoft Garage, 2025)
- Lazarillo: accessible GPS app that provides real-time audio information about the user's surroundings. (Lazarillo, 2025)
- Goodmaps: focuses on accessible indoor and outdoor navigation, often mapping large venues like airports and university campuses. (GoodMaps, 2025)

Assistive technology holds relevance in improving public transport hubs to overcome obstacles, especially for individuals with visual disabilities. As demonstrated, the path forward is not to find a single "better" technology but to create a cohesive ecosystem of solutions. It is also important to recognise that such technologies are not intended to replace physical wayfinding systems for navigation, as these are fundamental to orientation, but rather to serve as an integration for users who wish to utilise them.

Figure 12: NaviLens code marker at Jay St platform, New York Metro (Neosistec, n.d.).

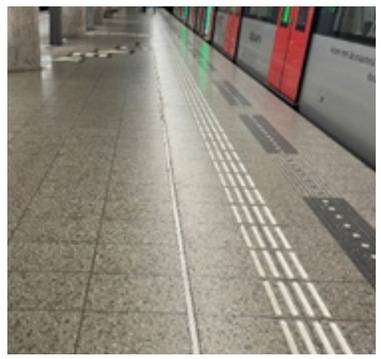


Figure 13: tactile paving in NieuwMarkt metro station, Amsterdam (photo taken by the author).

Figure 14: Braille and tactile sign in NS train (photo taken by the author).

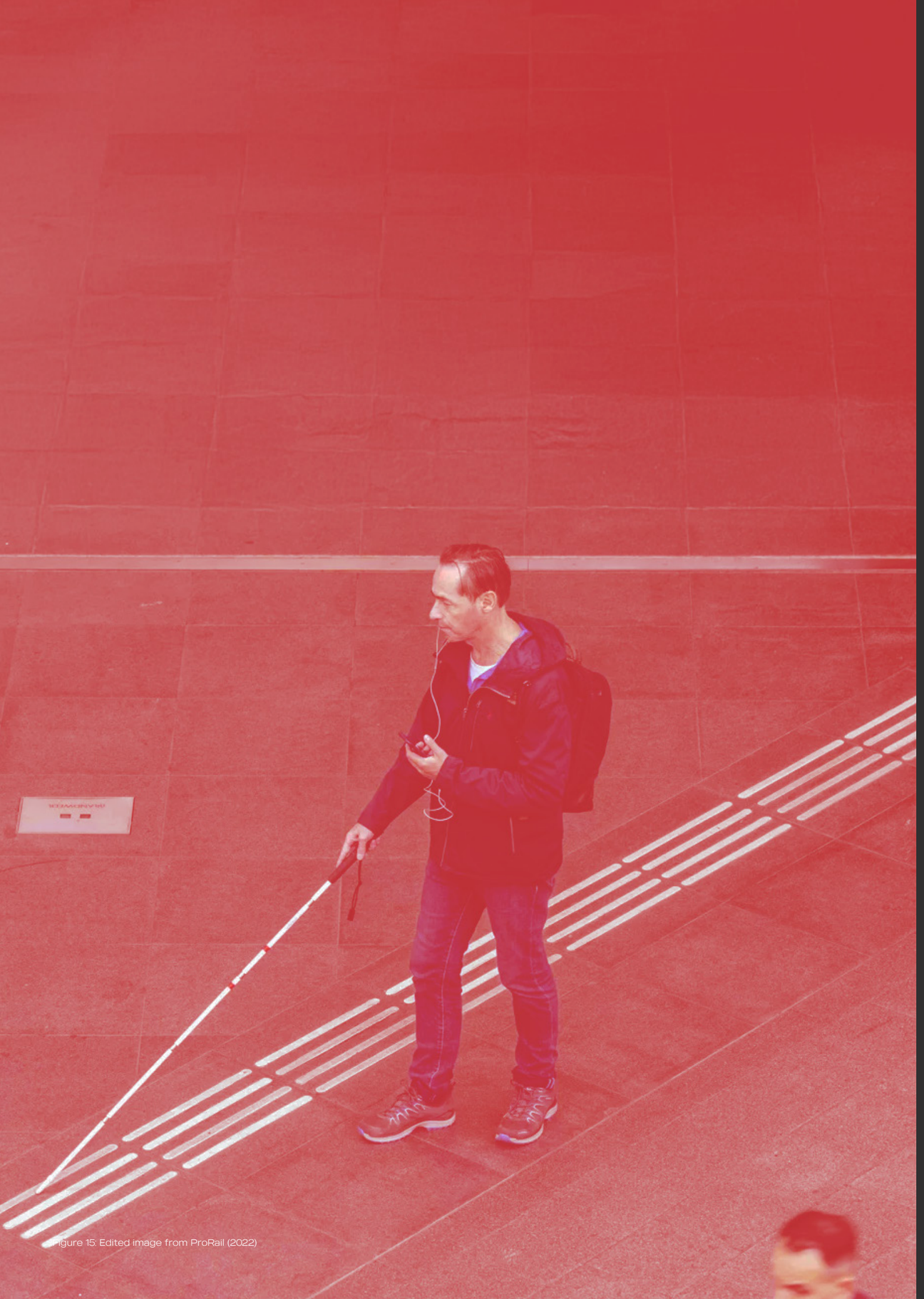


Figure 15: Edited image from ProRail (2022)

2.5 Main Takeaways

This chapter established the theoretical foundation for the research, critically examining the domains of wayfinding, public transportation, and inclusive design. The central takeaway is not simply a review of literature, but the deliberate synthesis of these different fields to create a unique analytical lens for the project. This chapter connected the cognitive stages of wayfinding theory to the practical, sequential steps of the travel chain framework.

This highlighted how disruptions in the journey are not just logistical failures but also create significant cognitive and emotional loads for users. Furthermore, by critically distinguishing between Universal and Inclusive Design, the chapter justified the adoption of an Inclusive Design approach. This choice shaped the entire project by prioritising the understanding of "mismatched interactions" and framing exclusion not as a personal deficit but as a consequence of design decisions.

The analysis of the Dutch regulatory landscape and existing assistive technologies revealed a critical gap: a predominant focus on physical and legally defined disabilities, which often overlooks informational barriers and the needs of individuals with "invisible" difficulties like low literacy. This insight was essential in defining the project's core challenge and narrowing its focus in the subsequent chapters.

Concept/Theory	Key Principles & Definitions	Relevance to Inclusive Wayfinding Project
Wayfinding Theory & Spatial Cognition	Wayfinding is a cognitive process involving four stages: Orientation, Route Decision, Route Monitoring, and Destination Recognition. It relies heavily on mental models (cognitive maps), landmarks, and multi-sensory environmental cues to reduce cognitive load.	This theory provided the psychological foundation for the research. It shifted the focus from merely analysing physical signage to understanding the mental and emotional processes of navigation. This informed the project's emphasis on creating a system that is intuitive, confidence-building, and reduces stress.
The Travel Chain	A journey is a sequence of interconnected links (e.g., planning, travel to station, navigation within, boarding). The core principle is that a failure in any single link can break the entire chain, rendering the journey inaccessible.	This framework provided the structural backbone for the analysis and the final design. It justified a holistic, end-to-end examination of the user journey within the metro station. This directly led to the use of a journey map as the central organizing element for both the research findings and the final outcome.
Universal vs. Inclusive Design	Universal Design aims for a single "one-size-fits-all" solution that works for the broadest possible audience. Inclusive Design acknowledges human diversity and focuses on creating multiple, tailored solutions to ensure equitable access, recognizing that one solution may not fit all.	This distinction guided the project's core philosophy. Inclusive Design was explicitly chosen because the research targets groups with contrasting needs (e.g., visual vs. literacy impairments) that cannot be met by a single solution. This decision justified the development of a flexible framework rather than a single, prescriptive design.
Dutch Public Transport Frameworks	The Dutch metro system, contrary to the national railway system, is characterized by fragmented governance (local vs. national operators), leading to inconsistencies in wayfinding standards. Existing regulations primarily focus on legally defined physical disabilities and, more recently, digital accessibility.	This analysis grounded the project in its real-world context. It identified the systemic cause of many user frustrations (inconsistency) and highlighted a regulatory gap concerning "invisible" difficulties like low literacy. This confirmed the need for an adaptable strategic tool for practitioners, not a top-down solution.
Assistive Technologies	A spectrum of technologies exists to support navigation, from low-tech foundational elements (tactile paving) to high-tech personal device applications (NaviLens, Aira). These technologies can supplement, but not replace, a well-designed physical environment.	This review informed the solution space. It established that the project's goal was not to invent a new technology, but to design a physical wayfinding system that could seamlessly integrate with and support these existing technologies. It reinforced the "physical-first, tech-aware" approach of the final framework.

Table 2: Summary of Theoretical Background and project relevance.

↘ The Problem Space

This chapter focuses on delineating the problem space by examining the current conditions that shape both the user and spatial context of wayfinding in Dutch metro hubs.
While previous sections have outlined the theoretical and regulatory frameworks surrounding accessibility, this chapter narrows the focus to the concrete barriers that persist in practice.

The aim is to develop a deeper understanding of the barriers that hinder accessibility and inclusivity, not only from the perspective of individuals with impairments but also considering broader societal and environmental factors.

To structure this exploration, a DESTEP analysis was employed, enabling a systematic review of Demographic, Economic, Socio-cultural, Technological, Environmental and Political/legal influences (Van Boeijen et al., 2020).

By mapping these external factors alongside user-specific challenges, this chapter establishes a comprehensive and evidence-based foundation that clarifies the nature of the problem and prepares the ground for exploring potential solutions in the Solution Space chapter.

3.1 User Context

3.1.1 Understanding Disabilities

Disability is a multifaceted, evolving, and contested concept, stemming from a wide range of health conditions that can be temporary, chronic, or progressive (O'Young et al., 2019).
In order to frame correctly this topic, an important distintion needs to be made between the terms impairment and disability. When people talk about impairment, they refer to a problem within a body structure or organ, which represent the underlying health condition. On the other hand, when it comes to disability, the common definition refers to the fuction limitation that arises from the interaction between an impairment and environmental or social barriers (Global Report on Health Equity for Persons With Disabilities, 2022). This relationship marks a crucial principle: a person with an impairment is not necessary disable, until the environment (or a specific task) prevents them from partecipating equally.

The World Health Organisation's International Classification of Functioning, Disability and Health (ICF) provides a standardized framework for understanding this dynamic. The ICF describes people's situations, not the people themselves, and formally recognises the critical role of environmental factors in either enabling or restricting participation (World Health Organization, 2013; Hollenweger & UNICEF, 2014). It is composed of two main components: "*Body Functions"* and "*Structures, and Activities and Participation"* (see Figure 16). By integrating *"Environmental Factors"* as a core component, the ICF provides a language to analyse how societal structures can be either facilitators or barriers, guiding a rights-based approach toward empowerment and full participation (Leonardi, 2001; World Health Organization, 2013).

The spectrum of impairments can be better understood by categorizing them by their nature, duration, and severity. Impairments can be broadly classified as physical, sensory, or cognitive (Feltham, 2024). Moreover, according to Sabilano (2024), their existence is a continuum of duration and context:

- Permanent impairments are conditions that last for a long time or for life and consistently affect an individual's abilities.
- Temporary impairments are short-term conditions, such as a broken leg, that limit abilities but are expected to heal over time.
- Situational impairments occur when a person's abilities are temporarily hindered by environmental factors, such as when carrying a child or communicating in a loud room.

Furthermore, impairments are often classified by severity, ranging from mild limitations with little impact on daily activities to moderate limitations requiring some adaptation and severe limitations that significantly restrict one or more major life activities (World Health Organization, 2013; Statistics Canada, 2019).
The inclusion of temporary and situational impairments highlights a critical insight: anyone can experience impairment at some point in their life.
This understanding triggers a crucial shift in perspective, from treating accessibility as a special feature for a minority to recognizing it as a fundamental standard of inclusive design. When accessibility is treated as a baseline requirement, it benefits everyone, not just those with permanent impairments.
Ultimately, this framework establishes that the responsibility for inclusion lies not in addressing an individual's impairment, but in systematically removing the barriers within the environment.

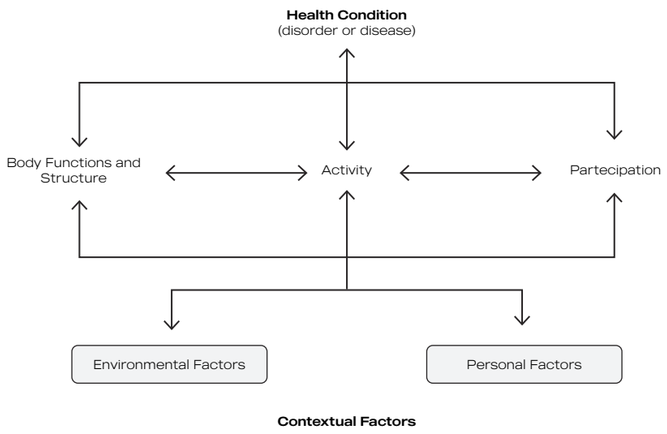


Figure 16: The ICF Framework **World Health Organization, 2013).**

3.1.2 Target Group Overview

In this research, two different target groups are identified. The first, referred to as the Primary Target Group, comprises the design practitioners who can directly use the project's outcomes to improve and implement inclusive wayfinding solutions. The second, the Secondary Target Group, encompasses the individuals who can benefit from the implementation and improvement of inclusive wayfinding, namely people with visual impairments and low-literate individuals.

Primary Target Group

For this research, the primary target group consists of the professionals involved in the design of wayfinding systems in the metro environment. These mainly include UX and service designers, and design consultants within municipal departments, transit authorities, and independent agencies such as Fabrique.
The aim of this thesis, therefore, is to equip these practitioners with research-driven insights and design strategies that support inclusive, practical, and scalable implementation.

By doing so, the project's purpose is to bridge the gap between accessibility regulation and design practice, thereby contributing to more usable and intuitive public space environments.

Secondary Target Group

The focus for the secondary group is on people who can travel independently or with some form of support, including those who may travel with a companion or an aid such as a cane, guide dog, or hearing aid.
For this research, the lower age limit was set at 16 years old, based on the estimation that individuals can start travelling independently from that age. While transport operators as NS consider individuals aged 12 and over to be adults for ticketing purposes, official bodies such as Eurostat define adults as people aged 16 and over (Statistics Explained, 2025).
Conversely, the upper age limit of the target range is 70 to 75 years old, even though NS considers seniors to be 65 and over. This decision is based on the reality that people aged 65-67 are often still working and actively using public transportation, placing them in the "young old" (55-64) category (Fiedler & Rupprecht Consult – Forschung & Beratung GmbH, 2007). Furthermore, the state pension age in the Netherlands is set at 67 until the year 2027 (Netherlands, 2024).
To further justify the inclusion of people up to 70-75 years old, the Eurostat Report on ageing in Europe was analysed. Specifically, data regarding participation in cultural and sporting events among people aged 65-74 highlights how active this age group remains. The report shows participation rates at least once in the previous 12 months, with variations across countries, including the Netherlands (Mariana Kotzeva, 2020).
While the report does not explicitly define a fixed age at which someone is considered "active," it provides clear evidence that many individuals in the 65-74 age group continue to engage in social and cultural activities, which serves as a strong indicator of societal activeness among older adults. Regarding the Netherlands, the country ranks highly in participation in cultural and sporting activities for the 65-74 age group. This suggests that many people in this age bracket in the Netherlands remain socially active (Mariana Kotzeva, 2020).

For this reason, the secondary target group will have an age range from 16 to 74 years old, a classification which also aligns with the Age Group Codelist from WHO (AGE16-74: 16-74 years) (Age Group Codelist, n.d.).

The research focuses on mild to moderate functional limitations that still allow for independent or semi-independent travel. Severe impairments, such as full paralysis or severe dementia that require constant human assistance, are outside the scope of this project.
For public transportation research, focusing on individuals with mild to moderate disabilities is more appropriate, as they are more likely to use transit systems independently.
Consequently, people with severe impairments and those above 74 years old are less likely to use public transportation due to their complex conditions, which is why this category will not be taken into consideration.
After this overview of the secondary target group, it is important to narrow down the specific impairment groups that will be considered.

Having established the broader parameters of the secondary target group, it is necessary to narrow the focus to specific impairment groups. While a universal design approach is ideal, addressing all disability groups is unfeasible within the scope of this project. This research, therefore, concentrates on two main

groups with different and potentially contrasting needs to demonstrate how the outcome can function effectively in varied scenarios and extend its benefits to other impairment groups. The following sections justify the selection of these specific groups.

Secondary Target Group A: Low Literate People

Low literacy is defined as being unable to complete tasks related to comparing and contrasting, paraphrasing, or making low-level inferences (Stichting Lezen & Schrijven, 2025).
Low literacy is not officially classified as a disability under most legal or medical definitions, such as the WHO's ICF. Still, it can create functional limitations that significantly overlap with cognitive and communication-related disabilities.
This category of people, not being "legally" disabled, are not protected by policies and regulations in the same way as people with disabilities. It means people with low literacy may remain unnoticed and therefore more vulnerable, especially in contexts of social participation. Therefore, this provides an opportunity to expand the target not only to people with disabilities but also to people with other difficulties. This group has been chosen because in the Netherlands there are about 3 million low-literate people between the ages of 16 and 75, which is around 16.37% of the population (Stichting Lezen & Schrijven, 2025).
Another aspect to keep in mind is the distinction between low literacy and illiteracy. Low-literate individuals are people who can read, write, and do calculations to a certain degree but have great difficulty exercising these skills in their daily activities. On the contrary, illiterate people are not able to perform these activities at all. Indirect beneficiaries of solutions for this group could potentially be people with mild cognitive impairments, non-native speakers, and the elderly.

Secondary Target Group B: Visually Impaired People

Visually impaired people present needs that may contrast with those of the first target group. This group was chosen not for its prevalence but for the fundamental challenge it represents for navigation.
The challenges are profound because wayfinding encompasses how people orient themselves in physical space and navigate between places, a process that is predominantly reliant on sight. As the most dominant of our senses, vision plays a critical role in all facets of life, and its absence requires fundamentally different design approaches (World Health Organization: WHO, 2023).
Vision impairment is defined as a condition of the eye that affects the visual system and one or more of its functions, limiting a person's ability to see (World Health Organization, 2019).
Solutions developed for this group, such as tactile and audible elements, can also indirectly benefit the elderly, people with temporary visual impairments, and individuals with other sensory impairments. Moreover, such features would prove highly beneficial for all users during emergencies.

3.2 Spatial Context

3.2.1 Regional Supervision

The context for this research is the metro station systems of the Netherlands. This choice is justified by a comparative analysis of the operational and governance structures that differentiate Dutch train and metro networks. The national train system is centrally managed by the Ministry of Infrastructure & Water Management, with ProRail overseeing the entire rail network (Mannetje et al., 2021). This results in a relatively uniform system across large, complex stations like Amsterdam Centraal, which feature rich, multilingual information displays and dedicated travel assistance services provided by the national operator, NS (Nederlandse Spoorwegen, n.d.). In contrast, metro systems are decentralised, falling under the jurisdiction of local transport authorities such as Vervoerregio Amsterdam or MRDH in the Rotterdam-The Hague metropolitan area. This decentralisation means that infrastructure, station design, information access, and support services are managed locally, leading to significant variability between municipalities (GVB, n.d.; RET, n.d.). Metro stations are typically smaller and simpler than train hubs, with more compact, localised information systems and a greater reliance on self-service design. A commonality observed across both systems, however, is that existing accessibility support predominantly focuses on addressing physical and mobility-related disabilities, often overlooking the needs associated with other types of impairments. The selection of the metro context is therefore influenced by its smaller, more manageable scale, which aligns with the timeline of this research project. The municipal-level governance creates a patchwork of wayfinding standards and service levels, a condition that directly impacts the continuity of a travel journey. This variability highlights a clear opportunity: developing a standardised and coherent approach to information access within these systems would represent significant added value, working toward more accessible and equitable urban infrastructures.

3.2.2 Public Transportation Barriers

Public transit spaces, with their high passenger volumes and multifaceted transit areas, are among the most complex navigational environments. As Ferri & Popp (2023) note, spatial and navigational cues are often found to be confusing, misleading, or intimidating, which contributes to negative perceptions of the transit system as a whole. This section outlines the most common barriers encountered in this context, focusing specifically on those within the scope of this research: information fragmentation and the challenges faced by individuals with sensory and cognitive impairments.
The fragmentation of travel information is a major bottleneck in trip planning for all users, but it mostly affects people with disabilities. Digital information regarding infrastructure accessibility is often inconsistent, making it difficult for passengers, especially those with low digital literacy, to confidently plan, book, and undertake a journey (Saarela & Partanen, 2024). This digital disconnect is compounded by physical barriers, such as inadequate multi-sensory guidance or malfunctioning infrastructure like elevators, which can abruptly break the travel chain. Even though universal design principles are applied, their effectiveness often deteriorates over time due to a lack of consistent maintenance.
A scoping review by Baric et al. (2024) confirms that clear information in appropriate formats, provided both before and during the journey, is crucial for planning and decision-making.

The review emphasizes that confidence is built on the ability to obtain and process sufficient information at all stages of the journey, a need highlighted across numerous studies (Angell and Solomon, 2018; Deka, Feeley, and Lubin, 2016; Kersten et al. 2020; Lim et al. 2021; Lindqvist and Lundälv, 2012; Rezae et al. 2019).
In the Dutch context, physical infrastructure presents its own set of challenges. Vehicle accessibility remains a significant issue, particularly on buses, where automatic wheelchair ramps have a notable failure rate and uneven boarding heights impede access (Netherlands Institute for Human Rights & DTV Consultants, 2017). Older vehicles, such as some of Amsterdam's trams, cannot accommodate larger mobility scooters, while shared bus and tram stops struggle with varying floor heights. These issues reflect a broader tendency to prioritise retrofitting existing infrastructure over adopting a universal design approach from the outset (Creba-Wright et al., 2019). Station design also presents limitations, with elevated platforms failing to align properly due to inconsistent standards across municipalities, and obstructions like poorly parked bikes creating unsafe conditions (Asamoah et al., 2020).
Operational and systemic challenges further complicate accessibility. Studies reveal a persistent tension between the operational duties of transport personnel, such as bus drivers, and their capacity to assist passengers with disabilities (Daemen, 2024). The prioritisation of punctuality over accessibility is a systemic issue; in Rotterdam, for example, high reliability rates for the metro and tram systems often come at the cost of accommodating passengers who require extra time (Creba-Wright et al., 2019).
For passengers with cognitive and sensory impairments, these barriers are amplified. Individuals with cognitive disabilities report significant difficulties interpreting real-time schedules and route maps, and the cognitive load required to navigate transfers or disruptions can lead to the complete avoidance of public transport (Asamoah et al., 2020). While programs like Amsterdam's OV-coaches show promise, their scale remains limited. Furthermore, standard visual and auditory information systems frequently fail to meet the needs of sensory-impaired passengers.
Research conducted by Able Amsterdam highlights that even for wheelchair users, a lack of clear signage and real-time updates makes navigation difficult, particularly in unfamiliar stations (Able Amsterdam, n.d.). These findings underscore a systemic issue summarised by Imrie & Luck (2014):
"Much of the designed environment is inattentive to the needs of many people, and this is particularly so for individuals with different types of impairment."

The experience of multisensory environments is particularly critical for people with visual impairments. Research by Jenkins et al. (2015) reveals that many public spaces are designed with sighted users in mind, prioritising visual aesthetics over functionality. Features like high-hanging signs, poor lighting, heavy shadows, and low-contrast signage can disorient users, while loud background noise masks important auditory cues needed for orientation. However, the same study highlights that helpful environmental features, such as audible pedestrian signals or landmark sounds, can greatly support wayfinding. This suggests that by thoughtfully embedding multi-sensory cues into the built environment, it is possible to improve accessibility for users and foster inclusive participation without stigmatising specific groups.

