TRansport Innovation for disabled People needs Satisfaction

UNDER REVIEW

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Abstract	The TRIPS **Quantitative survey report** (D2.3) presents disabled users' mobility needs and challenges, and initial attitudes towards ICT, assistive technology and future mobility trends. The survey profiles the users based on demographic information, and impairment, and general technology aptitude, and pays attention to gender differences. Our findings suggest an interactive, real-time, **accessible journey planner** would motivate users to travel and make their journey more independent, faster, easier, nicer and safer. **Bike sharing, e-scooters and motorbike taxis** are largely rejected by users. **Microtransit and cable cars, ride pooling and robotaxis** are quite promising alternatives, but we should pay special consideration to women's specific requirements around safety. **Cycle lanes** hold a promise for participants upon modification. Irrespective of their perceived technology competence, people are willing to use smart assistive technologies. **Augmented reality, robots, artificial intelligence alerts** and **wearables** are promising solutions across different forms of disabilities hence, the seamless integration of smart assistive and mobility systems holds a promise for improving the overall levels of accessibility. Our report

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	offers high-level design suggestions, as well as policy and industry recommendations for consideration.
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1. Executive Summary

1.1. Context

The first version of **Deliverable 2.3. Quantitative survey report** presents disabled users' mobility needs and challenges, and initial attitudes towards future transport trends. The 2020 European Sustainable and Smart Mobility Strategy highlights the vision for the transformation of EU transport.

By 2030:

- at least 30 million zero-emission cars will be in operation on European roads
- 100 European cities will be climate neutral.
- high-speed rail traffic will double across Europe
- scheduled collective travel for journeys under 500 km should be carbon neutral
- automated mobility will be deployed at large scale
- zero-emission marine vessels will be market-ready

By 2035:

- zero-emission large aircraft will be market-ready

By 2050:

- nearly all cars, vans, buses as well as new heavy-duty

Figure 1: EU's strategic objectives on mobility Source EC, *Sustainable and Smart Mobility Strategy – Putting European Transport on Track for the Future*.

The strategy highlights key action areas to make that vision a reality such as making mobility fair and just for all, making new mobility solutions affordable, accessible and safe for all passengers including those with reduced mobility and making the sector more attractive for workers[1]. While this document (D2.3) reports on the views of those with a registered disability, it's planned second iteration (D2.4) will collect, analyse and report on the views of other social groups at high risk of exclusion due to accessibility barriers. These may be the elderly or those who face some temporary health issue or are pregnant; travel with young children or even carry a suitcase or cumbersome object.

[1] See for example, Flagship 9 initiative, included in the EC, *Sustainable and Smart Mobility Strategy – Putting European Transport on Track for the Future*.

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1.2. Objectives

The main aim of the survey study is to quantify users' mobility needs and challenges regarding new mobility systems.

The survey profiles the users based on demographic information and enquires about their current mobility patterns and accessibility barriers faced. In doing so, it quantifies the users' mobility needs and challenges identified in the qualitative research conducted earlier in the project (task 2.2) about current accessibility conditions.

The survey however broadens the scope of user research to new mobility systems. These include: ridepooling, microtransit, accessible journey planners, motorbike taxis, e-scooter sharing, bike-sharing, cycle lanes, cable cars and robotaxis. Our choice of these systems was informed by the technology and future mobility trends identified and reviewed in WP3.

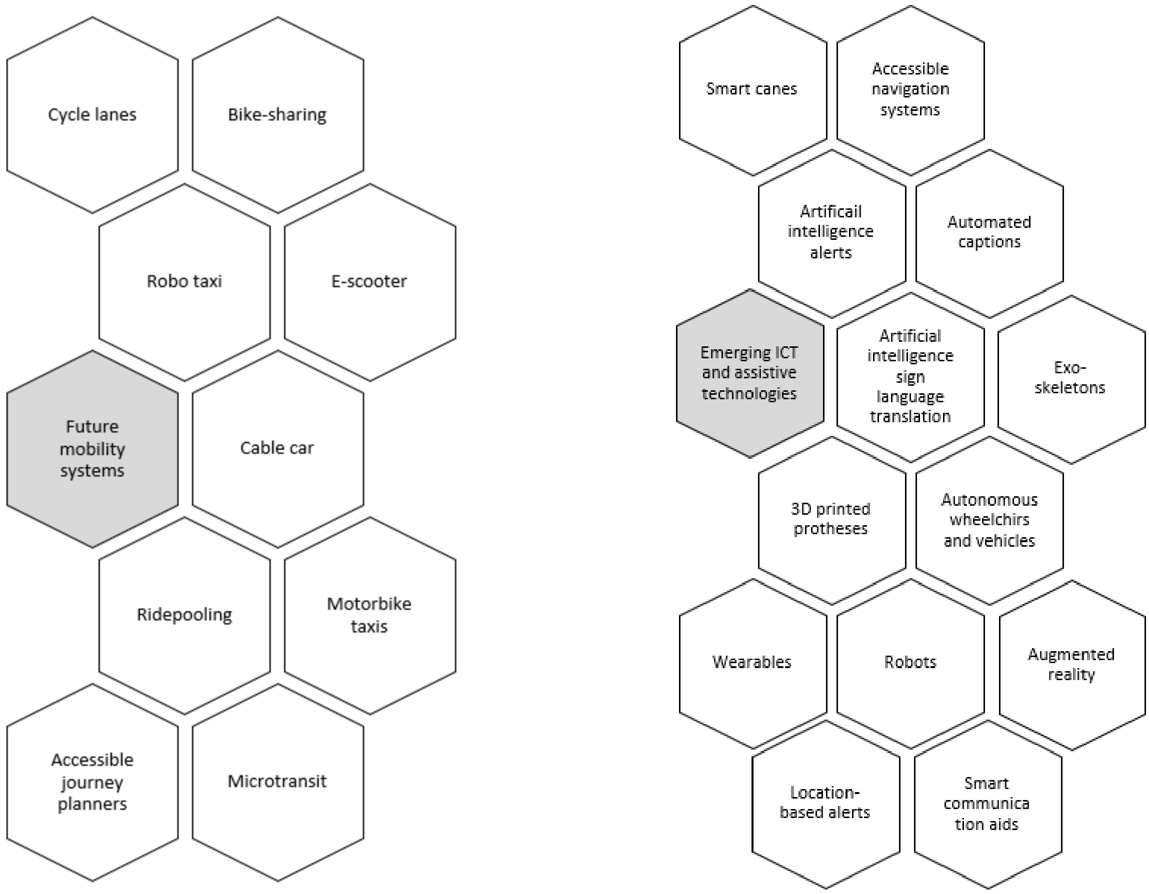

Figure 2: Future mobility systems (left) and emerging ICT and assistive technologies (right) identified in D3.3.

Given their importance for facilitating user interaction with these new mobility systems, we also enquired about respondents' attitudes and use intention towards technology.

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More specifically, the survey elicited responses about information communication technologies (ICT) and assistive technologies that could in part compensate for the barriers in existing transport infrastructure and in part facilitate users' interaction with mobility solutions and future mobility trends. These emerging trends were discussed in D3.3 and include: smart canes, accessible navigation systems, automated captions, artificial intelligence alters, artificial intelligence sign language translation, autonomous wheelchairs and vehicles, 3D printed protheses, wearables, robots, exoskeletons, augmented reality, location-based alerts and smart communication aids (see Figure 2 below).

1.3. The approach

The overall research design involves a two-phased survey. Phase 1 is aimed at capturing the views of disabled users' (D2.3) and developing the survey in collaboration with them. The outcomes of Phase 1 are reported in this document. Phase 2 will collect and synthesise data from disabled and other vulnerable-to-exclusion communities, like the elderly, those with temporary reduced mobility, migrants and others (D2.4). Findings will be presented in a final report in M35.

The quantitative survey of Phase 1 was developed in collaboration with the project partners as well as with the local teams of disabled people in each of the seven cities participating in the project. The survey was initially developed in English based on the findings of the qualitative research (D2.2), related literature review and inputs from the technology trends identified in WP3. It also includes the Mobility Divide Index dimensions (see D4.1), identified as important by participants, to rate future mobility solutions. The survey contains mostly quantitative questions to be answered in Likert scale format, but also open questions to collect users' ideas and recommendations on certain topics, such as requirements or specifications for making technologies usable and accessible. This initial survey was validated by the Local User Leads (LULs) in the seven pilot cities and translated into Italian, Portuguese, Greek, French, Dutch, Croatian, Swedish, and German, (as anticipated in the DoA), as well as into six additional languages - Bulgarian, Polish, Russian, Spanish, Lithuanian and Romanian - to expand the European reach of the survey. The translated versions of the survey were validated by the local teams of disabled people in the seven European cities – Bologna, Brussels, Cagliari, Lisbon, Sophia, Stockholm, and Zagreb. The survey was published on the main menu of the TRIPS webpage.

The original plan was to collect data at large EU events on disability, such as European Disability Days, ENIL Freedom Drive, Work Forum on the CRPD, EDF General Assembly, youth events, events on mobility/transport. We were also going to make use of the CUTs' informal or community interactions with their peers at local events, meetings and gatherings. Due to COVID-19 pandemic-related restrictions and social distancing rules, events were cancelled, and gatherings were forbidden for health and safety reasons. As a contingency strategy, the consortium intensified their efforts to disseminate the online survey to the members of disability organisations and customers of specialised transport services, recognising that some biases in the sampling method would be inevitable and the difficulties of engaging users in online research.

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The survey will remain 'open' until the end of the project, and quarterly campaigns will take place to keep collecting data from disabled people and other social groups at risk of exclusion (such as the elderly, migrants or low-income households) for further findings to be included in the final version of the report in M35.

1.4. Structure of this deliverable

The deliverable is structured in the following way:

- **Section 2** below, reviews literature on pre-existing research around disabled users' attitudes towards current and future mobility systems and factors that are expected to affect their attitudes towards these systems. It also cross-references previous work undertaken by partners within the TRIPS project (particularly in WP2 and WP3) that determined the research questions and survey design.
- **Section 3** outlines our methodology.
- **Section 4** presents our findings.
- **Section 5** synthesises our reflections on the methodology and findings so far.

2. Disabled users' attitudes towards future mobility systems

2.1.1. Measuring attitudes towards mobility systems

In this section we review literature on relevant research to understand what affects disabled users' attitudes towards current and future mobility systems.

A previous study has shown that as many as **two thirds of disabled people want to travel more** but are limited by current mobility options[2]. In the same study 59% said they wish to take more shopping trips, 46% wanted more trips for faith-based activities, 41% wanted more trips to agencies/organizations providing services, 35% desired more health care trips, 30% wanted more work trips, and 15% wanted to make more school trips[2]. While the results of this study are localised to a US context, they nevertheless shed light on the potential increase in transport demand by increasing accessibility and the ROI for accessibility investments[2].Lessons learned from current public transport can indicate prospective issues with future mobility modes (see Figure 3). Despite efforts to implement universal design, metros, trams and trains are still considered highly inaccessible for EU citizens due to problems of accessing and boarding the vehicles (lack of ramps, stairs and the lack of lifts in many stations, lack of automatic opening of doors), difficulties on board, particularly for wheelchair users, but also information barriers, such as the lack of

2 Mattson, Jeremy W, Jill A Hough, Alan R Abeson, and Upper Great Plains Transportation Institute., *Assessing Existing and Needed Community Transportation for People with Disabilities in North Dakota*, *UGPTI Department Publication*, Upper Great Plains Transportation Institute, North Dakota State University, http://library.nd.gov/statedocs/UGPTI/DP23120101118.pdf.

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accessibility signage at stations and inadequate accessible travel planning services[3]. Buses are still the most used public transport modes, though on-board accessibility issues remain, along with a low percentage of accessible buses, of less than 1/3 of the available bus fleets[3]. From a user perspective, the accessibility of a journey can be compromised by the weakest link along their end-to-end travel. Hence, the accessibility of multimodal/trans-modal transport chains should be considered as a whole through accessible urban transport design and planning across all modes, along with information about them. While staff assistance could help to mitigate the impact of infrastructural barriers, lack of staff training and their attitudes remain a burning issue of top priority[3].

Even with conservative calculations, the cost of universal design is more than covered by the anticipated increase in passenger journeys over time. Accessibility measures should be analysed as parts of transport planning projections, staff training plans and urban planning to ensure door-to-door accessibility[4]. In summary, accessibility specifications should be respected throughout the full end-to-end journey cycle.

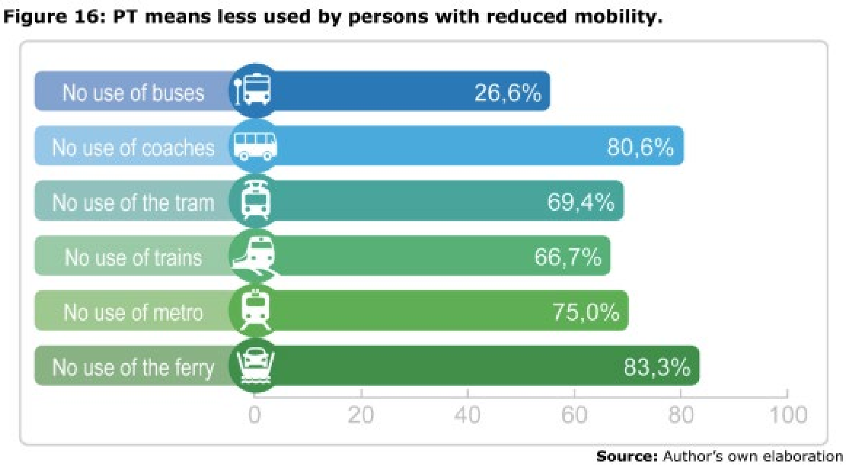

Figure 3: Public transport mode least used by disabled people. ***Source: Bekiaris E; Loukea M; Spanidis, P; Ewing.S; Denninghaus, M; Ambrose, I; Papamichail, K;, and R;Veitch C. Castiglioni, Research for TRAN Committee - Transport and Tourism for Persons with Disabilities and Persons with Reduced Mobility, 2018.***

In order to satisfy accessibility requirements it is crucial to understand user requirements from multiple perspectives. Research findings suggest that **the type and degree of disability affect people's attitudes** towards mobility systems. For example, for users

3 Bekiaris E; Loukea M; Spanidis, P; Ewing.S; Denninghaus, M; Ambrose, I; Papamichail, K;, and R;Veitch C. Castiglioni, *Research for TRAN Committee - Transport and Tourism for Persons with Disabilities and Persons with Reduced Mobility.*, 2018.

4 A Aarhaug, Jørgen, and Beate Elvebakk, "The Impact of Universally Accessible Public Transport–a before and after Study", Transport Policy, Vol. 44, November 2015, pp. 143–150. https://linkinghub.elsevier.com/retrieve/pii/S0967070X15300421.

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with mental health issues their overall levels of anxiety and fear of technology play a crucial role in their attitudes towards mobility systems. In contrast, increased curiosity and familiarity with technology, as well as a sense of control over technology ease stress and increase its acceptance[5]. The 2003 "Survey on information for people with reduced mobility in the field of public transport" commissioned by the European Metropolitan Transport outlines as key issues those relating to the accessibility of vehicle, stops, stations and as well the design and signage of ticketing kiosks, travel planning and in-vehicle information[6]. Another study highlights that embarking and disembarking difficulties are prominent and make most disabled people feel stressed and unsafe[7].

Information about accessibility throughout the end-to-end journey is also a major problem, particularly for the non-routine journeys of disabled people[8]. Timely and accurate information about the end-to-end journey, together with the availability of assistance during the journey, as well as the accessibility of journey planning information itself can greatly increase the reach of transport services to disabled individuals and provide a greater degree of independence. Still, interactive and accessible journey planners that make passenger information available for everyone are still a major issue across the EU, partly due to the lack of relevant databases[9]. The current EU mobility strategy predicts investment in the collection of relevant accessibility information, together with its integration and dissemination via accessible journey planning apps. A pilot study in Lisbon has highlighted the positive prospects of engaging local disability NGOs and users in crowdsourcing relevant city data to compile local accessibility information[17].

In the absence of fully accessible fleets, the **optimisation of accessible transport services** becomes a critical aspect of transport management. Optimising the accessibility of transport services could, for example, greatly improve the regularity and reliability of transport services, and hence minimise travel delays, ensure safe and comfortable transport at affordable tariffs[10]. In one study, the average travel delay was 30% (or

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[5] Bennett, Roger, Rohini Vijaygopal, and Rita Kottasz, "Willingness of People with Mental Health Disabilities to Travel in Driverless Vehicles", Journal of Transport and Health, 2019.

[6] "Survey on Information for People with Reduced Mobility in the Field of Public Transport - Final Report -", n.d.

[7] Soltani, Seyed Hassan Khalifeh, Mashita Sham, Mohamad Awang, and Rostam Yaman, "Accessibility for Disabled in Public Transportation Terminal", *Procedia - Social and Behavioral Sciences*, Vol. 35, No. May 2014, 2012, pp. 89–96.

[8] Daniela Carvalho, Alexandra Rodrigues, Maria Rodrigues, Tharsis Teoh, Jasper Tanis, Bryan Matthews, Carlos Costa, Rui Gomes (2020) Mapping Accessible Transport for Persons with Reduced Mobility

[9] Carvalho, D., Rodrigues, A. Rodrigues, M., Teoh, t. Tanis, J., Matthews, B., Costa, C. Gomes, R. (2020) Mapping Accessible Transport for Persons with Reduced Mobility.

[10] Gogiashvili, Pridon, Gocha Lekveishvili, David Kbilashvili, Jumber Chogovadze, and Vazha Dograshvili, "A Logistic Service Model for Disabled Persons in Mobility by Town-Service Buses", *Transport Problems*, 2018.

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approximately 18 minutes) more for disabled people compared to the journey of non-disabled people. This is primarily due to the inability of users to board the vehicle as not all vehicle are accessible, support to board the vehicle may not be provided, or disabled seats or spaces may be occupied due to overcrowding. The situation can be exacerbated by interchange transfers, due to poor accessibility signage or lack or faulty accessibility infrastructure[11].

Last but not least, **social attitudes** remain the biggest barriers for disabled people and perhaps the most emotive. Discriminatory attitudes from the rest of the passengers and the bus drivers, who often do not respect disabled peoples' needs, or provide help manifest themselves as ubiquitous issues in the transport context[12,13]. Inadequate staff training and stress are often associated with such attitudes and behaviours (ibid). Our own qualitative research indicated the lack of external auditing procedures as possible culprit (see D2.2). We ought, perhaps to rethink and change society's education on matters of diversity and inclusion, as well as recognise that "all of us depend on others, and on various support systems, including increasingly technological systems, for our lives"[14]. From this perspective, user research into the needs of disabled people can be reframed as a resource for extending the conceptualization, practices, frameworks, and resources for design interventions into smart mobility solutions[15].

Users' attitudes towards smart assistive technologies and their usefulness as mobility enhancing devices should also be further explored. Such technologies could improve users' independent travel safety without greatly increasing social security and transport infrastructure costs[16]. GPS-enabled smart canes, accessible navigation systems, automated captioning, autonomous wheelchairs and vehicles, social and assistive robot assistants may be able to bridge some of the current transport infrastructure gaps.

In the following paragraphs we review previous accessibility research and users' attitudes on the specific mobility solutions identified in WP3. These mobility solutions are proposed as emerging and promising for implementation over the next decade (see D3.1):

1. Conventional Public Transport
2. Ride Pooling / Demand Responsive Transport
3. Micro Transit

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[11] Mundi Blanco, Clemente, Patricia Galilea, and Sebastian Raveau. 2019., "Universal Accessibility Survey of Transport Modes Clemente", *RESEARCH DESIGN Qualitative, Quantitative, and Mixed Methods Approaches*, 2019.

[12] Mundi Blanco, Clemente, Patricia Galilea, and Sebastian Raveau. 2019., "Universal Accessibility Survey of Transport Modes Clemente", *RESEARCH DESIGN Qualitative, Quantitative, and Mixed Methods Approaches*, 2019.

[13] Stjernborg, Vanessa, "Accessibility for All in Public Transport and the Overlooked (Social) Dimension—A Case Study of Stockholm", *Sustainability*, Vol. 11, No. 18, September 7, 2019, p. 4902. https://www.mdpi.com/2071-1050/11/18/4902.

[14] Goggin, Gerard, "Disability, Connected Cars, and Communication", *International Journal of Communication*, 2019, p. 2764.

[15] Goggin, Gerard, "Disability, Connected Cars, and Communication", *International Journal of Communication*, 2019, p. 2764.

[16] The potential contribution of smart assistive technologies for mobility has been covered in D3.4 and excluded from consideration here.

