Institute of Transport Economics
Norwegian Centre for Transport Research

Universal design in transport

Editors: Nils Fearnley and Kjersti Visnes Øksenholt

Preface

The current literature on universal design has so far failed to fully address the challenges faced by transport agencies, and when the planners lack holistic knowledge, the solutions that are developed will not meet the required standard.

The aim of this collection of articles is to contribute to increased overall knowledge about what universal design and accessibility for all entails, and also the principles of how accessibility for all can be achieved in a transport context in terms of the planning process and physical solutions. In this way, the articles will contribute to the realisation of universal design, and thus promote a better quality of life and equality for people with disabilities.

The collection of articles is a topical reference work on universal design for various study programmes, fields of study and postgraduate courses in the higher education sector, and for transport agencies and planning authorities.

We would like to extend a big thank you to Liv Øvstedal and Stein Brembu at the Norwegian Public Roads Administration, who initiated and partly funded the articles, and to the Norwegian Directorate for Children, Youth and Family Affairs (Bufdir) who partly funded the collection through their grant scheme 'Universal design – knowledge development, skills development and information'. A big thank you also to Tanu Priya Uteng from the Institute of Transport Economics (TØI) who took on the role of substitute editor for the first article in the collection, which was written by the editors. And thank you very much to Hanne Sparre-Enger from the TØI's Department of Communication, who edited the texts and led the work on layout and design.

Finally, we would like to thank the anonymous reviewers who have peer reviewed all the contributions. The authors and editors agree that their close reading and thorough feedback have greatly improved the articles.

Published by:
NEHF – Norwegian Society of Ergonomics and Human Factors
www.ergonom.no

ISBN 978-82-995747-8-5 E-bok (PDF)

Original title: Universell utforming i transportsektoren
Translation to English by Akasie språktjenester AS
Design: Melkeveien Designkontor AS

NEHF Norsk forening for ergonomi og human factors

Statens vegvesen

toi Institute of Transport Economics
Norwegian Centre for Transport Research

A collection of articles: Universal design in the transport sector

The aim of this collection of articles is to contribute to increased knowledge about what universal design and accessibility for all entails, as well as principles of how accessibility for all can be achieved in a transport context in terms of both the planning process and physical solutions. We want the collection to strengthen universal design, and in turn contribute to a better quality of life and equality for people with disabilities.

The collection is comprised of seven articles, where this introductory article is Article 1. All shed light on various aspects of universal design in the transport sector.

Article 2. **'Functional requirements for inclusive transport'**, discusses the functional requirements that transport solutions must satisfy in order to facilitate social inclusion of people with disabilities (Bjerkan, 2022).

Article 3, **'Universal design and barriers to using public transport**, aims to deepen the understanding of how the transport system is perceived by different groups of people, and to understand and foresee challenges, weigh up the various issues, and facilitate good solutions that benefit as many people as possible (Nielsen and Øksenholt, 2022).

Article 4, **'Universal design and public participation in planning processes**', discusses how universal design can be better safeguarded in the planning process. The article aims to deepen the understanding of the complexity of the planning system, and how this can act as a hindrance for good and holistic solutions (Sjøstrøm et al., 2022).

Article 5, **'How can we ensure universal design of trip chains in a system with complex laws, regulations and responsibilities?'**, gives the reader an introduction to the statutory and organisational framework for universal design in the transport sector, with a particular focus on trip chains. The article discusses how to safeguard universal design of the transport system in a context where legislation and accountability are complex, and reforms alter the distribution of responsibility (Øksenholt and Krogstad, 2022).

Article 6, **'Effects of universal design: quality of life, demand and socioeconomic benefit'**, shows how the utility of universal design for passengers can be measured, and thus also used in cost-benefit analysis, which surprisingly often show that universal design measures in public transport are highly efficient, i.e. they improve social welfare because benefits exceed costs (Fearnley, Veisten and Nielsen, 2022).

Article 7, '**Transport solutions of the future: technology, design and innovation**, describes a selection of new and future transport solutions that are of particular relevance in Norway, and discusses these in the context of what we know about the needs of various user groups. The article demonstrates how new transport solutions are multifaceted and affect the various user groups in different ways (Aarhaug, 2022).