3.3 Main Takeaways

This chapter's primary achievement was to delineate the concrete problem space, moving from broad theory to the specific user and spatial contexts of wayfinding in Dutch metro hubs.

What was essential in this phase was framing of the problem through the lens of lived human experience rather than only regulatory compliance.
By selecting people with visual impairments and low-literate individuals as the secondary target groups, this research intentionally moved beyond the current situation, which predominantly focuses on mobility impairments.
This strategic choice allowed for a deep investigation into complex multi-sensory, informational, and cognitive barriers that are often invisible and inadequately addressed in current design practices.

A critical insight that shaped the direction of this thesis was the identification of fragmented regional governance as a root cause of inconsistent and confusing wayfinding systems in Dutch metros.
This stands in contrast to the unified national rail network and proves that a single, prescriptive design solution would be unfeasible.
This conclusion directed the project away from creating a specific design intervention (like a new sign or app) and toward the development of a strategic, adaptable framework for design practitioners.

Consequently, the project's goal shifted into the creation of a tool that could empower designers to navigate these fragmented systems and advocate for inclusivity, ensuring the final outcome would be both relevant and implementable in a real-world context.

↘ Methodology

This chapter outlines the methodological approach adopted to investigate accessibility and inclusivity in Dutch metro wayfinding systems. With the integration of multiple methods, the research ensures that the proposed design outcome is both grounded in theory and practically relevant.

The first part describes the desk and field research, which established the contextual foundation of the study. Desk research provided a review of existing literature, policies, and guidelines, while field research involved direct observations in metro environments to identify inconsistencies and "invisible" barriers.
Section 4.2 details the qualitative research, which forms the core of this methodology. Semi-structured interviews with experts and users were conducted to capture both professional perspectives and lived experiences. These interviews were analysed thematically to identify patterns and key themes. Complementing this, a user observation study offered a direct account of how visually impaired individuals interact with metro stations, leading to the development of a user journey map.
Further, a co-creation session with design practitioners of Fabrique took place to ideate potential solutions. By doing that, the voices of those who would ultimately use the framework were embedded in its development.
Finally, evaluation sessions with practitioners tested the clarity, usability, and perceived value of the proposed design, providing critical feedback for refinement.
Together, these methods created a cyclical process of discovery, design, and validation.

4.1 Desk and Field Research

In the first phase of the research, the goal is to understand the full context of inclusive wayfinding from multiple angles. This involves a broad exploration of the existing landscape through two primary methods: desk and field research.
For Desk Research, a review of academic literature, existing guidelines, and national and European regulations have been analysed. This explores the theoretical foundations of wayfinding, the challenges of the "travel chain", and the current state of public transportation environments and assistive technologies as well.
For Field Research, on-site observations were conducted in both the Amsterdam and Rotterdam metro systems. This fieldwork aims to document the existing wayfinding systems, identify inconsistencies, and gain a firsthand, contextual understanding of the physical environment in which users must navigate. Field Research is essential in this context because it allows the researcher to observe how people interact with products and services, or social situations, providing a more accurate picture of their needs and behaviours. Moreover, it offers a unique opportunity to immerse oneself in the subject matter through experiential learning (Reyes-Garcia & Sunderlin, 2011).

4.2 Qualitative Research

4.2.1 Interviews

Semi-structured Interviews

To ensure that the strategic framework proposed in this thesis is grounded in both expert knowledge and real-world user experience, a series of semi-structured interviews were conducted[3]. The use of semi-structured interviews as a primary data collection method lies in the need to balance the need for consistency with the flexibility required for in-depth exploration (Jamshed, 2014). The selection of interviewees was planned to capture a holistic, multi-faceted understanding of the challenges in designing accessible wayfinding systems.
The primary target group for the final solution, design and transport design practitioners, is represented by a variety of experts. This included a Wayfinding Designer for practitioner insights into the design process, an Inclusivity/Mobility expert to provide a systemic view on exclusion, and a Digital Accessibility Expert to address the critical link of physical and digital navigation. This variety of experts provided the necessary data to understand the professional, organisational, and technical constraints within which the proposed outcome must operate to be effective and actionable.

To ground the framework in authentic human needs, the research aims to engage directly with (part) of the secondary target group of end users. Interviews with individuals with visual impairments were fundamental to capturing the lived experience of navigating metro environments. This qualitative data moved beyond compliance-based metrics to uncover the emotional and psychological dimensions of wayfinding, such as stress, cognitive load, and the desire for independent mobility.

[3] Note: The qualitative research activities, including user interviews and observations, were approved by the Human Research Ethics Committee (HREC) of the Faculty of Industrial Design Engineering at TU Delft.

Although this research aspired to address the needs of a broad range of users, including low-literate individuals, a notable limit lies in the difficulty of accessing and identifying this user group. Individuals with low literacy may not identify themselves as such due to stigma, and language barriers, privacy concerns, and time constraints further hinder recruitment. While their needs were considered through literature review and indirect stakeholder input, their absence from the direct user research phase represented a limitation in the user data collected.
Besides planned or arranged interviews, informal conversations with Fabrique's colleagues were carried out. These moments (around 30-40 minutes per session) were important to explore and understand key dimensions in the team, such as employee responsibilities, workflow, challenges and pain points within relevant projects.

Thematic Analysis

Thematic Analysis is a widely used method to examine qualitative data, offering both a structured and flexible approach to identify patterns of meaning within datasets. It comprises six phases: familiarising with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming themes, and writing up (Clarke & Braun, 2013).
These phases ensure that qualitative analysis is not solely a descriptive task, but rather an interpretative endeavour that captures its richness, complexity, and depth.

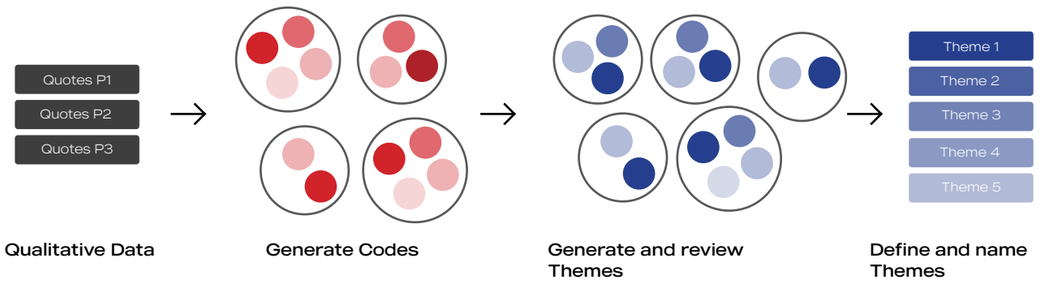


Figure 17: Simplified. scheme of Thematic Analysis.

4.2.2 User Observation

In order to gather deeper and direct insights from users who struggle using the metro to travel, a user observation was conducted. The participant of this user observation was a visually impaired person.

User research observation was derived from ethnographic research and is the process of watching users interact with specific products or services. The importance of user observation was its benefit in the exploration stage, when the focus is on understanding goals, struggles, and the user environment to create relevant user stories.
Different types of observation could be conducted. For this research, the "Shadowing" method was applied. Shadowing has combined elements of covert - conducted in places that do not expect privacy, and naturalistic observation, a non-partecipating approach in which the researcher observed the participant without interacting with them (Dovetail Editorial Team, 2023).

User Travel Journey Map

With the insights gained from the user observation, it was possible to map out a user travel journey, to visualise every step of the journey and the related user goals, actions taken, pain point moments and the connected emotions (Van Boeijen et al., 2020).

4.2.3 Co-Creation Session

For the Develop phase (following the Double Diamond framework), a co-creation session was conducted with some of the UX Designers of Fabrique. The co-creation session was divided into two moments: the first one was a brainstorm, and the second one was the ideation part.
A brainstorming session is a method used to generate a large number of ideas. It is often used in the creative thinking process (Van Boeijen et al., 2020) . There are different ways to use this methods, and for this research project specifically, the brainwriting variant was applied. The proposed alternative allowed partecipant of the session to write their ideas on post-its. Turns were taken to review each others idea, with the aim to build upon each other's thoughts (Van Boeijen et al., 2020).
An ideation session is a structured group meeting focused on generating new ideas to solve a specific problem or exploring new opportunities.
It is a creative process that encourages participants to think widely and build upon each other's ideas in a collaborative environment. In brief, an ideation session is a powerful tool for driving innovation and problem-solving by harnessing the collective creativity and collaborative energy of a group (Dam & Siang, 2025).
The following steps provide the structure used for the Co-Creation session:

1. Provide context of the research to align knowledge
2. Provide insights to let designers emphasise and immerse themselves in the topic.
3. First round of brainstorming, asking designers to generate HMW questions, with a wide perspective.
4. Showing more insights of the envisioned outcome that I aim to achieve, but that does not have a form yet
5. Second round of ideation, more specific to the structure and content of the potential result.

6. Round of discussion
7. Clustering and voting the ideas
8. Wrap-up

It is important to note that this session was not entirely for ideation. It served as a form of primary user research with the framework's intended audience, the design practitioners. This ensured the final tools would be desiderable, usable and could integrate into their existing workflows.
The ideas from the ideation session were synthesised to help in the process of defining the core concept, structure of the strategic framework. The format of it began to take shape here, moving from an abstract idea to a tangible solution.

4.2.4 Evaluation Session

The last fundamental step that followed the co-creation session and the subsequent concept development was the evaluation phase of the concept. In this step, the point of view of the design practitioners was essential. In fact, in this phase, the concept must be reviewed and used them to evaluate its clarity, usability, and integration within design practice.
Their professional experience ensures that the insights gathered reflect realistic applications in client-facing and project-oriented contexts.
It was necessary in order to have iteration moments based on the feedback received, which are cyclical process of refinement within the design process (Gibbons, 2024a) to improve the design quality and functionality.

Figure 18: Evaluation session with Fabrique's designers.

The evaluation sessions took the form of a structured conversation lasting approximately 45–60 minutes. It combined hands-on activities with guided group reflection in order to capture both individual impressions and collective discussions. The emphasis was on testing both the Knowledge Tool and the Participatory Tool, as part of the framework, which were showed, together with the Recommendation Cards, to gather as much feedback as possible. The session started with a short introduction and overview to the purpose of the tools and the evaluation process. Participants started with an initial exploration of the tools, where they could locate relevant stage(s) for the scenario and identify pain points and key insights.
For the second part, participants were asked to share their opinion, based on what they read, to understand which part of the tool was easy or complex to read, and if the elements were intuitive to analyse. The design practitioners provided valuable insights and comments that helped in developing the final design.

Figure 19: Rotterdam metro line (De Graaf, 2019).

↘ Research Findings

This chapter presents the findings of the research activities carried out to address the first sub-question of the project and to build an evidence-based understanding of accessibility challenges within Dutch metro environments. The chapter is structured to bring together insights from different sources–desk research, expert and user interviews, field analyses, and user observations, so that a multi-layered perspective can emerge.

The first part (Section 5.1) reports the desk research results, where existing literature, reports, and best practices were reviewed to identify the key accessibility barriers faced by different user groups across the travel journey. This helped surface gaps in current approaches to accessibility, highlight specific challenges of the metro environment, and outline the fragmented responsibilities of stakeholders.

The second part (Section 5.2) presents findings from interviews and observational studies. Semi-structured interviews with experts and users, together with informal conversations with staff, brought forward lived experiences and professional perspectives on accessibility.

These findings are organised into five thematic clusters that shed light on how accessibility is understood, practiced, and experienced in everyday metro travel. Complementing these, a field analysis and a user observation study in Dutch metro stations provide a grounded look at the practical realities of navigating the metro system, capturing both environmental conditions and user coping strategies.

5.1 Desk Research Results

In this section, results from the research conducted and insights gathered from the literature are presented, which helped answer the first sub-question: *"What are the key accessibility barriers that these different user groups face across the travel journey?"*

Main Challenges in Metro Environments

From the desk research, many insights came out, which were synthesised into key points:

- Gap in addressing 'invisible' difficulties: current systems often exclude users with non-legally recognised difficulties, such as low literacy, language barriers, or cognitive overload. These groups are less represented in policy and often go unnoticed in traditional accessibility audits, yet they face serious challenges in navigating transport environments. This reinforces the need for a broader definition of accessibility in wayfinding design.
- Accessibility is still mostly framed physically, not informationally: from the desk research and analysis of current practices, it was observed that accessibility in Dutch public transport is still predominantly defined in terms of physical infrastructure (e.g., ramps, elevators). There is significantly less focus on information accessibility and wayfinding clarity, even though these are crucial for independent navigation, especially for people with sensory impairments and difficulties.
- Metro environments are high-stress, multi-sensory spaces: metro stations (especially in bigger nodes) are complex and fast-paced, making them particularly difficult for people who rely on clarity, consistency, and simplicity in navigation. This setting confirms the relevance of my focus and supports the decision to limit the scope to metro stations.
- Stakeholder roles are fragmented across municipalities: the analysis conducted revealed that metro systems in the Netherlands are managed locally (e.g., GVB in Amsterdam, RET in Rotterdam), which leads to variation in accessibility strategies. This confirms the need for a strategic yet adaptable solution, one that can be transferred across different local authorities and applied by different actors (designers, city planners, agencies).

Stakeholders Map

In order to identify and have a clear representation of all the actors that are involved in the wayfinding system within the Dutch metro station context, a stakeholder map was made.
A Stakeholder Map is a visual representation of the various individuals or groups involved in a specific system. This map is helpful to identify the key parties for potential collaboration, to understand where the power and influence may originate regarding design decisions, and to have a different perspective of stakeholders and how they are related to the project.
At first, a list of all the possible stakeholders was made, but in this first version, there were also included groups that were not directly involved in the wayfinding system but still had an important influence and responsibility (e.g. Ministry of

Infrastructure and Water Management). From this first list, an initial stakeholder map was conceived to understand all the interactions between the stakeholders. To have a clear overview of the main stakeholders involved, a second version, more simplified was refined (see Figure 20). The list of stakeholders and the first version of the stakeholder map can be found in Appendix B.

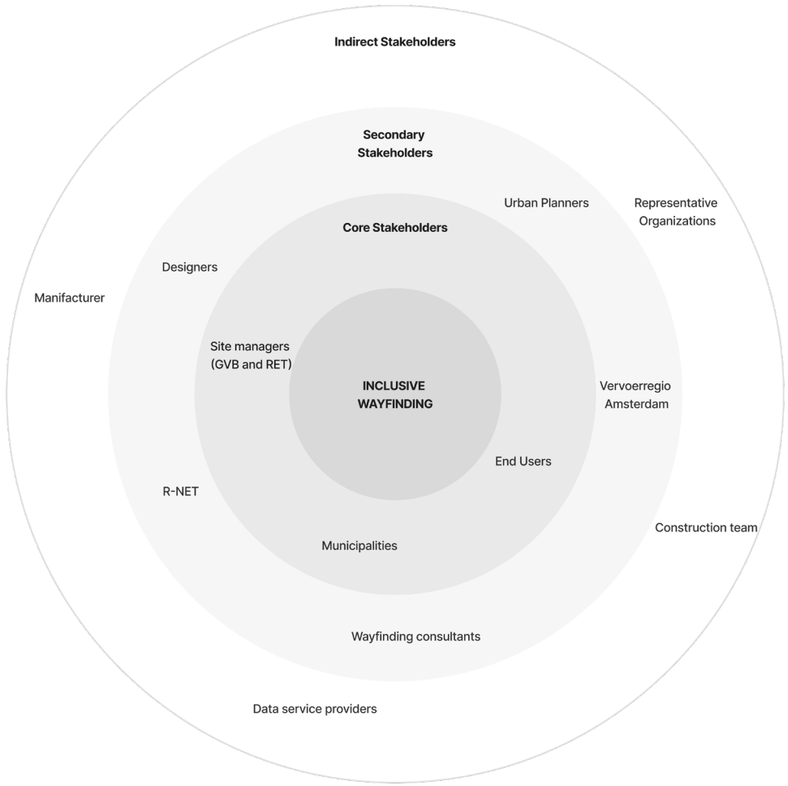


Figure 20: Overview of the main stakeholders involved.

In this final version of the stakeholder map, different "rings" were identified, which represent the core, secondary and indirect stakeholders, in relation to this design project.
While stakeholders' interests in this topic may differ, they all share, at different levels, some responsibilities around it.

5.2 Interviews and Observation Results

This qualitative analysis section helped to answer the second sub-research question, which is: *"How can inclusive design principles be applied to improve wayfinding in the Dutch metro stations beyond legal compliance?"*

Interviews analysis

The purpose of the interviews was to get a deeper understanding of accessibility from both experts in the field and users, with their lived experience. The interviews were carefully chosen to get as many different perspectives as possible, considering also the time constraints. The following Table 3 shows an overview of the participants and their primary role.

Participants	Role	Organisation	Form
P1	Person with lived experience, Researcher in inclusive and accessible design	Self-employed	Semi-structured
P2	Person with lived experience	Self-employed	Semi-structured
P3	Wayfinding and Information Designer	HfG Karslruhe	Semi-structured
P4	Associate Professor of Architecture member of Transport and Mobility Institute	TU Delft	Semi-structured
P5	UX Designer	Fabrique	Informal
P6	UX Designer in Public Spaces	Fabrique	Informal
P7	Strategist	Fabrique	Informal

Table 3 : Overview of the Interviewees.

The semi-structured interviews lasted between 45 minutes and one hour. Three of the seven interviews were conducted online via Microsoft Teams, and four were held in person. All interviews were recorded and transcribed with participants' permission.
For analysis, each transcription was reviewed individually, key quotes highlighted and extracted. Across all the interviews, the most insightful quotes were then clustered, and codes were generated. Those codes were then grouped by similar thematic to identify overarching patterns (see Appendix D).
For these informal conversations, no transcripts were made since this potentially restricted the freedom of speech for these employees. However, for every session, direct annotations and interesting insights were written down, with employees' permission.

Key Findings

The interviews revealed interesting insights related to different perspectives on accessibility and inclusivity of a public space, the human experience connected to emotions felt, but also highlighted what does work and what is still missing in the access to information in public transport environments.
Five main themes were generated from the interviews insights, which are the following: **Beyond Basic Accessibility, Emotional and Cognitive Load, Wayfinding System: Principles for Actions, Journey and Physical-First,** and **The Designer's Role.**

Beyond Basic Accessibility

The first theme revolves around the foundational mindset, in which the current approach to " accessibility" is no longer sufficient. This is because nowadays inclusivity can be seen as a social and cultural goal, rather than a technical checklist. It requires moving oneself perspective from "accessible" fixes towards a more universal design approach, where inclusive features can be integrated and serve everyone. In this way, what's essential is the balance beween values such as function, culture and aesthetics.

"The thing with accessibility, people forget it's just the beginning, especially the laws that are around it. And just because something is accessible, some people forget to make it usable and user friendly too. Just because something is required doesn't mean you can't go above and beyond." – P1

Emotional and Cognitive Load

The second theme delves into the impact of navigating in public space from an emotional level. It shifts the conversation from the physical barriers to the invisible, sensorial barriers, which are often to biggest obstacles for travelling to many users, especially those with sensorial difficulties.
The journey is measured in terms of energy and stress, not only in time and distance. The core insights gathered from interviews are that wayfinding systems' primary goal should be to reduce as much as possible the cognitive and emotional load, to make travel possible, but especially comfortable.

"When you look at subway stations, there are many cases, like in Amsterdam, where sometimes you end up in a very big space, where it's hard to use your intuition to understand where you have to go. So, I think with the subway, it's always more of an element of surprise and discomfort." – P2

Uncertainty, the fear of making mistakes, and the overall sensory overload create a significant emotional stress that most of the time leads to avoiding using public transport to travel, or in some cases, avoiding travelling at all. This issue can impact the social life of an individual, so that's the reason why it should be considered a priority when it comes to design.

"But there is a certain level of discomfort, and that's why I tend to cancel a lot of appointments last minute because I know that it could be too stressful" – P2

Wayfinding System: Principles for Actions

The third theme consolidates the needs of an effective system, which must be multi-sensory, predictable and consistent. Information should be available at least for two senses, for example, visual and tactile, to be robust and truly inclusive. Consistency is crucial for users' trust and intuitive navigation. Relying on a single sense (usually vision) leads to exclusion.

"I would go towards symbols if I'm honest because symbols works for everybody even if you don't speak the language even if you don't like to read or aren't well at reading. And if you make them tactile then it also works for everyone and you have to think about eye and hand height because if you see the levels you have to be eye height but if you feel them they have to be wherever your hands reads." – P1

However, from interviews emerged that consistency does not have to mean sterile uniformity, but rather there should be room to create memorable and unique spaces, combining a consistent framework with curated elements. By doing that, metro stations could be both predictable and memorable.

"[...] if you make everything the same, it is much better for safety reasons., but still I think there is always some room for wiggling, even in the most strict rules There is still some room to do it." – P3

Journey and Physical-First

The user journey is door-to-door and crosses multiple scales (urban, architectural, human). The interviews revealed that the physical environment is primary, and digital tools are secondary and sometimes even fragile. It has also been stressed that the station itself should be socially integrated, serving the local community, and not just being an isolated service.

"They can do a lot of things but for most of them need to have an internet connection and other than that you want your wayfinding to work even if somebody's phone is dead or if they have other issues with their phone." – P2

"So for me, working on the station is not only about the user level... but it's a constant, let's say a dialogue between the different scales of intervention and the different scales of analysis." – P4

The Designer's Role

The designer's role should expand beyond creator to that of facilitator, educator, and advocate. According to the interviews, designers must challenge their own biases, sharing competence through co-creation, and educate their clients on the value and necessity of inclusivity, and not an optional "quick fix".

"It's a responsibility, especially leading agencies, they have to educate their customers, and I think as soon as the designers realize that they have that responsibility, then they will also become more active in thinking about solutions." – P2

This is an essential shift in the perspective since, often happens that designers' own assumptions and lack of lived experience create "blind spots".

"The way I experience the world is very very different from people from minority communities [...], I need constant reminder of this, because I also don't notice some things." – P3

Field Research analysis

Before doing a user observation test, a field research analysis was conducted in the metro stations of Amsterdam Central, Amsterdam Lelylaan, Waterlooplein, Nieuwemarkt, and Rotterdam Centraal. This field analysis was useful to specifically identify all the wayfinding elements that make up the various metro stations and how they differ based on the municipality they belong to.
Various notes and pictures were taken, and some general observations were made, also related to the users navigating the place[4].

General observations:

- Some stations felt disorienting (e.g. Rotterdam Centraal metro station): it was very bright and with a glass wall, making it hard to orient myself.
- Very few directional signs and quite small, you may not see them at first.
- In some stations, no audio announcement was heard about the arrival of the metro. In the ones that had the audio announcements, those were only in Dutch, making it hard for a non-native speaker to understand specific situations.
- In many stations, either the elevators and escalators were not working and were not reported, or, in the case of Rotterdam Centraal, there was an elevator (which was working) but had some physical barriers in front of it, which made it hard to use.
- Tactile pavement is present in all the stations
- Signs: essential signs were displayed but not very readable from a distance, and also the background colour of the signs was white in Rotterdam Centraal, which was not very visible from a distance; you may not see them at first. Icons were clear in terms of design but too small within the sign; consistency was lacking, there were only essential signs, and there were not enough signs during the path that you had to follow to reach the platform/exit. In some of the stations in Amsterdam, there were no icons displayed on the signs, only text and emergency icons.
- No information in English for directional signs and decision points
- In general, once I reached the platform, there were very few indications in general. There was a digital display showing the arrival time and the map of the metro's route, but no clear info about the platform.

[4] Note: this first analysis was done before the interview with the site users, so the considerations made were personal, from a person who does not have any form of impairment. Besides that, the goal was to step into the user's shoes, taking into account the needs gathered from literature and desk research.

