Universal Design 2024: Shaping a Sustainable, Equitable and Resilient Future for All
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Essential Accessibility Information About Travel Chains for Everyone

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Abstract. Accessible travel for all passengers is considered a fundamental right in Europe, addressing both physical and digital accessibility needs. Public transportation must cater to a diverse range of passengers with varying physical conditions, cognitive abilities, and cultural backgrounds. The European Sustainable and Smart Mobility Strategy (2020) underscores the necessity of making mobility accessible and affordable for all, including better connectivity for rural and remote regions. This study examines the importance of considering universal design (UD) in public transport, emphasizing the need for inclusive solutions that benefit as many passengers as possible without requiring specialized adaptations. Research material on the effect of UD measures in accessible travel chains was collected during the planning and implementation phases of the travel chain. The usability and content of travel information sources related to accessibility were examined in these phases. The key findings highlight significant travel chain accessibility challenges in both digital and physical aspects. The planning phase findings show that the digital information about infrastructure accessibility was fragmented, creating difficulties for passengers with low digital literacy to identify, book, purchase, and obtain tickets for accessible transport. The implementation phase revealed inadequately designed physical environments, a lack of multi-sensory guidance, and gaps in the provided digital information. Various accessibility challenges in the physical environment and insufficient digital accessibility information prevent a seamless travel experience for persons with disabilities. While the built environment was initially designed using UD principles, maintenance and functionality have deteriorated over time. Providing accurate digital information about the functionality of infrastructure in advance could enable passengers to make more suitable route choices.

Keywords: Accessibility, universal design of public transport, travel chain experience.

1. Introduction

Public transport plays a crucial role in ensuring the rights of all citizens, with accessible travel being a fundamental right in Europe. Accessible and barrier-free public transportation requires equal access to services, physical environments, and information via accessible websites and mobile apps. Approximately 87 million Europeans have

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some form of permanent disability or temporary obstacles to mobility [1]. In Finland, nearly 19% of people have disabilities [2]. Barriers—such as obstructed infrastructure, poorly guided routes, and insufficient digital travel information—make traveling difficult for persons with disabilities (PwDs). *Disabilities* can include physical or motor impairments, visual and auditory impairments, cognitive difficulties, aging-related issues, and temporary impairments due to accidents or illnesses [3]. Therefore, designing physically and digitally accessible transport systems must consider these diverse needs.

Initiatives like the intelligent transport system (ITS) initiative [4] and the National Access Point (NAP) initiative [5] aim to create a more inclusive and accessible transportation network across Europe. Universal design (UD) in transportation is promoted by establishing common European specifications to ensure the compatibility, interoperability, and continuity of ITS solutions, such as providing real-time traffic and travel information. The development of multimodal travel information services is encouraged, integrating various modes of transport into a single, user-friendly system. NAPs serve as gateways for mobility data, ensuring that essential information (including accessibility details) is available to service providers and developers in order to create more accessible and user-friendly transport solutions. They facilitate the access, exchange, and reuse of transport-related data, helping provide EU-wide interoperable travel and traffic services. NAPs also promote the use of open and common standards and interfaces, enhancing the accessibility and usability of transport systems for all users. In Finland, the Act on Transport Services (643/2017) [6] obliges all transport operators to share essential information about their services, including information about the services and assistance available to PwDs, the accessibility of the equipment, and the equipment that facilitates the passenger's access to the vehicle and interaction with the driver. Mobility as a service (MaaS) [7], also known as *mobility combination services*, combines different transport modes to offer a tailored mobility package, and includes other complementary services, such as trip planning, reservation, and payments, through a single interface. MaaS is a user-centered service adopting the advances of technology and ICT to offer a transport solution that is best from customer's perspective to be made via multimodal trip planning feature and inclusion of demand-responsive services, such as taxi. Transportation providers collaborate to offer a seamless travel experience.