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4. Scooter Taxi
5. Car Sharing
6. E-Scooter Rental
7. Bike Sharing
8. (Rapid) Cycle Lanes
9. Urban Ropeways
10. Mobility Hubs
11. Mobility as a Service (MaaS)

The user research conducted in WP2 did not consider the following concepts from WP3: conventional public transport, mobility hubs and mobility as a service. Conventional public transport was regarded as the status quo and was addressed in a section regarding current barriers, but not focused as a new mobility solution. Views on Maas were explored via more concrete examples of ridepooling, microtransit, and bikesharing, and robot taxis as well as through the inclusion of accessible journey planner which integrates a transport system at information level. While, mobility hubs are part of the redesign of urban transport, they are not a mobility model per se and we consider them as part of the journey process to reach a mode of transport.

Robot taxis

While taxis and cars can provide convenient end-to-end transport, certain impairments hinder disabled people in obtaining driving licences and in many cases being able to afford them. Autonomous vehicles could potentially address these issues assuming that they do not require a licensed “driver” in the vehicle and that they are designed based on universal design principles. In particular, to cater for the needs of visually impaired users, cars may require refreshable Braille and auditory systems to notify the passenger where the car is at any given time, the progress of their trip, whether their vehicle requires maintenance or refuelling. Visual interfaces would be required for those with hearing impairments, and interfaces with minimal complexity for those with cognitive ones. In addition, tracking in the form of video cameras and/or GPS would also be helpful for caregivers and staff responsible for the safety and well-being of passengers. Finally, in-vehicle information about the accessibility of the points of disembarking would be vital to ensure overall journey accessibility[17]. While private car ownership is out of scope for the TRIPS project, and a downward overall trend, we nevertheless explore users’ attitudes towards autonomous vehicles via the notion of robot taxis.

[17] Bekiaris E; Loukea M; Spanidis, P; Ewing.S; Denninghaus, M; Ambrose, I; Papamichail, K;, and R;Veitch C. Castiglioni, Research for TRAN Committee - Transport and Tourism for Persons with Disabilities and Persons with Reduced Mobility., 2018.

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Bike sharing and Cycle lanes

Cycling is advocated as a healthy mobility solution promoting healthy living and ageing, improving physical and emotional well-being of individuals[18]. Cycling is currently promoted as sensible alternative for the post-COVID era in the EU[19].

Investments in cycling schemes and cycling infrastructures have been popularised in most major EU cities (see Figure 4) as a means to fight climate change and mitigate CO2 emissions in cities. Another 6 bn investment is expected in boosting EU bike revolution over the next 6 years (2021-2027). In most cases cycling initiatives and strategy documents, disabled users are lumped along with other user despite their accessibility requirements[20].

OVERVIEW OF ALL EUROPEAN FUNDS AVAILABLE FOR CYCLING BETWEEN 2014 AND 2020 BASED ON CURRENT INFORMATION

Type of fund	Estimated amount of funding available (€ million) based on:			Total
	Explicit references	Implicit references	Indirect references	
European-level programmes	12.8	0.0	131.3	144.1
Transnational programmes	15.4	22.8	1.0	39.1
Cross-border programmes	82.2	36.2	8.3	126.8
National and regional level programmes	1,214.4	349.1	167.8	1,731.3
Summary	**1,324.8**	**408.1**	**308.3**	**2,041.2**

Figure 4: Overview of EU investments in Cycling schemes Source: ECF-Cycling for Growth [21]

While 66% of disabled people could indeed cycle, inaccessible infrastructure, prohibitive cost of adaptive cycles, and non-legal recognition for cycles as a mobility aid hinder disabled users from cycling[22]. Adaptive cycles include tricycles, recumbents, and quadricycles, foot or hand hand-cranked, which may be either solo or tandem, and also

18 https://inactivity-time-bomb.nowwemove.com/downloadreport/The%20Economic%20Costs%20of%20Physical%20Inactivity%20in%20Europe%20(June%202015).pdf

19 https://ecf.com/dashboard

20 Andrews, Neil, Isabelle Clement, and Rachel Aldred, “Invisible Cyclists? Disabled People and Cycle Planning – A Case Study of London”, *Journal of Transport and Health*, Vol. 8, 2018, pp. 146–156.

21 Bodor, A.; Lancaster, *Cycling for Growth*.

22 https://wheelsforwellbeing.org.uk

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electrically assisted. In addition, certain devices can convert wheelchairs into cycles. Smart sensors can also augment the inclusivity of cycles. For example, in combination with electric power, ultrasonic sensors, can create audible orientation feedback for manoeuvring, and monitor muscle activity and heart rate to assist the user when needed[23]. The original design and urban planning for cycle lanes has so far not considered accessibility requirements and universal design principles, which may taint the perceptions and attitudes about the suitability of the initiative[24]. In their recent review on the topic, Centre for EU Transport Projects a number of recommendations to enable disabled users to access such systems as alternative transport. These include the integration of cycling with the mainstream public transport system, rethinking cycle lane to improve safety levels, ensure the cycle lane network can provide access to key city locations, and of course ensure cycles are designed to cater for a range of disabilities[25].

Microtransit and Ridepooling

Demand-responsive transportation, such as microtransit, started as a service for disabled people and the elderly. However, such services are becoming increasingly mainstream and available to the general public making them more viable solutions, while ICT and dynamic routing is making these services more responsive, hence reducing the long pre-booking time lapse[26].

A current review suggests that microtransit can serve different purposes. It can be used as a diversion service, as complementary service to fixed route transit, or as a circular service within local area. It can even change purpose of use on the fly to cater for different purposes while on an operation. e.g. in the case of emergencies[27].

Mobility-on-demand services, including microtransit, are seen to increase the geographical range of public transport (60%) as it allows convenient and/or more regular access in areas that regular transport services are lacking, increase service hours where service is rare or irregular (30%), and minimise the last-mile delays and barriers by picking

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23 Clayton, William, “Cycling and Disability: A Review”, *Universities’ Transport Study Group*, 2016.

24 https://www.bbc.com/worklife/article/20200724-will-covid-19-make-urban-cycling-more-inclusive

25 Centre for EU Transport Projects (2020) Bicycle available: People with disabilities and senior citizens also cycle

26 https://www.emta.com/spip.php?article1294

27 Volinski, Joel, *Microtransit or General Public Demand Response Transit Services: State of the Practice*, *Microtransit or General Public Demand Response Transit Services: State of the Practice*, Transportation Research Board, Washington, D.C., 2019. https://www.nap.edu/catalog/25414.

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up and dropping off passengers closer to their destinations (50%). The solutions are welcomed by male users, college graduates, individuals who have never heard of or used ride-hailing before, and individuals who currently receive inferior transit services. Female riders have safety concerns with regards to sharing rides with strangers and not being able to rely on known and predicted routes that will help them discern rogue drivers. Some technological concerns regarding web-based booking systems and over-reliance on mobile web connection, imprecision of location-based services as well as the affordability of such services were also raised[28].

Accessible travel planners

There are effectively no interactive, real-time travel planners that can provide disabled users with relevant, accurate and comprehensive information about the accessibility of their end-to-end journey. Information about accessibility is inexistent, fragmented or inaccurate. Even when information about the vehicles, stations, and stops is available, information about last-mile accessibility is often lacking. To design interactive travel planners for disabled people, one should not only consider the door-to-door accessibility for the type of access needs relevant to the user, but also how to provide them with travel planning information in ways that are meaningful, timely, and accessible to them[8]. Finally, information about accessible emerging services (such as cycle sharing schemes, microtransit services) should be integrated.

Cable cars

Cable cars are nothing new, however there is renewed interest in this solution due to its environmentally conscious nature, as one engine is sufficient to move several vehicles[29]. They can be easily retrofitted in densely populated cities to expand the reach of public transport (and hence accessibility) in hard-to-reach areas, particularly in cities with hilly terrains. Cable cars are also inexpensive in terms of their running costs and can carry a large number of people, thus making them affordable public transport solutions. They are considered particularly useful for connecting downtown recreation areas with the suburbs, and are easily accessible as cabins are levelled with station platforms, they can be stopped momentarily with stop-and-go technologies to onboard passengers, and spacious enough to cater for wheelchairs, bicycles and baby strollers[26].

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28 Yan, Xiang, Xilei Zhao, Yuan Han, Pascal van Hentenryck, and Tawanna Dillahunt, "Mobility-on-Demand versus Fixed-Route Transit Systems: An Evaluation of Traveler Preferences in Low-Income Communities", ArXiv, 2019.

29 Leitner (2020) Urban Passenger Transportation: A view from above into the future https://www.leitner-ropeways.com/en/application-areas/urban/, March, 2020

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2.1.2. Technology use of disabled people

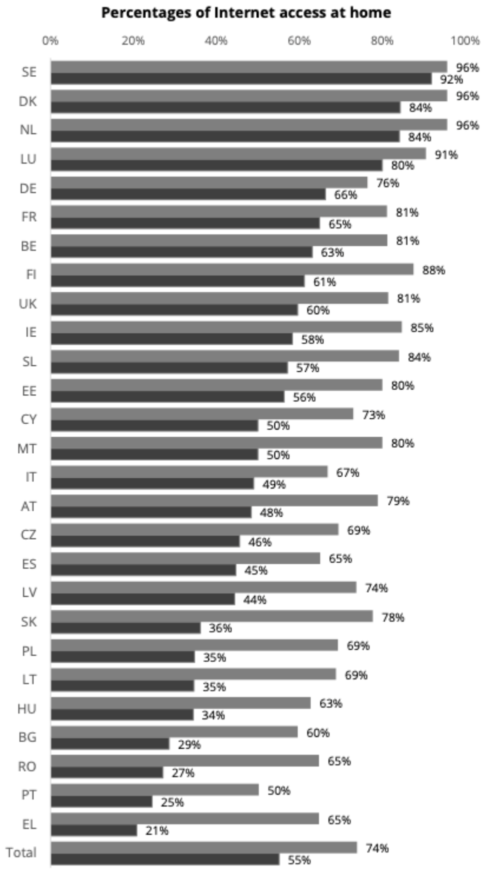

Figure 5: Comparison of internet access between disabled and non-disabled people in 27 EU countries (see Scholz, et. al (2017) below Error! Bookmark not defined..

Technology can be a facilitator for accessible and inclusive transport for disabled people. Especially ICT – like mobile apps and voice augmentation systems – promise opportunities for disabled people[30], assuming one can have access to such technologies and a level of competence in their use.

Stendal (2012) summarised research regarding the question of how disabled people use and experience ICT[31]. The challenge for disabled people in access to the internet or other means of ICT is called **digital divide**[32]. This is found to be a recurrent challenge even in more recent studies. Disabled people are over-represented among those who are digitally excluded overall but there are also gross differences across 27 European countries[33] (see Figure 5).

Other studies found mobile devices to be often inaccessible for persons with visual or motor disabilities[34]. Inaccessibility may be due to hardware, software or both[35]. Even relatives or caregivers can become obstacles to access as they can often make choices particularly for younger disabled people and deny them the

30 Anderberg, P. & Jönsson, B. (2005). Being there. Disability & Society, 20(7), 719-733.

31 Stendal, K. (2012). How do People with Disability Use and Experience Virtual Worlds and ICT: A Literature Review. Virtual Worlds Research, 5(1), 1-16.

32 Stendal, K. (2012). How do People with Disability Use and Experience Virtual Worlds and ICT: A Literature Review. Virtual Worlds Research, 5(1), 1-16.

33 Scholz, Frederike, Betul Yalcin, and Mark Priestley, "Internet Access for Disabled People: Understanding Socio-Relational Factors in Europe", Cyberpsychology, Vol. 11, No. 1Special Issue, 2017.

34 Kane, S. K., Jayant, C., Wobbrock, J. O., & Ladner, R. E. (2009). Freedom to Roam: A Study of Mobile Device Adoption and Accessibility for People with Visual and Motor Disabilities. Proceedings of the 11th International ACM SIGACCESS Conference on Computers and Accessibility, 115–122. https://doi.org/10.1145/1639642.1639663

35 Dobransky, K., & Hargittai, E. (2016). Unrealized potential: Exploring the digital disability divide. Poetics, 58, 18–28.

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opportunity to access a computer or the internet[36,37.] This can have knock on effects on other domains. For example, a study from Sweden indicated that disabled people do not use the internet for purposes like internet banking[38] or online shopping[30]. ICT could have beneficial effects for facilitating social interactions and a sense of equality and inclusion. Hence, universal design should be accelerated to facilitate the use of ICT for persons with disabilities[39,40].

The current proliferation of advanced digital technologies could improve the life of disabled people. Prototypes of Augmented Reality (AR) systems that can locate products in a store for persons with motor disabilities[41] and as a navigating tool for persons with intellectual disabilities[42] are in development. A significant body of literature explores the benefits of technology for the life of disabled people[43],[44],[45]. However, in itself this is not enough[46]. Research into users' digital and social barriers is equally important[47]. Research is challenged to study why some people are more likely to make use of technology than others. Recent studies investigated the motivational conditions for technology use[48] or

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36 Gutierrez, P. & Martorell, A. (2011). People with Intellectual Disability and ICTs. Comunicar Scientific Journal of Media Litreracy, 36(18), 173-180

37 Söderström, S. (2009). The significance of ICT in disabled youth's identity negotiations. Scandinavian. Journal of Disability Research, 11(2), 131-144.

38 Johansson, S., Gulliksen, J., & Gustavsson, C. (2020). Disability digital divide: The use of the internet, smartphones, computers and tablets among people with disabilities in Sweden. Universal Access in the Information Society. https://link.springer.com/article/10.1007/s10209-020-00714-x

39 Bradley, N. & Poppen, W. (2003). Assistive technology, computers and Internet may decrease sense of isolation for homebound elderly and disabled persons. Technology & Disability, 15(1), 19-25

40 Stendal, K. (2012). How do People with Disability Use and Experience Virtual Worlds and ICT: A Literature Review. Virtual Worlds Research, 5(1), 1-16.

41 Rashid, Z., Melià-Seguí, J., Pous, R., & Peig, E. (2016). Using Augmented Reality and Internet of Things to improve accessibility of people with motor disabilities in the context of Smart Cities. Future Generation Computer Systems, 76. https://doi.org/10.1016/j.future.2016.11.030

42 McMahon, D., Cihak, D. F., & Wright, R. (2015). Augmented Reality as a Navigation Tool to Employment Opportunities for Postsecondary Education Students With Intellectual Disabilities and Autism. Journal of Research on Technology in Education, 47(3), 157–172. https://doi.org/10.1080/15391523.2015.1047698

43 Bryant, L., Brunner, M., & Hemsley, B. (2020). A review of virtual reality technologies in the field of communication disability: implications for practice and research. Disability and Rehabilitation: Assistive Technology, 15(4), 365-372.

44 Gebresselassie, M., & Sanchez, T. W. (2018). "Smart" tools for socially sustainable transport: A review of mobility apps. Urban Science, 2(2), 45.

45 Marston, H. R., & Samuels, J. (2019). A review of age friendly virtual assistive technologies and their effect on daily living for carers and dependent adults. In Healthcare (Vol. 7, No. 1, p. 49). Multidisciplinary Digital Publishing Institute.

46 Kett, M., Cole, E., & Turner, J. (2020). Disability, mobility and transport in low-and middle-income countries: a thematic review. Sustainability, 12(2), 589.

47 Øksenholt, H.V.; Aarhaug, J. Public transport and people with impairments—Exploring non-use of public transport through the case of Oslo, Norway. Disabil. Soc. 2018, 33, 1280–1302.

48 Melenhorst, A. S., Rogers, W. A., & Bouwhuis, D. G. (2006). Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity. Psychology and aging, 21(1), 190.

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used technology acceptance models to assess behavioural intentions[49]. Some studies revealed disparities between disabled and non-disabled people with regard to computer anxiety and feelings of insecurity when using the web[50]. When it comes to disabled people, there is still a lack of knowledge about their technology use[51]. One approach to study the determinants of technology use of persons with disabilities is the concept of *digital capital*[52]. The concept of digital capital is inspired by Bourdieu's (1997) notions of social and cultural capital[53]. It can be described as a person's possession of technological competencies and knowledge that enable her or him to use technology[54].

2.1.3. Gender differences

Gender differences in travel choices and travel behaviour are often reported in the scientific literature[55,56]. Accordingly, women put high demands on transport because they frequently escort elderly persons or children and undertake household shopping[57]. For example, taking and picking up children from school is a regular use of public transport by women, often combined with other trips such as to or from work. In the case of disabled people, gender differences are expected to play an even more important role. Disabled women have additional safety concerns in public transport as they are more vulnerable to sexual (and non-sexual) harassment and assaults during travel. Many factors contribute to this, among them discriminatory attitudes towards disabled women, perceptions that disabled women and girls are 'asexual' or unaware of sexual harassment, thuggish and bullying attitudes, and women's compromised position to avoid

49 Chen, K., & Chan, A. H. (2011). A review of technology acceptance by older adults. *Gerontechnology, 10, 1-12.*

50 Vicente, M. R., & López, A. J. (2010). A Multidimensional Analysis of the Disability Digital Divide: Some Evidence for Internet Use. *The Information Society*, *26*(1), 48–64. https://doi.org/10.1080/01615440903423245

51 Harris, J. (2010). The use, role and application of advanced technology in the lives of disabled people in the UK. *Disability & Society*, *25*(4), 427-439.

52 Selwyn, N. (2004). Reconsidering political and popular understandings of the digital divide. New Media & Society 6:3,341-362.

53 Bourdieu, P. (1997). The Forms of Capital, In *Education: Culture*, *Economy*, *Society.* Halsey, H. Lauder, P. Brown and A.Stuart-Wells (Eds.), 46–58. Oxford: Oxford University Press.

54 Seale, J. (2013). When digital capital is not enough: reconsidering the digital lives of disabled university students. Learning, Media and Technology, 38(3) pp. 256–269.

55 Dobbs, L. (2005). Wedded to the car: women, employment and the importance of private transport. *Transport policy*, *12*(3), 266-278.

56 Beirão, G., & Cabral, J. S. (2008). Market segmentation analysis using attitudes toward transportation: Exploring the differences between men and women. *Transportation research record*, *2067*(1), 56-64.

57 Dobbs, L. (2005). Wedded to the car: women, employment and the importance of private transport. *Transport policy*, *12*(3), 266-278.

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or protect themselves[58]. Especially those with visible disabilities face a greater risk of targeted violence and hostility (77%) than those with hidden disabilities (33%)[59].

Special attention needs to be payed to the post-COVID investment strategies for urban mobility and transport and its implications for disabled women. For example, an emphasis on cycling and walking is envisioned as a safe strategy to 'open' the cities, but what does this mean for disabled women who might also be mothers and carers?

2.2. Research gaps and hypotheses

2.2.1. Identified research gaps

The quantitative research of WP2 is based on the preceding qualitative research. The two qualitative studies conducted in task 2.2 revealed several insights into the attitude, behaviour and choices of disabled people. Based on the results of a social media content analysis and a peer-to-peer interview study, several hypotheses and research questions were derived (see D2.2).

Qualitative research formed the empirical foundation and highlighted research gaps that informed our hypotheses, structure and methodology for survey development.

Highlights from qualitative research in D2.2	Implication for survey study
Sensory, mental and intellectual disabilities are underrepresented while physical disabilities (especially wheelchair users) are overrepresented in social media content. This that does not reflect their representation in the overall disability population.	To increase the participation of people with sensory, mental and intellectual disabilities that might not be able to answer the survey independently, we made the survey open to caregivers and relatives to respond on behalf of a disabled person.
Disabled people are unaware of technological solutions that can provide them with mobility assistance. For example, wheelchair users in Zagreb are unaware of the Accessibility Map of Zagreb for Persons in Wheelchairs.	The survey inquired about the use of technologies by disabled people with respect to transport.

[58] Ludici, Antonio, Laura Bertoli, and Elena Faccio, "The 'invisible' Needs of Women with Disabilities in Transportation Systems", *Crime Prevention and Community Safety*, Vol. 19, No. 3–4, 2017, pp. 264–275.
[59] Olkin, Rhoda, H'Sien Hayward, Melody Schaff Abbene, and Goldie VanHeel, "The Experiences of Microaggressions against Women with Visible and Invisible Disabilities", *Journal of Social Issues*, Vol. 75, No. 3, 2019, pp. 757–785.

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Social media users as well as interviewees emphasize the need for policy and transport providers to take next steps in improving accessibility of public transport.	The survey quantified respondents' satisfaction with the implementation of local accessibility policy.
Social distancing rules due to COVID-19 challenged persons with visual impairments by restricting physical contact to the driver who often serves as an information point.	The survey inquired about the overall impact of the COVID-19 restrictions on different forms of disabilities.
Little is known about the perception of persons with disabilities regarding new, shared mobility systems, particularly in Europe.	The survey focused on how disabled people perceive and assess new, shared mobility systems.

Table 1: Relation to the qualitative research (see D2.2)

2.2.2. Research questions

To this end, our survey set out to answer the following broad research questions:

- How do disabled people assess new mobility systems and would they use them?
- How do disabled people assess their own personal adaptivity to technology and can this predict their views towards mobility systems?
- Do disabled people use ICTs that are likely to be prerequisites for new mobility systems?
- Would disabled people use smart assistive technologies?
- How do disabled people feel about the overall implementation of accessibility strategy in their area?
- How do disabled people feel the impact of COVID-19 to be in their region?
- Are there any gendered differences in our findings?
- Are there any differences due to different types of disabilities in our findings?