Figure 21: Overview of the conducted field research.

User Observation analysis

To better understand how users interact within the Dutch metro station context, a user observation test was conducted. During this session, the participant (visually impaired person) was asked to travel as he would normally, without any help. With the participant's permission, notes were taken to capture key moments, and photos were used to document interactions with the interface, maps and environment.
The journey started from the Amsterdam Centraal metro station to the Weesperplein Station. This process helped identify usability issues, moments of confusion, and areas where the design supported or hindered task completion. In the following section, the key findings gathered from the user observation are presented.

Key Findings Along the Journey

Entry: at the point of entry, relevant environmental cues such as the prominent "M" signage, the ramp light, and the auditory warning "mind your step" helped orientation. In contrast, the ticket purchase causes notable stress, leading to the avoidance of this action, which reflects the high cognitive load associated with this task.
Concourse: the participant relied primarily on the red/green light of the gate for orientation, since directional signage was not legible from a distance. Tactile paving offered little functional benefit given that the participant does not use a cane, and changes in lighting conditions at times make the paving visually indistinct.
Platform: on the platform, the sound of arriving trains confirmed the platform area. The participant, by zooming with his phone camera, could identify the right metro line to take from the colour-coded map displayed. The participant still double-checks with his phone, the right direction from the real-time display.
Onboard: while on the metro, the participant positioned himself (without sitting) close to the route maps and depended on the indicator lights for reference. Missing auditory stop announcements were a source of frustration, as these announcements not only confirm station identity, but also indicate the side of the metro on which doors would open.
Exit: during exit, spatial features, such as long corridors, small signage, extensive advertising displays, and large open concourse areas, generated disorientation and stress. To compensate, the participant engaged in scanning strategies, to identify the exit through recognition of the word shape "uitgang", and tried to orient himself using environmental landmarks. When an incorrect exit was chosen, he preferred re-entering the metro station to locate clearer signage, rather than navigating the unfamiliar above-ground environment.

Key insights:

- Dependence on multimodal cues. Effective navigation was supported through the integration of multiple modalities, particularly color (e.g., green/red lights), auditory information (e.g., announcements, train sounds), and shape recognition (e.g., "M," "uitgang").
- Limited accessibility of information. Signage was frequently too small to be legible without technological assistance (e.g., phone camera), and tactile paving was ineffective for participants who do not use mobility aids.

- Spatial disorientation in large-scale environments. Architectural features such as extended corridors, open spaces, and pervasive advertising undermined orientation and increased cognitive strain.
- Importance of routine and reassurance. Consistency in entry/exit use, verification through personal devices, and assistance from sighted companions reduced stress and fostered a greater sense of confidence during travel.

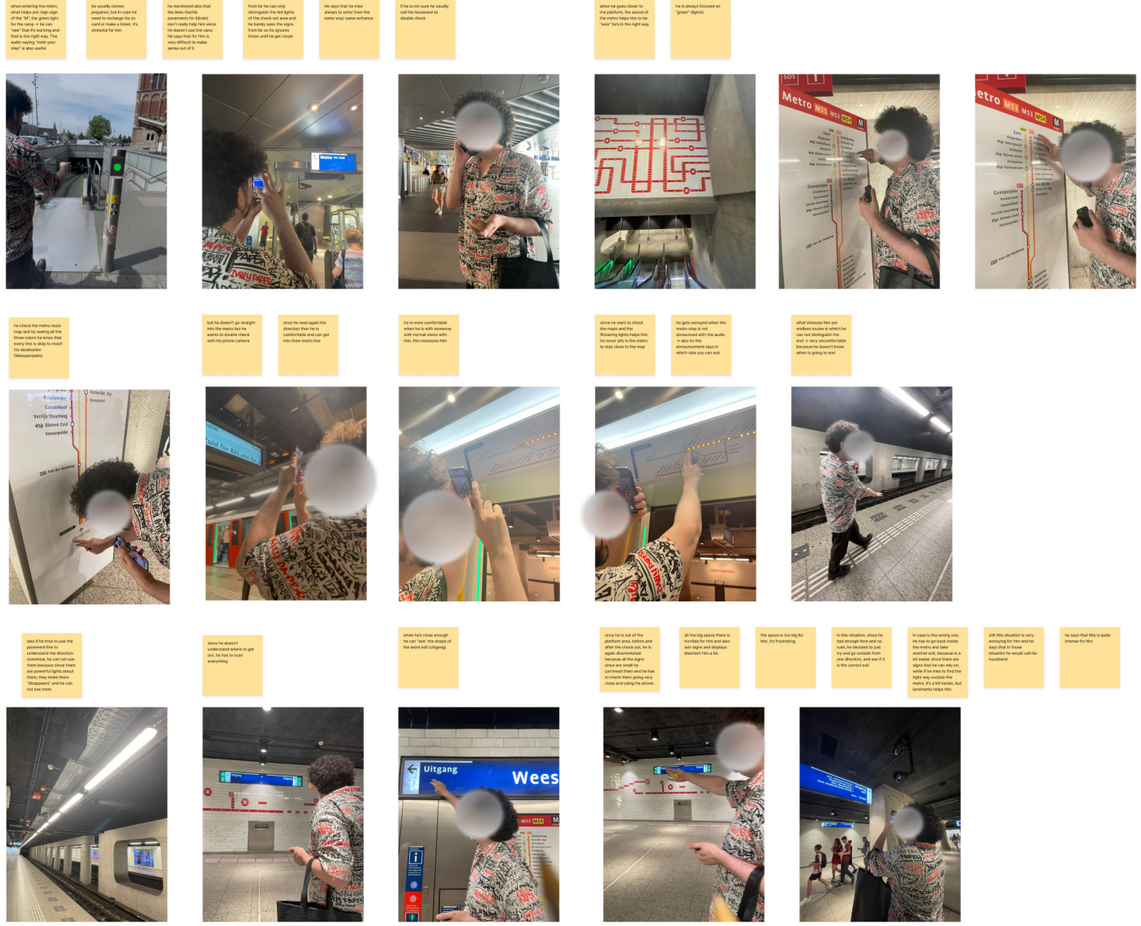


Figure 22: Visual documentation acquired during the observation.

User Travel Journey Map

From the user observation analysis, a User Travel Journey Map was developed to visualize touchpoints, pain points, coping strategies, and emotional states across the metro journey (see Table 4).

	Entrance	Ticket purchase	Navigation to platform	Boarding	Inside the metro	Exit
User goal	Enter in the metro station.	Purchase the ticket or recharge the card.	• Finding the main directional signage after the gates. • Navigating stairs and escalators	Be sure that he's int he write platform and direction.	Enter in the metro and navigating the gap between the platform and the train	Find the way to exit from the metro station
Actions	Find the right entrance : big sign of the "M" outside and the green lights of the ramps help him.	He's always prepared in advance and never use the ticket machine, only if he forgets his card (never happens).	From far he can only distinguish the red lights of the check out area and he barely sees the signs from far so he ignores those until he get closer; He tries always to enter from the same way/ same entrance; He is always focused on "green" (lights); Use his phone camera to zoom on signs: if he is not sure he usually call his housband to double check; When he goes closer to the platform, the sound of the metro helps him to be "sure" he's in the right way.	He checks the metro route map and by seeing all the three colors he knows that every line is okay to reach his destination; He doesn't enter straight into the metro but he double check with his phone camera; Once he read again the direction then he is comfortable and can get into the metro line.	The size of the horizontal gap is unpredictable, creating a tripping hazard; Since he want to check the maps and the flickering lights helps him, he never sits in the metro to stay close to the map.	Navigate big spaces; He tries to use the pavement line to orient himself but since there are powerful lights above them, they make them "disappears" and he can not see them; When he's close enough to signs, he can "see" the shape of the word exit (uitgang); Once out of the platform area, he is again disorientated becasue all the signs are small he can't read them and he has to check all of them. If he takes the wrong exit, he has to go back inside the metro and take another exit.
Emotions	Focused	Unbothered	Careful, trying not to get stressed; Uncomfortable	Stressed but relieved once he is in the right place	Focused but annoyed	Very uncomfortable; disorientated; frustration; relieved once he gets out, he says it's always intense
Pain Points	Before the entrance, in AMS station, there is a big panel with a lot of information that are unreadable.	Tickets machine only have touch screen and no audio, so he never use them.	Tactile pavements for blinds don't help him since he doesn't use the cane. For him is very difficult to make sense out of it. From far he can only distinguish the red lights of the check out area and he barely sees the signs from far so he ignores those until he get closer.	There are no lines on the floors that states the safe zone; No audio announcement about the upcoming metro line.	He gets annoyed when the metro stop is not announced with the audio, also because the announcement says in which side you can exit.	Endless routes in which he can not distinguish the end. he doesn't know when is going to end; Since he doesn't understand where to get out, he has to scan everything; Big space there are horrible for him and adv signs and displays disorient him a lot.

Table 4: User travel journey map.

5.3 Main Takeaways

One of the main takeaways from the research findings is that there is a significant disconnection between the current, compliance-driven state of accessibility in Dutch metro stations and the complex, lived experiences of many users. Across all research methods employed, a central theme emerged: the journey through a metro station is mainly an emotional and cognitive experience, not only a physical one.

Currently, accessibility standards focus heavily on physical infrastructure, but the research findings highlighted that the most barriers are often also invisible. The high cognitive load of navigating complex spaces, the stress caused by unclear signage, and the fear of making a mistake create significant emotional burdens. These challenges, which especially affect individuals with sensory difficulties, can be so overwhelming that they avoid travel altogether, impacting social inclusion.
The conducted field analysis confirmed what desk research suggested: a fragmented approach to wayfinding across different municipalities leads to inconsistent design, a lack of multi-sensory information, and an over-reliance on visual cues that are often too small or unclear.
The user observation demonstrated the consequences, as the participant had to develop personal coping strategies to overcome an environment that was not navigable. Therefore, this research points towards a necessary shift. To be truly inclusive, wayfinding design must move beyond a simple "checklist" approach and embrace inclusive design principles. An effective system must be multi-sensory, providing information through multiple channels; consistent, to build user trust and intuition; and predictable, to reduce the cognitive energy required for travel. These findings call for a more holistic and empathetic approach, redefining the designer's role as not just a creator, but an advocate for a system that prioritises clarity and comfort, ensuring public transport is truly accessible.

The most significant takeaway from interviews was the identification of five key thematic clusters that holistically define the reality of inclusive wayfinding: Beyond Basic Accessibility, Emotional and Cognitive Load, Wayfinding System Principles, Journey and Physical-First, and The Designer's Role.
This finding reframed the primary design goal from merely informing designers with practical solutions, to actively reducing user stress and fostering confidence. Furthermore, the analysis confirmed a strong "physical-first" user preference, where tangible, multi-sensory environmental cues are primary and digital tools serve as secondary, often fragile, supports.

This directly influenced the project's solution to be grounded in the physical environment. The User Travel Journey Map, developed from direct observation, became the structural basis of the final design. Its detailed, step-by-step mapping of actions, pain points, and emotions ensured that the subsequent strategic framework was authentically grounded in the lived experience of navigating the metro system.

↘ The Solution Space

Building on the insights presented in the previous chapter, this section transitions from problem exploration to solution development. Whereas Chapter 5 mapped the accessibility barriers and lived experiences of metro users, Chapter 6 outlines how these insights were translated into a concrete design direction and eventually shaped into a strategic tool.

The chapter begins by clarifying the design focus, which frames the scope and ambition of the solution. The requirements of this framework are introduced as criteria for its development and later evaluation. Section 6.2 presents the idea generation process, which combines personal ideation with a co-creation session involving professional designers.
Section 6.3 then details the concept development, describing how ideas and research insights were synthesised into the strategic framework. This includes the structure, the guiding principles, the prioritisation scale, and recommendation tools. Together, these elements answer the sub-research questions on how inclusive design principles can be operationalised in metro environments. Finally, Section 6.4 covers the evaluation of the guide with design practitioners. The feedback gathered from this process not only tested the guide's clarity, practicality, and relevance, but also informed refinements that strengthened its impact and usability.

In this way, the chapter moves progressively from framing the design focus, through generating and shaping ideas, to validating the outcome. It represents the connection between research insights into tangible solution space that equips practitioners to design for more inclusive and accessible metro travel experiences.

6.1 Design Focus

The research and analysis have established the core challenge: navigating Dutch metro hubs presents significant barriers for many users, rooted in a system that is functionally strong but often inclusively fragile and emotionally heavy.
Having defined the problem space, the next step in the design process is to converge on a clear focus for the solution. The conducted research made it evident that the most impactful intervention would not be a single redesigned artefact, but a tool that could change the process of design itself. In this context, it led to the decision to develop a strategic framework, and the following parameters define its scope and requirements. The outcome of this project is a solution to equip design practitioners to improve information access and independent mobility for people with visual impairments and low-literacy individuals. It is not a proposal for redesigning a specific station or creating a new mobile application, but rather a transferable method to guide future projects. The framework specifically focuses on informational and experiential wayfinding within the metro station environment. To ensure that the outcome is effective and relevant (Dam et al., 2022), its development is guided by three core requirements, which are assested during the evaluation session with design practitioners:

Desirability
The final result must produce outcomes that are desirable for end-users, leading to safer and clearer journeys. Crucially, the guide itself must be desirable for its primary users, the design practitioners, by being credible, usable, and inspiring.

Feasibility
The principles and solutions contained within the framework must be feasible within the real-world constraints of public infrastructure. This necessitates a focus on robust, scalable, and primarily physical solutions that acknowledge the practical realities of a metro hub.

Viability
The final project must be viable at an organisational level. This means being able to provide professionals with the motivation and evidence necessary to support inclusive design, framing it not as an optional cost but as a fundamental component of a high-quality public service that adds long-term value.

6.2 Idea Generation

This section details the idea generation process that begins the development phase. The creative sessions are examined to explore potential ideas, including a personal ideation session and a co-creation session with UX designers from Fabrique.
These sessions offer unique insights that aid in generating a wide range of ideas. All initial ideas are presented in this section and serve as the foundation for concept development by selecting and combining ideas in the "6.3 Concept Development" section.

6.2.1 Personal Ideation

Throughout the whole project, potential ideas were generated, both spontaneous thoughts and more structured, focused moments on ideating new design concepts. Methods used included mind mapping and sketching to create an overview of the various components of the problem (see Figure 24).

6.2.2 Co-creation Session with Practitioners

To collect ideas and perspectives from the specific target group, a one-hour co-creation session was organised with four UX Designers of Fabrique (see Appendix E). This session ensured that participants (designers) had the opportunity to contribute their knowledge, fostering a wide range of perspectives. Beyond brainstorming and ideation, the session was also designed to inspire enthusiasm among the participants.

This session was structured in the following way:

1. **Introduction to the problem and challenge** – In this first part, it was briefly explained the insights gathered from research and literature, sharing what are the main challenges for people with disabilities (VI and LL) and the main barriers in the Dutch metro system. This moment was essential because not all designers were at the same knowledge level of the project I was carrying out.

2. **Sprint 1 (Brainstorming)** – To warm it up, the first exercise was important to let them think with a broad perspective. It was asked designers to generate "How Might We" questions around the concept of Inclusivity and Accessibility to understand what their bigger concerns and priorities were. They wrote their HMW questions on post-its and then shared their thoughts around them together. This was an important opportunity to have an open discussion about the topic and reflect on that. To provide a profound understanding of every HMW question for each participant, all post-its were individually discussed and inductively clustered based on the group's consensus. Six clusters were made: *Responsibility, Creativity, Technology, Design Process, Testing, and Awareness*[5].

3. **Share of the Envisioned Structure of the outcome** – After this initial round, it was important to share the elements of the structure derived from research and literature insights. As a result, designers were able to participate in the second session and acquire a better knowledge. Because of worries about bias, which could prevent designers from exploring more widely, the intended structure was first kept hidden.

4. **Sprint 2 (Idea Generation)** – In this second round, the concept writing had taken place. It was asked to write down ideas about the shape that the outcome may be. It was essential to have their perspective on how this envisioned design could easily fit into their design process. All the ideas gathered were discussed individually and then clustered following the structure of the framework, divided into three layers (conceptual, journey and action) in order to contextualise and understand more deeply which ideas could work best.

Figure 23: Co-creation session at Fabrique.

[5] Note: In this first part, most of the post-its were related to the design process and the awareness. This indicates that these two themes were the most relevant for design practitioners to address and therefore focus on.

5. **Dot Voting** – In the last part of the session, the dot-voting was applied to make a clear decision on which ideas should be pursued further as concepts. This is a group voting method used to identify a team's preferences from a list of options

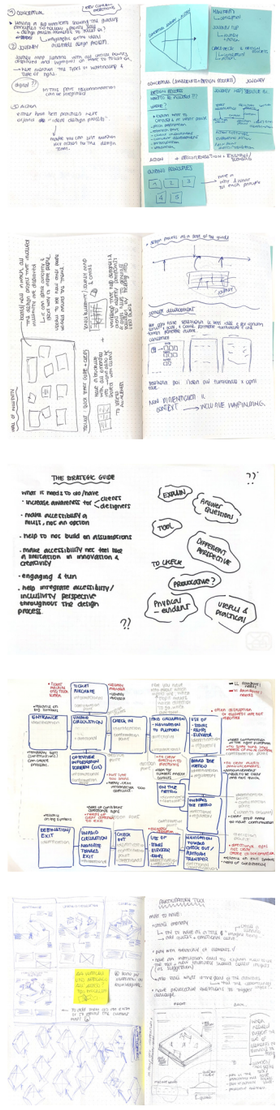


Figure 24: Concept sketches.

6.3 Concept Development

6.3.1 Structure of the Framework

The subsequent developed concept consists of a mix of multiple ideas and insights from the research results and previous sections (6.2.1 Personal ideation, 6.2.2 Co-creation Session with practitioners, and informal conversations with designers from Fabrique). The envisioned concept started with a clear structure of the framework, designed to be both strategic and highly practical. It is structured in three main layers, that helped understanding the elements that are necessary:

Conceptual: helps design practitioners understand what matters, outlining key principles related to inclusivity and accessibility within the metro station context, and critical points to consider;

Journey: highlight to them see where things break down, step by step. By using elements of journey map, the intention is to identify critical situations in a real user's journey experience through a metro station;

Action: shows them what they can do about it, providing prioritization criteria, and recommendations.

This structure allows the framework to support real design processes while maintaining a broad, inclusive vision. Two main pillars shaped the final design, which are the Guiding Principles and the Prioritisation Scale.

Guiding Principles

Once the core structure of the framework was built, it was possible to define five guiding principles that are used as a foundation for the strategic framework. These principles are synthesised from Universal, Inclusive and Wayfinding principles.

1. **Create a Legible and Equal Environment:** ensure everyone can perceive and understand the environment with equal ease, regardless of their sensory abilities, language, or prior experience. Every piece of information must be communicated in multiple ways (e.g., a sign is visual, high-contrast, tactile, and has a clear pictogram). The system assumes no prior knowledge.

2. **Offer Flexible and Empowering Choices:** accommodate a wide range of user preferences, abilities, and contexts by providing flexible options that empower the user to navigate in their own way. The system offers information in various formats (visual, tactile, audible). It provides both overview information (maps) and sequential information (directional signs). It offers multiple routes (e.g., stairs vs. elevator) that are all clearly marked.

3. **Design for Intuitive and Confident Journeys:** build a clear, consistent, and predictable system that reduces cognitive load and allows users to navigate with confidence and minimal effort. Creating a "rhythm" of information. Signage placement is consistent. Terminology is standardized. The user learns the system's logic once and can apply it everywhere.

4. **Build a Resilient and Forgiving System:** anticipate user errors and environmental failures, design a safe system, minimise the consequences of mistakes, and always provide a path to recovery. There are no dead ends. Every decision point offers clear confirmation. If an elevator is broken, the alternative route is immediately and clearly communicated. The system assumes people will get distracted or make mistakes and helps them recover gracefully.

5. **Develop a Meaningful and Enriching Place:** go beyond mere function to create an environment that is not just a passage, but a comfortable place, culturally relevant, and respects the dignity of every individual. Using art, light, and materials to make the space feel safe and welcoming. Integrating local culture and languages to make the community feel seen. Ensuring that the design process itself is participatory and respects the expertise of people with lived experience.

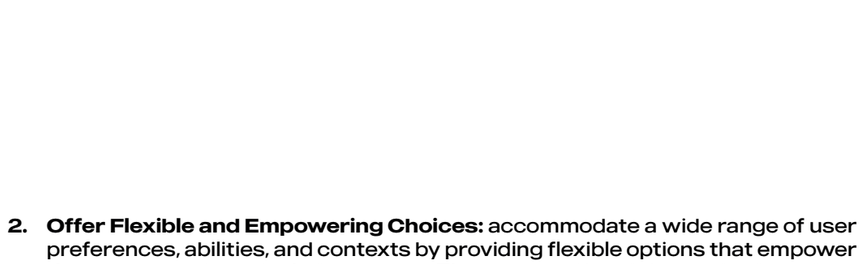


Figure 25: Guiding Principles.

Prioritisation Scale

Another essential element to have is a prioritisation scale to help clarify what is crucial and what can enrich the overall travel experience, which reflects a hierarchy of needs. The formulation of the Guiding principles together with the

prioritisation scale contributes to answering the second sub-research question, which was: *"How can inclusive design principles be applied to improve wayfinding in the Dutch metro stations beyond legal compliance?"*

Tier 1 – High Priority: Safety & Clarity
The system must work reliably and must not cause harm. This is the non-negotiable foundation.
Focus:
- Core Orientation: legible, high-contrast signs at all critical decision points.
- Basic Functionality: working elevators, clear and simple feedback on core interactions (e.g., gate check-in).
- Multi-Modal Communication: combining pictograms, plain language, and tactile/audio cues.

Tier 2 – Medium Priority: Comfort & Independence
The system must be understandable and navigable without assistance, empowering users and reducing their stress.
Focus:
- Predictability & Consistency: a "learnable" system with consistent layouts and terminology.
- Low Cognitive Load:uncluttered environments and simple, step-by-step processes.
- Emotional Comfort: creating a calm, welcoming atmosphere that respects the user.

Tier 3 – Lower Priority: Meaningful & Engaging
Enrich the functional journey by creating a connection to place and community. With this level, the aim is to enhance the journey experience and deepen the connection to the place by adding curated sensory, cultural and informational layers. Once the wayfinding system is safe (Tier 1), Comfortable and Clear (Tier 2), these enhancements can transform merely functional spaces into a memorable and engaging one, for every traveller.
Focus:
- Cultural Representation: using art, history, or local languages to give the station a unique identity.
- Sensory Enrichment: curated soundscapes or thoughtful use of materials to create a more pleasant environment.
- Social Inclusivity: integrating community functions that make the station a valuable "place," not just a "passage."

6.3.2 Touchpoints Across the Strategic Framework

This section help answering the third sub-research question, which is: *"What strategic approaches can support design practitioners in designing and implementing inclusive wayfinding systems that address a broader spectrum of needs?"*
Travel journey maps provide important user-centred insights (gathered from research and user observation) that can be translated into critical pain points and reveal the emotional level, offering further empathy to design practitioners.