3

Universal design and barriers to using public transport

ANJA FLETEN NIELSEN AND KJERSTI VISNES ØKSENHOLT

This chapter seeks to explain how the transport system is experienced by different groups of people, and to make it easier to understand and foresee challenges that may arise, weigh up the various issues that must be considered, and facilitate good solutions that benefit as many people as possible. The goal is for everyone who works in planning to look afresh and critically at universal design, and that they make it a habit to ask, 'Could this intervention have a negative impact on people who are not in the specific target group?'

Anja Fleten Nielsen

Anja Nielsen studied health geography at the Norwegian University of Science and Technology (NTNU), Trondheim. She has been working in the field of universal design and transport for seven years, specialising on how people with psychosocial disabilities experience transport systems.

Kjersti Visnes Øksenholt

Kjersti Visnes Øksenholt is a human geographer and former senior researcher at the Institute of Transport Economics. She has worked for several years on integrated land use and transport planning, regional and urban development and universal design.

1. Barriers and interventions

A universally designed transport system is a vision and goal that has gained increasing acceptance in Norway. A key challenge for those who work to achieve universal design in the transport sector and elsewhere in society is to facilitate good solutions that can be used by a wide section of the population. Universal design is a strategy that aims to make it easier for everybody to travel, irrespective of age, height, size and level of functionality.

This chapter seeks to raise awareness of challenges and needs that are not commonly known. People with different types of disability may have very different adaptation needs. These do not always coincide; at times they even conflict. Barriers and potential solutions are described separately for each user group to give a broader understanding of how it is possible to plan, develop and operate a well-functioning transport system. To provide a comprehensive picture, the barriers presented are linked to impaired mobility, vision and hearing, allergy problems, and cognitive and mental health challenges. We recognise that people who do not fit into any of these groups can also encounter barriers to travel in our current system. When we refer to transport systems, our focus is generally on public transport (bus, train, tram, underground, taxi).

This article is not intended to provide an exhaustive list of travel barriers encountered by different groups of people, nor of what measures should be implemented and how. The objective is to help readers better understand how the transport system is experienced by certain groups, and to make it easier to understand and foresee various challenges that may arise, weigh up the issues that must be considered, and facilitate good solutions that benefit as many people as possible.

Our objective is for readers to look afresh and critically at universal design for transport systems, and that they adopt the habit of asking 'Could this intervention have a negative impact on people who are not specifically in the target group?' Universal design can at times be tricky, but our hope is that a better understanding of the various barriers and needs, and how these may conflict, will help to ensure that implemented measures are well-considered and that they take society a step further towards full universal design.

'Could this intervention have a negative impact on people who are not specifically in the target group?'

This chapter will describe barriers and potential interventions linked to various forms of disability. Neither the list of barriers nor the list of interventions is exhaustive. The same applies for the tables, which are intended to summarise the text and provide an overview of specific barriers and potential interventions. There are many more barriers and many more interventions that may address the problems.

2. Barriers associated with impaired mobility

In the course of our lives, many of us will have our mobility impaired. Mobility impairments can be temporary or permanent and can range from conditions like knee pain, a broken leg or balance problems, to pushing a pram or using a walker or a wheelchair. Not all types of physical impairment are visible to other people. Various rheumatic diseases and other conditions that cause severe pain (disc prolapse, endometriosis, etc.) will also cause considerable mobility difficulties. An increasingly aging population will make it even more important to focus on universal design, as old age causes greater physical problems for most of us.

It is important for people with impaired mobility that they encounter minimal **physical obstacles** (e.g. steps, steep hills, kerbs) on their way to and from bus and tram stops, and that any such obstacle is compensated for by measures such as lifts and ramps. If a ramp is integrated within the design of the physical environment in a way that makes it appear to be an equal option to steps, then this is an example of good universal design. Elsewhere it may be required to retrofit ramps over existing steps to ensure access for all. This would not be universal design, but an accessibility measure. Universal design must always be the first choice; accessibility measures are supplementary interventions where it is necessary to ensure access. It is also important that aids such as ramps and lifts are regularly maintained and that good winter service ensures that everyone can get around outdoors. In a survey undertaken

among people with impaired mobility, as many as 74% of respondents answered that they find it difficult to travel in winter, and that poor snow clearance, banks of snow, slippery surfaces and darkness are challenges that make travelling more difficult. Better winter servicing is therefore necessary to ensure good access for all throughout the year (Aarhaug et al., 2011; Hjorthol et al., 2013; Krogstad and Skartland, 2016; Nordbakke and Skollerud, 2016). When planning bus routes and distances between stops, it is important to ensure that the nearest bus stop is not too far away, as distance is a significant barrier for people with impaired mobility (Lodden, 2001; Nordbakke and Skollerud, 2016; Nordbakke and Hansson, 2009). Hjorthol et al. (2013) found that the elderly wanted more benches to allow them to rest along the way. This measure would improve the journey to and from the bus stop where stops are far apart.