The sequence of different modes of transportation and services that a traveler uses are called a travel chain. It consists of different stages: planning, the initial journey, the main journey, and the final journey. Each stage has its own measures, opportunities, and challenges. An accessible travel chain enables barrier-free movement and access to information at all stages [8]. This includes accessible services, physically accessible and multi-sensory guided routes, stops, transport means, and station spaces, allowing all passengers to travel independently and smoothly. When designing public transport and travel chains, it is critical to consider accessibility for all potential passengers. Including the customer in the design process is key to developing universally designed travel chains and hubs [9]. PwDs prefer travel chains that are accessible, have minimal challenging exchanges, and are comfortable throughout. The fragmentation of travel information is a major bottleneck in trip planning for everyone, including PwDs [10]. During journeys, mobility challenges include physical barriers like long walking distances and irregular surfaces. Visually impaired persons face obstacles such as the lack of tactile braille signs and inadequate announcements. Concerns about platform locations, transfer times, and onward connections also affect confidence in using public transport. On the other hand, potential facilitators include the easy browsing of timetables and accessibility information, and the ability to buy tickets for the entire journey from one source. During the journey, facilitators include real-time information about the stages, departure platforms, delays, and disruptions, as well as intuitive navigation during exchanges. Universal technical solutions, particularly within MaaS, have the potential to simplify trip planning and enhance safety, benefiting all passengers, including PwDs [11].

Literature has extensively examined physical barriers in the built environment and public transport [12]. However, there is limited research on the availability and use of accessibility information for PwDs, which is related to the planning and execution phases of travel chains. This article addresses the gap by studying the essential accessibility information offered and its alignment with the needs of PwDs. The article is structured as follows: Section 2 describes the methodology, research area, participants, and the data collection process. Section 3 describes the results of the travel chain experiences of PwDs in relation to UD. Section 4 considers the development of accessibility information, and Section 5 concludes with recommendations for improving public transport travel chains from a UD perspective.

2. Methodology

The empirical material for the article is from the project Accessible Mobility Travel Chains (ELMA, based on the name of the project in Finnish), conducted by the authors during 2023–2024. The results of the project related to essential accessibility information about travel chains was reported in another article [11]. From the same research material, this article will examine the usability and content of travel information sources in relation to the available accessibility information about the travel chain in the planning and implementation phases. The goal is to demonstrate the importance of considering UD in building and in providing accessibility information about public transport.

2.1. A Description of the Study Area and Participants

The case study was conducted in Riihimäki, southern Finland, showcasing how accessibility information for travel chains is provided in smaller Finnish cities. Public transportation in Riihimäki includes standard local bus lines, demand-responsive transport R-kyyti (ride-hailing type small bus), two on-demand service small bus lines with door-to-door services, and taxi services for PwDs. All buses have low floors and space for wheelchairs and other aids. Key hubs include the railway station, bus station, and expressway connections to regional buses, ensuring interconnectivity. The city uses the Reitit ja Liput mobile application and its online version for reserving and buying all the tickets required by the chosen travel chain. This MaaS solution combines route planning and mobility services, allowing users to profile their transport needs. The mobile application also offers the option to book and buy tickets by phone. Another MaaS-based route guide, VR Matkalla, is available online and as a mobile app, providing similar services for train journeys. The third nationally available MaaS-based application paired with third-party navigation apps, BlindSquare, delivers detailed points of interest and intersections for safe, reliable travel both outside and inside, for the blind, deafblind and partially sighted passengers.

Thirteen volunteer representatives, aged 40 to 82, were recruited with the help of local and regional disability councils and organizations using the snowball method. The participants were current public transport users; eleven used public transport independently, while two required assistants. The group included individuals with

temporary or permanent mobility and/or sensory challenges due to illness, aging, or disability. Table 1 summarizes the diseases and conditions affecting the participants, the aids and services used by the PwDs, and the information and communication technologies they used. All the participants had computer and Internet access at home and owned a smartphone, but their skills in searching for information on the Internet and using a smartphone varied.

Table 1. The target group of the volunteers.