3. Methodology

3.1. Survey development

The survey was developed in collaboration with the LULs and the CUT teams. A draft survey was developed by TRI, ENIL and DLR in English. The draft survey was then communicated to LULs to gauge their interest and clarity of its content. LULs were asked to complete it as users and provide feedback in terms of their interest in the questions, its usefulness, length, and clarity, as well as any practical issues around accessing and interacting with the website.

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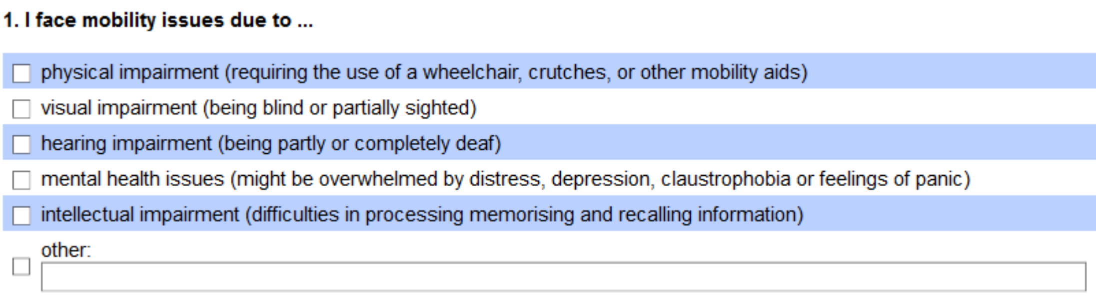
The initial survey was considered interesting but lengthy, amendments in terms of language were suggested, and there was an overall concern that the survey addressed ‘futuristic’ mobility solutions that will not resolve the immediate concerns of disabled people around transport. To address the first point about the length of the survey, we created three versions of the survey; each version enquires about three out of the nine mobility solutions. To respond to LULs desire to address immediate concerns around mobility, we included two sections around the accessibility of existing transport systems in their region and the impact of COVID-19 restrictions on their mobility. The CUT teams were invited to complete the translated versions of the survey and also provide feedback in terms of their interest in the questions, its usefulness, its length, and clarity and quality of translation, as well as any practical issues around accessing and interacting with the website. There were no reported practical issues with technology. The survey was considered lengthy, but interesting. Concerns about the futuristic nature of mobility solutions remained. Some translation and language issues were identified. CUTs suggestions and recommendations were addressed, and edits were made by DLR accordingly.

The resulting survey was agreed with LULs, either translated by the consortium members or machine-translated (and edited by native speakers later on) in 14 languages. Besides English, these languages were: Bulgarian, Croatian, Dutch, French, German, Greek, Italian, Lithuanian, Polish, Portuguese, Romanian, Russian, Spanish and Swedish.

In brief, the survey was structured in the following sections presented in order (see Appendix 2 for full details):

User profile: The section profiles users with respect to sociodemographic characteristics. It comprises questions concerning age, gender, country and city of residence, educational level and occupancy status. Respondents are also asked to specify their mobility impairments (see Figure 6). They are further asked to specify the kinds of assistance systems they use depending on the indicated form of impairment(s). Furthermore, respondents are asked to state how long they have lived with their mobility impairment(s). Respondents’ mobility behaviour is sampled with questions regarding possession of a driver’s license and modal split.


1. I face mobility issues due to ...

- ☐ physical impairment (requiring the use of a wheelchair, crutches, or other mobility aids)
- ☐ visual impairment (being blind or partially sighted)
- ☐ hearing impairment (being partly or completely deaf)
- ☐ mental health issues (might be overwhelmed by distress, depression, claustrophobia or feelings of panic)
- ☐ intellectual impairment (difficulties in processing memorising and recalling information)
- ☐ other:

Figure 6: Survey question on mobility impairments.

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Subjective technology adaptivity: The subjective technology competence was measured based on the subjective technology adaptivity inventory (STAI[60]). The STAI was developed to assess perceived personal adaptivity in technological environments among older adults. It was shown that subjective technology adaptivity predicts technology use in higher age[61]. The STAI is based on a motivational construct which is related to goal selection and goal pursuit on usage of technology. Kamin, Lang & Beyer (2017) showed the higher the score of the STAI the more interest in technological innovations and the more confidence while dealing with technology people exhibit[62]. In total, there are 15 items regarding the assessment of technology and the user's competence in using the technology. The STAI consists of items regarding a general assessment of usefulness of technology, e.g. "Using modern technology helps me to master everyday life", trust in technology, e.g. "I believe that new technology conforms to safety standards" and the respondents' own perception of competence in dealing with technology: e.g. "I consider myself competent enough to use modern technology". Responses are given using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Technology use behaviour and use intention: In this section, respondents are asked to state how often they use different technologies in their daily life. The technologies are: smartphone/tablet, PC/laptop, online maps/ journey planning apps (like Google maps), virtual assistants (like Alexa), mobile payment app (like Apple Pay), online games, social media (like Facebook) and smart home systems (like Google home, Apple homeKit). Respondents are further asked to assess whether they would use smart assistive technologies, such as:

- smart canes
- accessible navigation systems
- automated captions
- artificial intelligence alters
- artificial intelligence sign language translation
- autonomous wheelchairs and vehicles
- 3D printed protheses
- wearables
- robots
- exoskeletons

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[60] Kamin, S. T., Lang, F. R., & Beyer, A. (2017). Subjective technology adaptivity predicts technology use in old age. *Gerontology*, *63*(4), 385-392.

[61] Kamin, S. T., Lang, F. R., & Beyer, A. (2017). Subjective technology adaptivity predicts technology use in old age. *Gerontology*, *63*(4), 385-392.

[62] Kamin, S. T., Lang, F. R., & Beyer, A. (2017). Subjective technology adaptivity predicts technology use in old age. *Gerontology*, *63*(4), 385-392.

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- augmented reality
- location-based alerts
- smart communication aids

Each technology is introduced in one sentence and a possible application for transport is described.

Assessment of new mobility systems: The heart of the survey comprises the respondents' assessment of nine innovative mobility systems: ride pooling, microtransit, accessible journey planners, motorbike taxis, e-scooter sharing, bike-sharing, cycle lanes, cable cars and robotaxis. A full textual description of the nine mobility systems is given in Appendix 1. To reduce the length of the survey, every respondent is asked to assess three out of the nine systems. The assessment of each mobility system is comprised of three questions. First, respondents are asked whether they would use this system regarding different trip purposes. Second, they are asked if that mobility system would motivate travel and how it fares against the five dimensions of the Mobility Divide Index (MDI): **autonomy, duration, convenience, comfort, safety.** These are the most important dimensions along which users evaluate their journey as identified by the users during our work for Task 4.1 (For details on the development of the MDI see D4.1). Finally, respondents are presented with the open question "What would you need to make this system work for you?", aimed at eliciting ideas about how to make a system more accessible to the users.

Assessment of local accessibility: Respondents are asked to provide their opinion on the current level of accessibility in their city or region by answering to three statements: 1) "How satisfied are you with the use of public transport in your city or district?", 2) "Are you generally satisfied with the way the local inclusion policy works?", 3) "Are you satisfied with the level of support by the local population with regard to your impairment?".

Effects of the COVID-19 pandemic on travel: Given the fact that the survey is conducted during the ongoing COVID-19 pandemic, a question regarding the impacts of the measures to limit the spread of the virus was added: "What has been the impact of the corona virus pandemic (COVID-19) on your travel?". Six aspects representing the MDI facets are presented and respondents are asked to indicate the extent to which they are affected on a 5-point rating scale:

- made you less willing to travel?
- made your journey more dependent on others?
- made your journey longer?
- made your journey more difficult?
- made your journey less nice?
- made you feel unsafe?

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3.1.1. Procedure

The survey is conducted online, using the software SoSciSurvey (Leiner, 2019), and can be accessed through the following link: https://ts.dlr.de/survey/trips/. The survey can be completed by disabled people or by another person answering on behalf of the disabled person. Non-disabled people are excluded from participation by means of a filter question which leads directly to the final page of the survey. It takes about 20 to 30 minutes to complete the survey. To avoid missing data, all questions are mandatory.

Invitations informed users about the purpose of our study and about the TRIPS project overall, as well as about the projects' data management policy and practices, the use and management of their data in line with GDPR. Participants were also given contact details, should they needed to contact someone for clarifications and extra information. Participants were asked for their consent at the beginning of the study, although data was collected anonymously.

The survey has been distributed locally to disability user groups in the seven cities via the LULs and CUTs and more generally through ENIL and other European-wide organisations working with people with different disabilities and access needs. The survey has also been actively distributed on ENIL's social media and other channels, such as Regular Members' Mailing and Monthly Newsletter. In general, more than 121 local, regional and international organizations have contributed to disseminating this survey. Nevertheless, we appreciate that our sample may be skewed towards those who have internet access and are more technology savvy. A comprehensive list of the contacted organisations can be found here.

3.2. Data preparation

A total of 872 surveys were completed between 1 November 2020 and 12 February 2021 in all 15 languages. 312 respondents indicated that they had no disability and were therefore excluded from the data analysis. Four data sets were discarded due to wrongly recorded data at the beginning of the data collection period. Three further data sets originated from respondents from non-European countries and were also excluded from the analysis.

Responses to open-ended questions of the remaining data sets not given in English were either machine-translated to English or, where possible, translated by native speakers.

3.3. Sampling

The final sample that was analysed comprises 553 individuals. The majority of respondents filled in the surveys by themselves as a person with disabilities (87.7%). However, in 68 cases (12.3%) responses were given by persons answering on behalf of a disabled person. Persons answering on behalf of a disabled person represented primarily respondents with intellectual disabilities (58%, n = 21), implicating that **the majority of persons with intellectual disabilities did not participate on their own.**

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As shown in Figure 7, respondents from 21 countries are represented in the sample. However, the number of study participants varies strongly between the countries. The countries with the highest numbers of study participants are Italy (n =128), Germany (n = 90) and Croatia (n = 88). In contrast, only one person participated from Bosnia and Herzegovina, Poland, Romania, Russia and Switzerland. With regard to the number of study participants from the seven pilot cities, a considerable imbalance was shown: **Bologna** = 15, **Brussels** = 12, **Cagliari** = 48, **Lisbon** = 18, **Sofia** = 16, **Stockholm** = 7 and **Zagreb** = 41.

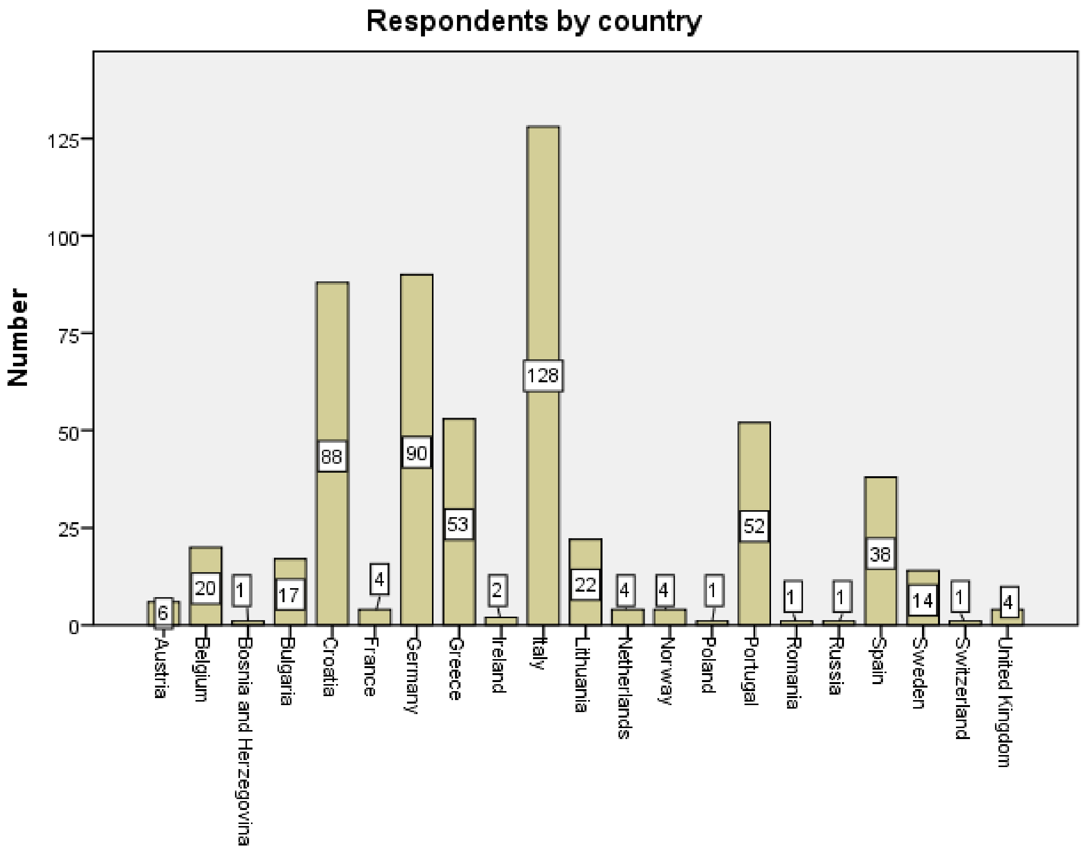

Figure 7: Number of respondents per country.

Gender was nearly equally distributed in the sample with some more **men** (51.4%) than **women** (45.8%). The gender distribution, however, varied for the forms of disability. The share of male respondents was higher for the group of respondents with visual impairment (58,4%) and lower for mental health issues (38,3%) and intellectual impairments (44,4%) (see figure 8). The **mean age** of the respondents was 46.41 years (*SD* = 15.7 years). The age range, however, was broad with respondents aged between 16 to 99 years (see Figure 9).

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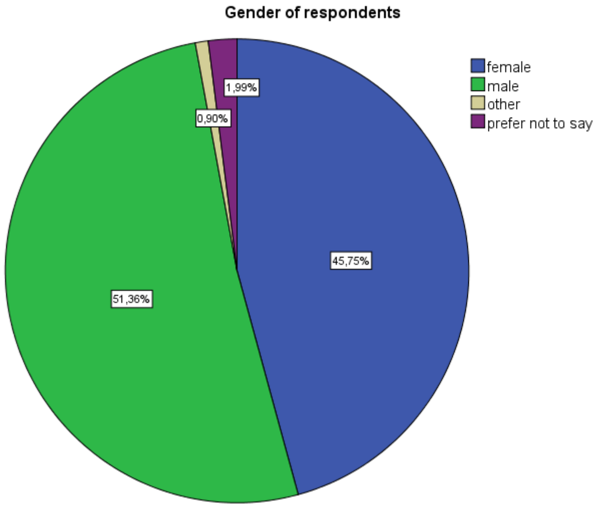

Figure 8: Gender balance in our sample

A cross-disability comparison showed that respondents with **physical disabilities are older** (M = 48.7 years, SD = 15.8 years) than respondents with **intellectual disabilities** (M = 40.72 years, SD = 20.5 years) or **visual impairments** (M = 42.2 years, SD = 14.3 years).

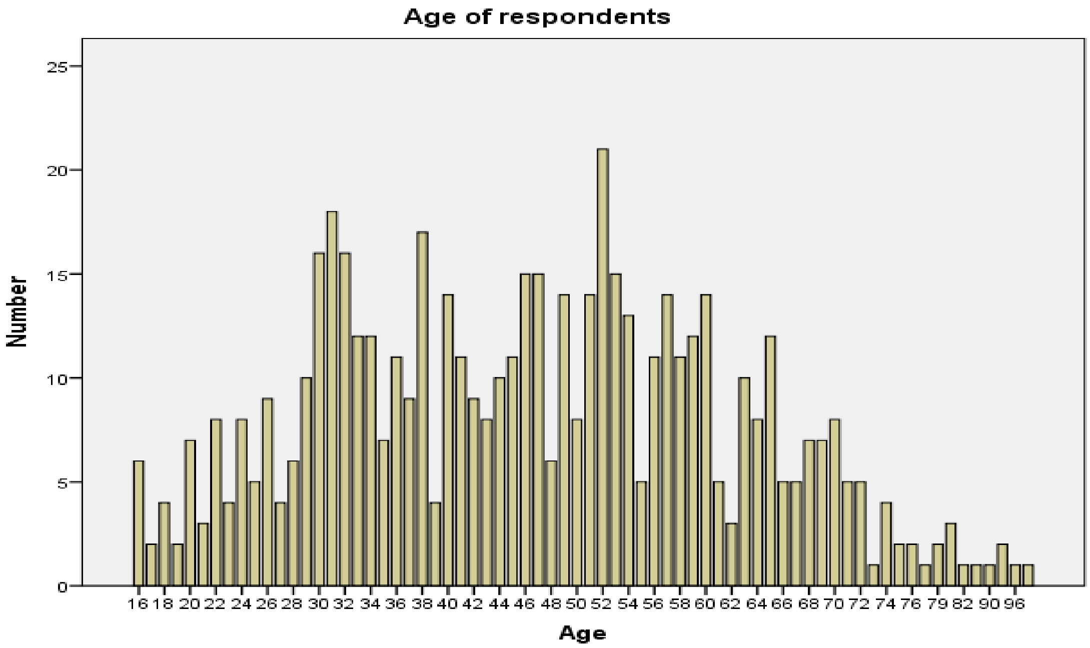

Figure 9: Age distribution.

As shown in Table 2, a high share of respondents held a Bachelor's (23.3%) or Master's degree (19.3%). Slightly more than a quarter of the respondents stated to be retired (25.7%). Exactly 40% of the respondents stated to work either part-time or full-time. The

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share of unemployed respondents with disabilities in our sample (15.7%) is higher than the share in the Euro area (8.3%) in December 2020[63].

Table 2: Description of sample according to highest educational level and occupancy

		Number	Percent
Highest educational level	None	29	5,2
	High School degree	256	46,3
	Bachelor's degree	129	23,3
	Master's degree	107	19,3
	Ph.D.	14	2,5
	Missing data	18	3,3
Occupancy	Unemployed	87	15,7
	Work full-time	158	28,6
	Work part-time	63	11,4
	Study	39	7,1
	Retired	142	25,7
	Other	64	11,6

Figure 10 shows the share of respondents for each type of disability. When comparing our sample with the general population[64], respondents with physical disabilities (n = 323, 58.4%) were slightly overrepresented compared to the 53.1% average in the general population; the share of visual impairments (n = 113, 17%) was slightly higher than the 12.6% average in the general population, and hearing impairments (n = 74, 11.6%) were at par with the general population. Cognitive impairments, including intellectual disabilities (n = 36, 6.5%) and mental health issues (n = 47, 8.5%) are less frequently represented in the sample compared to the general disability population statistics.

63 Eurostat (2021). Unemployment statistics. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics

64 Disabled World (2020). Disability Information List. Available online from: https://www.disabled-world.com/disability/

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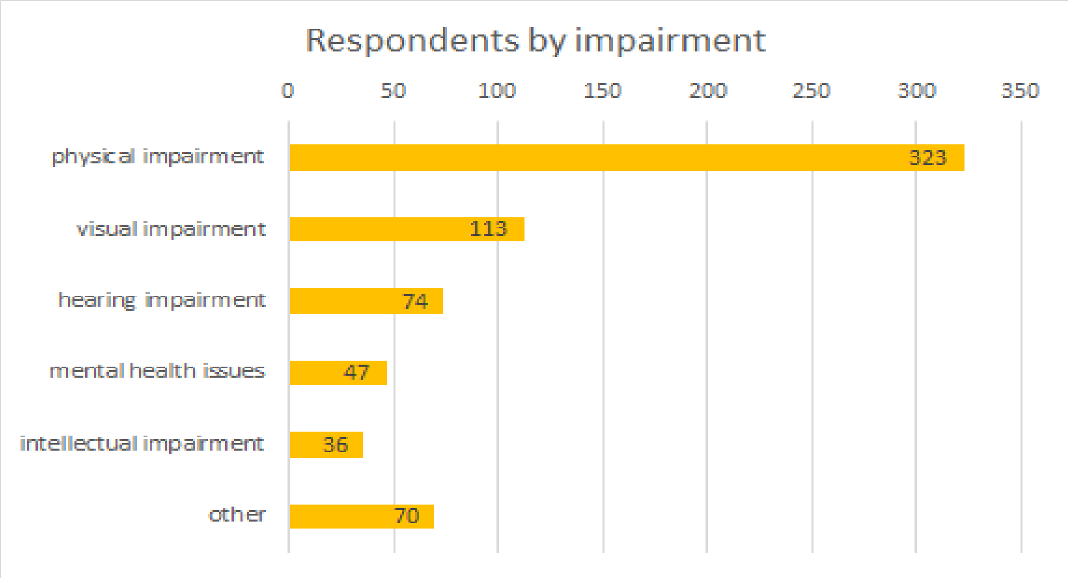

Figure 10: Representation of different impairments in our sample

Table 3 provides an overview of the types of disabilities that study respondents face and the assistance systems they use for compensating their disabilities. As shown here, the majority of respondents with physical disabilities use wheelchairs. The relatively low share of respondents with visual impairments who use contact lenses or glasses implies that the majority of respondents is completely blind.