It is important that there is enough seating at bus stops and in station areas so that waiting passengers who need to sit down can do so. In crowded stations, it can be difficult for drivers and conductors to identify whether passengers are in need of assistance. It is also challenging for passengers to see which train carriage is fitted with a lift if their sightline is obscured by crowds (Braarud, 2012; Krogstad and Skartland, 2016; Nordbakke and Skollerud, 2016).

Ease of **boarding and alighting** is also essential, as this is the biggest problem for people with impaired mobility. As many as 48% report getting on and off the vehicle as a problem when using public transport. Step-free boarding and alighting enable wheelchair users to get on and off the bus without depending on assistance from fellow passengers or the driver. Low-floor busses will also make boarding and alighting simpler for those with impaired balance or other mobility issues.

'48% report getting on and off the vehicle as a problem when using public transport.'

Low-floor and low-entry buses allow for faster boarding and alighting, but it is also important that the design and location of stops ensure a minimal gap between platform and vehicle. Raised bus stop platforms is a measure that makes it simpler for many to board the vehicle, particularly those who use a wheelchair or a walker (Rødseth, 2004; Aarhaug and Elvebakk, 2012; Krogstad and Skartland, 2016; Nordbakke and Skollerud, 2016).

On board the vehicle it is important that there is sufficient space for wheelchairs, that there are enough seats and that there is no overcrowding or erratic driving. Wheelchair users report that they have insufficient space to manoeuvre their chair on board vehicles; 40-45% have experienced this on buses and 75% on trains. Wheelchair users also find that there is insufficient space set aside for the wheelchair; 25-30 % have experienced this on buses, and 30% have experienced this on trains (Braarud, 2012).

It is important that **information**[1] is provided at different heights – both via high-level monitors that are mounted at a good angle, and low-level monitors for wheelchair users (some of whom may find it difficult to read from 'seat height'). Signposting of alternative entrances is important for people with impaired mobility. It is also important to ensure that information is provided during the journey. Because the sightlines of wheelchair users may be restricted, visual orientation may be difficult. Incorrect or non-existing (real-time) information can therefore cause people to lose awareness of where they are, so that they fail to alight at the correct stop. Ticket machines must be mounted at a height appropriate for wheelchair users, but screens should not be so low that those with balance impairments will find them difficult to read because of the need to bend down. Although there are statutory standards for the design and positioning of ticket machines, it is difficult to take on board all implications. Local light conditions can also add to the challenges and affect the user friendliness of the machine. A status survey conducted by The Authority for Universal Design of ICT found that approximately 50% of all self-service ticket machines are non-compliant with the requirements for universal design, and that more than a third do not comply with the requirements for access to service areas.[2] Staff that are on hand to assist with ticket purchases can also help to provide a better passenger experience (Aarhaug and Elvebakk, 2012; Kummenje et al., 2014; Krogstad and Skartland, 2016).

1 The regulations on universal design of ICT solutions provide definitions and requirement for the design of ICT.

2 https://www.uutilsynet.no/statusmalingar/tilgjengelige-automater-status-universell-utforming-av-selvbetjeningsautomater/937

Accessible toilet facilities are extremely important for those who travel by public transport. Although universal design of accessible toilets is a statutory requirement, there is often inadequate space on both sides of the toilet. Also, wall-mounted toilets are often shorter than the wheelchair – which may cause a risk of falling during the transfer. The positioning of flush buttons and paper dispensers also cause problems, as well as the use of disabled toilets as a storeroom (Norges Handikapforbund, 2012).

Table 1: Examples of barriers associated with impaired mobility, with suggested interventions.