On the other hand, the service blueprint helps visualise organisational processes to optimise how a business delivers a user experience. Therefore, it is fundamental for design practitioners to understand how to improve specific touchpoints across the journey.
For this concept, according to feedback from the co-creation session, the tool needs to include:

- Increase awareness for designers and stakeholders
- Help not to build on assumptions
- Make inclusivity not feel like a limitation in innovation and creativity
- Could be engaging and fun
- Help to integrate an inclusive perspective throughout the design process
- Practical and physical

The strategic tool can feature a journey map "look", which is familiar to design practitioners, since is a tool already utilised in their design processes, also during participatory sessions with clients. The tools need to be informative and knowledgeable to enable designers to consult it effectively. After informal discussions with designers, further interesting insight emerged: it also has a simpler version to use in co-creation sessions with clients, besides serving as a knowledge reference. The reason is that, to raise awareness around the topic, there is the need to collaborate and share ideas with clients. This approach fosters stakeholder collaboration and helps them better understand potential critical issues related to access to information.
Additionally, to maintain the original structure, it is important to expand the conceptual section. Besides including essential information in the knowledge tool itself, it would be valuable to provide a separate informational cards with recommendations. This document could be useful for consultation throughout the entire design process to "check-in" and also serve as a resource to share information with clients during a design proposal presentation.

6.4 Main Takeaways

This chapter documents the crucial transition from problem analysis to solution development, detailing the methodology for generating, conceptualizing, and evaluating the project's outcome.

The central takeaway is the deliberate and structured process used to translate abstract research insights into a tangible, strategic tool for practitioners. The decision to develop a strategic design framework, defined by the core requirements of desirability, feasibility, and viability, was a direct response to the complexity of the problem space, confirming that a process-oriented tool would be more impactful than a single design artefact.

A key innovation in this phase was the co-creation session with UX designers, which functioned as a form of user research on the primary target group (the practitioners themselves).
This moved beyond simple ideation; it validated the need for a tool that could build awareness, challenge assumptions, and integrate seamlessly into their existing workflows.
The feedback from this session was essential, helping with shaping the guide's three-layered structure (Conceptual, Journey, Action) and its supporting components.

↘ Final Design

In the following chapter, the final design outcome is showed, encompassing all the research and results collected during this project.

In the first section the final design, which is a strategic framework is explained, providing the core structure that generated the different components (Knowledge Tool ,Participatory Tool and Recommendation Cards). Here the benefits for the design practitioners and stakeholders are provided.

The next sections, include detail overview of each tools, with explanations on how is structured and the rational behind.

The section 7.2 focuses on the flexibility of use of the framework, explaining how a design practitioners can use it and at what stages of the design process.

In the last section (7.3 Scenario Application) To demonstrate the different usage of the strategic framework, specifically for the knowledge tool. Scenario applications are provided to demonstrate how to move from problem to solution, and its value in a design process, from the designers' perspective.

7.1 The Strategic Framework: Finding The Way Together

With this artefact the main research question is answered, which is: *"How can inclusive design be strategically implemented to improve wayfinding in Dutch metro stations for people with visual impairments (VI) and low literacy (LL)?"*

This thesis argues that an effective approach for complex public systems like wayfinding must synthesise the best of Universal and Inclusive Design. It draws on the ambitious goal of Universal Design to create a cohesive and intuitive environment for all, while grounding the process in the participatory methods and deep empathy of Inclusive Design.
The resulting framework, therefore, is not about providing a single "perfect" design, but about equipping practitioners with a process and a set of principles to challenge their perspectives and guide inclusive decision-making.
It aims to foster solutions that are both broadly usable across different metro stations, offering a more seamless journey while remaining sensitive to the human experience of navigation.
"Finding the Way Together" is not a final, static wayfinding system. It is a dynamic tool that guides practitioners through a process of diagnosis, ideation, and implementation.

For clarity throughout this report, the final outcome is referred to as the **"Finding the Way Together" Strategic Framework**. This framework shape itself around two fundamental pillars (Guiding Principles and Prioritisation Scale) and is composed of three distinct tools (see Figure 26): the Knowledge Tool, the Participatory Tool, and the Recommendation Cards.

Together, they ensure that the framework serves both as a comprehensive reference for practitioners and as a participatory instrument for stakeholder engagement.

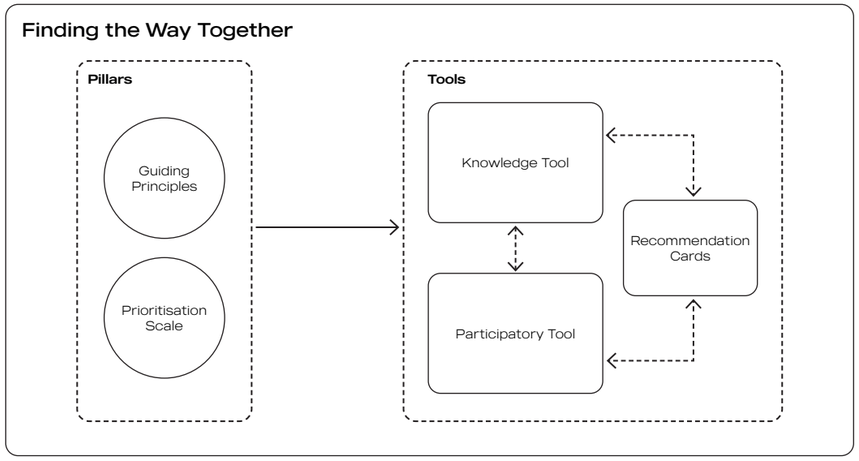


Figure 26: The Strategic Framework: *Finding the Way Together.*

The choice of these formats is informed by insights from both the literature and the interviews conducted with designers. In both cases, a clear need for physical design tools emerged.

Drawing on The Convivial Toolbox (Sanders & Stappers, 2012), this decision is not founded on the idea that digital tools are inadequate, but rather on the recognition that physical tools are suited to specific stages and goals of the design process, particularly early-stage, divergent, and exploratory phases of co-creation.

While digital tools excel in documentation, scalability, asynchronous collaboration, and convergent tasks, physical formats are better at fostering inclusive, creative, and participatory interactions.
Physical toolkits create a more democratic and intuitive "language" that allows all participants, regardless of their disciplinary background or technical expertise, to communicate visually and directly. As Sanders and Stappers (2012) explain, *'generative tools'* refers to shared design language that designers/researchers and other stakeholders can use to communicate visually and directly with each other. This is generative in the sense that by using it, allowing people to express numerous ideas with a limited set of stimulus items.
This idea underscores the creative power of constraint and the generative potential of physical objects, which enable the expression of ideas beyond verbal or digital means.

Within this framework, the selected formats, the **Knowledge Tool** for internal consultation by design practitioners, the **Participatory Tool** for use with stakeholders, and the set of **Recommendation Cards** designed to support both, respond directly to the needs identified through the research process.
Collectively, these tools aim to:

- increase awareness among designers and stakeholders;
- establish inclusivity as a requirement rather than an optional consideration;
- reduce reliance on assumptions;
- foster engagement;
- support the integration of inclusivity perspectives throughout the design process.

These tangible tools serve as convivial artifacts, empowering and intuitive resources that allow all participants to meaningfully contribute to co-creation activities, with the ultimate goal of improving wayfinding by making it more inclusive. This is in line with Sanders and Stappers' (2012) affirmation that *"designers in the future will make the tools for non-designers to use to express themselves creatively."*

To conclude, the benefits of the strategic framework are the following:
For design practitioners: a structured tool to bridge research and practice, and a way to foster empathy and buy-in for inclusive design solutions.
For clients/stakeholders: active engagement, testing assumptions, building awareness of invisible barriers, aligning perspectives, sharing ideas and gaining confidence in evidence-based decisions.

First round of Evaluation Session

To ensure that the proposed design outcome is not only theoretically but also practically relevant, evaluation sessions were conducted with UX designers at Fabrique. The purpose of these sessions was to test the clarity, usability, and perceived value of the outcome. This activity is designed to test whether the proposed design is effectively clear and easily usable, stimulates reflection, exposes blind spots and potential assumptions of designers, and encourages ideation for improvements. Apart from getting feedback from experts, also fellow students were included, to provide a different perspective on the design outcome.

The feedback provided by the designers' perspective, helped in the refinement of the final design of the Knowledge Tool.
Feedback from the "first round" evaluation sessions highlighted several points that were essential in shaping the final design. The extended version of the tool was considered valuable as a knowledge base, while the recommendations cards were perceived as more actionable and suitable for participatory use. Reviewers noted that the participatory version, if presented as a compact version of the knowledge tool, was difficult for non-designers to read, and therefore should be simplified and more tailored. For example, a suggestion was to give greater importance to illustration and to add provocative questions to stimulate the discussion. Another suggestion was that the project could be structured around three complementary media: the knowledge tool (as a knowledge reference base for designers), the participatory tool (for co-creation sessions with stakeholders) and recommendation cards (as a supporting material). stronger storytelling, empathy and step-by-step layering were identified as ways to improve engagement and clarity. In terms of terminology, participants of the evaluation session felt that names like "map" or "framework" better reflected the envisioned outcome than "guide". Additionally, the guiding principles should play a more central role, as an active call to action. Finally, incorporating questions in the participatory setting was recommended, as they could also enhance the tool's scalability and adaptability to other contexts.

7.1.1 Knowledge Tool

The Knowledge Tool (see Figure 27) is the research-based strategic reference for deep analysis and consultation by the design team. Structurally, it integrates elements of a *travel journey map* and a *service blueprint*, enriched by user emotions, critical pain points, and supporting actions.
A journey map, as described in the Delft Design Guide (Van Boeijen et al., 2020), visually represents the sequence of user interactions with a product or service from the user's perspective, highlighting experiences, needs, and emotions along the way.
The service blueprint complements this by mapping the corresponding frontstage and backstage processes that enable these interactions, offering a holistic view of both the user journey and the system that supports it (Gibbons, 2024b).

This configuration provides practitioners with a systemic and evidence-based overview of the metro travel chain, offering detailed insights into barriers and opportunities across all stages of the user experience.
It combines more generalized insights, such as user actions, critical pain points, and supporting actions, specified for the different secondary target groups

Finding the Way Together

Design practitioner's Knowledge Tool for Inclusive Wayfinding in Dutch Metro Stations for Visually Impaired (VI) and Low Literate (LL) people.

Guiding Principles:

- Create a Legible and Equal Environment
- Offer Flexible and Empowering Choices
- Design for Intuitive and Confident Journeys
- Build a Resilient and Forgiving System
- Develop a Meaningful and Enriching Place

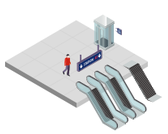
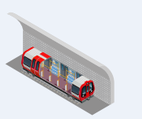
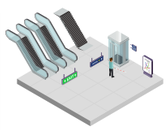
Macro Stages	**Station Access & Preparing for Travel**			**Pre-Boarding Navigation**		**Primary Journey**			**Post-Journey Navigation & Transfer**			**Station Egress**	
Micro Stages	ENTRANCE	UNPAID CIRCULATION	CHECK-IN	NAVIGATION TO PLATFORM	USE OF STAIRS/ ELEVATOR	BOARDING METRO	INSIDE METRO	ONBOARDING METRO	USE OF STAIRS/ ELEVATOR	NAVIGATION TO CHECK-OUT	CHECK-OUT	UNPAID CIRCULATION	EXIT/ DESTINATION
Physical Evidence ⓘ Whenever possible, consider going in person to check the physical evidence in the specific environment, since it can differ between metro hubs.													
User Actions	**User Actions** The user scans the environment for large, simple, and recognizable visual cues, to confirm they are in the right place and to find the entrance. User rely on strong visual patterns instead of reading detailed text.	**User Actions** Identifies the main doorway (also through sound or touch), navigates the entry system, and crosses the threshold, pausing inside to adjust to the new sensory environment. Usually the users already have their valid ticket, to avoid the use of a ticket machine.	**User Actions** Locates fare gates, finds the card reader and listens for the confirmation sound before moving through the physical barrier. **VI:** Looks for the visual cue of accessible gate. Visually locates the colored or illuminated card reader. **LL:** Looks for universally understood symbols to understand where and how to act.	**User Actions** Follows the primary wayfinding system. Pauses at decision points to gather information from audio announcements, braille signs, or symbols to choose the correct direction. Locates and uses stairs or an elevator to change levels.	**User Actions** Follows directional signs that leads to stairs or elevator.	**User Actions** Actively listens to announcements and/or looks for visual line colors/symbols on the train to confirm it is the correct one. **VI:** Orient themselves to the sound of the opening doors and carefully steps across the gap to board the train.	**User Actions** Stays close to the map and to the doors. Try to get information from the map to track progress. **VI:** Tries to read the text on the in-train map to track progress. **LL:** Watches a simple, animated "moving dot" map to visually track progress. Listens for announcements and matches station names to landmarks they know.	**User Actions** Exits the train when their stop is announced. Pauses on the platform to re-orient, then seeks out and follows the directional cues (tactile paths, audio cues, or symbolic signs) that lead toward their next goal: either a transfer to another line or the main station exit.	**User Actions** Follows directional signs that leads to stairs or elevator.	**User Actions** Follows the primary wayfinding system. Pauses at decision points to gather information from audio announcements, braille signs, or symbols to choose the correct direction. Locates and uses stairs or an elevator to change levels.	**User Actions** Navigates to the exit fare gates, locates the card reader on the correct side, and taps their card to complete the journey, listening for the beep that signals the gate is open.	**User Actions** Follows the final guidance path from the fare gates to the exit. Tries to identify the correct exit that will place them closest to their final destination, using external sounds or landmark-based symbols, before passing through the last set of doors.	**User Actions** Looks for a large, clear "EXIT" sign paired with a pictogram. Seeks out exit signs that use landmark pictograms (e.g., a bus symbol) to choose the right way out.
Frontstage Touchpoints *Represents all the actions and interactions that are visible to the customer during the service experience.*	**Frontstage Touchpoints** • Audible pedestrian signals at crosswalks. • Ambient sounds of traffic, crowds, and station announcements spilling outside. • The physical architecture of the entrance (e.g., wide opening, automatic doors) and identification signs. • The distinct change in acoustics from outdoors to indoors.	**Frontstage Touchpoints** • Ticket Vending Machine (TVM) • Spoken instructions from the TVM's audio interface. • The physical counter of an information/ticket booth. • The voice and instructions of a station agent. • Costumer Information screen (CIS) • Wayfinding directional signs ⚠ Accessible technology preserves independence; without it, or with untrained staff, users are left vulnerable, forced to seek help for basic tasks.	**Frontstage Touchpoints** • The physical structure of the standard and wider accessible fare gates. • The specific (tactile) location of the card reader. • The audible beep and visual light confirming a successful tap. • The physical movement of the gate opening and closing. • Wayfinding signs for confirmation ⚠ This is a high-speed, high-stress interaction with physical risk. A backstage software bug or a poorly maintained sensor can cause a frontstage collision, public embarrassment, and physical danger.	**Frontstage Touchpoints** • Wayfinding signs at decision and confirmation points. • The physical handrail of a staircase. • The elevator call button, braille panel, and onboard audio announcements ("Platform level, doors opening").		**Frontstage Touchpoints** • Presence of warning signs at the platform edge. • The real-time display for timetable • The sound of the approaching train. • Audio announcements for the train's line and destination. • The audible sound signaling doors are opening/closing. • The physical gap between the platform and the train.	**Frontstage Touchpoints** • Automated onboard audio announcements for the next station. • Handrails, poles, and other stability aids. • Designated priority seating areas. • The ambient noise of the train in motion. • Real-time display with next station names. ⚠ Information ensures safety: users rely entirely on the automated announcement system to track their location, and any failure, silence or wrong stop, leaves them disoriented.	**Frontstage Touchpoints** • Onboard announcement for the arrival station. • Directional and orientation signage and announcements indicating "Exit" versus "Transfer to Line M2." • Stairs/Elevators to the concourse level.	**Frontstage Touchpoints** • Wayfinding signs at decision and confirmation points. • The physical handrail of a staircase. • The elevator call button, braille panel, and onboard audio announcements ("Platform level, doors opening").		**Frontstage Touchpoints** • The exit fare gates. • The audible beep confirming the journey is complete. • Wayfinding signs	**Frontstage Touchpoints** • Directional signs leading to a specific exit. • Costumer information screen (CIS) • The final set of doors to the street. • The reappearance of outdoor sounds, smells, and air.
Backstage Processes *Includes all the internal processes and activities that are not visible to the customer but are necessary to deliver the service.*	**Backstage Processes** • Municipal Public Works department installs and maintains sidewalks and tactile paving. • City traffic department maintains audible signals. • Architectural design and adherence to accessibility building codes (e.g., NEN standards, CRPD). • Regular maintenance schedule for automatic door mechanisms.	**Backstage Processes** • IT department's software development and updates for TVM and CIS accessibility features. • Procurement policy that mandates the purchase of accessible hardware. • Staff training programs on accessibility and customer assistance.	**Backstage Processes** • Fare collection system software and payment processing network. • Hardware maintenance schedule for gate sensors and mechanisms. • System parameters defining gate speed and open-duration. • Security monitoring of the fare gate area.	**Backstage Processes** • Station strategy plan and universal design standards for wayfinding. • Third-party contractor for elevator inspection and maintenance. • Staff responsible for keeping pathways clear of obstacles and hazards. • System for reporting and tracking out-of-service elevators. ⚠ This is the core navigational task. The reliability of backstage systems (like elevator maintenance) is paramount. A single failure, like a broken elevator, can render the entire journey impossible and represents a service failure for the user.		**Backstage Processes** • Vehicle design specifications that aim to minimize the platform gap. • Real-time train tracking data feeding the display and announcement system. • Automated door control system logic and timing. ⚠ Information ensures safety: users rely entirely on the automated announcement system to track their location, and any failure, silence or wrong stop, leaves them disoriented.	**Backstage Processes** • GPS-linked automated announcement system and its software. • Real-time train tracking data feeding the display and announcement system • Vehicle maintenance schedule to ensure interior fittings are secure. • Service policies regarding priority seating. • Central transit control managing train schedules and routes.	**Backstage Processes** • Station planners who designed the flow for transfers and exits. • Signage strategy that differentiates between different journey paths. • Real-time information systems that announce connecting train statuses. ⚠ Backstage planning shapes the frontstage; poor layouts or unclear signage cause errors, delays, and frustration.	**Backstage Processes** • Station strategy plan and universal design standards for wayfinding. • Third-party contractor for elevator inspection and maintenance. • Staff responsible for keeping pathways clear of obstacles and hazards. • System for reporting and tracking out-of-service elevators. ⚠ This is the core navigational task. The reliability of backstage systems (like elevator maintenance) is paramount. A single failure, like a broken elevator, can render the entire journey impossible and represents a service failure for the user.		**Backstage Processes** • Fare collection system logic that calculates the fare and logs the exit. • Maintenance and monitoring of the exit gates.	**Backstage Processes** • IT department's software development and updates for TVM and CIS accessibility features. • Architectural design of exit routes. • Exit signage strategy. • Cleaning and maintenance to ensure exits are not blocked or hazardous. ⚠ This is the final "goodbye" from the service. A clear, well-marked, and unobstructed exit path reinforces a positive overall experience and successfully delivers the user to their final destination, completing the service promise.
Emotions ⓘ This is a specific example of the emotional journey that can be felt, and it is used to help emphasize with the user. Please consider that it may vary from person to person. If possible, consider involving directly targeted users to understand deeper their experience.	Positive: Focused; Unbothered Negative: Frustrated; Careful, trying not to get stressed				Uncomfortable; Stressed, always had to double check	Stressed but relieved once he is in the right place	Very focused during the entire trip, can't relax	Annoyed; Disoriented	Relieved because he took the right direction		Reassured once he sees the red lights of the check out. Frustrated: he has to double check all the signs to understand the direction to take	Focused to exit the right direction	Calmed down: the journey is over
Critical Pain Points	**Critical Pain Points** • **VI:** The sudden change from bright sunlight to a dim interior causes temporary blindness and disorientation. • **LL:** Immediately upon entering, the user is faced with a wall of text-heavy signs and complex maps, creating instant information overload and a sense of being overwhelmed.	**Critical Pain Points** • **VI:** The Ticket Vending Machine (TVM) is a flat touchscreen with no tactile markers or audio output, making it completely unusable. • **LL:** The user feels shame or embarrassment having to ask for help with a "simple" task like buying a ticket, potentially leading them to abandon the journey.		**Critical Pain Points** • **VI:** The tactile path ends abruptly in the middle of an open concourse, leaving the user feeling stranded and completely lost. Or, it leads directly into a temporary obstacle. • **VI:** Directional signs hanging too high. • **LL:** The wayfinding system relies on reading signs with line names. The user cannot differentiate between lines and takes the wrong path.	**Critical Pain Points** • **VI:** The elevator is out of service, and there is no audio announcement or sign to indicate its status or direct the user to an alternative, forcing a long and frustrating search.	**Critical Pain Points** • **VI:** Platform announcements are drowned out by noise, or omitted entirely. User have to rely on platform display which is too small. • **LL:** Two trains for different lines use the same platform. The only differentiator is text on the front of the train, which is unreadable.	**Critical Pain Points** • **VI:** The metro is crowded, making it hard to hear the audio announcements. The digital map is too small. • **LL:** The digital map is complex or broken. Announcements too fast or not audible or says only station names, which the user doesn't know or can't match to their destination on a map, leading to anxiety about when to get off.		**Critical Pain Points** • **VI:** The concourse level area is disorientating, there are no clear and consistent directional signs. • **LL:** Transfer signs use only text ("Transfer to Lines M51, M53"). The user doesn't know which letter corresponds to their desired destination line.		**Critical Pain Points** • **VI:** The tactile path leads to an exit that is unexpectedly closed for maintenance, with no alternative path provided. • **VI/LL:** The station has multiple exits, all labeled with street names (e.g., "Exit A - Main St.," "Exit B - Park Ave."). The user has no way of knowing which exit leads to their actual destination (e.g., the bus stop). They emerge onto a completely unfamiliar street, feeling disoriented. • **LL:** The user needs to find a specific bus stop after exiting, but all directional signs are text-only, making the final part of the journey an exercise in stressful guesswork.
Supporting Actions ⓘ The supporting actions here are specific for Dutch metro stations. They can be used as inspiration, also for other context within public transportation, but not as guideline references. Consult the recommendation cards for more detailed information.	**Supporting Actions** The service must be identifiable without reading (tactile and auditory/ symbolic). Reduce cognitive load from the very first step. An easy-to-navigate entrance minimizes initial anxiety for everyone, allowing users to focus their mental energy on the more complex tasks ahead.	**Supporting Actions** This is a major barrier for both groups. A text-heavy interface is a hard stop. The goal is independence. A well-designed TVM and CIS with audio and symbolic interfaces empowers users. Otherwise, they are forced into a potentially stressful human interaction where they may feel vulnerable.	**Supporting Actions** The action must be intuitive and the feedback unambiguous. This reduces hesitation and the risk of error or collision, especially in a crowded environment.	**Supporting Actions** This is where redundancy is most critical. A user who cannot read signs (LL) must be able to navigate by color and symbol. A user who cannot see color (VI) must be able to navigate by tactile path and sound. The system is only truly accessible when multiple, overlapping navigational aids are present.	**Supporting Actions** This is the final confirmation before committing to a vehicle. The cost of error is high. Information must be provided in both audio (for VI) and large visual formats (for LL) to prevent mistakes.	**Supporting Actions** The system must continuously answer "Where am I?" for all users. For VI users, this is auditory. For LL users, it can be a simple, dynamic visual that doesn't rely on text.	**Supporting Actions** Reduce the potential for error at a complex decision point. By using distinct tactile patterns and clear, universally understood symbols, the system can guide users with confidence, preventing them from getting lost. Consider using floor directional signs to help users find their way out.	**Supporting Actions** This is where redundancy is most critical. A user who cannot read signs (LL) must be able to navigate by color and symbol. A user who cannot see color (VI) must be able to navigate by tactile path and sound. The system is only truly accessible when multiple, overlapping navigational aids are present.	**Supporting Actions** Provide a clear and satisfying end to the paid portion of the journey, leaving no ambiguity.	**Supporting Actions** The service's responsibility is to connect the user to the city. Landmark-based symbolic signage is far more useful for LL users than street names and provides valuable context, ensuring a successful end to the entire journey.

Figure 27: Knowledge Tool.