Table 3: Overview of impairments of respondents and used assistance systems Note. Multiple responses are possible

Physical impairments and assistance systems	total	323	58,4%
	wheelchair	226	
	crutches	67	
	protheses	23	
	walker	27	
	other[65]	42	
Visual impairment	**total**	**113**	**20,4%**

[65] e.g., scooter

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	contact lenses/glasses	40	
	long cane	55	
	guide dog	4	
	Human companion	62	
	other	6	
Hearing impairment	**total**	**74**	**13,4%**
	hearing aids	37	
Mental health issues	**total**	**47**	**8,5%**
Intellectual disabilities	**total**	**36**	**6,5%**
Other[66]	**total**	**70**	**12,6%**

The cross-country comparison regarding the types of disabilities revealed no considerable differences in the share of disabilities between countries (see Figure 11). As shown in the following pie charts for the countries with the largest number of respondents, the share of physical impairments ranged from 19.9% in Italy to 26.0% in Sweden. Visual impairments were often represented in the Bulgarian sample (22.5%).

[66] e.g., Epilepsy, communication disorder, Autism

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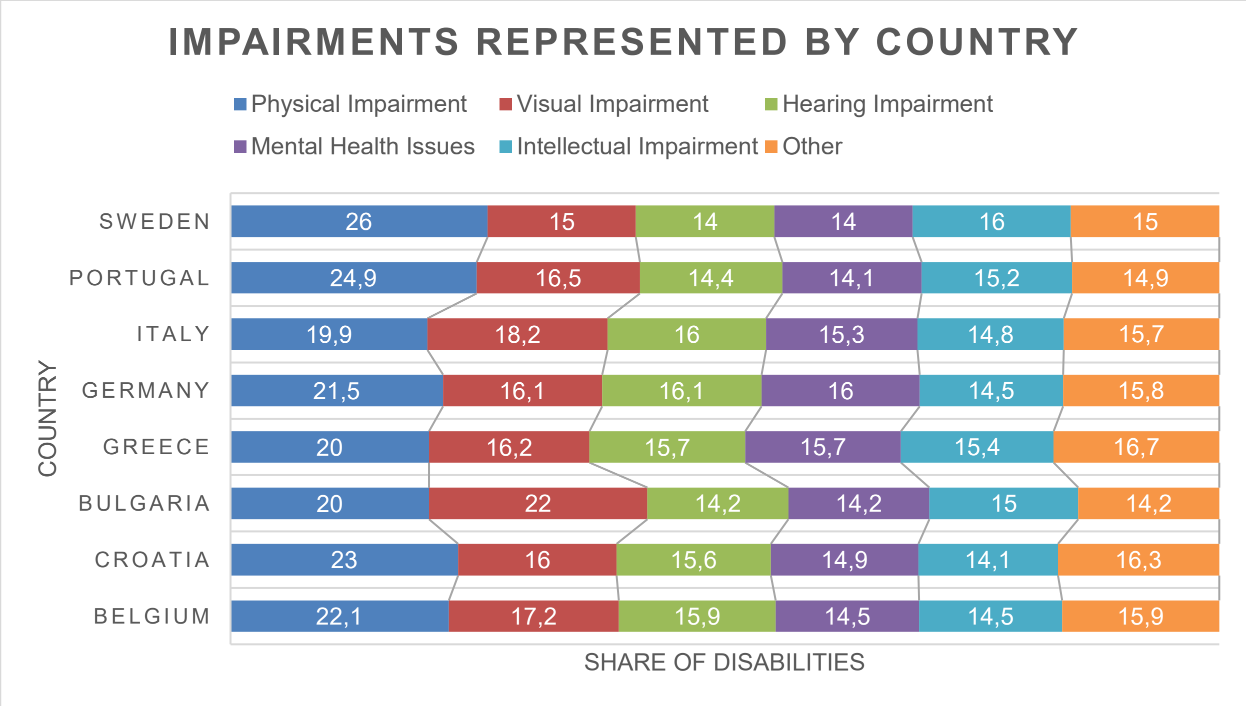

Figure 11: Share of disabilities by country

With regard to the time participants have lived with their disabilities, the analysis showed that the majority was either born with their disability (40.9%) or have lived with it for more than 10 years (43.0%) (see Figure 12).

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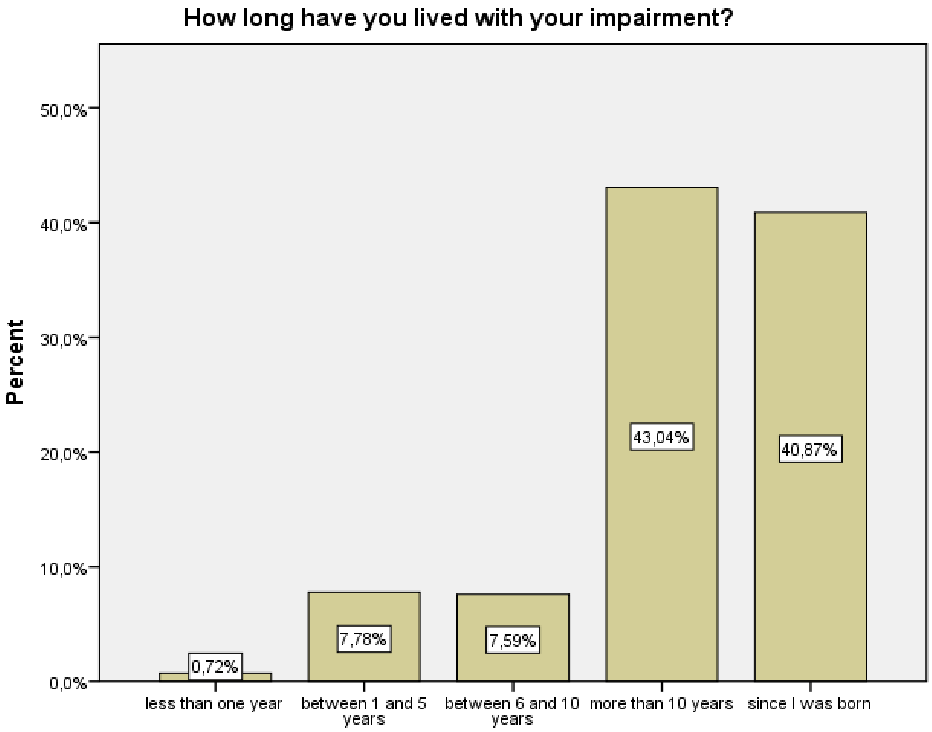

Figure 12: Time since when the disability has existed.

With regard to their ability to drive a car, nearly forty percent of the respondents stated to **own a driver's license** (39.8%) whereas 36.9% stated to not possess a driver's license (rest missing). Possession of a driver's license did not differ between genders ($X^2(3) = 1.21$, $p = .751$). Respondents without a driver's license were significantly younger than respondents who possess a driver's license ($F(1;423) = 77.58$, $p < .001$). Furthermore, respondents with physical impairments ($X^2(1) = 12.12$, $p = .001$), intellectual disabilities ($X^2(1) = 15.78$, $p < .001$) or visual impairments ($X^2(1) = 10.76$, $p < .001$) held a driver's license less frequently.

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4. Results

4.1. Descriptive results

4.1.1 Modal split

The use of different modes of transport for different types of disabilities was assessed (see Figure 13). We also assessed how many respondents with a specific disability indicated that they are not able to use a given means of transport.

A high share of persons who are not able to use bikes have physical disabilities (42%), visual impairments (28%) and intellectual disabilities (44%). Interestingly, the share of persons who are not able to ride a car was smaller than for bikes (9% for physical impairments, 28% for visual impairments, 17% for intellectual disabilities).

Respondents with **physical disabilities** mostly specified the **car to be their most often used means of transport on a daily basis** (27%). Buses are used by 21% of those with physical disabilities at least several times a week.

For persons with **visual impairments**, the public transport means train and bus are most frequently used. 54% of visually impaired respondents declared to use buses several times a week or daily. Trains were used by 35% on a regular basis, several times a week.

Persons with **hearing impairments** most often specified the car to be their most frequently used means of transport. In more detail, 51% stated to use the private car at least several days per week. Buses and trains were used by this group of respondents equally often (38%, resp. 39% stated to use them several times a week).

Persons with **mental health issues** also used the private car very frequently (51% at least several times a week). Buses and trains were also often used by this group of respondents, as shown in Figure 13. Persons with intellectual disabilities showed no clear modal preferences. 33% stated to use the car several times a week or on a daily basis. Buses, trains and bikes were used less frequently among this group of respondents than among other groups of respondents.

Respondents that specified to face **other impairments** stated to use specialized transport more often than other groups of respondents (23% at least several times a week). This group of respondents also used cars frequently (41% at least several times a week).

It should be highlighted that the share of respondents that never use specialized transport was high, ranging from 19% for persons with other impairments to 76% for persons with hearing impairments or mental health issues.

In conclusion, **it was shown, that the modal split varied considerably across the different types of disabilities.**

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Figure 13: Modal Split

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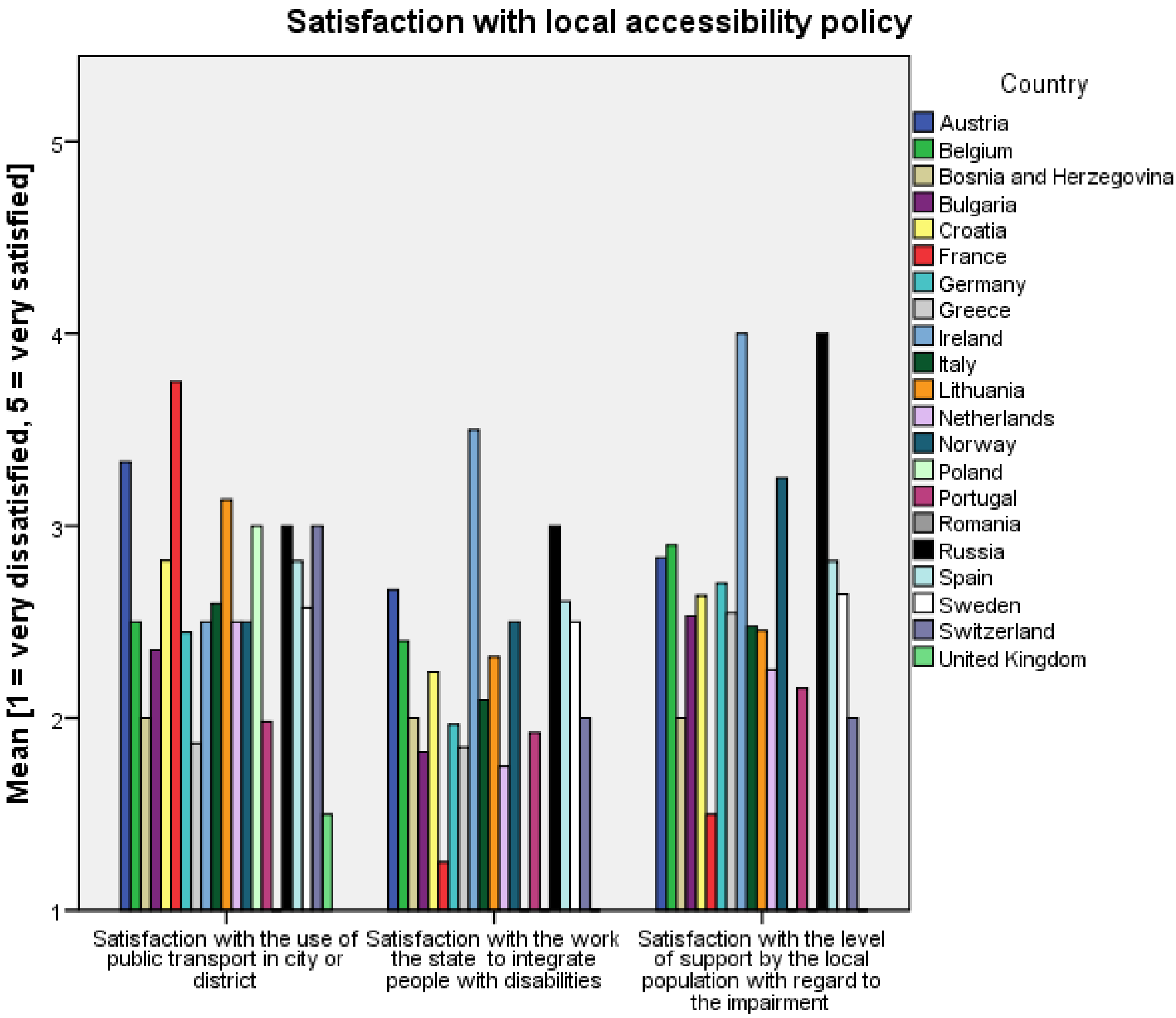

Figure 14: Satisfaction with local accessibility policy implementation per country

With regard to the seven partner cities, differences are shown in the assessment of their citizens concerning local accessibility policies. **Satisfaction with public transport** was lower in **Sofia** (M = 2,4, SD = 1,3) than in the other six cities. Respondents from Sofia also assessed the state's application of accessibility policies rather as dissatisfactory (M = 1,9, SD = 1,0). Respondents from **Stockholm** expressed the highest satisfaction with integration policies, however, the mean value of 2,7 (SD = 0,8) was far from an acceptable level. With regard to the assessment of the support by the local population regarding to

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their impairment, respondents from Brussels (M = 3,2, SD = 1,3) and Stockholm (M = 3,1, SD = 0,7) were the most satisfied (see Figure 18).

4.1.2 Local accessibility assessment

The analysis of the three questions regarding the respondents' satisfaction with the local accessibility policies shows that the majority of respondents is very dissatisfied (n = 134, 24.2%) or fairly dissatisfied (n = 161, 29.1%) with the use of public transport in their city or district (see Figure 15). However, 14 persons (2.5%) stated that they are very satisfied and 127 (23.0%) that they are fairly satisfied with public transport.

Among those who were satisfied, were 75% from the Norwegian sample (n = 3), 25.5% from the German sample (n = 23) and 28.9% of all respondents from Spain (n = 11). The share of respondents indicating to be fairly or very satisfied with public transport in their area was higher among respondents with visual or hearing impairments (30%) than among respondents with other types of disabilities (about 20%).

Figure 16 shows that across all types of disabilities, satisfaction with the work of the authorities to integrate disabled people was rather low. With regard to the level of support by the local population rather small differences in the satisfaction of respondents were shown between different types of disabilities (see Figure 16).

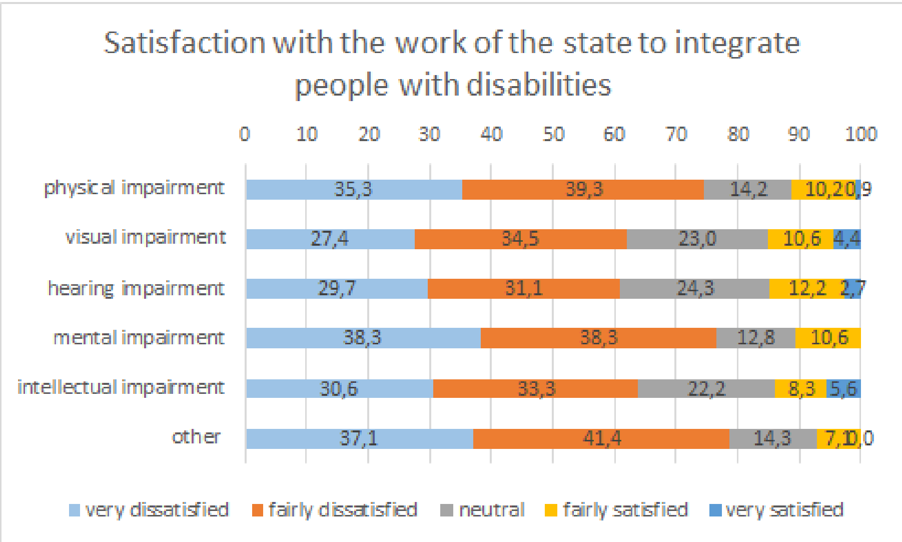

Figure 15: Satisfaction with the work of the state

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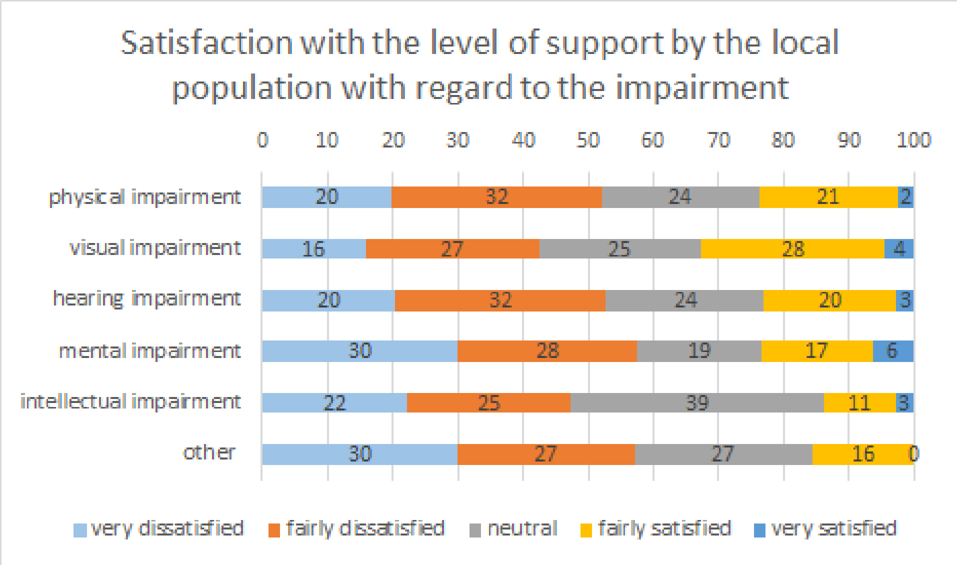

Figure 16: Satisfaction with the level of support by the public

Figure 17 shows that the satisfaction with local public transport differs among the countries. Whereas mean satisfaction was very low in Greece (*M* = 1.87, SD = 0.81) and the United Kingdom (*M* = 1.50, SD = 0.58), it was the highest in France (*M* = 3.75, SD = 0.50) and Austria (*M* = 3.33, SD = 1.03). The perceived satisfaction with the implementation of accessibility policies by their state did not vary much between the countries, with an exception of the few respondents from Russia and Ireland[67] (see Figure 17). The **mean satisfaction across all countries was rather low** with *M* = 2.11 (SD = 1.05).

The satisfaction with the level of support provided by the local population showed great variance between the countries (see Figure 17). Satisfaction was very low in France (M = 1.50, SD = 0.58), Portugal (M = 2.15, SD = 1.13) and Switzerland (M = 2.00). Satisfaction was higher, but yet not high, in Ireland (M = 4.00, SD = 1.41), Norway (M = 3.25, SD = 1.50) and Russia (M = 4.00). However, it should be noted that the number of respondents was very low in some of the countries and a cross-country comparison is therefore not recommended.

[67] It should be noted that the data for some of the countries, like Russia or Ireland are not sufficient to draw conclusions.