BARRIERS ASSOCIATED WITH IMPAIRED MOBILITY	INTERVENTIONS
Steps, kerbs, steep hills	Lifts, ramps, signposting of alternative routes
Snow and ice	Good winter servicing
Long distances	Benches to allow rest
Boarding the vehicle	Low-floor and low-entry buses, raising the bus stop level, no large gaps between platform and vehicle
Space problems on board the vehicle	Sufficient number of seats, space to manoeuvre a wheelchair
Crowded platforms make it difficult to spot the accessible carriage	Platform audio/light indicator to notify staff that someone needs special assistance. Activated by push-button or app by the person who needs assistance.
Lack of information	Screens at different heights – low-level monitors as well as high-level monitors mounted at a good angle; visible, audible and updated information on board.
Access to toilets	That they exist and are not locked, enough space both sides of the toilet, avoid wall-mounted toilets, position flush button/dispensers, etc. at wheelchair height.

3. Barriers associated with impaired vision

WHO uses five categories of partially sighted/blind, ranging from moderate vision impairment (category 1) to complete loss of vision (category 5). These categories are based on visual acuity (at what distance you can see an object) and the size of the visual field (normally 180 degrees). Additionally, there is a category of unspecified visual impairment, which is often used when there is a severe problem that cannot be measured in the same way as the above categories (Blindeforbundet, 2019). In the course of our lives, most of us will experience impaired vision. The challenges we meet will differ depending on whether our acuity of vision is poor, our visual field is limited, our light perception is impaired or if there are other problems. Colour

impairment (not impaired eyesight) can make it difficult to differentiate between different shades of colour. Some need as much light as possible while others are highly sensitive to light. In combination, all of these issues make it challenging to find good solutions that suit everybody. Clear, logically laid out environments, good tonal contrasts, and the same information conveyed in several different ways (e.g. tactile features, audio, colours, pictograms) will aid most of these groups.

The blind and those with severe vision impairments often make use of a cane to *navigate,* and they rely on the navigability of their environment: simple and logical layouts, footways free of obstacles, lines/kerbs for guidance, and elements that can serve as landmarks are all important features. The more navigation clues there are, the simpler it is to follow a route. When the built environment naturally incorporates elements that the visually impaired can use for wayfinding (like kerbs along pavements and distinct differences of material), these are referred to as natural guide lines. This type of guide line is preferable to artificial ones (also referred to as tactile), except when warning of danger. We should therefore aim to integrate natural elements in the design as much as possible.

'Artificial guide lines incorporate elements within the paving that indicate direction and danger. In areas where there are no natural guide lines, such as kerbs and walls, artificial guide lines make it easier to navigate for the partially sighted. This is particularly the case in open spaces and complex transport hubs.'

People with guide dogs will be able to benefit from good design that reduces navigation barriers, and they have an added advantage in that they are guided past all obstacles by their dog (Storliløkken et al., 2012; Tennøy et al., 2013, The Norwegian Public Roads Administration and The Norwegian Building Authority, 2015).

It is particularly important for the visually impaired that they feel safe when crossing the road on *pedestrian crossings*. The blind will find the crossing by following the kerb to the end of the rounded edge with their cane. Signposts and traffic light posts are used to detect where the crossing starts, and a warning strip can be a good help if not covered by ice/snow. The visually impaired navigate across roads and pedestrian crossings by rolling their feet on the kerb before they head off at 90 degrees. If the kerb is curved or too low, this can cause a hazardous situation and will make navigation difficult.

For those who use guide dogs, the challenges are slightly different. Guide dogs are trained to find zebra crossings and to use them to cross the road. If the zebra stripes are covered by snow and ice, the dog may well be unable to find the crossing. Those who use a cane will find that a normal kerb is a better navigation aid than other options, but because dogs might walk past normal kerbs – particularly in the winter if snow clearance is poor – there is a preference for dropped kerbs among guide dog users as this allows them to detect that they are heading onto the road (Tennøy et al., 2013).

'In station areas, the blind and partially sighted face more challenges than any other group of people, mainly due to barriers associated with navigation and information.'

Navigation clues are essential for the partially sighted/blind to be able to find their way across long sections and/or in unfamiliar places as they walk **to and from bus stops and railway stations.** Blind and partially sighted people face more challenges than any other group in station areas, mainly due to barriers associated with navigation (and information). Navigation barriers in station areas and on the way to/from stations are largely associated with a lack of standard designs for guide lines, broken guide lines, inadequate contrast marking of doors, poles, etc., and illogical platform number sequences (the blind often count their way to the correct platform). This is confusing for anyone trying to find their way. Other navigation barriers include covered-up navigation clues such as shrubs that break a natural guide line along a kerb; gravel and dirt in tactile guide lines due to a lack of servicing; or obstacles placed on footways (bollards, bicycles, A-frames, etc.), on top of guide lines or in front of information screens. Good winter servicing is important to ensure that guide lines are kept clear of snow and ice, and to reduce other challenges like slippery and uneven surfaces (Aarhaug et al., 2011; Aarhaug and Elvebakk, 2012; Tennøy et al., 2013; Øksenholt et al., 2014; Krogstad and Skartland, 2016).