(visually imapaired and low literate people), with data-driven components, including the emotional curve derived from user observations and field research. This dual structure allows designers to navigate seamlessly between broad patterns and detailed, situational data.
The different levels of detail within the tool are explicitly indicated, enabling its use both as a high-level strategic overview and as a source of in-depth reference information. Feedback from this evaluation session confirmed the effectiveness of this configuration: designers reported that the "shape" of the tool is intuitive and easy to navigate, as it aligns with familiar visual formats and practices commonly used in design processes.
This familiarity enhances usability, allowing teams to focus on interpreting insights rather than learning a new framework.
Overall, this version works as a strategic reference document to support design and implementation.

Second round of Evaluation Session

The second part of the evaluation session took place after refining the components of the framework with the first round of feedback received. By doing that, it was possible to "confirm" if the design of the components was aligned with the previous feedback received. In this "second round" the focus was mainly for the Participatory Tool, in which the designers from Fabrique checked if the tiles were effectively suitable for co-creation sessions with non-designers stakeholders.
The main feedback received were related to clarity:

- Identify the stakeholders who could be involved in the co-creation (since the stakeholder map was done during the research process, this information can be integrated into the instructions).
- Define the outcomes of the session, both for designers and stakeholders, for instance, what the next steps in the process should be.
- Explain how the insights gathered from the session can be combined with the knowledge tool.

Another important feedback was to reconsider the question placed on the back of the tile. The previous version: "What could be the main user actions at this stage?" might limit participants' thinking and discourage exploration of broader solutions. During the evaluation session, designers suggested reframing this participatory moment asd a brainstorming activity with stakeholders, focusing on removing barriers and improving navigation. Possible alternative question could be "How might we help the user at this stage?" or "What could be the improvements here?".
By using this type of open-ended question, it becomes easier to initiate discussion and gather valuable insights from participants. It also makes the session more engaging, as participants feel actively involved in the design process.
Feedback from designers indicated that they find the structure of the tiles effective: they are tangible and easy to use. The illustrations and reflective descriptions help emphasise the situation, and the instructions are a valuable element, especially for preparing the facilitator before the session.

The feedback received were essential to have a clear picture of designer's needs, as well as their expertise to understand how to best make the various components of the framework work within their workflow.
The following section explain and shows the final version of the Participatory Tool, improved with the feedback received from the designers of Fabrique.

7.1.2 Participatory Tool

The reason behind the inclusion of a participatory component within the framework was influenced by two main factors. Firstly, as argued by Visser et al. (2005), the understanding of the context (intended as all the aspects that affect the experience of a product/service) helps designers in promoting empathy with other participants and to avoid reliance on assumptions. In this way, the development of innovative concepts regarding the experience of a product is possible. Secondly, the use of participatory elements is necessary to be able to bring the tacit knowledge of participants into the light. This happens because often people have valuable experiences and ideas, but they are not consciously aware of or they can not easily explain them (Eliasen & Lykke, 2024).

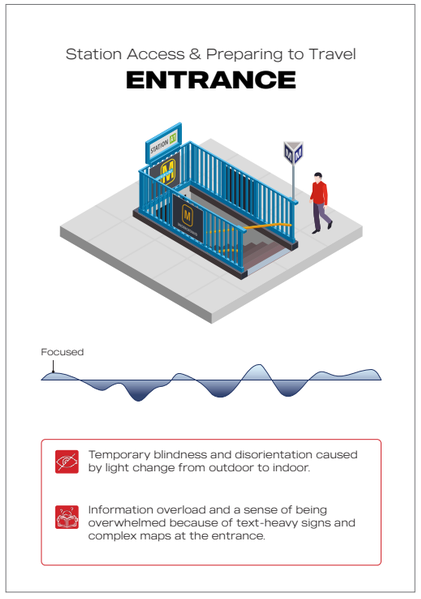
The Participatory Tool was generated with the intent of creating a space for understanding, in which participants could brainstorm together and share their knowledge, experience and ideas. For example, stakeholders such as transport authorities understand the system through data, regulations, and budgets, while users experience it through a complex web of emotions and sensory inputs.
The physical tiles of the participatory tool serve as a methodological bridge to connect the end-users' lived experience information of the Knowledge Tool into a compelling format for stakeholders. They act as tangible proxies for the user's voice, transforming their tacit feelings of stress and disorientation into structured, visible problems that stakeholders can see and address.
While the tool is envisioned to function effectively even when only designers and stakeholders are present, it is most powerful when end-users are included in the session. In this context, the tool facilitates a direct dialogue, allowing stakeholders to hear firsthand experiences and collaboratively explore solutions.
This process creates a shared language and a common ground, shifting the conversation from mere compliance to genuine human-centred problem-solving.
As previously mentioned, the tool reflects the data presented in the Knowledge Tool, translating its journey stages, user actions, and pain points into an intuitive, tangible format designed for co-creation workshops with clients and stakeholders. This facilitates an inclusive dialogue by removing barriers for non-designers. Structurally, the tool consists of 13 tiles each representing a phase of the metro journey (see Figure 28), and a manual of instruction for the facilitator (see Appendix F for all the tiles and the manual of instructions).
The configuration of the tiles is the following:

- Front: a visual illustration of the journey stage paired with concise experiential insights (emotions and critical pain points) to foster empathy and engagement.
- Back: a curated prompt (a reflective description and a question) designed to encourage a structured, reflective dialogue and promote multi-perspectival insights.

The manual provided is meant to guide designers in facilitating the participatory session. It begins with an introductory section clearly stating the activity's

objective. Following this, the manual offers suggestions on how to facilitate the session, including ideas on engaging stakeholders and ways to “break the ice”. Specifically, it suggests the use of “simulators’ to help participants empathise with end users and better understand their challenges and needs.
These simulators include two prototypes: one mimics the vision of individuals with visual impairments, and the other simulates the reading difficulties faced by low-literate individuals. This one is designed as a “mirrored’ version, which increase the cognitive effort required for reading. Additionally, the manual provides advice on the facilitator’s mindset and practical tips for effectively collecting information during the session. To help participants who become “stuck” in reflection or for generating discussion, provocative questions are included to spark conversation or assist in idea generation. Lastly, a complete list of guiding principles is provided for easy reference, especially during the development of opportunities.

The strategic objective of the Participatory Tool is to close the perceptual gap between stakeholder assumptions and the authentic lived experience of the end-user. It serves to brainstorm and gather qualitative data in an emotionally resonant way, moving beyond problem diagnosis to actively generate valuable insights and identify potential opportunity areas.
By promoting empathy and fostering a shared understanding, the tool becomes an essential component for executing inclusive, human-centred design processes that are grounded in reality and focused on innovation.



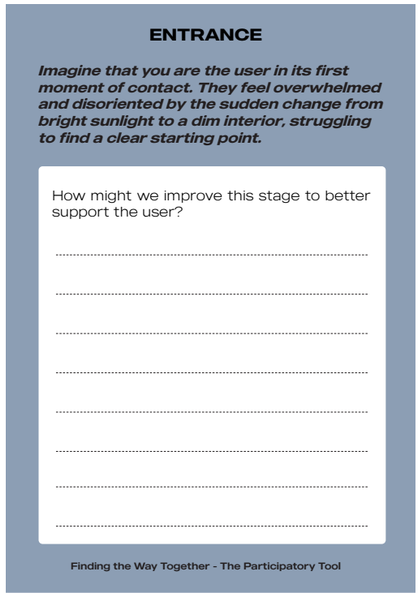
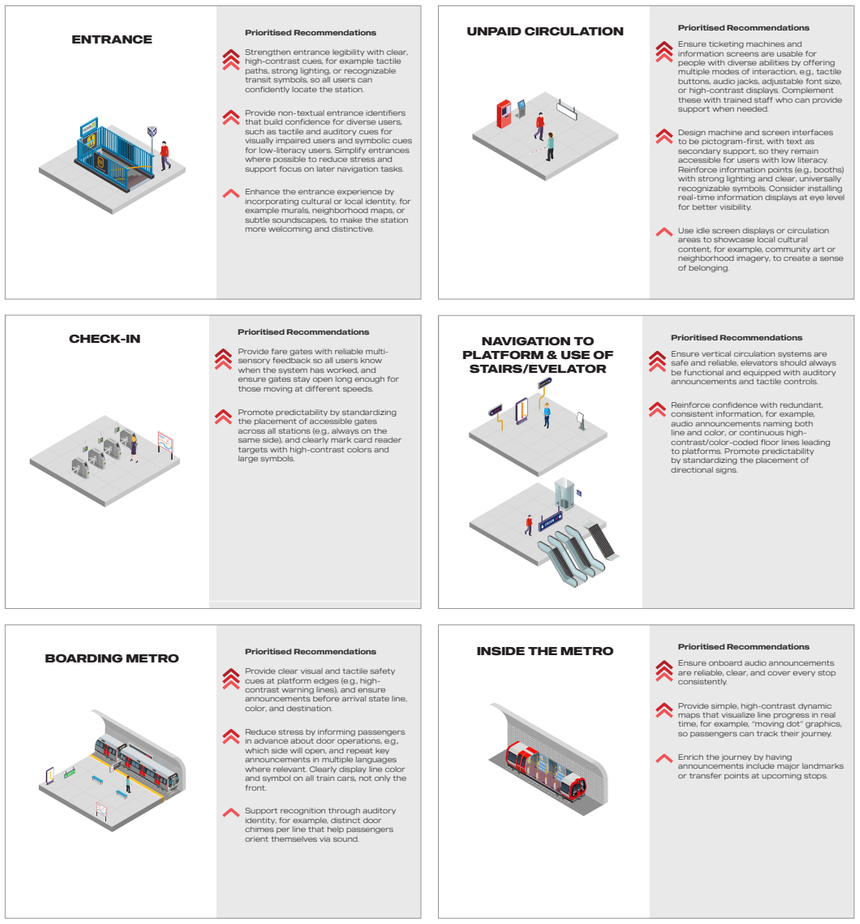


Figure 28: Example of one tile that forms the Participatory Tool.

7.1.3 Recommendation Cards

To complement both tools, a set of Recommendation Cards was developed (see Figure 29). Each card elaborates on a supporting action, detailing why it matters, and how it can be prioritised. The cards are organised by priority level, enabling practitioners to quickly distinguish between fundamental requirements and enhancement opportunities.
In the Knowledge Tool, the cards act as a bridge between analysis and action, helping practitioners move from diagnosing issues to implementing solutions. In the Participatory Tool, the cards provide a practical hint for discussion, allowing participants to connect their reflections directly to concrete, actionable steps.



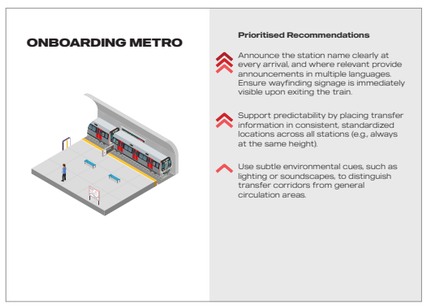


Figure 29: Recommendation Cards.

Complementary System

When used together in a design process, the Knowledge Tool and the Participatory Tool create a complementary system that bridges analysis and action.
The Knowledge Tool functions as a strategic and analytical reference, providing evidence-based insights from research, while the Participatory Tool translates this information into an interactive format that stimulates discussion, reflection and collaboration.
The Recommendation Cards serve as a support, connecting these two layers: they convert insights into concrete, actionable guidance that supports decision-making during ideation and implementation.
This integrated framework enables design teams to move easily from understanding complex systemic challenges to engaging stakeholders in meaningful dialogue and co-creation, and finally to identifying practical design directions.
At the core of this system lies empathy: not only as an emotional response but as a methodological principle that guides designers and stakeholders to understand, share, and act upon users' perspectives.
By raising empathy through tangible, shared tools, the design process becomes more inclusive, reflexive, and grounded in real user experiences.

7.2 Flexibility of Use

The proposed framework "Finding the Way Together" is ideate to be flexible and adaptable in its use across different phases of the design process.
By following the double diamond framework, in the first phase of it, design practitioners are encouraged to involve clients and other stakeholders (e.g., targeted users, municipality, etc) by using the Participatory Tool, supported by the Recommendation Card set when needed.
In this stage of the design process, the tool is necessary to set the scene and frame the context through open exploration and dialogue.
Fostering empathy and reflection helps participants build a shared understanding of the problem space, aligning around user needs and priorities, avoiding surface assumptions. In the second phase of the design process, design practitioners shift towards the Knowledge Tool, again supported by Recommendation Cards. This supports deeper design exploration and connects research and co-creation session insights with actionable design solutions.

While this framework offers a suggested sequence of use, it is intentionally non-prescriptive. Because of the tools' degree of flexibility, design practitioners can modify their use to suit various project sizes, contexts, and situations.
For instance, practitioners may decide to invert the order of use in the design process, or combine simultaneously the tools into a singular workshop. Its openness ensures that the framework can evolve with practice, supporting a range of design approaches while maintaining its core emphasis on empathy, inclusivity, and shared understanding.
Lastly, the framework's adaptability positions it as a valuable asset not only for this specific project but also for broader applications within the public transportation domain.

7.3 Scenario Application

To demonstrate the different usage of the Knowledge Tool, scenario applications are provided to show how to move from problem to solution, and its value in a design process. For these scenarios, it is assumed that the co-creation session with stakeholders (using the Participatory Tool) has already been done, and insights of that session are merged with information from the Knowledge Tool to explore opportunities. The flexibility of the framework's tools allows them to be adapted based on the needs of the designer and the project. In fact, it is possible to use it in its entirety or focus solely on specific sections. For example, for the Knowledge Tool, by following the horizontal axis, the designer can examine the user's actions concerning emotions and critical points; or, by following the vertical axis, it is possible to concentrate on a particular step of the journey, analysing each element of the Knowledge Tool in depth.

Example 1: Scenario for Horizontal Crossing

Goal of the Designer: to follow part of the journey of a Visually Impaired Persona (made-up name: Lucas) from left to right across the "Finding the Way Together" knowledge tool, and use its insights and recommendations to systematically redesign the experience.

Stage: Entrance

- Lucas' issue: he feels overwhelmed and lost in the wide, anonymous concourse, with no clear starting point. He can only see the big sign ("M") outside. He needs to be extra focused.
- Design Process: by checking the user action and critical pain points, the hidden entrance is confirmed. By checking the recommendation card, the designer read the first two tiers, which advise to strengthen entrance legibility and provide non-textual identifiers, such as auditory and symbolic cues.
- Potential solutions: first, a backstage policy change: all station entrances must have a big sign on the floor that indicates the entrance side (big, high-contrast symbol) that indicates the direction from the public sidewalk. Second, installing a subtle auditory beacon, that emanates from above the main automatic doors. This transforms the entrance from an invisible hazard into a discoverable auditory landmark.
- Value: the tool "forces" the designer to think multi-modally.

Stage: Unpaid Circulation

- Lucas' issue: he usually has his OV card charged, to avoid using the ticket vending machine (TVM), but today he forgot it at home, so he needs to buy a ticket. The problem is that the ticket machines are touchscreen only and font size is too small, making them impossible to use for him and he doesn't like to ask for help.
- Design Process: by looking at the Front stage touchpoint, it mentions that TVM should have spoken instructions from the audio interface, but the current design doesn't have it. Furthermore, it should be important to consider the font size adjustment choice.

Figure 30: Knowledge Tool, horizontal crossing.

Critical Pain Points

- **VI:** The sudden change from bright sunlight to a dim interior causes temporary blindness and disorientation.
- **LL:** Immediately upon entering, the user is faced with a wall of text-heavy signs and complex maps, creating instant information overload and a sense of being overwhelmed.

Frontstage Touchpoints

- Ticket Vending Machine (TVM)
- Spoken instructions from the TVM's audio interface.
- The physical counter of an information/ticket booth.
- The voice and instructions of a station agent.
- Costumer Information screen (CIS)
- Wayfinding directional signs

Accessible technology preserves independence; without it, or with untrained staff, users are left vulnerable, forced to seek help for basic tasks.

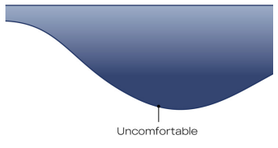


Figure 31: Elements of the Knowledge Tool.

Figure 32: Knowledge Tool, vertical crossing.

- Potential solution: redesign the TVM including spoken instructions and/or buttons to ask for help and make the screen interface adaptable in terms of font size and color contrast.
- Value: the User Action layer reveals that the TVM is 100% inaccessible for a user group, but also that the human help should be easily findable as well. The frontstage touchpoint helps the designer understand which elements are not currently present in the design of the TVM.

Stage: Navigation to the platform

- Lucas' problem: the tactile path is just a simple, straight line. It doesn't tell him when he is approaching a critical junction. The station-wide announcements are a confusing mess of overlapping sounds, creating auditory chaos. He always has to double-check the signs using his phone camera zoom.
- Design process: the emotional curve, together with the critical pain point layer highlights that the tactile path ends abruptly and that the directional signs are hanging too high. With the use of the recommendation card for this stage, it is clear what needs to be prioritised. It suggests different ways for consistent information and reinforce confidence, for example, by having continuous high-contrast/color-coded floor lines leading to platforms. It also suggests predictability by standardizing the placement of directional signs.
- Potential solution: introducing a tactile path with a new texture, a "decision point" texture, that alerts blind and visually impaired users to the upcoming junction. Moreover, the designer can consider having standardise directional signs also at eye-level height. Another potential solution for audio chaos, is to integrate assistive technologies, such as the NFC tags. Tapping his phone to the tag will instantly trigger the phone's screen reader to announce clear, simple, private instructions.
- Value: it focuses the design effort on mitigating the direct cause of a negative emotional spike, and helps give priority. It provides different perspectives to solve issues and leads to a synergy between the physical and digital worlds.

Example 2: Scenario for Vertical Crossing

Goal of the Designer: to follow a step of the journey of a Low Literate Persona (made-up name: Maya) from top to bottom across the "Finding the Way Together" Knowledge Tool, to deeply understand all the elements, emotions, critical points and actions that could be taken to improve the wayfinding system in that specific stage.

Macro Stage: Pre-boarding navigation

- The Moment: Maya has just successfully passed through the Check-in fare gates. She knows she has to reach Platform 11. She now stands in a wide, busy hall facing a critical junction where the path splits left and right. She freezes, trying to figure out which way to go.

- Design Process: the designer starts by looking at the user action layer in the tool. It states that the user is supposed to “Follow the primary wayfinding system… Pauses at decision points to gather information…” Maya is doing exactly this: she has paused and is desperately trying to gather information. However, her next action is to look around in confusion. The design does not support the very action it requires and is failing on her.

- Frontstage Touchpoint: the tool prompts the designer to experience the frontstage as Maya does, and lists the available touchpoints. The only touchpoint that contains the specific information Maya needs is text. The frontstage offers no alternative pathway to understanding for a non-reader. It is a mono-sensory design in a multi-sensory world.

- Backstage Processes: by looking at the backstage processes, the designer can “diagnose” that the current strategy is the root problem. The signs are likely written with an “average” literate user in mind and have no policy requiring pictograms, symbols, or multi-modal information redundancy. The designer checks with stakeholders and sees that the maintenance schedules don’t include checks for the legibility of signs for different user groups, only for their physical integrity. The system is maintained, but its usability isn’t.

- Emotional Layer: by consulting the emotional layer, the designer can build their case for change. It shows a marked drop from “Careful” to “Uncomfortable”. Maya is not only functionally stuck, but she is having an important negative experience.

- Critical Pain Point: this layer confirms and synthesizes the findings, which shows that there is a combination of signage failure and too little information (for a non-textual user).

- Final Analysis: the system makes a dangerous assumption: that all users can read. When that assumption fails, the entire wayfinding system collapses, leaving the user stranded.

- Proposed solution: the designer, with the help of recommendation cards can redesign the overhead signs. Text becomes secondary. The primary information is conveyed through large, high-contrast platform numbers paired with a universal metro pictogram and a simple arrow. The designer can use the entire diagnosis to advocate for a fundamental change to the signage strategy document, mandating a “pictogram-first” approach for all future wayfinding projects.

- Value: it transforms a vague problem of confusing signs into a specific diagnosis. The tool provides both the “why” of the problem and the “what” of the solution. In this way, it pushes the designer to look beyond the user-facing elements and identify the root cause in the company’s internal policies. This means that the potential solution is not a temporary fix but a sustainable, systemic improvement.

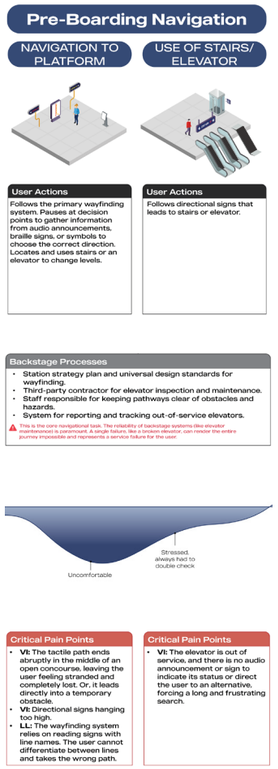


Figure 33: Elements of the Knowledge Tool.

7.4 Main Takeaways

The Final Design chapter presents the final design outcome, “The Strategic Framework: Finding The Way Together,” which serves as the comprehensive answer to the main research question. The most significant takeaway is that the outcome is not a traditional, static guideline but a complementary and dynamic system of tools.
At its core, “Finding the Way Together” is a tangible design, developed to bridge the critical gap between research, design, and stakeholder decision-making. The framework consists of three integrated components:

- The Knowledge Tool: an internal, research-based reference for design teams. It combines the structure of a journey map with a service blueprint to provide a deep, evidence-based analysis of the user experience, highlighting critical pain points and emotional lows for users with visual impairments and low literacy.
- The Participatory Tool: a set of physical tiles designed for co-creation workshops with stakeholders. This tool translates complex user insights into an accessible, tangible format, fostering empathy and creating a shared language. It transforms abstract problems into visible challenges that stakeholders can collectively see, discuss, and address, moving the conversation from compliance to genuine problem-solving.
- The Recommendation Cards: a set of actionable prompts that support both tools. These cards bridge the gap between analysis and action, offering concrete, prioritized suggestions to guide ideation and implementation.

The choice of physical tools is intentional, fostering a more democratic and intuitive dialogue. The rationale behind its embodiment in physical, tangible formats was directly informed by both the literature (Sanders & Stappers, 2012) and practitioners’ feedback. While acknowledging the utility of digital tools for other tasks, this project argues for the unique power of physical artifacts in the early, exploratory phases of co-creation. The physical tools are designed to create a more democratic and intuitive “language” (Eliasen & Lykke, 2024), fostering empathy and enabling a richer dialogue among diverse stakeholders, including non-designers.
Together, these components form a complementary system that guides practitioners from deep analysis to collaborative engagement and, finally, to actionable design.
The framework is designed for flexible application within established design processes, such as the Double Diamond. Its value is demonstrated through practical scenarios that show how a designer can use the tools to move methodically from identifying a user’s pain point to diagnosing the root systemic cause and developing multi-modal, empathetic solutions. By making empathy a methodological principle, “Finding the Way Together” equips designers and stakeholders not just with a process, but with a new perspective to create a more inclusive and navigable public transport experience for everyone.

The framework’s inherent flexibility, demonstrated through the application scenarios, validates its potential as a valuable asset that can be adapted to various project contexts, empowering designers to transform abstract legal obligations and user needs into concrete, inclusive travel experiences.

↘ Conclusions

This last chapter brings the research journey to a close by synthesizing its key outcomes, generating reflections on the work carried out.

The first section opens with the Discussion. In which the strategic framework is proposed within the context of the literature and the expert interviews, providing a justification for its core principles and design choices.

Following this, project's limitations are discussed, acknowledging the boundaries that shaped the research, such as time restrictions, and sensitivity of the people involved.