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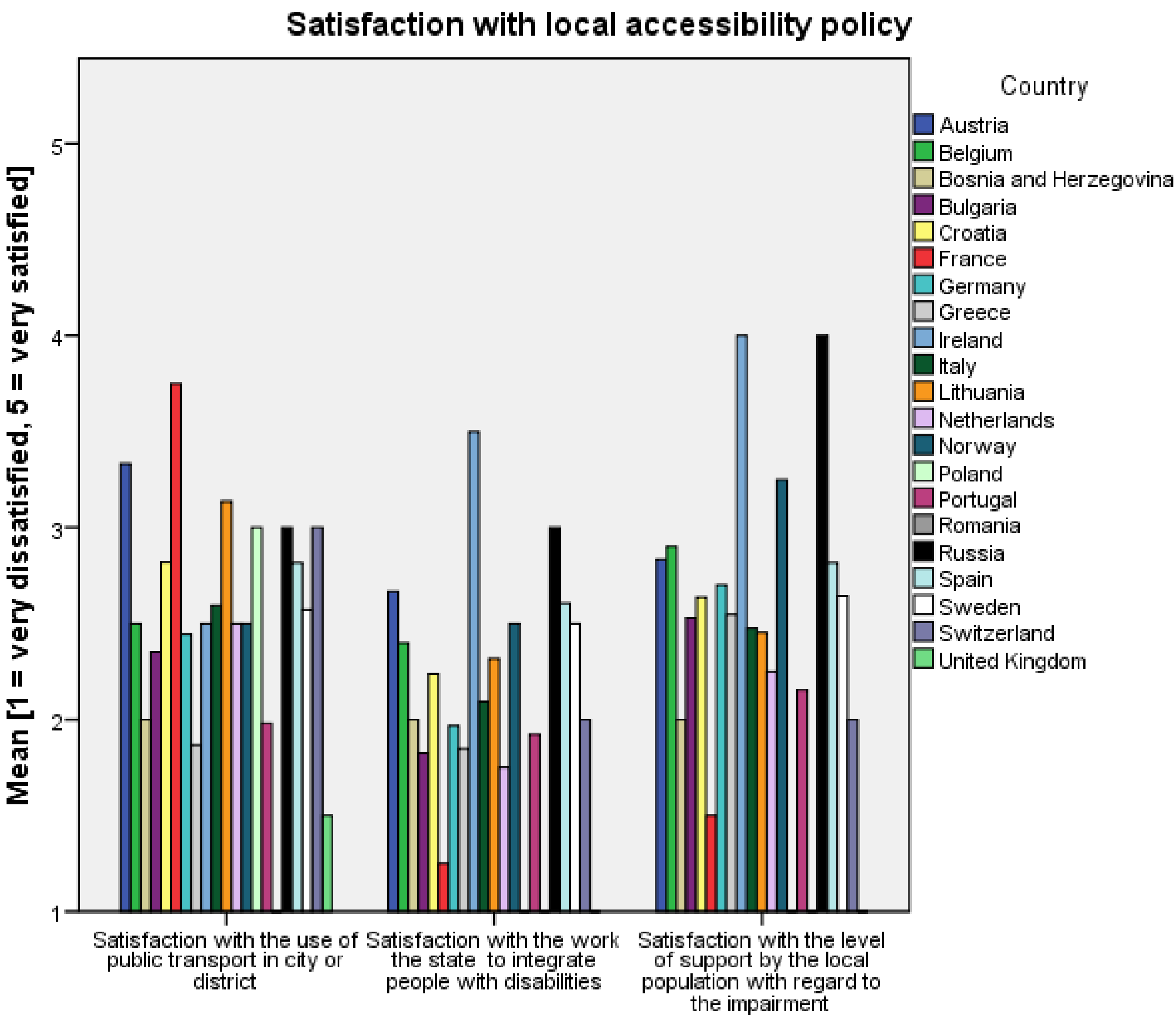

Figure 17: Levels of user satisfaction with local accessibility policy implementation

With regard to the seven partner cities, differences are shown in the assessment of their citizens concerning local accessibility policies (see Figure 18). **Satisfaction with public transport** was lower in **Sofia** (M = 2.4, SD = 1.3) than in the other six cities. Respondents from Sofia also assessed the state's application of accessibility policies as rather dissatisfactory (M = 1.9, SD = 1.0). Respondents from **Stockholm** expressed the highest satisfaction with integration policies, however, the mean value of 2.7 (SD = 0.8) was far from an acceptable level. With regard to the assessment of the support by the local population regarding their disabilities, respondents from Brussels (M = 3.2, SD = 1.3) and Stockholm (M = 3.1, SD = 0.7) were the most satisfied.

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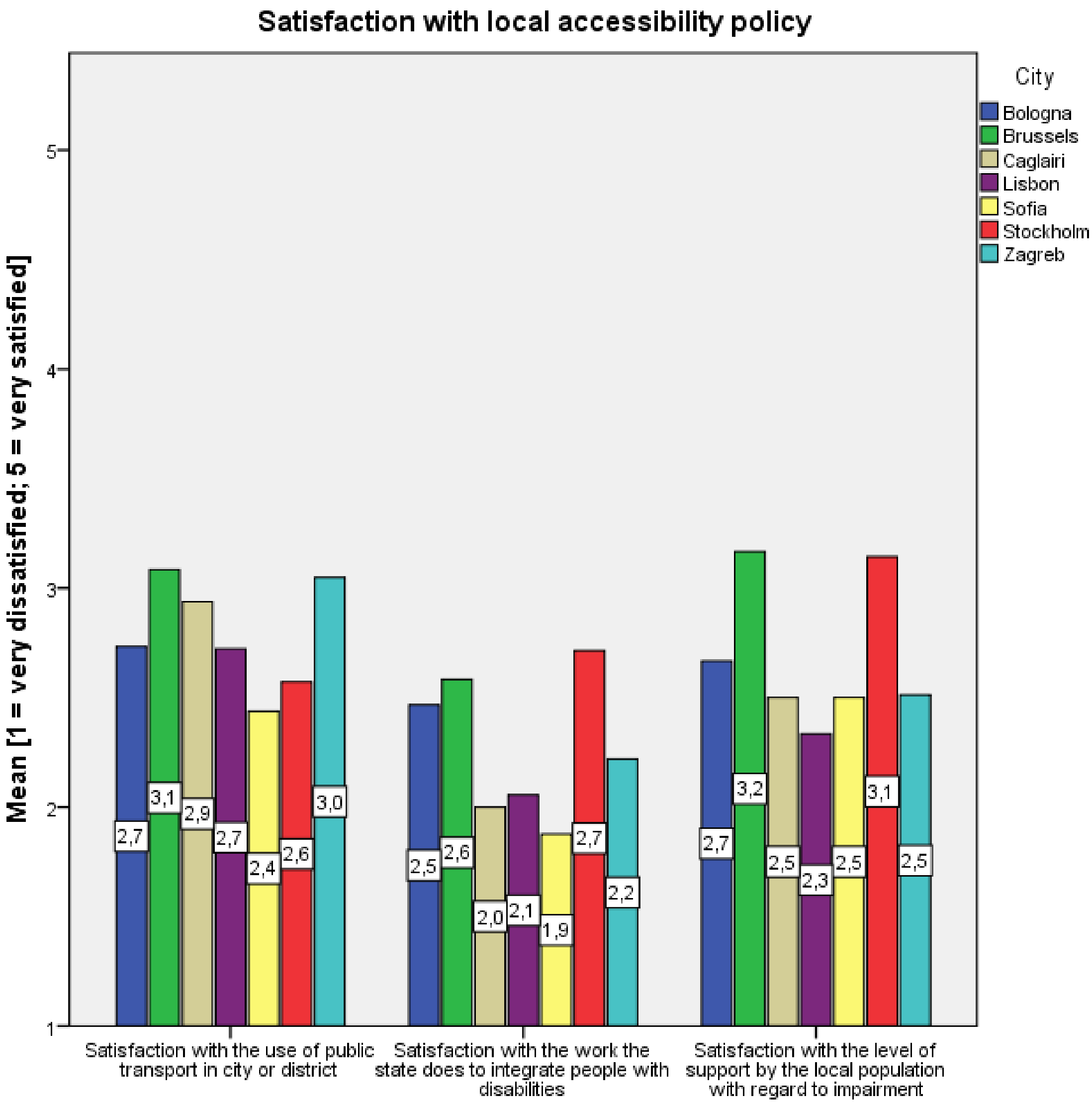

Figure 18: Satisfaction with local accessibility policy implementation for participating cities

4.1.3 Qualitative analysis of barriers

The following table presents a frequency analysis of the coding of participants' free-text responses on the current barriers they are facing. We coded the responses along the MDI dimensions of Comfort, Convenience, Security, and the facets that constitute each of these dimensions in yellow, red and blue, respectively. Also, we coded the responses along the dimensions of Time, Affordability and Autonomy.

Frequency analysis of the free-text responses on the open question about mobility barriers revealed people's difficulties reaching and boarding a vehicle. Social barriers, manifesting as lack of consideration or support by transport staff and disregard from other

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passengers. Access to the open question excel file and its analysis can be provided upon request

Table 4: Frequency analysis of barriers based on our Mobility Divide Index (MDI) Factors

	Barrier	TOTAL
Comfort	Reaching transport access point	64
	Using facilities and supporting infrastructures	58
	Getting on and off the mean of transport	80
	Comfort on board	53
	Be oriented	13
	Finding information	19
	Using intermodal facilities	2
	Easy driving of shared vehicles	0
Convenience	Social barriers	33
	Surrounding environment	16
	Limited access to information	52
	Inconveniences in emergency situations	4
	Outage of the regular operations	4
	Impact of the pandemic restrictions	4
Security	Risks on the way to the transport access point	3
	Risks at the transport access point	3
	Risks on board	4
	Risks in Emergency situations	0
	Pandemic related risks	1
	Risk of incident while driving shared vehicles	0
Travel Time		57
Affordability		8
Autonomy		51

4.1.4 Effects of COVID-19 on travel behaviour

The effects of the COVID-19 pandemic on the travel experience of respondents were analysed with regard to the respondents' disabilities (see Figure 19). Overall, respondents assessed the impacts of the pandemic on their travel behaviour to be strong. Nearly 60% of the respondents strongly agreed with the statement that the pandemic made them less willing to travel (n = 327, 59.1%). Almost half of the respondents stated that the pandemic made their journeys more difficult (n = 260, 47.0%), less safe (n = 268, 48.4%) and less nice (n = 265, 47.9%). However, there was also a considerable share of respondents stating that the pandemic did not make their journeys more dependent on others (n = 156, 28.2%, stated "no" and n = 58, 10.4%, stated "not a lot").

It was shown that persons with visual and hearing impairments experienced less barriers as a result of the pandemic. However, especially persons with mental health problems or intellectual disabilities experienced that their journeys have become more difficult. With regard to the question if the pandemic made journeys less nice, the assessment across all types of disabilities were homogenous.

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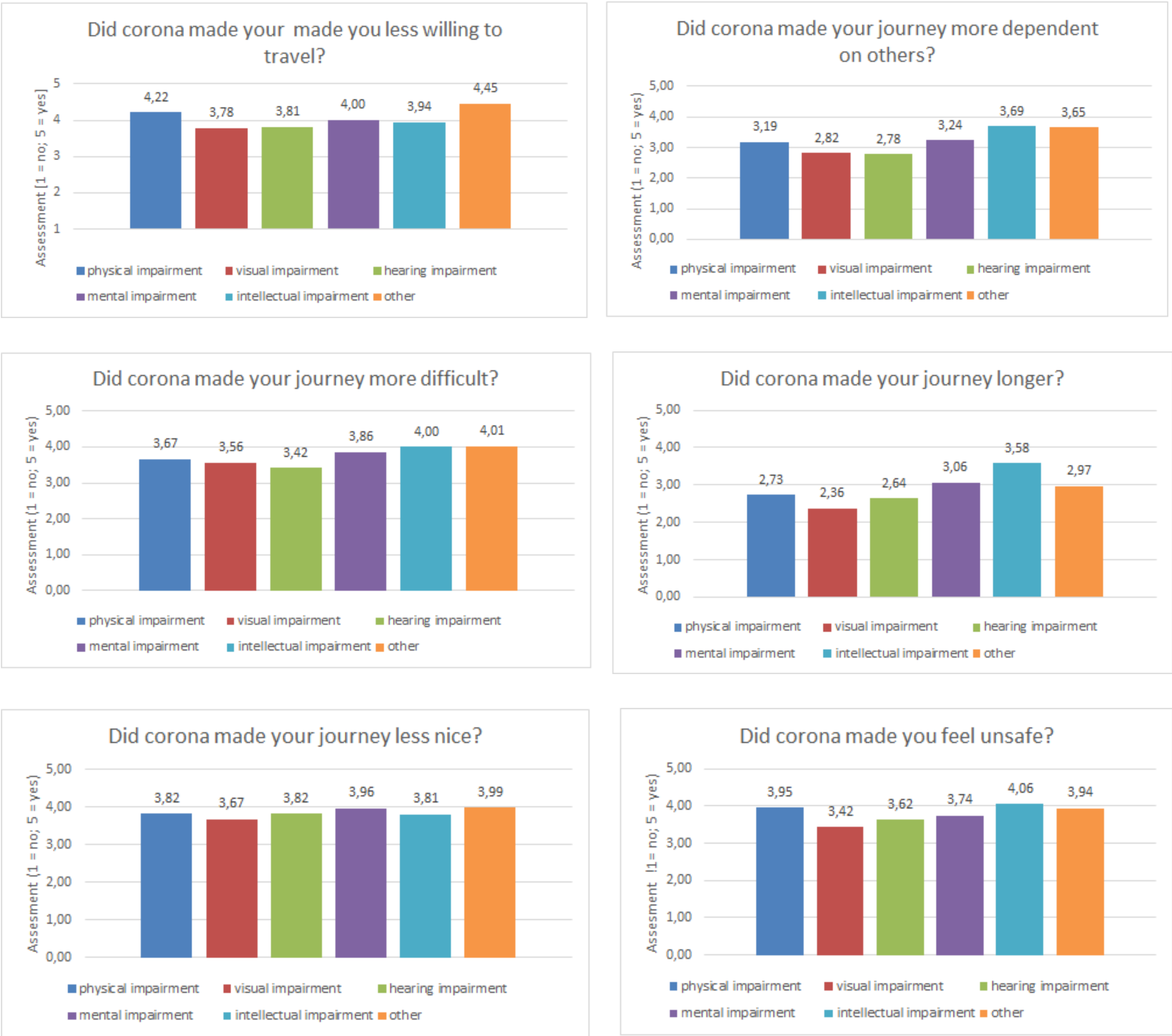

Figure 19: Responses on the effect of COVID-19. With 1= no, 2 = not a lot, 3 = neutral, 4 = a bit, 5= yes

A new variable was calculated to assess the overall impact of the pandemic on travel behaviour, that describes the mean of all six variables.

For the overall impact of the pandemic on travel behaviour, a significant gender effect was shown ($t(535) = 2.71$, $p = .007$), with women experiencing the effects more strongly (M = 3.65, SD = 1.04) than men (M = 3.39, SD = 1.11).

For the two age groups (younger than the sample mean of 46 years vs. older than 46 years), no difference in travel experience during the pandemic was shown ($t(551) = -1.45$, $p = .148$).

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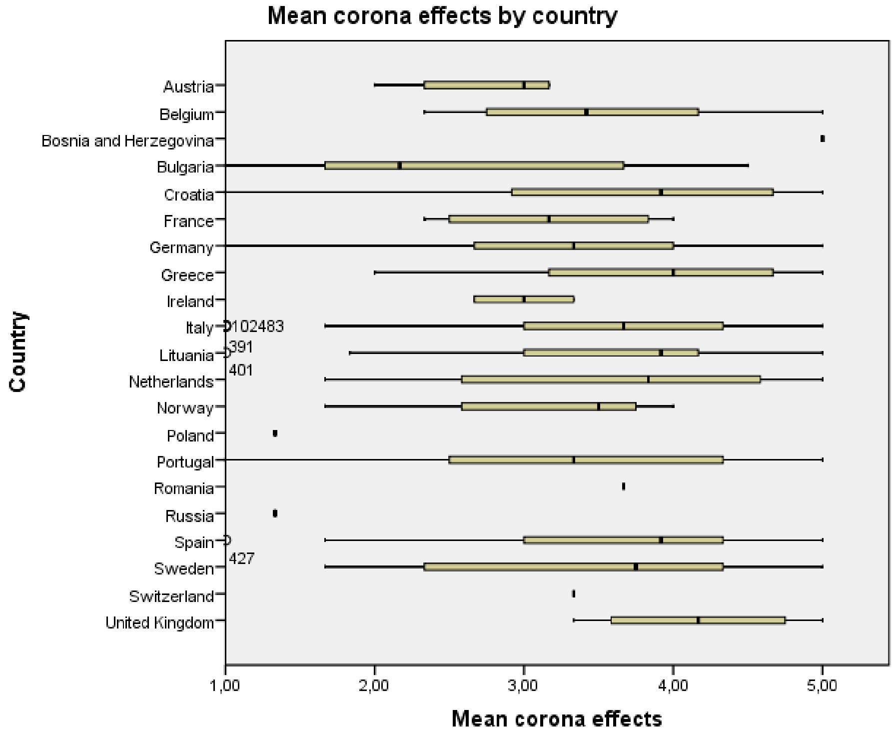

Figure 20: Mean COVID effects per country

With regard to the mean corona effects by country, considerable differences were shown. As displayed in Figure 20, the mean assessment of effects due to the pandemic on travel behaviour, was low in Bulgaria (M = 2.5, SD = 1.1) and Austria (M = 2.8, SD = 0.53). Rather high impacts were experienced among the respondents from Greece (M = 3.9, SD = 0.9), United Kingdom (M = 4.2, SD = 0.7) and Spain (M = 3.7, SD =

4.2. Subjective technology competence and usage

4.2.1 Current usage of technology

Respondents were asked to state their current usage of technology in their daily lives. Regarding current technology usage it was shown that smartphones and tablets (*M* = 4.4, *SD* = 1.1) and (*M* = 4.3, *SD* = 1.0) are used very frequently by the respondents.

However, the descriptive analysis showed that 5.6% (n = 31) of respondents never use computers and another 36 (6,5%) never use smartphones, indicating that a small share of study participants is not digitally active. The detailed analysis of the non-digital users showed that they do not differ in age (*M* = 47.7 years, *SD* = 17.9 years) from respondents who use smartphones more often (*M* = 46.3 years, *SD* = 15.5 years). However, among the non-digital users, that stated to never use smartphones nor computers, men were the majority (63.9%). The contrary was shown for PC and laptops. Respondents that stated to never use these technologies were most often female (67.7%) and somewhat older (*M* = 54.9 years, *SD* = 22.2 years) than respondents who use PCs and laptops more regular (M = 45.9 years, *SD* = 15.1 years).

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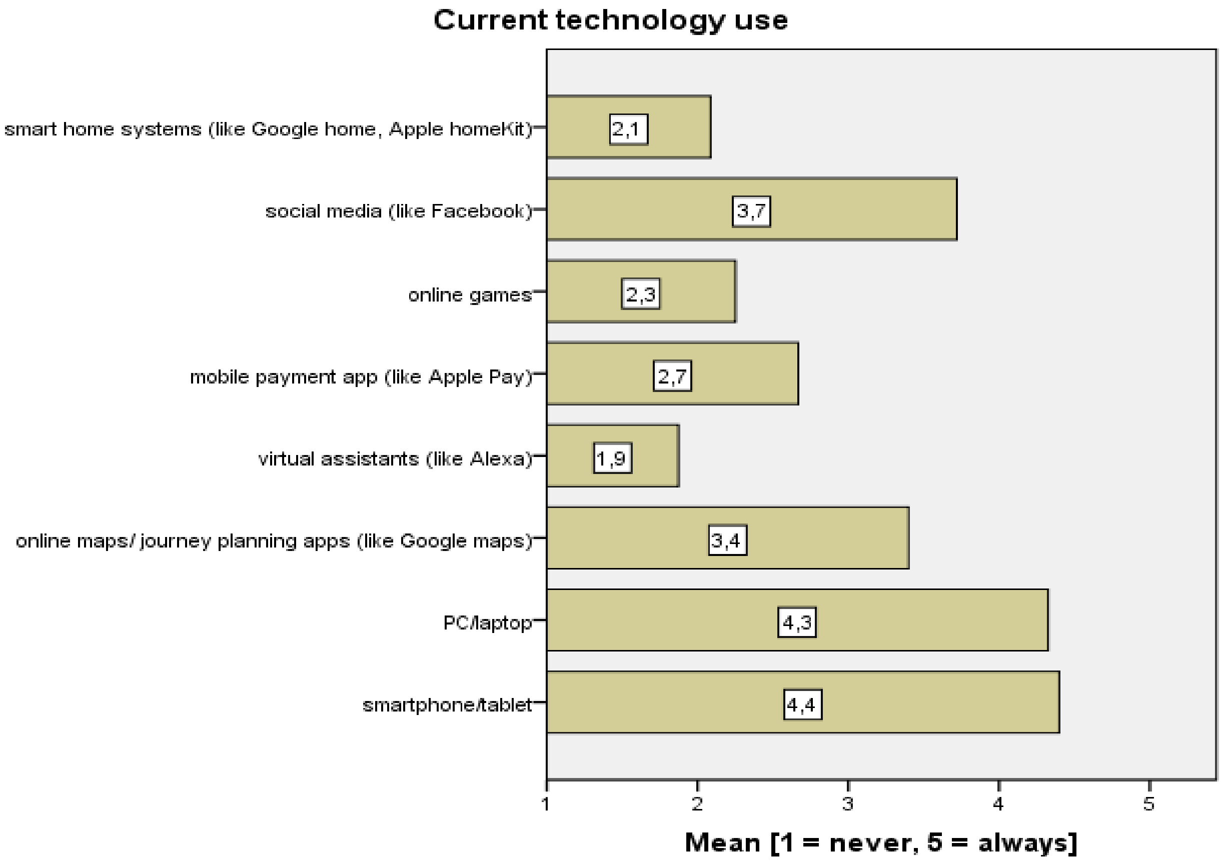

Figure 21: Mean averages of current technology use

When looking at the cross-country comparison, it was shown, that the share of non-digital respondents was extremely high in Belgium with 30% of respondents (n = 6) declaring that they never use smartphones.

In more detail, especially respondents with intellectual disabilities used smartphones and tablets significantly less often (M = 3.5, SD = 1.5) than persons without intellectual disabilities (M = 4.5, SD = 1.0, $F(1, 550) = 28.7$, $p < .001$). The same applies for the use of PC and laptop ($F(1, 550) = 25.1$, $p < .001$).