Disease/condition	**Number of PwDs**	**Assistive devices/services**	**Information and communication technology**
Physical or motor disability	6	Wheelchair (x1), occasional electric wheelchair (x1), electric wheelchair (x4)	Computer, smartphone
Visual impairment, blindness	3	White cane (x3), guide dog (x1)	Computer, smartphone
Visual impairment, low vision	1	None	Computer, smartphone
Aging with temporary physical difficulties	3	Assistant	Computer, smartphone

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2.2. Data Collection

Data collection began by identifying the available and useful accessibility information for PwDs before and during the trip. *Regarding the planning phase*, the goal was to understand how the participants typically planned their trips, the tools, and sources they used, the accessibility information they sought, and what they missed. The travel chain included traveling from the point of origin to the destination with necessary vehicle exchanges at hubs. Thematic interviews and travel chain planning were conducted in eight workshops wherein the participants explained their planning processes and choices. All the conversations were recorded and analyzed using content analysis methods. Each volunteer participated in 2–6 workshops and interviews.

During the implementation phase, data was collected through the direct observation of the journey and by participants and researchers retrospectively recalling the journey with thematic interviews afterward. The effects of UD were analyzed using both the observation data from the journeys and the retrospectively recalled data covering the entire travel chain. To ensure a comprehensive collection of data, reflecting the diverse impairments and informational needs of the PwDs, information was gathered from various travel chains, encompassing multiple journeys made by the PwDs using different modes of transportation and locations. These joint journeys helped understand how UD is present in the physical environment and how different stages of travel are affected by varying information needs.

3. Results

The study results were compiled into different phases, highlighting the access and information needs within the travel chain. The planning phase findings illustrate the strategies employed and how the PwDs found the necessary information to meet their accessibility needs. The implementation phase findings detail the information and methods used by the PwDs during the actual travel, emphasizing the access and utilization of available information and addressing the missing information during their journeys. Additionally, it provides insights into how well the built mobility environment and universally designed public transport solutions worked for the PwDs. Data from the PwDs and observations were compiled into a themed table (Table 2), summarizing joint journeys, categorized by different disabilities and travel independence.

Table 2. The results of the PwDs experiences and observations from joint journeys.

Disability and travel independence	**The digital applications/ websites used**	**Travel booking strategies**	**Access to transfer stations and accessibility information**
Physical or motor disability	- Ticket options were researched using a computer - The web version of VR Matkalla was used for booking and purchasing tickets using - The Reitit ja Liput app was used for DRT[a] booking - In-person assistance at an R kiosk was relied upon	- Using online platforms to research and book tickets - Initially planning to buy tickets at an R kiosk - Using DRT and a PwDs' taxi for transportation to the station - Preferring to buy tickets at an R kiosk in order to get personal service	- Checking for maps multiple times in order to understand the stop locations - Receiving helpful notifications from DRT[a] - Facing issues with non-automatic doors at the station - Having no clear feedback channel for door issues - Requiring assistance from other passengers to enter the station - Using an accessible entrance when available - Not needing a ramp service due to using a rollator
Visual impairment, blindness, independent	- The VR Matkalla application was used for booking a ticket - The Junat.net app was used to check a station node - The Lahitaxi application was used to order taxi - E-mails were used for communication and assistance	- Using a mobile phone to buy a ticket for a taxi service - Buying train tickets with the VR Matkalla application - Buying tickets from an R kiosk	- Using the BlindSquare application to simulate the pathway to the transfer station - Relying on previous trips and navigation at stations
Visual impairment, blindness, assistant	- Digital applications were not used for booking - In-person service was relied upon - The assistant helps with tickets and uses applications	- Walking to the station - Buying tickets at an R kiosk	- Navigating the station on foot - No specific accessibility issues mentioned; the information consists of information on old trips

[a]DRT: demand-responsive transport.

This analysis examines how these disabilities affect access to transfer stations, strategies for acquiring travel information, and booking and retrieving tickets, and it outlines the digital tools used to obtain information about the travel chain.