In the 8.3 section, suggestions for potential project advances have been developed, to encourage future researchers to investigate further more on how to build upon this work and explore new frontiers in inclusive wayfinding.

Lastly, a Personal Reflection has been made, to retrace the moments that shaped somehow, the process of the project, such as the people involved, the working environment and the insightful moments that contributed to the in-depth analysis of the important theme chosen for the project.

8.1 Discussion

This research set out to answer the question: *How can inclusive design be strategically implemented to improve wayfinding in Dutch metro stations for people with visual impairments (VI) and low literacy (LL)?*
The investigation moved beyond a search for singular design fixes, aiming instead to develop a process-oriented solution that could empower design practitioners to create more equitable and accessible public transport environments. This section discusses the final outcome, the "Finding the Way Together" strategic framework, by interpreting its core principles and structure in the context of the theoretical foundations and research findings that shaped its development.

The primary conclusion of this research is that the strategic implementation of inclusive design is best achieved not through a prescriptive set of rules, but through a structured, empathic, and participatory process. The developed framework, is the tangible manifestation of this conclusion. It answers the "how" by providing practitioners with a system of tools that bridges the gap between abstract user needs and concrete design actions. This approach directly challenges the prevailing "compliance-driven" model of accessibility, which, as the research confirmed, often results in fragmented and emotionally stressful user experiences that fail to look "beyond compliance".
The framework's structure, a comprehensive Knowledge Tool for internal analysis and a Participatory Tool for stakeholder engagement, is the response to the multifaceted role of the modern designer, who must act as a researcher, facilitator, and advocate. This approach is influenced by the principles of co-creation, where tangible tools serve as "convivial artifacts" that enable a shared, democratic dialogue, a concept heavily supported by the work of Sanders & Stappers (2012). In this way, the framework's structure and content are rooted not only in theory but are validated and enriched by the lived experiences uncovered through this research.
The framework implements key theoretical concepts that were crucial in comprehending the wayfinding challenge.

Wayfinding as a Cognitive and Emotional Journey
The literature defines wayfinding as a cognitive process reliant on mental mapping and environmental cues (Lynch, 1960; Passini, 1981), involving distinct stages from orientation to destination recognition (Klimek, 2025). As Passini (1996) argued, these challenges become psychological barriers just as obstructive as physical ones. The "Finding the Way Together" framework operationalises this insight by structuring its analysis around user emotions and pain points. Its prioritisation scale, particularly Tiers 1 (Safety & Clarity) and 2 (Comfort & Independence), provides practitioners with a clear mandate to design not just for functional efficiency but for psychological comfort and confidence.

Operationalising the Travel Chain
The Travel Chain concept, which states that a journey is a sequence of interconnected links (Carlsson, 2004), was foundational. The research validated the criticality of what Park & Chowdhury (2018) and Maynard (2009) describe as "accessible journey chain", confirming that a failure in any single link renders the entire trip very challenging. The framework translates this theory into a practical diagnostic tool. Its journey-based structure allows designers to systematically identify these weak links within the metro environment. By mapping backstage

processes to frontstage touchpoints, the tool encourages practitioners to diagnose root causes, such as the inadequate maintenance or fragmented information systems highlighted by Saarela & Partanen (2024), rather than just treating symptoms.

Embodying Inclusive Design Approach
The thesis makes a deliberate choice to adopt an Inclusive Design approach, focusing on fulfilling as many users' needs as possible rather than seeking a single universal solution. The final framework is a direct embodiment of this approach, which actively avoids the "bolt-on" accessibility solutions that often lead to isolated and stigmatizing user experiences (Iwarsson & Stahl, 2003). Moreover, the needs of the selected secondary target groups (Visual Impaired and Low Literate people) can be potentially extended to a broader range of users, such as older people and non-native speakers.

Strategic Framework Value
The framework is designed to create value for the key actors responsible for shaping public spaces.
For Design Practitioners, the framework serves as both a shield and a sword. It is a *shield* in that it provides an evidence-based, structured methodology that protects designers from their own unconscious biases, which the literature identifies as a primary source of exclusion (Microsoft Design, 2016), and what one interviewee called their "blind spots". It is a *sword* in that it equips them with a compelling, visual, and human-centred narrative to advocate for deeper inclusivity with clients. By framing accessibility through user stories and emotional journeys, the tool helps elevate the conversation about inclusivity from an optional expense to a core component of high-quality service design, as interviewees suggested was a key "responsibility" of designers.
For Transport Authorities and Municipalities, the framework offers a methodology to address the systemic issue of fragmented governance and inconsistent standards identified in the research. While it cannot change wayfinding systems overnight, it provides a consistent, transferable process that could be adopted across different cities (e.g., GVB in Amsterdam, RET in Rotterdam) to align their wayfinding strategies. By fostering collaboration between designers, authorities, and user representatives, the framework promotes a bottom-up approach that can inform more effective, human-centred policies.
It demonstrates a pathway to move beyond a patchwork of inconsistent solutions toward a more seamless and equitable public transport network, fulfilling the need for wayfinding systems to be *"designed with inclusivity and continuity in mind"* (Jost et al., 2024).

In conclusion, this research demonstrates that the strategic implementation of inclusive design requires a fundamental shift: from a process where inclusivity is an add-on, to one where it is embedded from the very beginning.
The "Finding the Way Together" framework facilitates this shift by providing the language, the process, and the tools necessary to place empathy, collaboration, and lived experience at the very heart of the design process itself.

8.2 Limitations

While this study aims to offer a meaningful contribution to inclusive wayfinding in public transportation, several limitations that can occur must be acknowledged. The geographic focus is restricted to metro stations in the Netherlands, and therefore, the findings may not be directly transferable to other types of transit environments outside the country.
Additionally, although the research seeks to incorporate the voices of individuals who experience navigation-related difficulties, access to participants was limited due to ethical sensitivities, recruitment challenges, and time constraints. As a result, the user insights collected may not fully represent the diversity of impairments types or difficulty profiles. Since the project is also shaped by the timeframe of a 100-working-day academic schedule, this limited its scope to the development of the strategic framework, especially the Participatory Tool, which should be further tested and delve deeper into each phase.
Furthermore, while the outcome aims to align with national and European accessibility regulations, it does not cover the full technical or legal depth required for compliance auditing or infrastructural engineering.
Lastly, due to language barriers, certain language-specific accessibility challenges may not be addressed in full detail. The decision to focus on visual impairments and low literacy meant that other disability groups were not examined in detail. Time constraints limited the scope of evaluation, which relied primarily on design expert feedback and not transport authorities.

8.3 Future Research

Regarding future research, what could be valuable to further explore, in order to strengthen the proposed framework, would be:
Firstly, it would be important to test the framework in a real-world design project, as well as expand the research around the Participatory Tool.
Then, involving a broader spectrum of users (for example, people with temporary and situational impairments), to assess how improvements informed by the tools positively impact the overall journey experience across diverse population needs.
Another aspect to consider would be having direct engagement with transport authorities to further enhance the practical relevance and adoption of the framework, to ensure alignment with technical and operational priorities and constraints.
Moreover, investigating budgetary and resource limitations could inform strategies to optimise the framework's implementation within different organisational contexts.
Lastly, by applying the framework in different settings (within the public transportation domain), it would allow researchers to validate its adaptability and scalability, helping them to identify potential refinements to maximise its relevance in a diverse transport system.
To conclude, these suggestions for future research could contribute to a more robust and widely applicable framework for inclusive wayfinding design.

8.4 Personal Reflection

To conclude, I would like to reflect on my path during this project thesis. Talking about inclusivity and try doing it right is complex. Especially when it comes to public spaces, such as public transport in this case.
This thesis project was born not from an academic prompt, but from a place of personal frustration. It stems from observing the way exclusion is designed into our public spaces, with a perception of what is "normal" that leaves many people behind. Accessibility should be an undoubted right, yet seeing people unable to use services that are meant to be for everyone generated a sense of injustice in me. The decision to tackle this complex issue, without a direct request from transport authorities or municipalities, was a conscious choice to turn that frustration into a constructive mission.

During this journey I had the opportunity to witness important transformations, both in others and in myself. During interviews for example, I saw stakeholders who had never explicitly linked their roles to inclusivity begin to reflect on their responsibilities and engage in new and important discussions. This was a great reminder to me that change often starts with a single conversation.
My understanding of inclusive design has expanded in depth. Despite having already had previous experience, this thesis gave me the opportunity to deal with the enormous complexity of organizations such as GVB and RET. I learned how their complex systems can inadvertently create barriers for implementation of inclusive navigation solutions.

Working in the stimulating environment of Fabrique was fundamental to this process. The opportunity to meet and learn directly from people with lived experience during accessibility talks was not only enlightening, but also transformative. Their stories and feedback were decisive in shaping the final picture, ensuring that it was grounded in genuine human needs.
I would like to sincerely thank my Fabrique colleagues for their willingness to share ideas, points of view, challenge my perspective and forcing me to reflect for every decision I made. Thank you for engaging with curiosity with the topic of my thesis, it was profoundly helpful and inspiring. Being surrounded by curious and engaged designers who took a genuine interest in the thesis project gave me a great sense of hope for the future of inclusive design. It confirmed that deeper insights emerge not in isolation, but through dialogue and shared exploration.

This project was not designed as a definitive answer, but as a catalyst for continued dialogue and action. My ambition is for the "Finding the Way Together" Strategic Framework to empower other designers and stakeholders, triggering meaningful reflections that lead to systemic change in the real world.
Looking to the future, this thesis consolidates my direction and purpose as a designer. It reinforced my belief that our role goes beyond creating artifacts; we are facilitators of understanding, we challenge assumptions and we advocate for a more fair world. I am committed to bringing the principles and energy of this work into my career, helping to shape a future where inclusive design is not an afterthought, but a standard practice.

Figure 34: Monthly Meetup at Fabrique.

Figure 35: GAAD Meetup (Abra, 2025).

Figure 36: Evaluation session at Fabrique.

Figure 37: Accessibility talk at Fabrique.

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↘ Appendix

A. Design Project Brief

DESIGN FOR our future

TUDelft

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:
- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name [redacted]
Initials
Given name
Student number

IDE master(s) IPD ☐ Dfl ☐ SPD ✔
2nd non-IDE master
Individual programme *(date of approval)*
Medisign ☐
HPM ☐

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair [redacted] dept./section SDE/XInD
mentor dept./section HCD/HICD
2nd mentor
client:
city: country: The Netherlands
optional comments

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.
! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.
! 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in **by the Chair** of the supervisory team

Sign for approval (Chair)
[redacted]

CHECK ON STUDY PROGRESS
To be filled in **by SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total ____ EC
Of which, taking conditional requirements into account, can be part of the exam programme ____ EC

★	YES	all 1st year master courses passed
	NO	missing 1st year courses

Comments:

Sign for approval (SSC E&SA)
Name [redacted]

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES		Supervisory Team approved
NO		Supervisory Team not approved

Comments:

Based on study progress, students is ...

	ALLOWED to start the graduation project
	NOT allowed to start the graduation project

Comments:

Sign for approval (BoEx)
Name [redacted]

DESIGN FOR our future

TUDelft

Personal Project Brief – IDE Master Graduation Project

Name student [redacted]

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title **Designing Accessible Navigation Strategies**

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Accessible wayfinding in public transportation is crucial for autonomy and social inclusion, especially for individuals with disabilities. Beyond physical infrastructure, access to clear, usable information is equally essential (Boadi-Kusi et al., 2023), and information barriers can significantly hinder travel experiences (Mwaka et al., 2024).
According to Park and Chowdhury (2018), the link between the built environment and public transport must be seamless for the whole journey. This is referred to as the 'accessible journey chain' (see Fig. 1).
The focus, therefore, is on wayfinding, which is the process of orienting and reaching a destination (Passini, 1981). This is highly dependent on the availability and accessibility of such information, especially in complex transportation environments such as train and metro stations (Prandi et al., 2021).

This master's thesis aims to improve information access through inclusive wayfinding design in public transport hubs. Its primary goal is to develop a strategic framework, supported by a practical toolkit to guide professionals in implementing accessible wayfinding systems.

Key stakeholders will include individuals with disabilities, transportation authorities (such as GVB and NS) and design agencies. Each has distinct interests, and understanding their perspectives is essential to developing wayfinding strategies that effectively balance usability, compliance, and practicality.
The research supports the European Accessibility Act 2025, which standardises accessibility requirements (European Accessibility Act, 2025). By focusing on wayfinding, it contributes to more inclusive public spaces.
Conducted in collaboration with Fabrique, a Strategic Digital Design agency in the Netherlands, this study benefits from their UX and digital innovation expertise in public settings. Their involvement ensures the framework is grounded in real-world insights and applicable across diverse transit environments.

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introduction (continued): space for images

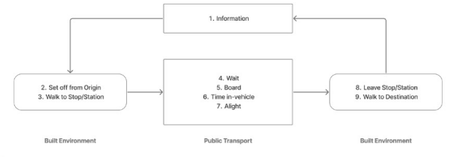


image / figure 1 The Accessible Journey Chain (Park & Chowdhury, 2018)

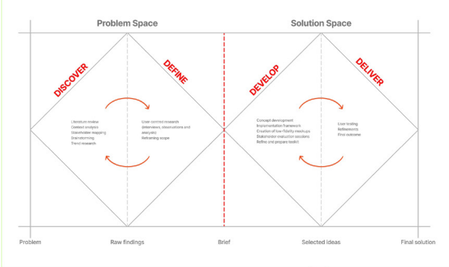


image / figure 2 Design process following the Double-Diamond (Design Council, n.d.)

DESIGN FOR our future

TUDelft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

I aim to address the challenge of insufficient accessible wayfinding systems in public transportation hubs, which limit independence in mobility and access to information for individuals with sensory, cognitive, and mobility impairments. This is because many public spaces lack clear, consistent, and multimodal navigation aids (Park & Chowdhury, 2018).
Within the 100 working days available,my primary goal is to design a strategic framework that supports the implementation of accessible wayfinding solutions. I will focus on developing a design implementation plan that provides practical, research-driven strategies for improving accessibility in wayfinding systems. I see an opportunity to add value for key stakeholders, such as individuals with disabilities (seeking greater independence and ease of movement), transportation authorities (who must comply with accessibility regulations) and design agencies (who aim to create functional and inclusive spaces, focusing on innovative and user-friendly solutions). This approach not only supports compliance with the European Accessibility Act 2025 but also helps create more inclusive and user-friendly public environments.
Collaborating with Fabrique ensures that my research remains industry-relevant, bridging academic insights with real-world applications. This collaboration allows them to gain insights and inspiration on how they can improve accessible wayfinding for other clients and in future projects. Simultaneously, their involvement will allow me to benefit from their expertise and so gain a better understanding of (technological) innovation and UX in public spaces.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for.
Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design wayfinding strategies, including design guidelines and concept sketches/visual prototypes, to support stakeholders and design agencies in improving inclusive and accessible navigation solutions for people with disabilities, in public transportation hubs.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

For my thesis, I will follow a double-diamond approach (see Fig. 2) to develop accessibility-focused wayfinding strategies. In the Discover phase I will conduct a literature review and a context analysis, analyzing existing wayfinding systems, universal design standards and best practices. During the second phase I will focus on user-centered research, including interviews and observations, to understand the needs of individuals with sensory, cognitive, and mobility impairments. Based on these insights, in the Develop phase, I will start developing potential implementation solutions, using human-centred design and inclusive design principles. Low-fidelity prototypes will be created to visualize ideas, which will be refined through stakeholder feedback and iterative testing. The last phase will consist of a strategic implementation plan with guidelines, templates, and visual prototypes, ensuring practical applicability.
The expected outcome of this project is a strategic framework, supported with a practical toolkit, that empowers end users such as designers and planners to create more accessible and inclusive wayfinding systems, with a strong emphasis on providing clear and navigable information for a wider range of people.
The aim is to develop the strategic framework into a visual product such as a map/template and the practical toolkit into a (digital) booklet.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a ***kick-off meeting****,* ***mid-term evaluation meeting****,* ***green light meeting*** *and* ***graduation ceremony****. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	2 May 2025
Mid-term evaluation	10 Jul 2025
Green light meeting	2 Oct 2025
Graduation ceremony	6 Nov 2025

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	✔
For how many project weeks	25
Number of project days per week	4,0

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

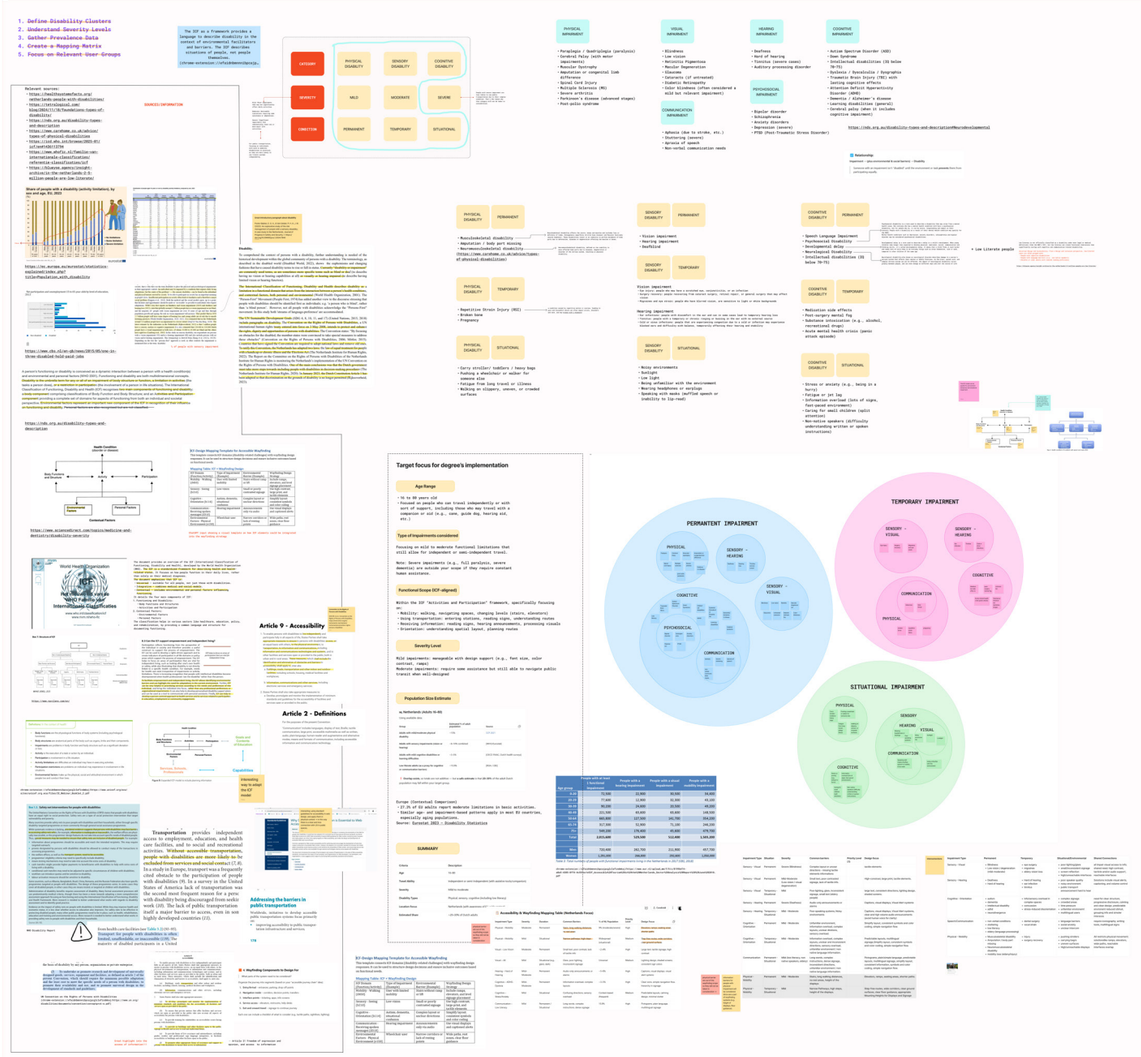
As a Strategic Product Design student, I am particularly interested in how design can go beyond aesthetics to serve a meaningful purpose, interconnecting the needs of people with the needs of organizations. This project allows me to merge my passion for design with my growing interest in accessibility, creating solutions to guide professionals to improve navigation for individuals with sensory, cognitive, and mobility impairments.
My previous experience in my bachelor's graduation project, where I designed an accessible graphic poster for blind and visually impaired individuals, sparked my curiosity about inclusive and accessible design. Now I will have the opportunity to shift from a product to a space, and I want to expand this approach by exploring how wayfinding systems can be visually and functionally optimized to create more inclusive public spaces.
By combining graphic design, user-centered research, and strategic thinking, I aim to develop a strategic plan that enhances accessibility and demonstrates its potential social impact.

Personal Learning Ambitions:

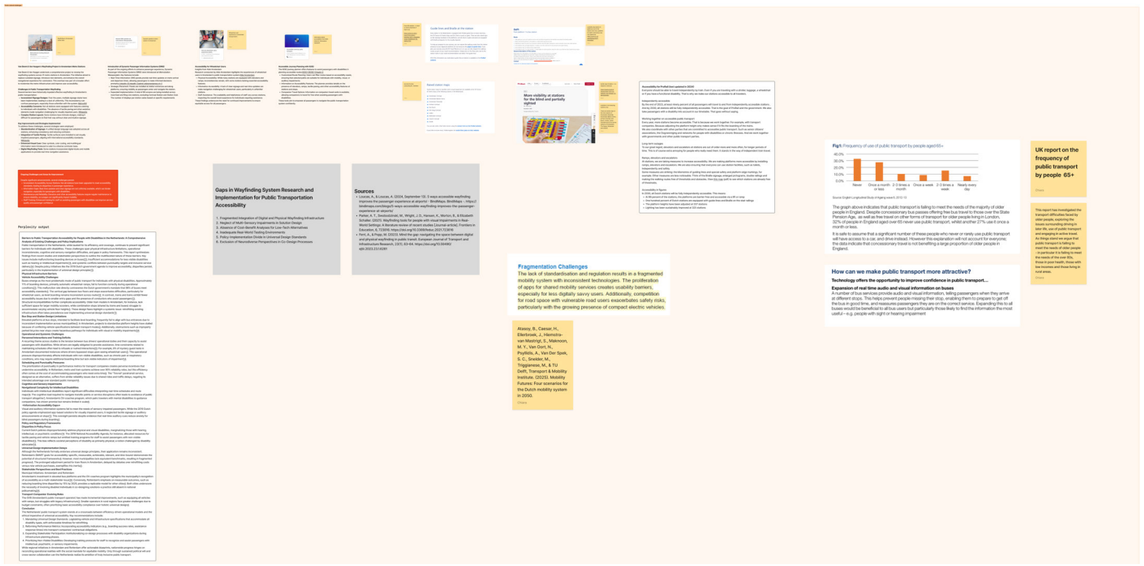
- Collaborating with industry experts to learn how to work effectively with professionals from agencies like Fabrique, integrating academic research with industry expertise to develop practical and impactful design solutions.
- Gaining in-depth knowledge and building expertise in the topic through direct interaction with professionals.
- Building a professional network with key stakeholders in the strategic design sector to create potential future job opportunities.