4.2.2 Subjective technology competence

Respondents‘ subjective technology competence was assessed by the STAI (subjective technology adaptivity inventory, see section 3.1). The STAI can be divided into three categories. Each category contains four questions. The questions for the first category, Perceived Adaptive Utility (PAU), are based on the principle of selection. We gather data about how good technology is, while making decisions and going through the daily life. The category “Technology-related Goal-Engagement” (TGE) based on the principle of optimization. How high is the commitment and the motivation to investigate time in learning new technology? The answers give us an assumption about how useful

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technology is, for achieving a goal. The last category is the Perceived Safety of Technology (PST), which have to recourse to the principle of compensation. This category refers to a sense of trustworthiness, safety and security, while using technology (Kamin & Lang, 2013).

These three categories pool into the Subjective Technology Adaptivity (STA) which "indicates a consistent, purposeful, and self-regulated disposition of adaptive functioning in behavioural transactions with new environment and technology demands […]" (Kamin & Lang, 2013, p. 2). Through all categories we capture the agreement for all 4 statements (questions). The agreement for category one, the help through decisions and the daily life (PAU, M = 4.06, SD = 0.83), is slightly higher than Technology-related Goal-Engagement (M = 3.66, SD = 0.92) and Perceived Safety of Technology (M = 3.71, SD = 0.82).

Figure 22 shows a comparison of ratings within each category of the STAI between the gender "male" and "female". To get an overview, we compare the mean values for the two genders through all categories. No considerable differences between male and female respondents were revealed. For example, the STA for femle gender (M = 3.81, SD = 0.73) and for male gender (M = 3.83, SD = 0.72) did not differ. The other possible answers "prefer not to say" and "other" are unlisted because of insufficient data.

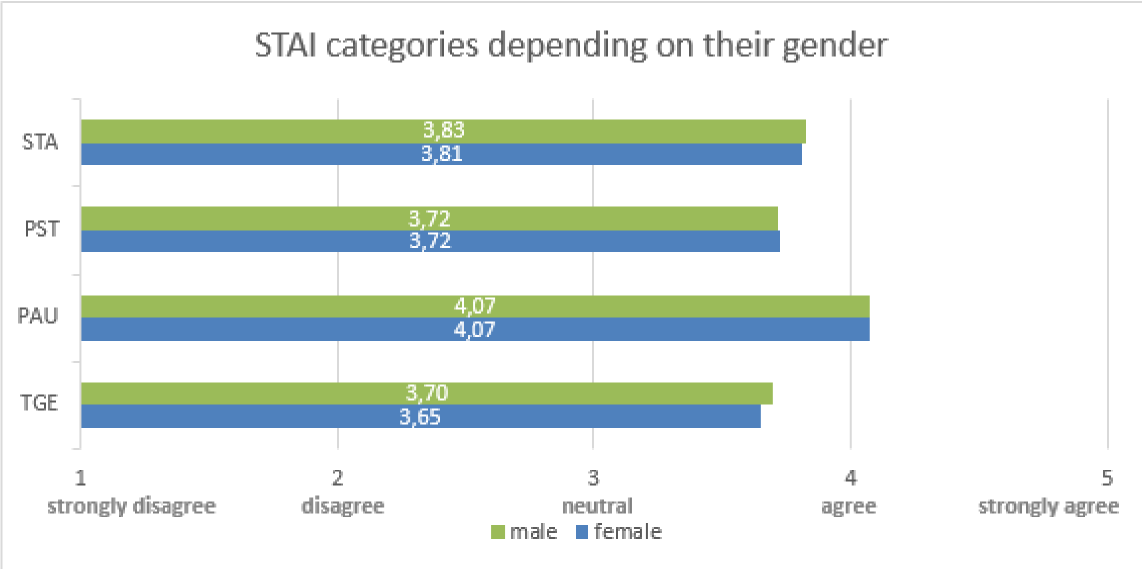

Figure 22: Gender differences in Subjective Technology Adaptivity (STA).

With the regard to their disabilities, differences show between the subjective technology assessment. In figure 23, the comparison of the means over the three categories of the STAI and the junction of these, the STA, is displayed. Over all disabilities the category PAU seems to get more agreement for all kinds of disabilities. As shown in figure 23, respondents with intellectual disabilities are less engaged in using technology (TGE: *M* = 3,12, *SD* = 1,21).

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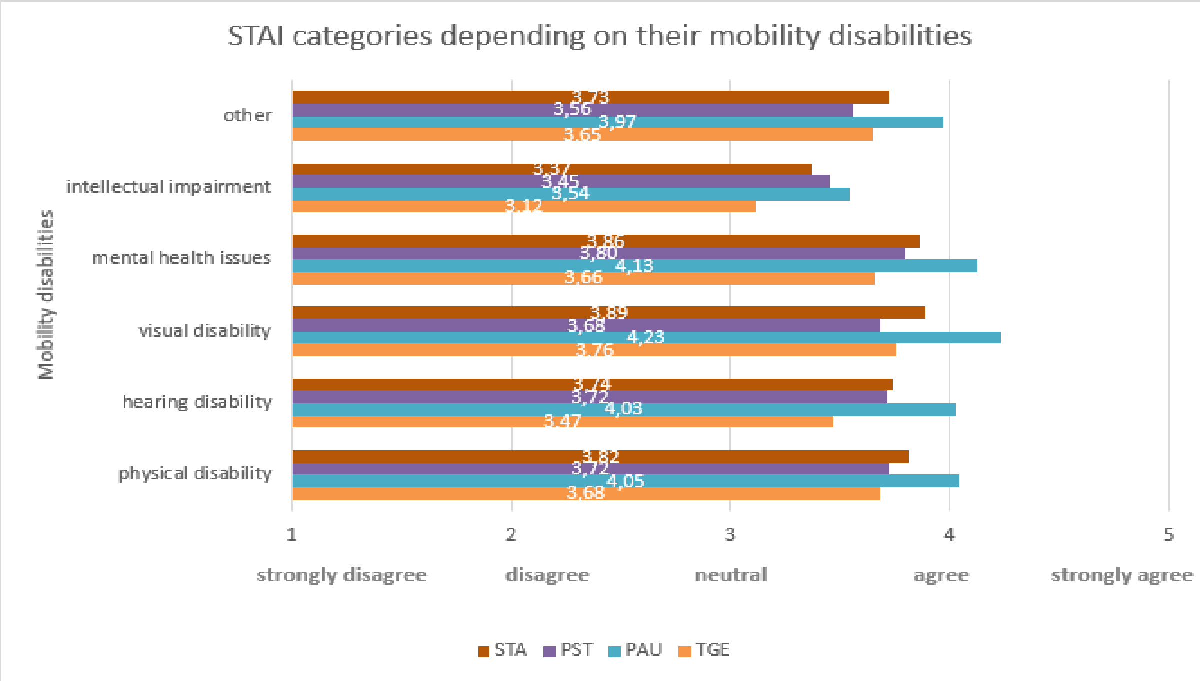

Figure 23: Impairment differences in Subjective Technology Adaptivity

Table 5 shows the correlation between STA and Perceived Technology Competence (PTC). The PTC consists out of 3 questions which is defined as perceived competence and the general involvement with technology. According with the STA, there is a highly positive correlation between STA and PTC.

Paired sample correlation			
	n	**Correlation coefficient**	**p**
STA & PCT: Generally, I use modern technology frequently	553	,727	,000
STA & PCT: I am interested in technological innovations	553	,701	,000
STA & PCT: I consider myself competent enough to use modern technology	553	,691	,000

Table 5: Subjective Technology Adaptivity and Perceived Technology Competence

When looking at the extreme groups of self-assessed technology competence, it was shown that respondents, who consider themself as less competent (n = 30) are less willing to use accessible navigation systems (M = 2,97, SD = 1,74) than persons with high self-assessed technology competence (n = 269, M = 3,75, SD = 1,266, $F(1;301)$ = 10,313, p = .001). The same applies for wearables, exoskeletons, artificial intelligence sign language translation, artificial intelligence alerts and automated captions. No differences were shown for smartcanes, autonomous wheelchairs and vehicles, 3D

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printed protheses, augmented reality, location-based alerts and smart communication alerts.

4.3. Users' assessment of assistive technologies

The respondents were asked to state which of the assistive technologies they would use, if available. As shown in Figure 23, most of them would be used "sometimes". Top of the list are wearables (M = 3.9, SD = 1.3), artificial intelligence alerts (M = 3.7, SD = 1.3), and robots (M = 3.7, SD = 1.5), as well as autonomous wheelchairs and vehicles (M = 3.7, SD = 1.4) which seem to cater not only for the needs of those with physical disabilities but also for those with intellectual disabilities.

We also enquired which technologies respondents regarded as non-applicable, i.e. not appropriate for their disability, to see which assistive technologies are excluded from consideration.

As expected, smart canes and automated captions were seen as specialised tools for those with visual and hearing impairments, whereas robots, augmented reality and artificial intelligence alerts are applicable for respondents across disabilities. Somewhat less expected, accessible navigation systems were welcome by blind people, but also by people with intellectual disabilities. Artificial intelligence alerts were particularly welcomed by those with intellectual disabilities who are also open to a host of other assistive technologies, like location-based alerts, augmented reality, robots, and smart communication aids, and autonomous wheelchairs.

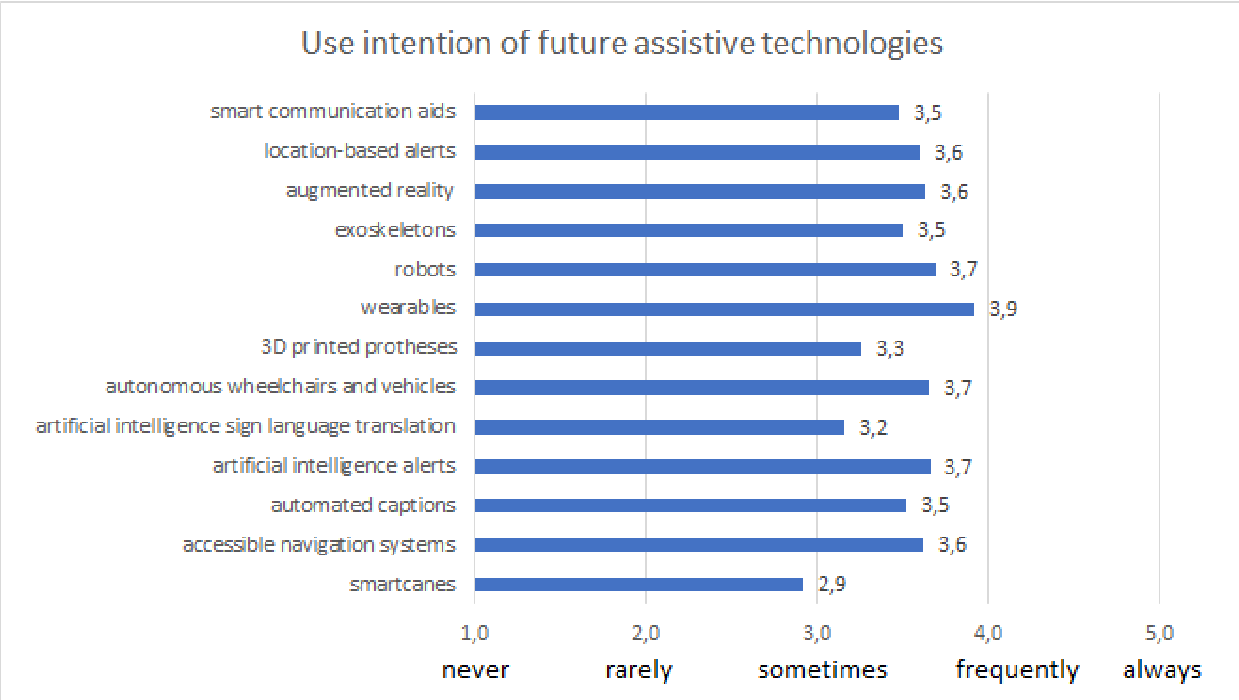

Figure 24: Intention to use future assistive technologies

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We should note that these views may also reflect the needs of their caregivers, as often caregivers filled out the survey on behalf of people with intellectual disabilities. Automated captions and artificial intelligence alerts are seen as useful tools by those with a hearing impairment. Those with visual impairments would welcome accessible navigation systems, robots and augmented reality solutions. Persons with physical impairments would prefer a variety of specialised solutions from autonomous wheelchairs and exoskeletons, to more general ones, such as wearables, robots, location-based services and to some extent augmented reality (see Figure 25 for details).

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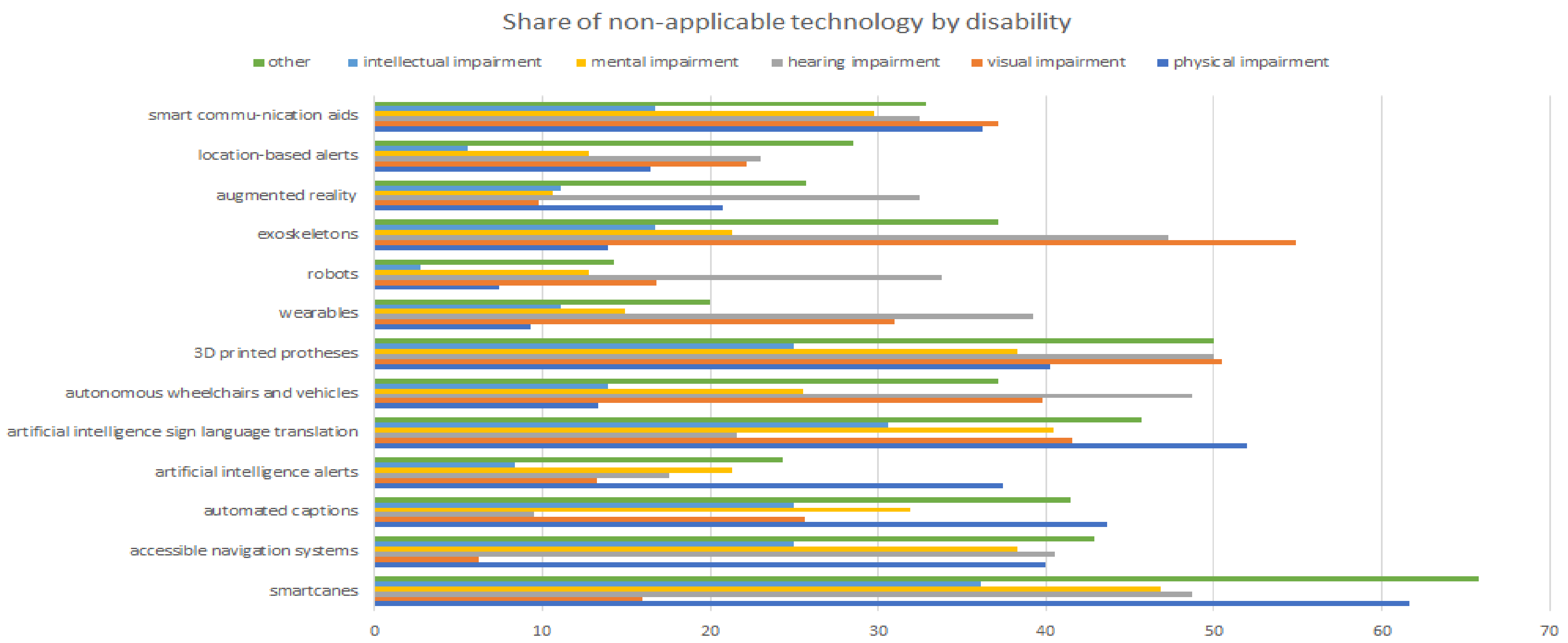

	smartcanes	accessible navigation systems	automated captions	artificial intelligence alerts	artificial intelligence sign language translation	autonomous wheelchairs and vehicles	3D printed protheses	wearables	robots	exoskeletons	augmented reality	location-based alerts	smart commu-nication aids
other	65,7	42,9	41,4	24,3	45,7	37,1	50,0	20,0	14,3	37,1	25,7	28,6	32,9
intellectual impairment	36,1	25,0	25,0	8,3	30,6	13,9	25,0	11,1	2,8	16,7	11,1	5,6	16,7
mental impairment	46,8	38,3	31,9	21,3	40,4	25,5	38,3	14,9	12,8	21,3	10,6	12,8	29,8
hearing impairment	48,6	40,5	9,5	17,6	21,6	48,6	50,0	39,2	33,8	47,3	32,4	23,0	32,4
visual impairment	15,9	6,2	25,7	13,3	41,6	39,8	50,4	31,0	16,8	54,9	9,7	22,1	37,2
physical impairment	61,6	39,9	43,7	37,5	52,0	13,3	40,2	9,3	7,4	13,9	20,7	16,4	36,2

Figure 25: Assistive technologies that were considered non-applicable by type of disability

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4.4.1 Assessment of use intention

Accessible journey planner is the single most favoured solution across different travel purposes of use by users (see Table 6).

Cable cars and cycle lanes hold a promise across travel purposes for users with access needs. Our participants would use cycle lanes to reach a place of study (26%) or to commute (31%), to go shopping (40%) or to a scheduled appointment (35%) or when going out (46%). Participants reported that they would use cable cars to reach a place of study (24%) or to commute (39%), to go shopping (35%) or to a scheduled appointment (40%) or when going out (50%).

Microtransit, Ride pooling, Robotaxis also hold a promise for commuting, shopping, going to a scheduled appointment and socialising, but not so much for educational purposes. On average, 32% of the respondents would use microtransit. On average, 27% would use ride pooling. Finally, 32% of the respondents would use robotaxis.

Accessible journey planner is the single most favoured solutions across purpose of use by users (see Table 5 below). Accessible journey planners were described as online systems or mobile apps that provide information on how you can travel with public transport from point A to B when you use a wheelchair or you want to avoid walking up and downstairs. Accessible journey planners will also be the foundation for developing accessible navigation systems for the blind but also for those with intellectual disabilities.

Investments in **bike sharing, motorbike taxis and e-scooters** have left behind disabled people, at least in their current format.

Table 6: Intention to use mobility solution

Respondent answered 'Yes'

Mobility solution	education	commuting	shopping	appointments	leisure	Average
Accessible journey planner	29%	44%	46%	50%	54%	44%
Bike sharing	14%	18%	16%	17%	24%	18%
Cable car	24%	39%	35%	40%	50%	37%
Cycle lane	26%	31%	40%	35%	46%	36%
E-scooter	15%	22%	25%	22%	27%	22%
Microtransit	19%	36%	32%	35%	40%	32%
Motorbike	17%	21%	20%	26%	27%	22%
Ride pooling	15%	28%	30%	29%	33%	27%
Robotaxi	23%	30%	35%	34%	37%	32%

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We report on solutions favoured for going out and socialising as well as for shopping, as users reported in previous studies[2] that they would like to do more of the activities should transport become convenient.

Except the accessible journey planner which seems to be favoured consistently across every analysis regardless of type of disability and purpose of travel, cable cars and microtransit were favoured for socialising purposes across occupation groups. Robot taxis were preferred for shopping.

Leisure	Study	Work Full Time	Work Part Time	Unemployed	Retired	Other
Accessible journey planner	**77%**	**76%**	**86%**	**70%**	**69%**	**85%**
Bike sharing	50%	55%	33%	36%	36%	32%
Cable car	**70%**	**89%**	**86%**	**85%**	**81%**	**85%**
Cycle lane	67%	67%	60%	71%	66%	60%
E-scooter	63%	46%	50%	63%	45%	45%
Microtransit	**77%**	**85%**	**57%**	**73%**	**75%**	**63%**
Motorbike	56%	46%	68%	61%	63%	33%
Ride pooling	57%	70%	50%	72%	63%	58%
Robotaxi	**65%**	**67%**	**69%**	**60%**	**76%**	**71%**
Shopping	**Study**	**Work Furll Time**	**Work Part Time**	**Unemployed**	**Retired**	**Other**
Accessible journey planner	**69%**	**71%**	**79%**	**70%**	**69%**	**70%**
Bike sharing	38%	45%	20%	30%	27%	32%
Cable car	**70%**	**78%**	**57%**	**70%**	**62%**	**82%**
Cycle lane	67%	58%	45%	68%	63%	53%
E-scooter	50%	46%	37%	59%	45%	45%
Microtransit	54%	60%	50%	77%	59%	42%
Motorbike	69%	39%	50%	54%	50%	25%
Ride pooling	64%	62%	44%	66%	62%	47%
Robotaxi	**76%**	**65%**	**69%**	**64%**	**74%**	**57%**

Table 7: Mobility solutions favoured for socialising (top) and shopping (bottom)

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4.4.2 Assessment of travel behaviour based on MDI components

Indications about the reasons behind users' preferences towards different mobility solutions can be seen by their evaluations across the MDI dimensions.