The planning phase revealed significant shortcomings in the digital information provided by authorities. Although there was a wealth of information available, web-based details about infrastructure accessibility were fragmented and sometimes inconsistent across different routes. This information included specifics about the accessibility of vehicles, platforms, stops, advance details on platform locations, and accessible routes at intersections. Passengers with limited digital skills faced challenges in finding the necessary accessibility information online, as well as in booking, purchasing, and obtaining tickets. Consequently, they often relied on telephone advice and in-person services instead of digital information.

The implementation phase highlighted inadequately designed physical environments and infrastructure, a lack of multi-sensory guidance, and gaps in digital knowledge. Significant issues included elevator malfunctions, particularly at junctions where passengers needed to switch between modes of transport or platforms via tunnels or station bridges. These problems often interrupted the entire journey or required rerouting, lengthening, and complicating the journey. There was no advance digital information about these elevator malfunctions at the stations, nor were alternative routes or service options provided. The PwDs who were proficient with digital tools and able to access data on their smartphones were more likely to travel independently. However, their independence was contingent on the travel information provided by the application being up to date.

4. Discussion

A range of accessibility challenges related to the physical environment and lack of digital information prevented the realization of a safe, smooth, and seamless travel chain experience for PwDs. These challenges arise due to inadequate design or maintenance. The planning phase revealed that fragmented digital information about infrastructure accessibility created difficulties for passengers with low digital literacy skills in relation to finding the necessary accessibility information and booking, purchasing, and obtaining tickets for accessible transport.

The implementation phase of travel chains showed that the design of the built environment in regard to mobility is insufficient to meet today's accessibility requirements. Although the built environment was designed according to the accessibility standards in force at the time, the functionality and maintenance of these solutions have deteriorated over time. Inconsistently guided accessible routes at junctions, such as stations, proved to be challenging. Similarly, advance information about the malfunctioning of primary accessibility solutions, such as the out-of-order elevators, and guidance for alternative routes were almost entirely lacking. Providing digital information about the functionality and non-functionality of the physical environment in advance would enable passengers to consider more suitable route choices.

Regarding MaaS, both the Reitit ja Liput and VR Matkalla solutions were found to be useful and reasonably easy to use. The participants appreciated the combination of services, allowing them to search for routes and schedules, and purchase tickets through the single application. They also benefited from the ability to browse the services via a computer and valued the digital accessibility of these services. Additionally, everyone emphasized the importance of having travel information services that are available in alternative formats.

MaaS solutions benefit from more comprehensive data access, advanced combination services, and enhanced user profiling in order to help reroute travel chains during unexpected challenges. However, in the apps under consideration the current user profiling options were still quite limited. VR Matkalla offers choices for pets, a bike, a wheelchair, and an escort, while Reitit ja Liput provides options for a wheelchair, strollers, and a rollator. The wheelchair option ensures barrier-free routes during planning but does not update if there are unexpected changes during trips. In Reitit ja Liput, user profiling primarily benefits operators for predicting space requirements rather than directly aiding passengers. Overall, there is significant room for improvement in real-time adaptability and passenger-focused features in MaaS applications.

5. Conclusions and Future Work

The study indicates that the UD of public transport has not been fully realized, often leading to disrupted travel chains or rerouting. However, the analysis also highlights improvements achieved through universal planning, providing insights into developing seamless travel chains and enhancing the travel experience for all.

Legal frameworks and ethical guidelines promoting UD and equal treatment emphasize accommodating diverse needs during the development and execution of public transportation systems. The travel chain consists of successive stages, wherein UD use and its implementation determine the travel experience. Various actors specialize in planning and implementing these stages, but ensuring seamless compatibility and functionality from a universal accessibility perspective remains a challenge. Verifying user experience is crucial in the UD process to ensure goals are met regarding installation, construction, and performance. Post-construction evaluations would determine whether UD guidelines were successfully implemented. Several large players, such as the VR Group in Finland, have started focusing on accessible travel chain experiences by hiring dedicated service designers, involving diverse passengers, and organizing customer councils and forums.