The *physical design of station areas* must take account of several important factors. It is essential that all steps have handrails, and that automatic outward-opening doors do not open too fast, to avoid them crashing into somebody's face if they fail to detect the door in time. Bane Nor's station handbook (Stasjonshåndboka) presents all the requirements, recommendations and guidelines for station design. Good lighting is important for those with some residual vision. Indoor lighting should never involve excessive contrast as the visually impaired can take time to adjust to changes in light. Large windows can cause a glare that makes navigation challenging for some (The Norwegian Public Roads Administration, 2014; Krogstad and Skartland, 2016).

On board public transport, real-time systems must provide audio information. If a real-time system is not available or is down, the partially sighted are completely dependent on the driver for relevant information. If a partially sighted person does not use a cane or a guide dog and does not inform the driver of their disability when boarding, it can be difficult for the driver to show due consideration and provide appropriate assistance during the journey (Aarhaug et al., 2011; Aarhaug and Elvebakk, 2012).

'Access to information before and during the journey is extremely important for the visually impaired.'

Access to information before and during the journey is extremely important for the visually impaired. This group of people will often be using special text-to-speech software. If PDF timetables are laid out incorrectly, not all software will be able to convert to speech. This increases the risk of miscommunication. It is therefore important to ensure that information is easy to access by as many people as possible through apps, journey planners, websites, enquiry phone lines, etc.

Many visually impaired people find their smartphone very useful, but to ensure that people with sight loss have access to relevant information, screens and monitors should nevertheless be mounted at the right height (not too high), font sizes must be sufficiently large, and glare must be minimised for outdoor screens. Audio information is also important for the partially sighted, but this is often not provided, or the chosen solution is unsatisfactory (poor sound quality, difficult to find the buttons). Tactile information boards in station areas can also help the partially sighted and blind to navigate, but these must be designed well and should never include too much irrelevant information. It is very important to the visually impaired that staff are on hand to provide assistance and information in station areas and on board vehicles. In many cases, this is the group that relies most heavily on driver information to make sure that they get on and off the right bus at the right stop, and it is important that the driver stops the bus at marked boarding points and informs passengers where the bus is going (Skjetne and Zachariassen , 2003; Aarhaug et al., 2011; Aarhaug and Elvebakk ,2012; Krogstad and Skartland, 2016).

'Unforeseen events are often difficult to handle for the visually impaired because they tend to memorise complete routes. This makes them particularly vulnerable when changes occur.'

Unforeseen events are often difficult to handle for the visually impaired because they tend to memorise complete routes. This makes them particularly vulnerable when changes occur. Whenever a passenger encounters a problem, it is important that the

driver and other staff provide good service. Such situations can make passengers feel they are an inconvenience, particularly if the driver is pressed for time and is too rushed to assist those who need it (Aarhaug and Elvebakk, 2012).

Good and clearly visible signposting of toilets is also important. Bold symbols should be used to ensure that the visually impaired can find their way to the correct rest room. This group finds it hard to access toilets with self-service paid entry. Toilets should therefore be left open to ensure access for all (Krogstad and Skartland, 2016).

Table 2: Examples of barriers associated with impaired vision, with suggested interventions.