B. DESTEP and Stakeholders Analysis

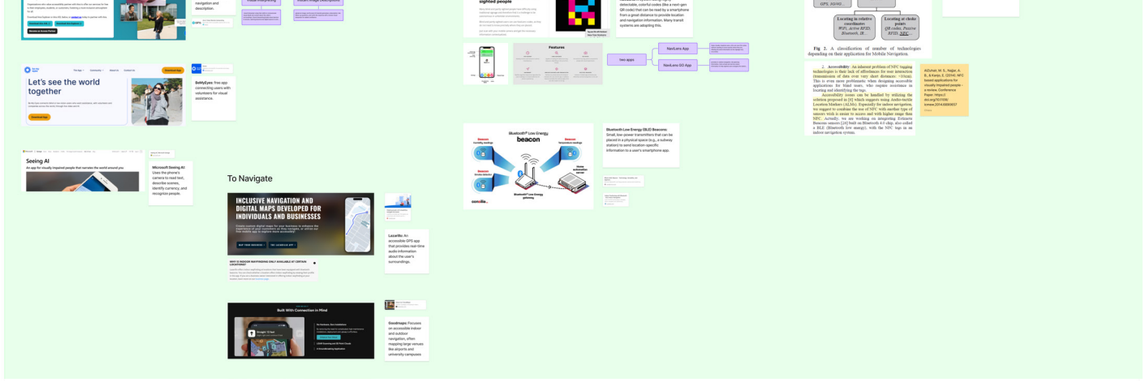
Demographic



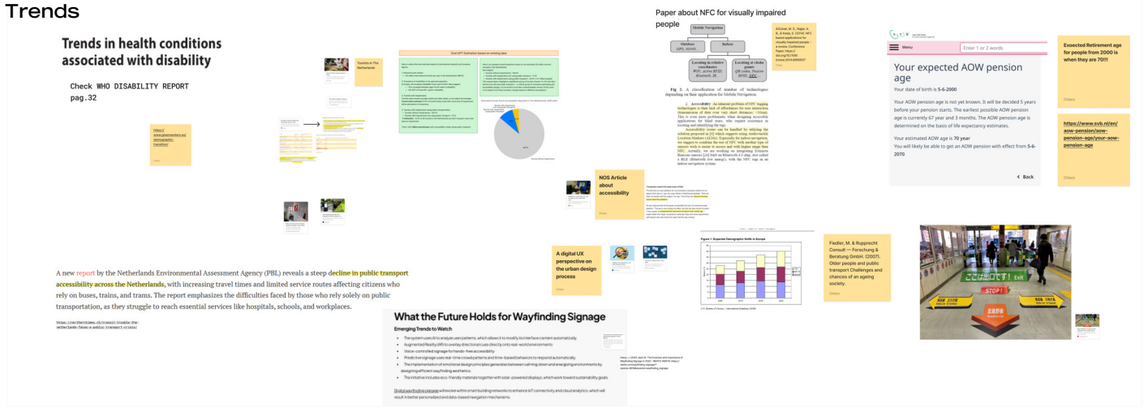
Socio-economical



Technological

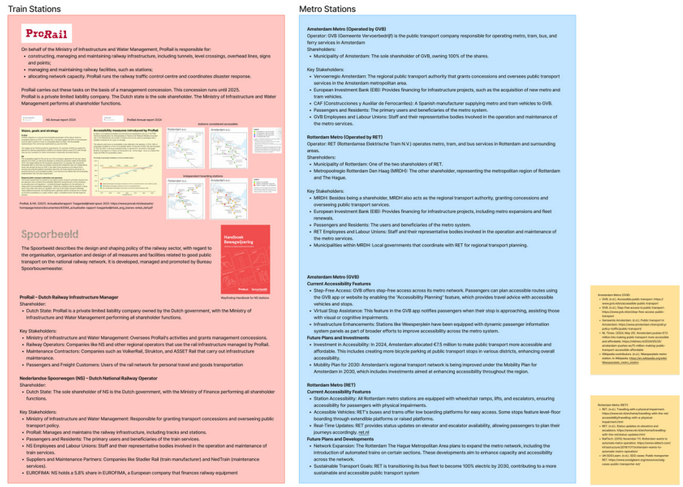


Trends



A new report by the Netherlands Environmental Assessment Agency (PBL) reveals a steep **decline in public transport accessibility across the Netherlands**, with increasing travel times and limited service routes affecting citizens who rely on buses, trains, and trams. The report emphasizes the difficulties faced by those who rely solely on public transportation, as they struggle to reach essential services like hospitals, schools, and workplaces.

Environmental

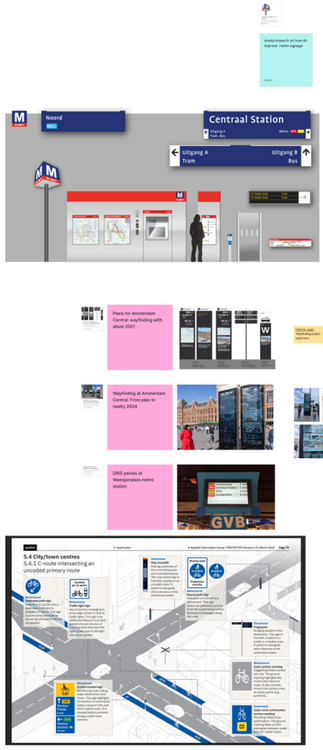


more interesting to explore solutions in this context

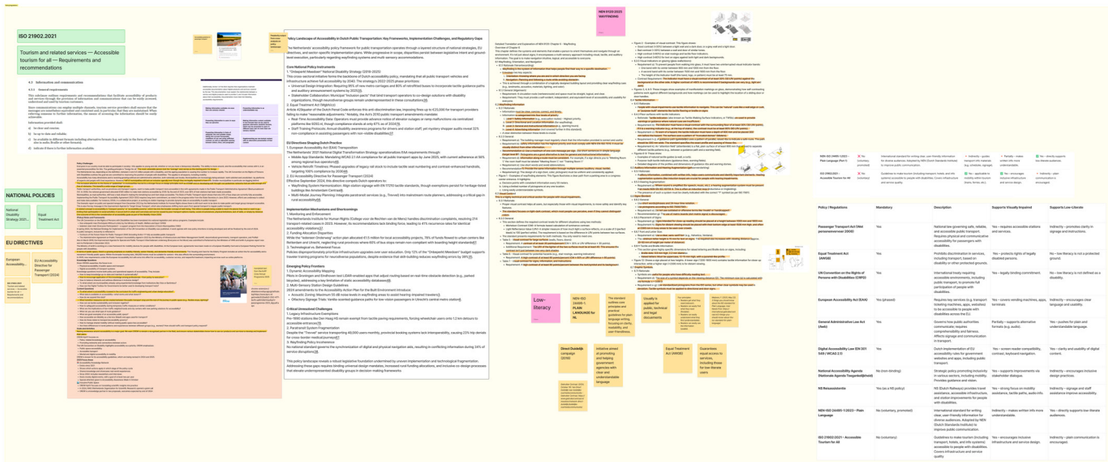
Main differences

Criteria	Train Stations (NS)	Metro Stations (GVB)
Information Access	High: multilingual signs, apps, staff support	Moderate: digital displays, app, limited live help
Audio Announcements	Frequent, sometimes bilingual	Minimal, mostly Dutch
Step-Free Access	Partial; may need help boarding trains	High; level boarding standard in most metro stations
Tactile Guidance	Widespread in major hubs	Expanding, more present in new lines
Human Assistance	Available on demand via NS service	Rare; metro is largely self-service
App Support	NS app: trip planning, accessibility booking	GVB app: step-free route planning, stop alerts

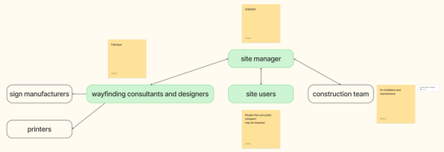
Key points for metros
→mostly dutch announcements
→mostly self-service
→ municipaly manage differently
→



Policy / Regulations



Stakeholders



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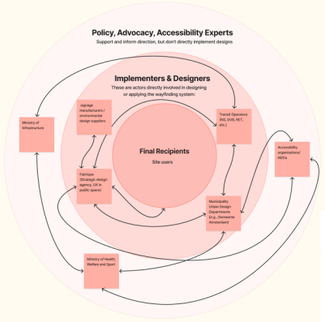
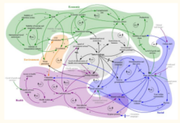
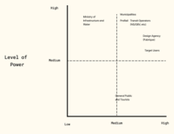
Stakeholder Type	Example Entities	Role in Implementation
Government bodies	- Ministry of Infrastructure and Water Management (IenW) - Dutch Ministry of Health, Welfare and Sport (VWS)	Set national accessibility policy, funding frameworks, and regulation enforcement.
Municipal authorities	- Gemeente (local municipalities) e.g., Gemeente Amsterdam, Gemeente Rotterdam	Urban planning, wayfinding infrastructure, signage approval and implementation.
Public transit authorities	- NS (Dutch Railways) - GVB (Amsterdam) - RET (Rotterdam) - Arriva, Connexxion	Manage public transportation systems, passenger information, and in-station navigation.
Design & Innovation agencies	- **Fabrique** - Other spatial and UX design studios - Accessibility consultants	Design user experience in public space, lead accessibility-focused design interventions.
Accessibility NGOs and advocacy groups	- Ieder(in) - Accessibility.nl - Oogvereniging (Dutch Eye Association)	User representation, legal advocacy, inclusive design evaluation and feedback.
Users	- People with disabilities - Elderly - Tourists - Non-native speakers	Key testers and co-creators of wayfinding systems. Feedback loop for continuous design.

Stakeholder	Interest	Power	Role	Engagement Strategy
Fabrique (Design Agency)	High	Medium	Co-designer, implementation partner	**Collaborate:** Regular check-ins, co-creation
Target Users (disabled, elderly, etc.)	High	Medium	End users, testers	**Involve:** Co-design sessions, user testing
Transit Operators (NS, GVB, RET, etc.)	Medium-High	High	Infrastructure implementers	**Manage Closely:** Strategy alignment, workshops
Municipalities (e.g., Gemeente Amsterdam)	Medium	High	Urban planners, signage owners	**Manage Closely:** Planning, permissions
Ministry of Infrastructure & Water (IenW)	Low-Medium	High	National policy, funding	**Keep Satisfied:** Report outcomes, align with regulations
Accessibility NGOs (Ieder(in), Oogvereniging)	High	Medium	Advocates, compliance feedback	**Consult:** Reviews, feedback, representation
ProRail (Railway infrastructure)	Medium	High	Station design and maintenance	**Manage Closely:** Planning and standards
App/platform developers (e.g., NS App)	Medium	Medium	Digital access providers	**Consult:** Coordinate for consistent wayfinding
General Public / Tourists	Low-Medium	Low	Indirect beneficiaries	**Inform:** Wayfinding visible and usable to all



+ avarage user





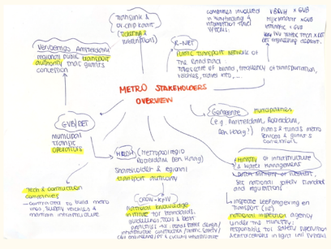
Target group specifications

In this research we will have two different target groups:

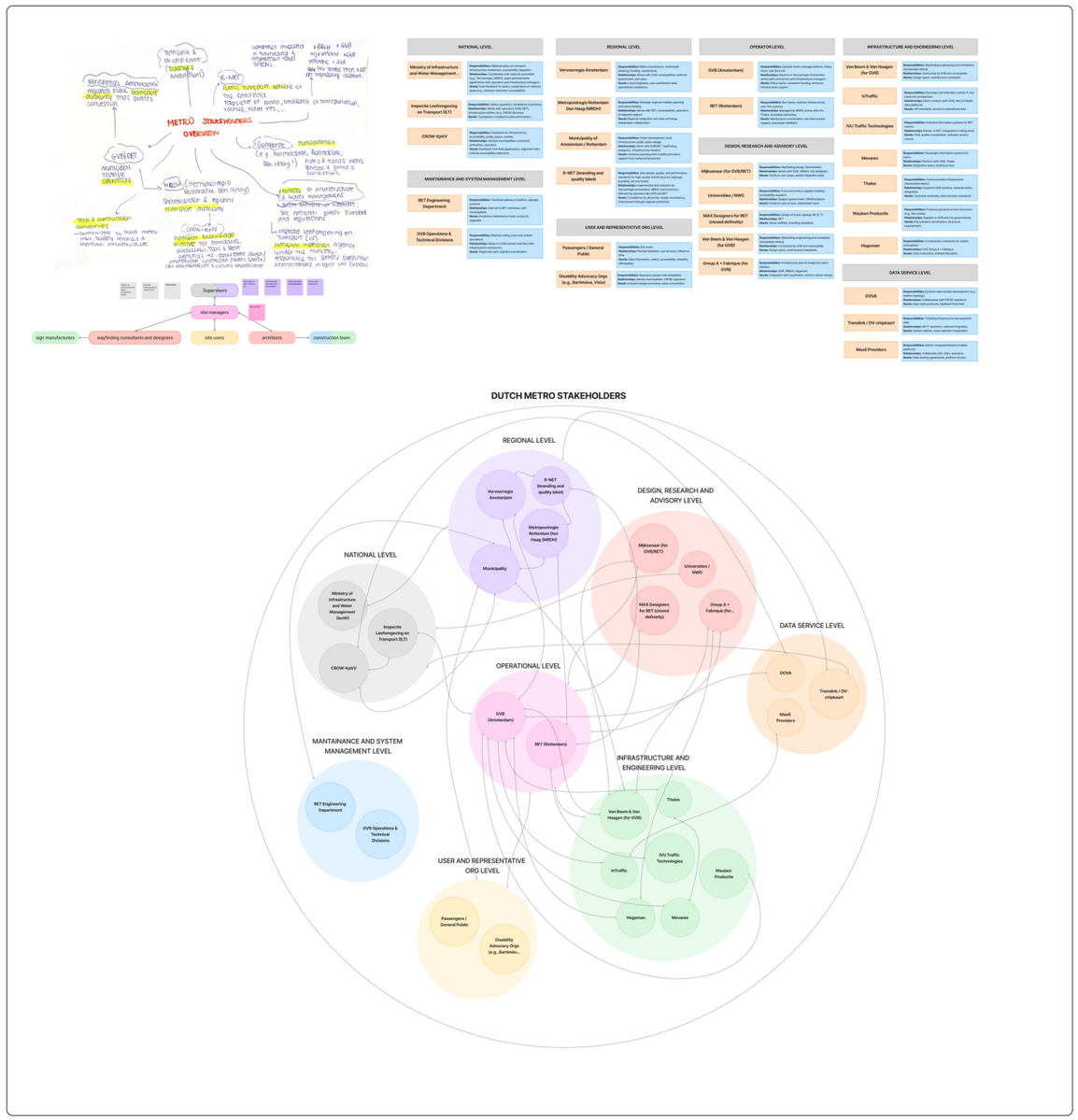
1. the first one, which will be called Primary Target Group, will comprehend the designers and professionals which will have to use directly the outcome of the project, in order to improve and implement accessible wayfinding solutions.
2. the second one, which will be called Secondary Target Group, will comprehend the people who will benefit from the implementation and improvement of accessible wayfinding, so people with impairments.

Why from the report of Navigating Diversity: Enhancing Inclusivity and Accessibility in Amsterdam through a serious game.

(look at Slack for reference, Chiara send it to you)



National Level	Regional Level	Operator Level	Infrastructure and Engineering Level
Ministry of Infrastructure and Water Management...	Vervoerregio Amsterdam	GVB (Amsterdam)	Van Boeen & Van Haagen (for GVB)
Inspectie Leefomgeving en Transport (ILT)	Metropoolregio Rotterdam Den Haag (MRDH)	RET (Rotterdam)	Infraffic
CROW-KpVV	Municipality of Amsterdam / Rotterdam	R - NET	IVU Traffic Technologies
MAINTENANCE & SYSTEM Management Level	R-NET (branding and quality label)	Design and research Level	Movares
RET Engineering Department	**USERS and REPRESENTATIVE ORGANIZATIONS Level**	Mijksenaar	Thales
GVB Operations & Technical Divisions	Passengers / General Public	Universities / NWO	Vauben
	Disability Advocacy Orgs (e.g., Bartimeus, Visio)	MAX Designers for RET (closed definetly)	**DATA SERVICES Level**
		Van Boeen & Van Haagen (for GVB)	DOVA



C. Interview Guide

Infrastructure/Mobility Expert

Section 1: Introduction & Context (5 minutes)
Purpose: To introduce the project scope and goals, establish the interviewee's experience in the context of mobility and complex projects.

1. Could you briefly describe your current involvement in projects related to mobility infrastructure or public transport architecture?
2. How do you see the role of wayfinding within complex public spaces like transit hubs?

Section 2: Understanding Spatial and Design Complexity (10 minutes)
Purpose: To explore how complexity is managed in mobility-related architecture and what opportunities or tensions exist when integrating inclusive design.

3. In your experience, what are some of the key spatial or architectural challenges when designing transit hubs for a broad and diverse public? 4. How do you typically approach the integration of different stakeholder requirements—including inclusivity or accessibility goals—in the early phases of a complex project?
5. Where do you see gaps in how wayfinding systems are considered in architectural design? Are they usually considered early on, or added later?

Section 3: Accessibility, Inclusion & Wayfinding (15 minutes)
Purpose: To discuss how inclusive design and accessibility are (or could be) embedded in complex building design, especially concerning cognitive and sensory impairments.

6. How do current architectural practices address information accessibility—for instance, signage, spatial logic, or user navigation?
7. Do you see a difference between meeting compliance standards (e.g. regulations) and actually designing for inclusion?
8. From your perspective, what would it mean to embed wayfinding systems that are truly accessible to people with visual impairments or low literacy levels?
9. How do you view the role of digital vs. physical wayfinding in future public infrastructure? Should they be integrated, or treated separately? 10. Can you recall any project (in your own work or others) where inclusive wayfinding was successfully addressed?

Section 4: Strategic Implementation & Design (10 minutes)
Purpose: To gather insight on what kind of strategic tools or frameworks professionals like her would find useful in practice.
11. What kind of tools, resources, or guidelines do architects or planners actually use when addressing accessibility challenges?
12. If a toolkit were to support professionals in making wayfinding more inclusive, what kind of format or features would make it genuinely usable (e.g., prioritisation matrix, scenario cards, checklists)?
13. What types of evidence or validation do you think are most persuasive in getting inclusive strategies adopted (e.g., user data, legal alignment, cost-benefit cases)?

Section 5: Closing Reflections (5 minutes)
Purpose: To collect final thoughts and possible suggestions for further development or contacts.

14. What advice would you give to someone designing for accessibility in public infrastructure—beyond compliance?
15. Are there specific colleagues, disciplines, or domains you think I should involve or consult as I further develop the framework?

Wayfinding/ Informational Expert

Section 1: Introduction & Context (5 minutes)

Purpose: To introduce the project scope and goals, establish the interviewee's experience in the context of mobility and complex projects.

1. Could you tell me a bit about your background in wayfinding design and the types of projects you worked on at Mijksenaar?
2. In your view, what are the biggest challenges in designing effective wayfinding systems in public transport spaces?

Section 2: Wayfinding in Public Transport Environments (10–15 minutes)
Purpose: To explore how complexity is managed in mobility-related architecture and what opportunities or tensions exist when integrating inclusive design.

3. How do you typically approach designing for large, multi-user public systems like metro networks?
4. Where in the design process are decisions about inclusivity usually made—or missed?
5. Have you noticed any patterns in how visual impairments or low literacy are accounted for (or overlooked)?
6. Can you describe a project where accessibility concerns played a central role in shaping the wayfinding?

Section 3: Inclusive Design in Practice (10–15 minutes)
Purpose: To discuss how inclusive design and accessibility are (or could be) embedded in complex building design, especially concerning cognitive and sensory impairments.

7. What does "inclusive wayfinding" mean to you from a design and implementation standpoint?
8. What are some common misconceptions that designers or clients have when trying to make signage accessible?
9. How do you balance clarity for all users with complex needs of specific groups?
10. Do you think current best practices—like those around typography, symbols, or redundancy—go far enough in supporting vulnerable users?

Section 4: Strategic Tools & Design Input (10 minutes)
Purpose: To gather insight on what kind of strategic tools or frameworks professionals like him would find useful in practice.

11. If you were handed a framework or toolkit to support inclusive wayfinding decisions, what would make it useful and credible for someone like you?
12. Would visual examples (e.g. before/after, good/bad signage) be helpful?
13. How important is it for designers to co-create with users like visually impaired travelers—or is this usually not feasible in practice?
14. What kind of evidence or testing would help convince clients or municipalities to adopt more inclusive wayfinding approaches?

Section 5: Closing Reflections (5 minutes)
Purpose: To collect final thoughts and possible suggestions for further development or contacts.

15. If you could give one recommendation to younger designers or public clients working on transport signage, what would it be?
16. Would you be open to reviewing or giving feedback on the framework once it's further developed?

User Expert

Section 1: Introduction & Context (5 minutes)
Purpose: To introduce the project scope and goals, establish the interviewee's experience in the context of mobility and complex projects.

1. Could you briefly tell me about your work and how you support companies in designing for accessibility?
2. How often do you use public transport, and specifically metro systems?

Section 2: Navigating the Metro: Challenges & Experiences (15 minutes)

3. When you travel by metro, what parts of the journey are the most difficult or stressful?
4. Are there any stations or features that you feel are particularly well-designed or helpful?
5. Can you share a situation where you felt disoriented or unsure of how to proceed in a station?
6. How do you usually orient yourself or find information when entering a new metro station?

Section 3: Interacting with Information (10–15 minutes)

7. What kind of information do you typically rely on when navigating a metro station?
8. Do you use any tools (digital or physical) to help you plan or carry out your trips?
9. How well do digital and physical information systems work together in your experience?
10. What's your experience with signage design—things like typography, placement, contrast, or readability?