Information about mobility services and their purchase is increasingly dependent on online services, with in-person service only being provided at stations and service points. The challenge is to ensure that mobility services are accessible to everyone, including individuals with limited digital skills, those needing assistive technologies, and people facing challenges in obtaining digital travel information. The study confirmed that multiple options are needed for passengers with different digital skills, particularly during the planning phase. While improving digital information flows is essential, customer service development must not be overlooked.

Declaration of Conflicting Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

[1] Grammenos S. European comparative data on persons with disabilities. Statistics. Data 2020. Summary and Conclusions. Centre for European Social and Economic Policy. 2022. doi: 10.2767/31545.
[2] Suomen virallinen tilasto, Väestöennuste 2021–2070. [Official Statistics of Finland, Population forecast 2021-2070]. [Internet, accessed June 1, 2024.]. Available from: https://www.stat.fi/til/vaenn/2021/vaenn_2021_2021-09-30_fi.pdf. Finnish.
[3] Hidalgo D, Urbano C, Olivares C, Tinjacá N, Pérez JM, Pardo CF, Rodríguez M, Granada I, Navas C, Glen C, Ramos C, Gutierrez MC, and Pedraza L. Mapping universal access experiences for public transport in Latin America. Transportation Research Record 2020, 2674(12):79–90, doi: 10.1177/0361198120949536.
[4] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport. [Internet, accessed 2021.] Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0813.
[5] National Access Points. [Internet, accessed Sept 18, 2024.] Available from: https://transport.ec.europa.eu/transport-themes/smart-mobility/road/its-directive-and-action-plan/national-access-points_en.
[6] NAP - Suomen liikkumispalveluiden tietojen avoin yhteyspiste palveluiden kehitykseen. [NAP - Finnish national open transport service catalog]. [Internet, accessed June 24, 2024.] Available from: https://finap.fi/#/. Finnish.
[7] Laki liikenteen palveluista 320/2017. [Transport Services Act 320/2017]. Oikeusministeriö. [Ministry of Justice]. Edita Lakitieto Oy. [Internet, accessed June 24, 2024.] Available from: https://finlex.fi/fi/laki/ajantasa/2017/20170320. Finnish.
[8] Somerpalo S, Tamminen T and Alinikula P. Liikenteen digitaalisten palveluiden esteettömyyden edistäminen. [Promotion accessibility in digital transport services]. Publications of the Ministry of Transport and Communications 2/2017. [Online]. Available from http://um.fi/URN:ISBN:978-952-243-496-8. Finnish.
[9] Design for All – Accessibility following a Design for All approach in products, goods, and services – Extending the range of users. EN 1716:2019. [Internet, accessed June 1, 2024.] Available from: https://accessible-eu-centre.ec.europa.eu/content-corner/digital-library/en-171612019-design-all-accessibility-following-design-all-approach-products-goods-and-services_en.
[10] Kaukoliikenteen matkaketjun alku- ja loppumatka. Liikenneviraston tutkimuksia ja selvityksiä 38/2018. [The start and end distance of the long-distance travel chain. Investigations and reports of the Finnish Transport Agency 38/2018]. [Internet, accessed June 1, 2024.] Available from: https://urn.fi/URN:ISBN:978-952-317-577-8. Finnish.
[11] Saarela M and Partanen A. Challenge of producing accessibility data for public transport and travel chains. SMART ACCESSIBILITY 2024: The Ninth International Conference on Universal Accessibility on the Internet of Things and Smart Environments. Courtesy of IARIA Board and IARIA Press. Original source: ThinkMind Digital Library https://www.thinkmind.org. ISBN: 978-1-68558-170-1.
[12] Mwaka CR, Best KL, Cunningham C, Gagnon M, and Routhier F. Barriers and facilitators of public transport use among people with disabilities: a scoping review. Front. Rehabil. Sci. 2024 4:1336514. doi: 10.3389/fresc.2023.1336514.