Unsurprisingly, an accessible journey planner would motivate travel and make one's journey more independent, faster, easier, nicer and safer. In contrast, bike sharing, e-scooters and motorbike taxis score low on all dimensions and for all categories of users (see table 8).

Respondents' answer was positive ('Yes' or 'Quite a bit')

Mobility solution	Travel more	More Independent	Faster	Easier	Nicer	Feel safer	Average
Accessible journey planner	**60%**	**67%**	**56%**	**67%**	**64%**	**57%**	**62%**
Bike sharing	**23%**	**22%**	**22%**	**22%**	**23%**	**18%**	**22%**
Cable car	53%	54%	52%	58%	56%	42%	53%
Cycle lane	47%	47%	47%	51%	50%	46%	48%
E-scooter	28%	30%	34%	31%	29%	19%	29%
Microtransit	53%	54%	46%	57%	48%	44%	50%
Motorbike	36%	35%	41%	34%	28%	22%	33%
Ride pooling	42%	40%	32%	38%	35%	35%	37%
Robotaxi	46%	48%	35%	44%	43%	32%	41%

Table 8: Respondents who answered yes or quite a bit to questions relating to the MDI components

Microtransit and cable cars are favoured by almost half of the participants across all travel purposes, and, surprisingly, more than ride pooling and robotaxis, which score lower in all dimensions and bear further investigation. While we expected safety to be an issue particularly for robot cars, it was surprising to see that ride pooling and robot taxis were not considered to make people journey neither nicer nor faster. Cycle lanes hold a promise for participants and their modification of their use is worth further exploring.

4.4.2 Report per disability

This section reports on participants' views on mobility systems. It is worth noting that as each participant could comment on 3 of the 9 mobility systems, our findings represent 972 intention to use views on of people with physical impairments, 339 views from those with visual impairment, 222 views from those with hearing impairment, 150 and 108 views from those with mental health issues and intellectual disabilities. For a more detailed analysis see Table 9 below.

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Mobilty Solutions	Physical impairments	Visual impairments	Hearing impairments	Mental health issues	Intellectual disabilities	Other
Accessible journey planner	104	36	20	15	10	19
Bike sharing	123	43	29	21	16	19
Cable car	122	47	35	20	14	20
Cycle lane	98	34	26	15	11	31
E-scooter	122	43	28	21	16	19
Microtransit	103	36	19	14	9	19
Motorbike	99	30	20	16	13	30
Ride pooling	118	38	19	13	10	19
Robotaxi	83	32	26	15	9	31
Total	**972**	**339**	**222**	**150**	**108**	**207**

Table 9: Breakdown of views per future mobility solution per impairment

Those with physical impairments have a clear preference for an accessible journey planner, but would also entertain a number of alternative mobility solutions, except bike sharing, e-scooters and motorbike taxis (see Table 10).

Mobility Solution	Yes	Maybe	No	N/A
Accessible journey planner	53%	17%	13%	17%
Bike sharing	13%	15%	29%	44%
Cable car	35%	35%	14%	16%
Cycle lane	37%	21%	23%	19%
E-scooter	21%	21%	31%	27%
Microtransit	33%	25%	26%	15%
Motorbike	23%	21%	26%	30%
Ride pooling	28%	24%	22%	14%
Robotaxi	30%	34%	20%	15%

Table 10: Preference of those physically impaired

Those with visual impairments have a balanced preference for almost all studied solutions with the exception of bike sharing, cycle lanes and e-scooters. See Table 11 below for a breakdown.

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Mobility Solution	Yes	Maybe	No	N/A
Accessible journey planner	38%	23%	18%	16%
Bike sharing	20%	13%	24%	44%
Cable car	33%	36%	14%	17%
Cycle lane	25%	15%	25%	35%
E-scooter	17%	13%	31%	40%
Microtransit	34%	30%	28%	7%
Motorbike	23%	33%	38%	6%
Ride pooling	28%	37%	23%	6%
Robotaxi	34%	29%	21%	16%

Table 11: Preferences of those with visual impairments

Those with hearing difficulties favour the use of cycle lanes and cable cars (see Table 12). The views of hearing-impaired respondents on bike sharing, e-scooters, and motorbike taxis are polarised. While 29% would use bike sharing and at least consider it (16%), 27% would not use such schemes and 28% do not even consider it appropriate for one's disability. A similar pattern is seen for e-scooters with 27% willing and 17% open to try them, yet 31% are not willing and 24% would not even consider it as appropriate. Correspondingly, while 22% stated a willingness to try motorbike taxis and 19% were open to them, 28% were not willing and for 31% motorbike taxis were not an applicable mobility solution.

Mobility Solution	Yes	Maybe	No	N/A
Accessible journey planner	31%	21%	9%	39%
Bike sharing	29%	16%	27%	28%
Cable car	46%	23%	10%	21%
Cycle lane	42%	22%	12%	24%
E-scooter	27%	17%	31%	24%
Microtransit	28%	38%	12%	22%
Motorbike	22%	19%	28%	31%
Ride pooling	26%	49%	5%	19%
Robotaxi	24%	33%	20%	23%

Table 12: Preferences of those with hearing impairments

Table 13 below indicates the preferences of participants with mental health issues. Cycle lanes seem to be their most preferred solution, with bike sharing beyond the lowest not

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only in their preferences but the lowest across all impairment categories including those with visual impairments.

Mobility Solution	Yes	Maybe	No	N/A
Accessible journey planner	33%	24%	15%	25%
Bike sharing	4%	16%	49%	31%
Cable car	34%	24%	25%	17%
Cycle lane	45%	21%	13%	20%
E-scooter	14%	19%	50%	16%
Microtransit	26%	30%	24%	19%
Motorbike	18%	24%	35%	24%
Ride pooling	31%	35%	22%	12%
Robotaxi	29%	25%	31%	15%

Table 13: Preferences of those with mental health issues

Table 14 indicates that cable cars are a clear preference for people with intellectual disabilities with 47% willing to use them and another 29% open to using them. E-scooters divided opinions with 29% willing and 21% open to using them on the one side, yet another 35% unwilling to use them or even consider them (15%).

Mobility Solution	Yes	Maybe	No	N/A
Accessible journey planner	30%	24%	6%	36%
Bike sharing	21%	21%	19%	39%
Cable car	47%	29%	7%	17%
Cycle lane	18%	27%	13%	42%
E-scooter	29%	21%	35%	15%
Microtransit	16%	40%	18%	24%
Motorbike	22%	38%	9%	31%
Ride pooling	14%	24%	16%	26%
Robotaxi	36%	4%	31%	29%

Table 14: Preferences of those with intellectual disabilities

4.4. Gender Analysis

This section presents a gender comparison with respect to respondents' preferences of future mobility systems (see Table 15).

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Average of male respondents across travel purposes

Mobility solution	Yes	Maybe	No	N/A
Accessible journey planner	43%	22%	14%	18%
Bike sharing	18%	18%	25%	40%
Cable car	39%	37%	14%	10%
Cycle lane	36%	19%	24%	21%
E-scooter	22%	22%	29%	27%
Microtransit	34%	31%	24%	11%
Motorbike	26%	24%	31%	19%
Ride pooling	28%	27%	21%	12%
Robotaxi	35%	32%	20%	14%

Average of female respondents across travel purposes

Mobility solution	Yes	Maybe	No	N/A
Accessible journey planner	42%	17%	10%	29%
Bike sharing	15%	15%	28%	42%
Cable car	33%	29%	13%	25%
Cycle lane	32%	20%	24%	24%
E-scooter	20%	18%	32%	30%
Microtransit	29%	27%	24%	20%
Motorbike	19%	25%	24%	32%
Ride pooling	24%	30%	20%	17%
Robotaxi	28%	32%	24%	20%

Table 15: Men's and Women's preferences across mobility solutions

Women's views are more polarised in relation to the accessible journey planner. While the same number of women would use it, a considerable 10% more women consider it is not for them.

Cable cars and microtransit are less favoured by women than by men.

There is an indication that men are more open to motorbikes and robotaxis than women. There is a little more preference by men over women for cycle lanes, e-scooters, and ride pooling, but differences are small and could be due sampling.

There are indications but not statistically significant differences. There seems however to be a significant difference in how women and men respond about their intention to uses

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this systems in relation to education (p-value = 0.03) and commuting (p-value = 0.045), but not in relation to shopping, leisure or going to scheduled appointments.

4.5. Users' suggestions for each mobility system

This section reviews respondents' answers to the question: "What would you need to make this system work for you?" The question aimed to gather users' ideas about how to improve the accessibility of a mobility system or what would be a requisite for them to use it. It is worth noting that we do not present a quantitative analysis of data, but list potential improvements as offered by users that may inspire design directions.

Accessible journey planner: Due to its popularity across disability groups, respondents' ideas are diverse. Users stress the importance of the application a) to be accessible, b) to contain real-time information about accessibility, for example availability of seats in the next bus or if certain accessibility infrastructure is "out of order", c) to be able to act as a navigation tool en route, possibly be able to interact with it like with Alexa, d) to give information in multiple ways (sign language, audio, lip reading, etc.), e) to be integrated with smart glasses, f) to be available without registration and free, but also point to the need, g) to have a smarter mobile phone, h) to be more comfortable with using digital technologies.

Bike sharing: Bike sharing is one of the least popular means of transport in our survey, as people on wheelchairs and those with visual impairments feel excluded, as well as those who do not know how to or are physically unable to ride a bike. Some people had a hard time envisioning answers to this question and perhaps feel a bit cynical about it. For example, people gave answers such as: "If my legs allowed me to ride a bike, then I would not be disabled" or "another pair of eyes". On the other side, there were also practical suggestions about a) self-balancing bikes, b) tricycles, handcycles, quadracycles, attachments that convert wheelchairs into cycles, and c) adaptable steering wheels for those with upper body impairments; d) electric or self-powered bikes, e) well-marked cycle lanes, e) safety measures, such as physical barriers, f) cycling education. There were also more systemic suggestions such as g) accessibility of the bike-sharing station and h) access to a smartphone and an accessible app in one's own language.

Cable car: The cable car was a very popular solution across groups with different disabilities, hence suggestions also vary in nature. The guaranteed existence of standing personnel while boarding and exiting the cabin is a must not only as a help to board but also as a person to protect the disabled passenger from other passengers and guarantee their safety. Some respondents requested a) a person to get them a ticket, b) a vocal narration of the journey so people can know where they are, c) wheelchair accessibility of the cabins and the seats, d) written narration and announcement of stops, e) short booking times, f) quiet motors, g) short distance and accessibility to the cable stations, h) accessibility of the cable platforms, i) accessibility of the city and inclusion of the system in an integrated city map. Some even dreamed of systems that may not require personnel on platforms; others mentioned their fear of heights.

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Cycle lane: Cycle lanes received a mixed reception by disabled people. People in wheelchairs see the possibility of using the cycle lane infrastructure as an alternative to sidewalks: "I sometimes use the cycle paths in a wheelchair but it is by default if the sidewalk is not accessible.” And so they are interested in the extent of the network to allow them to go everywhere and some protection from faster riders to secure their safety: “In a wheelchair I am not safe on the cycle paths because I go much slower than the cyclists.” They want cycle lanes a) not to have bumps, b) to have ‘parking places’ where people can put down their bags, long canes in order to onboard the cycle, c) to be wide enough to cater for wider forms of cycles (e.g. tandems or tricycles), d) wide enough for others to overtake them at a distance, for them to feel safe or separate cycle lanes altogether, avoidance of intersection with cars and traffic, e) clear signposting and control of traffic. There were also comments that dismiss cycle lanes: “this is rubbish” and some people made recommendations about the types of cycles and cycles’ ownership, which we have included in the section on bike sharing.

E-scooter: Much like bikes, e-scooters are non-applicable to those with visual impairments. For those with physical impairments, balancing is an issue, as well as standing for a long time. Many consider using e-scooters “impossible”, some discussed solutions that would a) allow users to balance, like three-wheel or four-wheel scooters, b) the option to have a sitting scooter, or c) to use a scooter as a traction for a wheelchair were discussed and even the possibility of a tandem e-scooter. Some people requested: d) a voice assistance, e) charging stations across the city, f) safe lanes away from traffic. Much like other solutions, g) the booking apps must be accessible in any device they use (smartphone or laptop) and h) in the local language, and people should have ownership of a smartphone or other such device.

Microtransit: Suggestions about microtransit covered a variety of incremental to futuristic suggestions from a fully accessible app to an “avatar for the hearing impaired”. Some could not see a big difference with scheduled buses and it is our understanding that many of the concerns around onboarding and travelling on buses also applied here. Particular concerns related to a) accessible ways to finding the ‘stop’, b) short booking lead times, c) guaranteeing arrival times.

Motorbike taxi: Much like the other two-wheel solutions motorbike taxis were unpopular and even out of the question to the extent that some respondents felt a sense of cynicism even being asked about it: “Good grief, make the existing system accessible instead of making up such nonsense.” or “Comes on the wheelchair and ventilation, out of the question!” were indicative answers. Interestingly, this solution did not attract many suggestions. On the contrary, people complained that they would not want to communicate with the driver, that they would not see the driver’s face to interact en route, other respondents would not want to hold on to the driver, had no idea how to bring their companion dogs on it or carry their wheelchair or did not feel safe on a motorbike due to their disability. There were a few users who would use the system and they had nothing to add apart from safe drivers and an easy and accessible booking system, a common concern across solutions.

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Ride pooling: To make ride pooling accessible, people would need: a) an accessible mobile app to book it, b) and it should be able to guide them to the meeting point, and c) monitor the journey to reassure users that they are safe. Preferably the journey is d) from door to door and f) is much cheaper and affordable. The vehicle is g) accessible by wheelchair or able to store one and h) has single seats. Also, i) drivers should still be able to help users and j) allow companions or personal assistants.

Robotaxi: There were enthusiastic adopters:" to make it available, I need absolutely nothing but ROBO TAXI" to deniers: "Stupid questions". Naturally, there were also many who had concerns about safety and requested that robotaxis are: a) legally and ethically mature and approved, b) drive safely, c) help in case of an emergency, d) reassurance that robotaxis are properly maintained and some respondents would bestow their safety only to a human. Other suggestions related to d) an accessible booking application, e) a means to notify a blind user that their car has arrived, f) help with onboarding the vehicle, g) space for an electric chair, g) space and help to stow a wheelchair, h) affordability, i) a simple payment system, j) narration of the journey to reassure short-sighted users that they are on the right track, k) accessible ways to interact with the car (text-to-speech, voice commands, laptop apps), m) the ability to geo-locate users when they do not know exactly where they are.

5. Discussion

5.1. Conclusions

We organise our conclusions as answers to the key questions of the study.

How do participants assess new mobility systems and would they use them?

We asked disabled people whether the proposed mobility systems would motivate them to travel more, and if these mobility systems would make their travel more independent, faster, easier, nicer, and safer. These criteria are the essence of the MDI evaluation dimensions developed by users in T4.1.

Unsurprisingly, an **accessible journey planner** would motivate travel and make users' journey more independent, faster, easier, nicer and safer. In contrast, bike sharing, e-scooters and motorbike taxis scored low on all dimensions and for all groups of disabilities.

Microtransit and cable cars were favoured by almost half of the respondents across all travel purposes, and surprisingly more than **ride pooling and robotaxis,** even in making users' journey nicer or faster.

Cycle lanes hold a promise for disabled people and their modification to make them usable for disabled people is worth further exploring; qualitative data show that some respondents in a wheelchair do use cycle lanes when available to avoid the hurdles in pedestrian places, despite fears for their safety. Investments in **bike sharing,**

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motorbike taxis and e-scooters have left behind disabled people, at least in their current format and they are the least favoured solutions.

We reported separately on **solutions favoured for going shopping and socialising** as users in previous studies reported the need to do so, should transport be more convenient. Our analysis found that cable cars and microtransit were favoured for socialising purposes across occupation groups, with cable cars presumably preferred for long-distance travelling and microtransit for the flexibility to meet anywhere in the vicinity. Robot taxis were preferred for shopping presumably due to assistance with carrying the shopping. This should be factored into the requirements for automated mobility which is expected to go mainstream as early as 2030[1].

Suggestions for an accessible journey planner were varied. We believe they also apply to the booking systems of other mobility systems and they also represent the users' needs to bridge the digital divide. Users stress the importance of the app to provide real-time accessibility information in an accessible format, and this should include seat spaces in vehicles, 'out of order' facilities, exit points and elevators, ability to accurately geolocate the user. Apps should consider their integration into wearables, such as augmented reality glasses, and interfaces customisable to users' needs while in transit, for example as audio navigation directions of the blind and those with intellectual capabilities.

Despite the unpopularity of bike sharing, people had many ideas of how to adapt the system to their access needs (see 4.5), unlike motorbike taxis, which was the solution with the least number of suggestions. For cable cars, suggestions were oriented towards onboard the cabin, but also controlling other passengers who might be disrespectful. Microtransit was basically treated as a bus, with the additional requirements for monitoring the route and arrival times. All solutions required accessible booking systems with geolocation to ensure the user can be found by the driver or directed accurately to the pick-up point.

How do participants assess their own personal adaptivity to technology and can this predict their views towards mobility systems?

With regard to the question, whether modern technology helps them to master their everyday life, the majority of respondents agreed. However, there was also a considerable share of 4.1% of respondents who disagreed or strongly disagreed. Most of the respondents consider themselves able and competent to use modern technologies. Yet, nearly one person in ten did not consider themselves comfortable with technology.

It was shown that people who consider themself as less competent in using technology are less willing to use digital assistance systems, like accessible navigation systems, wearables among others. However, no differences were shown for smartcanes, autonomous wheelchairs and vehicles, 3D printed protheses, augmented reality, location-based alerts and smart communication alerts, indicating that also persons that perceive themselves as less competent in using technology are willing to use these systems.

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Do participants use ICTs that are likely to be prerequisites for new mobility systems?

The respondents of the sample mostly use digital devices like smartphone on a regular basis. However, there is also a considerable share of respondents that never use computers (5,6%) or smartphones (6,5%). The results indicate a digital divide of disabled people. Among the different kinds of disabilities, especially those persons with intellectual disabilities have less access to digital devices. Most respondents experience modern technology to help them in mastering their everyday life and most of them feel optimistic about technological innovations. However, a considerable share of 4,1% disagreed or strongly disagreed that technology helps them. It should be also stated that about one in ten persons feels not competent enough to use modern technology.

It should be given regard, that the sample consisted of individuals who has access to computers or care givers and relatives who accessed the survey for them. Thus, it can be assumed that the share of persons with disabilities who do not have access to computers or smartphone is even higher in the general population. Thus, before developing and operating digital mobility services and assistance systems, we need to sort out the digital divide in order to facilitate access to digital systems to all.

How do participants assess their own personal adaptivity to technology and can this predict their views towards mobility systems?

With regard to the question, whether modern technology helps them to master their everyday life, the majority of respondents agreed. Approximately, 4.1% of respondents disagreed or strongly disagreed. Most of the respondents considered themselves able and competent to use modern technologies. Yet, nearly one in ten persons did not consider themselves competent enough to use modern technology.

It was shown that people who consider themselves as less competent in using technology are less willing to use digital assistance systems, like accessible navigation systems or wearables among others. However, no differences were shown for smartcanes, autonomous wheelchairs and vehicles, 3D printed protheses, augmented reality, location-based alerts and smart communication alerts, indicating that also persons that perceive themselves as less competent in using technology are willing to use these systems.

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The respondents of the sample mostly use digital devices like smartphones on a regular basis. However, there is also a considerable share of respondents that never use computers or smartphones. The results indicate a digital divide of disabled people. Among the different kinds of disabilities, especially those persons with intellectual disabilities have less access to digital devices. Most respondents experience modern technology to help them in mastering their everyday life and most of them feel optimistic about technological innovations. It should be also stated that about one in ten persons feels not competent enough to use modern technology.

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It should be noted, that the sample consisted of individuals who have access to computers or care givers and relatives who accessed the survey for them. Thus, it can be assumed that the share of persons with disabilities who do not have access to computers or smartphones is even higher in the general population. Thus, before developing and operating digital mobility services and assistance systems, we need to remove the digital divide in order to facilitate access to digital systems to all people.

Would participants use smart assistive technologies?

The willingness to use smart digital devices, such as wearables or artificial intelligence was rather high. The most desirable solutions across all types of disabilities are wearables, artificial intelligence alerts, robots and autonomous wheelchairs and vehicles; the latter was not only preferred by people with physical, but also with intellectual disabilities.

Accessible navigation systems were welcome by blind people but also by people with intellectual disabilities. Artificial intelligence alerts were particularly welcome by those with intellectual disabilities who were also open to other assistive technologies, like location-based alerts, augmented reality, robots, and smart communication aids, and autonomous wheelchairs. We should note that these views may also reflect the needs for their caregivers, as often caregivers replied on their behalf.

Automated captions and artificial intelligence alerts are seen as useful tools by those with hearing impairments. Those with visual impairments would welcome accessible navigation systems, robots and augmented reality solutions. Persons with physical impairments would welcome a variety of specialised solutions from autonomous wheelchairs and exoskeletons, to more general ones, such as wearables, robots, location-based services and to some extent augmented reality.