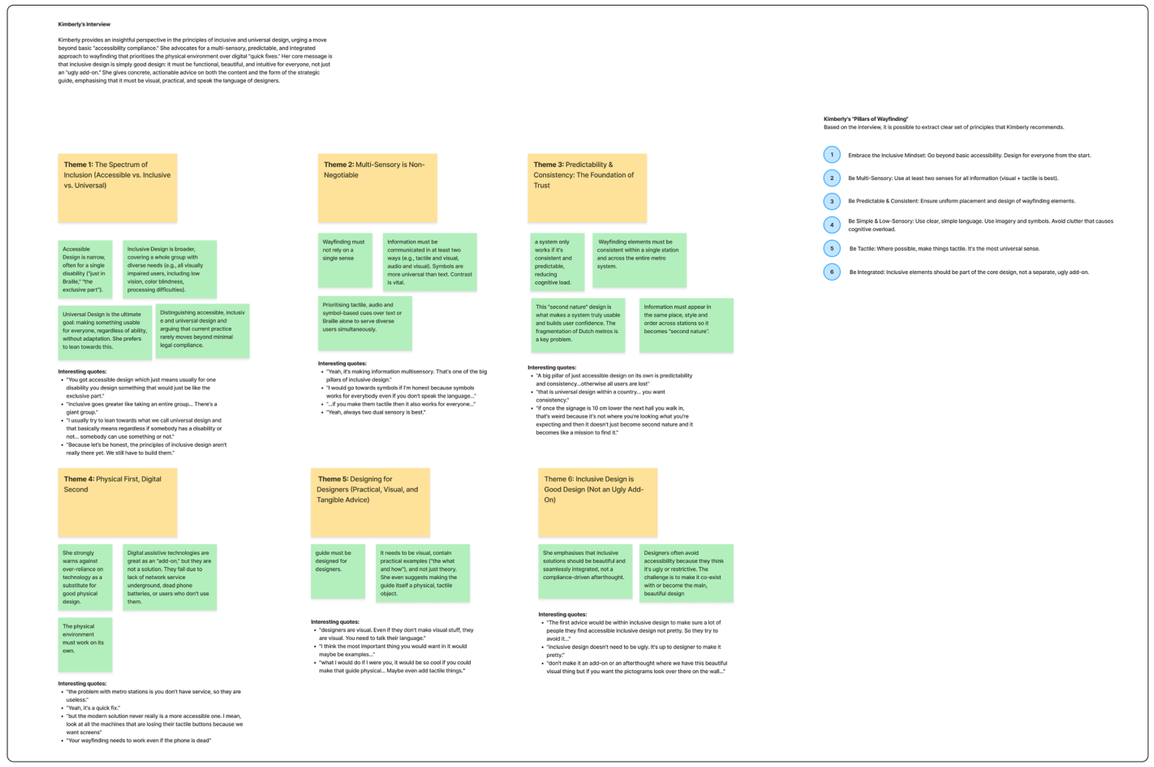
Section 4: Perspectives on Inclusive Design (5–10 minutes)

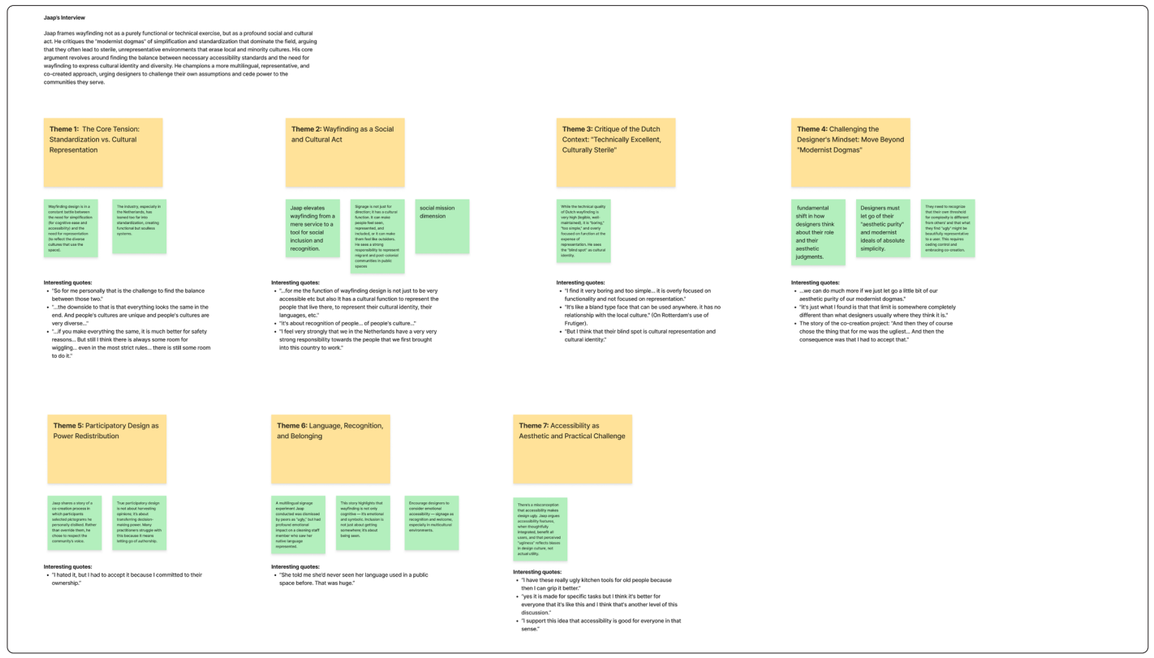
11. When you run workshops on accessibility, what are the biggest things you try to get designers to understand?
12. What does "inclusive wayfinding" mean to you personally?
13. Do you feel that your needs are considered during the design of public infrastructure—or more as an afterthought?

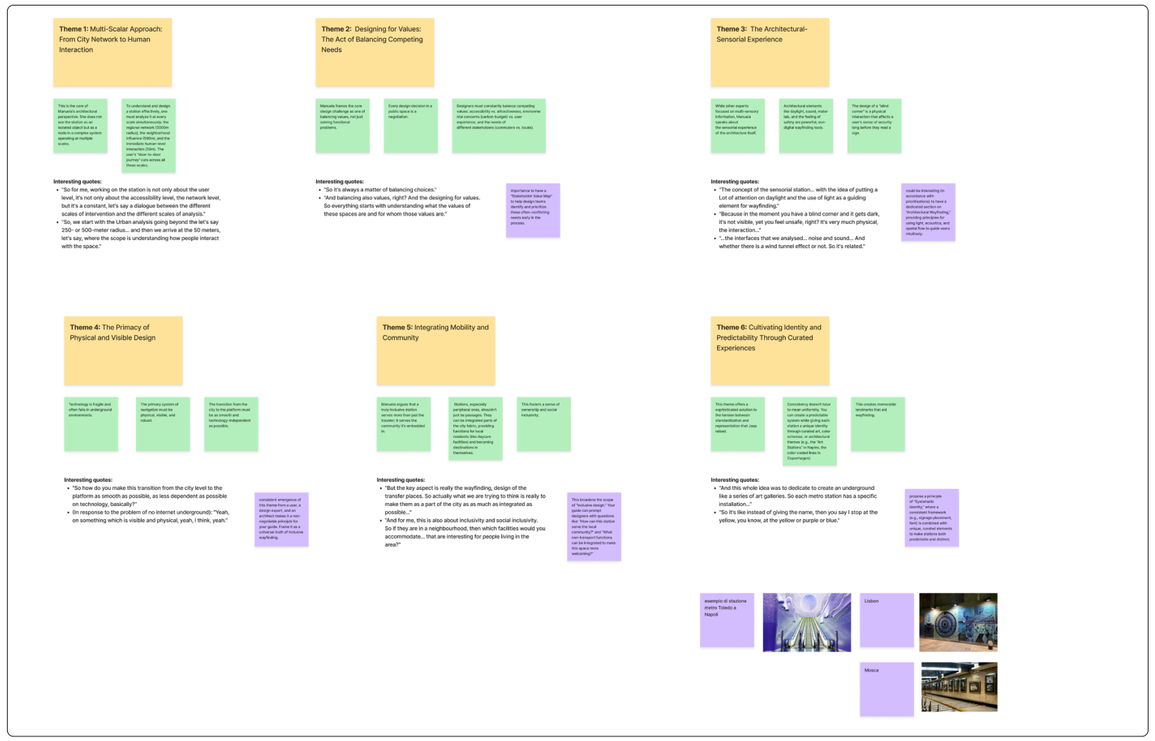
Section 5: Closing Reflections (5 minutes)
Purpose: To collect final thoughts and possible suggestions for further development or contacts.

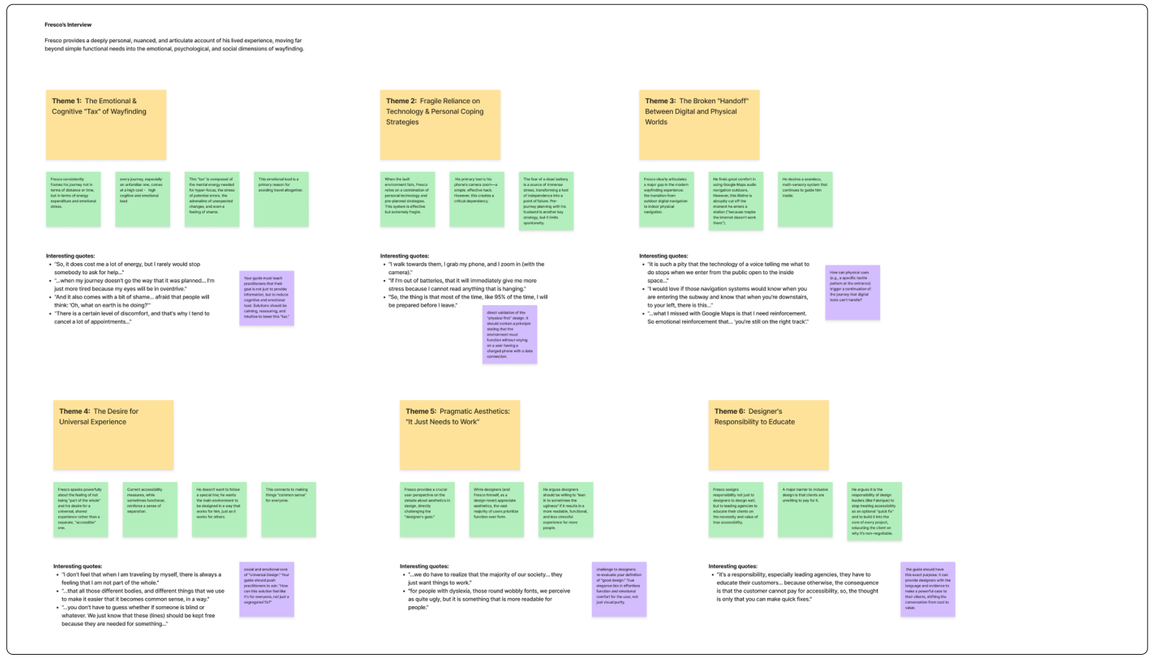
14. If you could tell designers or urban planners one thing to change or improve, what would it be?

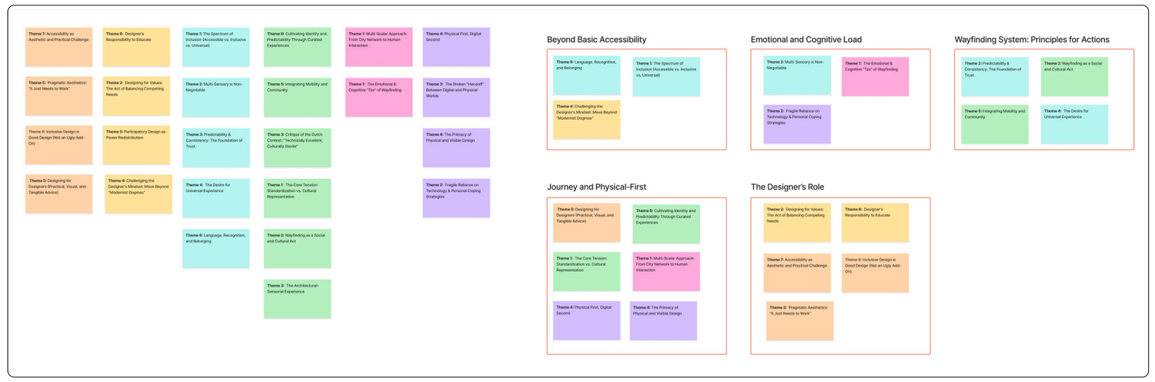
D. Thematic Analysis



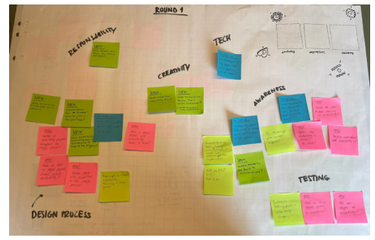


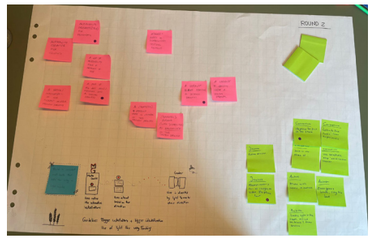






E. Co-Creation Session





F. Participatory Tool

Station Access & Preparing to Travel

ENTRANCE

Focused

- Temporary blindness and disorientation caused by light change from outdoor to indoor.
- Information overload and a sense of being overwhelmed because of text-heavy signs and complex maps at the entrance.

ENTRANCE

Imagine that you are the user in its first moment of contact. They feel overwhelmed and disoriented by the sudden change from bright sunlight to a dim interior, struggling to find a clear starting point.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Station Access & Preparing to Travel

UNPAID CIRCULATION

Unbothered

- Ticket Vending Machine (TVM) are not usable at all because of their interface: flat touchscreen with no tactile markers or audio output.
- Shame or embarrassment feeling for asking for help for a "simple" task. This can lead user to abandon the journey.

UNPAID CIRCULATION

You feel a moment of panic, you need to buy a ticket, but the machine looks complicated. You're worried about holding up the line and feel a sense of shame about potentially needing to ask for help.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Station Access & Preparing to Travel

CHECK-IN

Frustration
Careful trying to not get stressed

- Fare gates are not easy to locate, reliance on colored lights and sounds.
- Ambiguous feedback from fare gates generate stress and hesitation, especially in crowded environments.

CHECK-IN

You're in a line of people, feeling rushed. You need to find the small card reader quickly. You tap your card and hold your breath, listening for the beep that tells you it's okay to go through.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Pre-Boarding Navigation

NAVIGATION TO PLATFORM

Uncomfortable

- Directional signs hinder the navigation. Tactile path ends in a middle of open concourse and/ or leads to temporary obstacle. Directional signs hanging too high.
- Wayfinding system relies on reading signs with line names. The user cannot differentiate between lines and takes the wrong path.

NAVIGATION TO PLATFORM

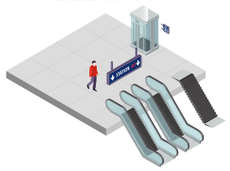
You've just passed the gates and are now in a wide, open space. The signs you see are high up and hard to read. You feel a wave of uncertainty and stop, trying to figure out which way to go.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Pre-Boarding Navigation

USE OF STAIRS/ ELEVATOR



Stressed, always have to double check

- The elevator is out of service, and there is no audio announcement or sign to indicate its status or direct the user to an alternative, forcing a long and frustrating search.

USE OF STAIRS/ELEVATOR

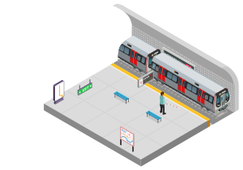
You've followed the signs to the elevator, only to find it isn't working. There's no sign, no announcement. You feel frustrated and abandoned.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Primary Journey

BOARDING METRO



Stressed but relieved once the user is in the right place

- Platform announcementsare hard to hear because of noise, or omitted. Users have to relay on platform display which are often too small.
- Confusion generated by two trains which use the same platform for different lines. What differentiate them is the text in front of the train, which is hard to read.

BOARDING METRO

You're on a noisy, crowded platform. The train is arriving. You have one last chance to confirm it's the right one before you step on. You feel a spike of anxiety.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Primary Journey

INSIDE METRO

Very focused during the entire trip, can't relax
Annoyed

- Crowded metro makes difficult to hear audio announcements. Digital map is too small to read.
- Digital map is too complex or doesn't work. If announcements are too fast or not audible or says only station names, it leads to anxiety.

INSIDE METRO

You can't relax. You need to constantly check your progress so you don't miss your stop. The digital map is hard to see, and you're straining to hear the announcements over the noise of the train.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Primary Journey

ONBOARDING METRO

Disoriented

- Directional signs hinder the navigation. Tactile path ends in a middle of open concourse and leads to temporary obstacle. Directional signs hanging too high.
- Wayfinding system relies on reading signs with line names. The user cannot differentiate between lines and takes the wrong path. No symbols are used in signs.

ONBOARDING METRO

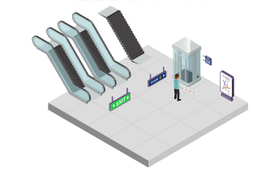
The doors open, and you step out into a new environment. You pause for a moment to orient yourself, looking for the first clue that tells you where to go next.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Post-Journey Navigation & Transfer

USE OF STAIRS/ ELEVATOR



Relieved because the user took the right direction

- The elevator is out of service, and there is no audio announcement or sign to indicate its status or direct the user to an alternative, forcing a long and frustrating search.

USE OF STAIRS/ELEVATOR

You're heading up from the platform to the main concourse. You remember the broken elevator from earlier and are hoping this part of the journey is simple and predictable.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Post-Journey Navigation & Transfer

NAVIGATION TO CHECK-OUT

Frustrated: the user has to double check all the signs to understand the direction to take

- Concourse level area is disorientating, there are no clear and consistent directional signs.
- Transfer signs use only text. The user doesn't recall which letter correspond to their desired destination line.

NAVIGATION TO CHECK-OUT

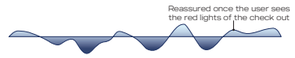
You've reached the main hall and are again in a wide, open space. You know you need to find the exit gates, but the signs are minimal and you feel a familiar sense of being lost.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Post-Journey Navigation & Transfer

CHECK-OUT



Reassured once the user sees the red lights of the check out

- Fare gates are not easy to locate, reliance on colored lights and sounds.
- Ambiguous feedback from fare gates generate stress and hesitation, especially in crowded environments.

CHECK-OUT

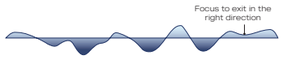
You approach the final gates. You start feeling a sense of relief and closure; the paid part of your journey is officially over.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Station Egress

UNPAID CIRCULATION



Focus to exit in the right direction

- The tactile path leads to an exit that is unexpectedly closed for maintenance, with no alternative path provided.
- The user needs to find a specific bus stop after exiting, but all directional signs are text-only, making the final part of the journey an exercise in stressful guesswork.

UNPAID CIRCULATION

You are so close, but now you face the final, frustrating hurdle. You see multiple exit doors, but the signs above them are just street names you don't recognize. You have no idea which one leads to the bus stop.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Station Egress

EXIT/DESTINATION

Calmed down: the journey is over

- The station has multiple exits, all labeled with street names, no symbols provided, text size too small or signs hanging too high. Users have no way of knowing which exit leads to their destination. They emerge onto an unfamiliar street, feeling disoriented.

EXIT/DESTINATION

You are almost outside. You hear the sounds of the city. You feel a wave of relief, but also the exhaustion from the mental effort it took to get here.

How might we improve this stage to better support the user?

Finding the Way Together - The Participatory Tool

Finding the Way Together: the Participatory Tool

This tool is designed to retrieve valuable insights from stakeholders. By walking through the user's journey step-by-step, we can build a shared understanding and co-create a more inclusive wayfinding experience, for visually impaired people and low literate individuals.

Goal of This Activity
The purpose of this session is to move beyond assumptions and design from a place of shared, evidence-based empathy. Together, we will:

- Build Awareness: uncover the "invisible" barriers that affect users.
- Test Assumptions: Challenge our own perspectives on what is "easy" or "obvious."
- Align Perspectives: create a shared understanding between design, operations, and policy.
- Generate Opportunities: identify concrete areas for impactful, inclusive design interventions.
- Gain Confidence: make decisions grounded in real user needs.

By the end of this session, we aim to generate a set of prioritized insights. These outcomes will guide the next design iteration and help align follow-up actions across teams. Designers will use the insights to identify and develop new opportunities.

How to Facilitate the Session

1. Introduce the project and welcome participants and explain the goal of the session. Briefly explain who is in the room and their roles (e.g., designers, municipality representatives, transport authorities, accessibility experts, and, if possible, end-users). Clarify how each stakeholder's perspective contributes to the co-creation process, for instance, designers bring creative exploration, while transport authorities may identify feasibility or policy implications. Emphasize that this is a collaborative exploration where all perspectives are valuable (if needed, as an ice breaker, use tools to simulate visual impairments and low literacy). Present a single, clear slide titled "Our Guiding Principles." This slide should visually display the five principles with their symbols and one-sentence summaries. Those principles are important to keep in mind when exploring opportunities.
2. Introduce the Persona: briefly tell the story of the user(s) whose journey you are following to ground the session in a human context.
3. Walk the Journey:
   - place the Journey Tiles on the table one by one, in sequential order. For each tile, focus the group on the Front Side. Discuss the visual, the user's actions, and especially the emotional curve and the Pain Point.
   - Flip the tile to the back side and and let participant read and reflect on the description. Let them write down what improvements they think could help the user.
   - If they are stuck help them with provocative or "How Might We..." (HMW) questions and/or show the Recommendation Cards.
   - Capture emerging issues and ideas.
4. After this activity, let the discussion flow between participant and keep capturing insights.

Facilitator's Mindset
You are a guide, not a lecturer. Your role is to ask questions and listen. Connect emotion to operations. Constantly ask: "Why is this feeling happening? What part of our system is causing this?". If possible, include end-users. Their presence is invaluable. When they are in the room, direct questions to them to validate or challenge the insights presented on the tiles, making their lived experience central to the conversation.

Practicalities
Capture insights in real-time: to ensure no valuable insights are lost, assign a second person as a dedicated "scribe". Their role is to capture key quotes, stakeholder assumptions, and emerging questions on sticky notes or a digital whiteboard as the conversation happens. This allows the facilitator to remain fully focused on guiding the dialogue. Consider also recording the entire session.
After the session, review all captured insights and cluster them under relevant categories in the Knowledge Tool. This helps consolidate findings, reveal recurring themes, and link each insight to existing data or previous research. Doing so ensures that co-created ideas are grounded in both stakeholder input and evidence-based understanding.

Example of "provocative" questions

1. If participants are describing the "ideal" action instead of the realistic one, the goal is to introduce real-world friction and distraction, e.g.:*"They should just follow the signs to the platform."*

Try asking: "Imagine doing that while pulling a suitcase, two tired kids are screaming, and you just heard an announcement in a language you don't understand. Does the action change? Do you still just 'follow the signs,' or do you stop to get your bearings?"

What if this is your first time ever in a metro station? You've never seen a check-in gate before. What is your action now? Is it confident, or is it hesitant? Do you watch someone else go first?"

2. If participants are stuck and can't think of any action, *e.g.: at the "EXIT" tile, they are just staring blankly.*

Try asking: "Close your eyes for a second. What is the one sound you are listening for at this moment that tells you you're going in the right direction?"

Guiding Principles

- **Create a Legible and Equal Environment:** ensure everyone can perceive and understand the environment with equal ease, regardless of their sensory abilities, language, or prior experience. Every piece of information must be communicated in multiple ways (e.g., a sign is visual, high-contrast, tactile, and has a clear pictogram). The system assumes no prior knowledge.
- **Offer Flexible and Empowering Choices:** accommodate a wide range of user preferences, abilities, and contexts by providing flexible options that empower the user to navigate in their own way. The system offers information in various formats (visual, tactile, audible). It provides both overview information (maps) and sequential information (directional signs). it offers multiple routes (e.g., stairs vs. elevator) that are all clearly marked.
- **Design for Intuitive and Confident Journeys:** build a clear, consistent, and predictable system that reduces cognitive load and allows users to navigate with confidence and minimal effort. Creating a "rhythm" of information. Signage placement is consistent. Terminology is standardized. The user learns the system's logic once and can apply it everywhere.
- **Build a Resilient and Forgiving System:** anticipate user errors and environmental failures, design a safe system, minimise the consequences of mistakes, and always provide a path to recovery. There are no dead ends. Every decision point offers clear confirmation. If an elevator is broken, the alternative route is immediately and clearly communicated. The system assumes people will get distracted or make mistakes and helps them recover gracefully.
- **Develop a Meaningful and Enriching Place:** go beyond mere function to create an environment that is not just a passage, but a comfortable place, culturally relevant, and respects the dignity of every individual. Using art, light, and materials to make the space feel safe and welcoming. Integrating local culture and languages to make the community feel seen. Ensuring that the design process itself is participatory and respects the expertise of people with lived experience.

Macro Stage

MICRO STAGE

Micro Stage Illustration

Emotional Curve

Critical Pain Points

- Critical pain points for **Visual Impaired** users.
- Critical pain points for **Low Literate** users.

MICRO STAGE

Empathy reflective description of the user situation.

How might we improve this stage to better support the user?

Use this space to write.

Finding the Way Together - The Participatory Tool
LEGENDA

Note on the use of Artificial Intelligence

Generative Artificial Intelligence was utilised throughout this project as a tool to enhance productivity and refine the quality of the research narrative. Its role was strictly that of an assistant, not a substitute for original thought, critical analysis, or synthesis. Tools such as ChatGPT and Grammarly were employed for language polishing and clarifying complex sentences, ensuring the final text was clear and professional. During the literature review and data analysis phases, platforms like NotebookLM and Perplexity served as advanced search and summarisation engines, helping to efficiently navigate academic papers and identify key themes. Finally, tools like Google AI Studio assisted in structural editing by identifying potential inconsistencies and summarizing content for tables and summaries. The core arguments, the synthesis of research findings, and the final design framework presented in this thesis remain the exclusive intellectual work of the author.

Master Graduation Thesis

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