How do people feel about the overall implementation of accessibility strategy in their area?

With regard to the respondents' assessment of the accessibility policies and practices in their region, it was shown that the majority of respondents was very dissatisfied or fairly dissatisfied with the use of public transport in their city or district. Respondents with sensory disabilities were less likely to be satisfied with local public transport than those respondents with physical disabilities. The satisfaction with the work of the state or local municipality to integrate disabled people was rather low.

Frequency analysis on the qualitative data revealed people's difficulties reaching and boarding a vehicle. Complaints about using the infrastructure as well as access to travel information for those with sensory disabilities and comfort on board particularly for those with physical disabilities are an issue. Social barriers by drivers and other stuff underpin people's complaints. Our qualitative data from the mobility survey confirm our findings reported in D2.2.

How do people feel the impact of COVID-19 to be in their region?

The analysis showed that the majority of respondents experienced severe impacts of the pandemic situation on their travel behaviour. About 60% of the respondents stated that they are less willing to travel during pandemic than before. A comparable share of respondents stated that the pandemic made their journeys more difficult, less safe and less nice. It was further shown that women experience the effects of the pandemic more strongly than men. With regard to the impairment, it was shown that persons with hearing disabilities experienced less barriers as a result of the pandemic. Persons with mental health issues or intellectual disabilities, however, experienced that their journeys have become more difficult.

Are there any gendered differences in our findings?

Interestingly, no gendered differences were found for the self-assessed technology competency using the STAI. This may however be due to an overall study bias due to the fact that we can only conduct an online study due to COVID, as opposed to a mixed online and offline study as originally planned, which meant we only reached those with access to digital technologies and a level of competence in their use.

With respect to their intention to use an accessible journey planner, women were more polarised. While an equal number of men and women (approx. 40%), 10% more women indicated this is not applicable to them.

Women favour less cable cars and microtransit for which we suspect safety and harassment concerns according to prior studies. They also favour a bit less motorbikes and robotaxis. Our data also indicated small differences in women's willingness to use cycle lanes, e-scooters and ride pooling, but differences are small and could be attributed to sampling error; we will monitor this closely in our second version of the report.

Finally, women tend to experience the effects of the pandemic on their travelling more strongly than men.

Are there any differences due to different types of disabilities in our findings?

The analysis revealed several differences that are related to the types of disabilities respondents face. For the pandemic-related effects, it was shown that especially persons with mental health issues and intellectual disabilities experienced more difficulties when travelling.

When looking at the modal split, it was shown that a considerable share of persons with physical disabilities, visual disabilities and intellectual disabilities are not able to use bikes, and thus might not be able to use bike sharing or e-scooter sharing schemes. Whereas respondents with physical disabilities and those with hearing disabilities specified the car to be their most often used means of transport on a daily basis, persons with visual disabilities use public transport the most frequently

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High-level recommendations

Our report offers high-level design suggestions (see 4.4.3) for nine, future mobility systems. Accessibility across all categories can greatly improve by prioritising the development of a journey planner that can provide real time information for the accessibility of door-to-door journeys in formats accessible by each user.

To solve the door-to-door accessibility issues urban planning, transport planning, social services and education systems should collaborate to: a) provide disabled users with smart technologies (e.g. smartphones) to enable them to interact with smart mobility systems; b) raise their confidence in the use of digital technologies; c) update their assistive technologies, with smart assistive technologies that can compensate to some extent for inaccessible urban and transport infrastructures; d) combine urban with transport planning to design accessible routes to modes of transport e) use machine to machine communication to automate or transfer control of accessibility aids (e.g. lowering bus amps) to user to improve their self-sufficiency and reduce their reliance on station and vehicle staff for embarking and disembarking.

Along with energy efficiency, we should also consider the accessibility of vehicles in the current renewal of fleets to minimise the time delays due inability to board or overcrowding.

Finally, governments and transport authorities should invest in public campaigns to improve social attitudes and transport etiquette towards citizens with disabilities.

5.2. Reflection on the Survey

On the 4th March 2021, we had 3515 clicks on the survey. This means that our dissemination strategy worked and people are interested in the topic. Of those who accessed the survey, however, only 838 persons finished and submitted the survey, which indicates that we might have to restructure the survey to make it more inviting and perhaps more relevant. The higher number of interested people who did not start the survey might be related to the framing of the survey for disabled people. It might be possible that a considerable share of interested persons did not consider themselves disabled and thus did not start the survey.

Our analysis is based on the 553 responses representing disabled people and their caregivers. The remaining 285 were non-disabled respondents, who were excluded from the study. By excluding those 285 responders, we may have missed out on caregivers who might not have understood the options properly and people who do not consider themselves disabled but do face mobility difficulties or access needs, such as the elderly.

In our effort to keep the survey short by presenting respondents with only three out of a total of nine mobility solutions to assess, we missed out on views on other, even more relevant solutions for people's disability. We need a different strategy to maximise the value of those willing to respond to our survey and a strategy to keep the survey short,

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but relevant. For example, we could use funnelling questions where people declare those options not applicable to them upfront give them the opportunity to give the reasons why through open questions.

Women were generally less open to use future mobility systems; we suspect that concerns of safety from harassment are at play, but possibly other concerns too. Differences suggest that we should pay attention to the special requirements of the mobility divide for disabled women and possibly in combination to the digital divide.

Typically, as in most accessibility studies, people with intellectual disabilities were underrepresented. Unlike with other groups of disabilities, this group was younger in age and their caregivers responded on their behalf. We suspect that caregivers are mostly women which might have special needs that we have not sufficiently captured here and might require a separate study and analysis in the future.

It should be further emphasised that the sample is most probably biased by the self-selection of participants. Thus, poorly connected people or people with limited access to the internet might not have been reached by the invitation. The rather low average age of respondents indicates that the survey may have had some problems in reaching older disabled people.

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5.3. Outlook

The survey provides insights into further wishes and needs of respondents regarding the innovative mobility systems (“What would you need to make this system work for you?”) Responses were analysed qualitatively and will be used to inform the co-production in WP6.

The survey will be further used to collect data from other groups of persons that are vulnerable to exclusion, like the elderly and migrants. The survey will remain ‘open’ until the end of the project, and quarterly campaigns will take place to keep collecting data from disabled users and other vulnerable-to-exclusion groups for further findings to be included in the final version of the report in M35.

Our results will inform the briefs and design directions of the solutions of WP6 where possible. They will also inform our recommendations to policy makers, operators and authorities in the transport ecosystem in WP7, through presentations and webinars to UTIP, white paper publication, and interactions with EDF transport, AGE concern. We will also prepare findings for publication to conferences and academic journals as part of our dissemination strategy in WP8.

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Appendix 1 - Description of the nine mobility systems

Ridepooling

Ride pooling is a kind of shared taxi. Imagine that you need to go across town. You book a taxi via a mobile app. The taxi also picks up other people that are going in the same direction. It might take a little longer as the car needs to stop to let people on and off on the way to where you are going. The ride is cheaper than a normal taxi, but you have to share, and sometimes you are not brought all the way to your doorstep.

Micro transit

Microtransit is a minibus service that can only service your local area. Imagine that you plan a long journey and you need to reach the main rail station, but to get there is really complicated. You book a Microtransit service, via a mobile app. The minibus will not pick you up from your doorstep, but from a nearby location and drop you off at the rail station.

Accessible journey planners

Accessible journey planners are online systems or mobile apps that you can search for how you can travel with public transport from point A to B when you use a wheelchair or you want to avoid walking up and downstairs.

Motorbike taxis

Motorbike taxis are a taxi service on a small motorbike (like a scooter or a moppet). You can book a ride on a mobile app. The scooter driver picks you up from your location and drops off at your destination. You have to wear a helmet and there is usually a small space to store stuff on the bike. Sometimes, bikes are electric. Motorbike taxis are very popular in Asia, because you don't have to get stuck in traffic and they are cheaper. This is also great for city traffic and pollution, but would it be good for you?

E-Scooters

E-Scooters are electric-powered scooters that can be picked up from a nearby location in the city and dropped off at another location in the city. You can use a mobile app to find one close to you, and also pay for it and unlock it so you can use it. A scooter should be driven on the road or a cycle lane, (not the pavement) and can reach around 30 kilometers per hour. You are expected to balance on a scooter to drive it, and you can control the speed and break from the bar handles. Hiring e-Scooters for short city rides have become very popular in many cities.

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Bike sharing

Bike sharing is a scheme of public bicycles that can be rented out for a (short) period of time. Bikes can be picked up from a nearby and dropped off at a nearby parking dock or outside one's destination (for dockless systems). A mobile app shows you where you can find one, and also allows you to check it out and pay for it via your phone. The bicycle should be driven on the road or cycle lanes (not the pavement), wearing a helmet. The users should be able to ride a bicycle, and, of course, watch out for road traffic. Although there are some electric-assisted bikes, most rental bicycles require manpower and may (or may not) have gears. Increasingly cities dedicated cycle lanes, usually located next to car lanes.

Cycle lane

A cycle lane is a visibly marked road lane dedicated to cycling, and more recently to e-scooters too. Perhaps other micro-mobility solutions may be able to use these in the future. Cars are not allowed to drive or park on them. The lanes are usually 1.5 meters wide, and cycles and scooters can reach a speed up to 50 kilometres per hour. While there are no cars on these lanes, riders still need to be able to steer their cycle or scooter to avoid other riders and follow instructions and signs to navigate.

Cable cars

Cable cars are cabins on steel ropes high up above ground that go from one station to another. The cabins can fit 10-20 people, depending on their size. Cable car cabins are at ground level and can be stopped so that wheelchair users can easily get on and off. Station staff is usually available at these getting on and off points for assistance. Cable cars are becoming popular because they avoid road traffic, are relatively inexpensive and they don't take much space to build, they are electric and hence less polluting and run automatically which makes them cheap to run.

Robo taxis

Robo taxis are autonomous cars that are driven by artificial intelligence which checks the road and traffic via sensors, GPS and other smart technologies that communicate with other cars and the road infrastructure. Very likely these cars will also be electric. Because they are driverless, these taxis will be more affordable, and you will be able to book a taxi by a mobile app.

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Appendix 2 – Survey

TRIPS MOBILITY SURVEY

The TRIPS project focuses on the design of future transport systems.

All the mobility solutions we will present, are solutions that are currently promoted by governments in Europe and globally as promising to solve the traffic and pollution problems in cities. This means that a lot of public money will be invested and changes in the city infrastructure will be made to accommodate them.

If these solutions are inaccessible, then all this investment will be spent on solutions that will not cater to your needs. So, it is important to let governments, transport operators and companies know what we think and how we feel about the proposed mobility solutions before it is too late. We would also like to ask you what you would need to make these systems/services work for you. We will use your creative ideas to sit together with transport experts and discuss how to redesign their vehicles and services to make them accessible-by-design, so we don't end up with the problems we have today. It may be a ramp, or something to do with information about the service; it may be extra time of wait or even storage for something; it may even have to do with the price for this service. Whatever it may be, we would like to know it!

But first, we would like to get to know you a bit more so we will ask you some questions about yourself and what you think of technology in general.
The survey will take 20 - 30 minutes to complete.

First, we would like your consent to participating in the survey.

I agree to take part in the survey and to having my responses anonymized in project deliverables and dissemination material.

- Yes

I complete this questionnaire...

- on behalf of myself
- as a disabled person for a disabled person
- as a non-disabled person

Important: Please remember to fill in the following information on behalf of the person you are referring to. This means please do not state your age or gender but that of the person you fill out this survey for.

Tell us a bit about yourself.

This section asks for some demographic information about you
1. Which country do you live in?

2. In which city do you live in? Or which is the closest city to your home?

3. I am ...

- Female
- Male

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- Other
- prefer not to say

4. How old are you?

5. Which is your highest educational degree?
- None
- high school bachelor’s degree
- master’s degree
- Ph.D.
- prefer not to say

6. Which describes your employment status best?
- unemployed
- work full-time
- work part-time
- study
- retired
- other: ____________

7. I face mobility issues due to ...
- physical impairment (requiring the use of a wheelchair, crutches, or other mobility aids)
- visual impairment (being blind or partially sighted)
- hearing impairment (being partly or completely deaf)
- mental health issues (might be overwhelmed by distress, depression, claustrophobia or feelings of panic)
- intellectual impairment (difficulties in processing memorizing and recalling information)
- other: _________________

8. How long have you lived with your impairment?
- less than one year
- between 1 and 5 years
- between 6 and 10 years
- more than 10 years
- since I was born

9. Do you use any auxiliary means or tools?
- wheelchair
- crutches
- prothese
- walker/rollator
- other mobility aids: ______
- none

10. Do you use hearing aids?
- yes, what?:
- no

11. Do you use contact lenses or glasses?
- Yes
- no

12. Do you regularly use the following assistance systems when travelling?
- long cane
- guide dog
- human companion
- others: ______

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- none

Please tell us something about your mobility behaviour.

13. Do you have a driver's license for cars?

- yes
- no

14. How often do you use the following transport means in general? Please refer to the time before the coronavirus pandemic (last year).

	never	few times a year	Several times a month	Several times a week	daily	I am not able to use it
car	o	o	o	o	o	o
Bike/e-bike	o	o	o	o	o	o
bus	o	o	o	o	o	o
Specialized or adapted transport train	o	o	o	o	o	o
train / metro / tram / subway	o	o	o	o	o	o
taxi	o	o	o	o	o	o

15. What are the main barriers you face while using public transport in your area?

Tell us a bit about technology in your life

We would like to ask you about your general views about technology and its role in your daily life.

16. What do you think about the role of technology in your life?

Tick the option that represents your views best.

	strongly disagree	disagree	neutral	agree	strongly agree
Using modern technology helps me to	o	o	o	o	o

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make important decisions					
Using modern technology helps me to master everyday life	o	o	o	o	o
Using modern technology supports my independence	o	o	o	o	o
Using modern technology helps me to be more efficient in my daily routines	o	o	o	o	o
I invest as much effort as I can until a device works as intended	o	o	o	o	o
I practice with a new device until I can use it as intended	o	o	o	o	o
I put in more effort when a new device is more difficult to use than expected	o	o	o	o	o
When obstacles get in my way in using a device, I invest more effort	o	o	o	o	o
I trust modern technology	o	o	o	o	o
I feel optimistic about technological innovations	o	o	o	o	o
I believe that new technology conforms to	o	o	o	o	o

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safety standards					
Modern technology makes me feel secure	o	o	o	o	o
Generally, I use modern technology frequently	o	o	o	o	o
I am interested in technological innovations	o	o	o	o	o
I consider myself competent enough to use modern technology	o	o	o	o	o

17. Which of these technologies do you use in your daily life?

	never	**rarely**	**sometimes**	**frequently**	**always**
smartphone/ tablet	o	o	o	o	o
PC/laptop	o	o	o	o	o
online maps/ journey planning apps (like Google maps)	o	o	o	o	o
virtual assistants (like Alexa)	o	o	o	o	o
mobile payment app (like Apple Pay)	o	o	o	o	o
online games	o	o	o	o	o
social media (like Facebook)	o	o	o	o	o
smart home systems (like Google home, Apple homeKit)	o	o	o	o	o

18. Which of these innovative accessibility tools would you use, if they were available?

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Please tick the one that most represents you. If you feel this technology is not relevant for your access needs, please choose “not applicable”.

	never	rarely	sometimes	frequently	always
smartcanes: Imagine you could have a long mobility cane with sensors to help you know what is happening around you by giving you audible or tactile warnings.	o	o	o	o	o
accessible navigation systems: Imagine that you owned a tool that could recognise objects and provide navigation and information on how to avoid obstacles.	o	o	o	o	o
automated captions: Imagine there was a system that could produce text captions on videos automaticall y.	o	o	o	o	o
artificial intelligence alerts: Imagine a system that could alert	o	o	o	o	o

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you in your local language via your phone or wearable when your name is called, or your bus stop is announced, or a fire alarm rings.					
artificial intelligence sign language translation: Imagine a system that can translate movements, gestures, and sign languages into text and vice versa.	o	o	o	o	o
autonomous wheelchairs and vehicles: Imagine them being able to navigate from point A to B with no need for steering	o	o	o	o	o
3D printed protheses: Imagine that a printer could print prosthetics that fit perfectly to your body	o	o	o	o	o
wearables: Imagine wristbands or rings that	o	o	o	o	o

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can automatically open and close doors, pay and even pull out a ramp for you.					
robots: Imagine having a robot personal assistant to help you with cooking, eating, cleaning, shopping, carrying stuff, playing games, chatting.	o	o	o	o	o
exoskeletons: Imagine you could wear a body suit that could help you stand, walk, and lift or handle objects with ease.	o	o	o	o	o
augmented reality: Imagine a pair of glasses that can tell you or show you information about the world around you, for example show you a route or where accessible facilities are, or how to	o	o	o	o	o

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find a station manager.					
location-based alerts: Imagine an app that assesses if you are at risk of harm and provide you with guidance or alert your carer or staff to assist you.	o	o	o	o	o
smart communication aids: Imagine a system that can augment your voice to help you communicate with others and with machines more easily and faster.	o	o	o	o	o

Tell us your views about upcoming mobility solutions.
Now we are going to ask your opinion about three different mobility solutions. These mobility solutions are becoming increasingly popular with governments across Europe and the globe, for their potential to solve the traffic and pollution problems in cities. This means that a lot of public money will be invested and changes in the city infrastructure will be made to accommodate them.
19. What do you think about Ride Pooling?
Ride pooling is a kind of shared taxi. Imagine that you need to go across town. You book a taxi via a mobile app. The taxi also picks up other people that are going in the same direction. It might take a little longer as the car needs to stop to let people on and off on the way to where you are going. The ride is cheaper than a normal taxi, but you have to share, and sometimes you are not brought all the way to your doorstep.

If we could make this system accessible, would it ...	**no**	**not a lot**	**don't know**	**quite a bit**	**yes**
make you want to travel more?	o	o	o	o	o
make your journey more	o	o	o	o	o

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independent ?					
make your journey faster?	o	o	o	o	o
make your journey easier?	o	o	o	o	o
make your journey nicer?	o	o	o	o	o
make you feel safe?	o	o	o	o	o

20. Would you use this system?

	yes	**maybe**	**no**	**not applicable**
for educational purposes	o	o	o	o
for commuting	o	o	o	o
for shopping/ to make purchases	o	o	o	o
for scheduled appointments	o	o	o	o
for leisure and socialising	o	o	o	o

21. What would you need to make this system work for you?
Please fill in below.

22. What do you think about Microtransit?
Microtransit is a minibus service that can only service your local area. Imagine that you plan a long journey, and you need to reach the main rail station, but to get there is really complicated. You book a Microtransit service, via a mobile app. The minibus will not pick you up from your doorstep, but from a nearby location and drop you off at the rail station.

If we could make this system accessible, would it ...	**no**	**not a lot**	**don't know**	**quite a bit**	**yes**
make you want to travel more?					

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make your journey more independent ?					
make your journey faster?					
make your journey easier?					
make your journey nicer?					
make you feel safe?					

23. Would you use this system?

	yes	**maybe**	**no**	**not applicable**
for educational purposes				
for commuting				
for shopping/ to make purchases				
for scheduled appointments				
for leisure and socialising				

24. What would you need to make this system work for you?
Please fill in below.

25. What do you think about accessible journey planners?
Accessible journey planners are online systems or mobile apps that you can search for how you can travel with public transport from point A to B when you use a wheelchair, or you want to avoid walking up and downstairs.

If we could make this system accessible, would it ...	**no**	**not a lot**	**don't know**	**quite a bit**	**yes**
make you want to travel more?					
make your journey more independent ?					

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make your journey faster?					
make your journey easier?					
make your journey nicer?					
make you feel safe?					

26. Would you use this system?

	yes	maybe	no	not applicable
for educational purposes				
for commuting				
for shopping/ to make purchases				
for scheduled appointments				
for leisure and socialising				

27. What would you need to make this system work for you?
Please fill in below.

28. What do you think about the current level of accessibility in your city/region?

	very dissatisfied	fairly dissatisfied	neutral	fairly satisfied	very satisfied
How satisfied are you with the use of public transport in your city or district?					
How satisfied are you with the work the state does to integrate people with disabilities?					
Are you satisfied with the level of support by the local population					

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with regard to your impairment?					

29. What has been the impact of the corona virus pandemic (COVID-19) on your travel?
Has the corona virus pandemic...

	not	**not a lot**	**neutral**	**a bit**	**yes**
made you less willing to travel?					
made your journey more dependent on others?					
made your journey longer?					
made your journey more difficult?					
made your journey less nice?					
made you feel unsafe?					

Thank you for all your views and ideas.
Your responses have been submitted successfully.
Your responses are valuable to help us understand how to design accessible future transport.
If you would like to keep in touch with updates about the results of the survey and the project, leave us your contact details at: https://trips-project.eu/project-updates/

Thank you again.

The TRIPS project team
Dr. Tally Hatzakis, TRIPS project – 2020

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