BARRIERS ASSOCIATED WITH IMPAIRED VISION	INTERVENTIONS
No navigation clu	Designs should prioritise natural guide lines. Artificial guide lines for where there are no natural ones, or to warn of danger.
Obstacles on the footway	General maintenance, cut back shrubs etc. that obscure natural guidelines, remove gravel from guide lines, note the positioning of cycle racks, A-frames etc.
Ice and snow og snø	Good winter servicing
Non-standardised station designs	• Design standardisation • Logical numbering of platforms • Unbroken guide lines • Contrasting colours on doors • Handrails by steps • Automatic doors that will not open too fast • Good lighting (avoid excessive contrast, be aware that large windows can cause glare that makes it difficult to see) • Consistent use of warning and hazard strips • Marking of glass surfaces
Difficult to get on the right bus	Føreren stopper på markerte påstigningspunkter og informerer om hvilken buss det er ved synlig synshemmelse (stokk, førerhund), automatisk opprop utenfor buss (kan bidra til lydforurensning), utvikling av app eller knapp slik at synshemmede kan gi beskjed om behov for assistanse
Access to information	Driver stops at marked boarding points and informs those with visible visual impairment (white cane, guide dog) which bus it is; automatic callout outside the bus (may cause noise pollution); develop app or push-button for use by the visually impaired to notify staff of their need for assistance
Timetables that are unreadable or incompatible with technical aids	Timetables in reader friendly formats (not PDF),
Info at unforeseen events	Staff on hand
Access to toilets	Toilets that need no (self-service) payment

4. Barriers associated with hearing loss

Little research has been conducted on the travel habits of people with hearing loss and the travel barriers they meet. This group includes the deaf as well as people with partial hearing.

There are two categories of deafness: i) prelingual deafness, where the hearing loss occurs before learning speech or language and ii) post-lingual deafness, where the hearing loss develops after the acquisition of language (Espedal and Jaatun, 2002).

Some deaf people have limited speech, which makes it more difficult for them to ask for help and information. In addition to the deaf, there are many people with partial hearing. As we age, we generally lose the ability to hear high frequencies, but some will also lose the ability to hear low frequencies. While some people find that all sounds decrease evenly, others experience varying degrees of sound distortion, or they can hear sounds of a neurological nature.

In addition to an inability to hear sound at certain frequencies, many will find it difficult to differentiate between meaningful sound and background noise. Fifteen per cent of the population have partial hearing (Folkehelseinstituttet, 2004), and the proportion is clearly highest among those over 65 years of age. Almost half the population over 65, and approximately three quarters of the population over 74 have hearing loss that impacts communication.[3]

Poor sound reproduction from poor-quality loudspeakers, and hard surfaces that produce poor acoustics, can make it virtually impossible to hear what is being said. It is important to keep in mind that people who use a hearing aid will not only have sounds that they want to hear amplified, but general noise as well. When choosing equipment, the aim should therefore always be to opt for the least noisy alternative, and if possible, noisy sound sources should be strategically positioned and separated (Espedal and Jaatun, 2002). Consideration should also be given to fitting noise-absorbing materials in walls and ceilings, and to installing hearing loops and sound equalisers.

'Poor sound reproduction from poor-quality loudspeakers, and hard surfaces that produce poor acoustics, can make it virtually impossible to hear what is being said.'

Photo: Ruter AS/Nucleus/Magnus W. Sitter

Good lighting is important to ensure that people with hearing loss can read text, signs, signals and monitors, and makes it easier to lip-read (Espedal and Jaatun, 2002).

It is essential that people with hearing loss have access to good and **updated visual information** such as real-time systems on board vehicles and in the station area. Krogstad and Skartland (2016) found that many wanted a dedicated screen for reading

3 https://www.fhi.no/nettpub/hin/grupper/eldre/

important messages and/or that existing screens should make more use of the comments field to provide sufficient information. When unforeseen events occur and changes are introduced (e.g. bus replacements for trains) most information is provided over loudspeakers, which means that people with hearing loss will not hear where they are meant to go, etc. The same applies to information provided on board vehicles. Warnings like boarding signals and fire alarms should be accompanied by flashing lights, so that people with hearing loss are made aware of important events (Krogstad and Skartland, 2016,; Aarhaug et al., 2011).

Table 3: Examples of barriers associated with hearing loss, with suggested interventions.

BARRIERS ASSOCIATED WITH HEARING LOSS	INTERVENTIONS
Poor sound reproduction	Choose the least noisy sources of sound, isolate noisy sound sources, use noise absorbing materials in walls and ceilings, hearing loop system, sound equalisers
Depend on their vision for information	Good lighting
Lack of information	Visual information (e.g. fire alarm with flashing light), accessible screens, real-time systems with good visual information

5. Cognitive and psychosocial barriers

Psychological and mental health impairments can involve different forms of congenital medical conditions, or various types of temporary mental health issues that any one of us may encounter. Psychological disorders include diagnosed as well as undiagnosed conditions, that can be permanent or temporary and can present in different ways with degrees of severity.

There is little research available on the travel habits of people with disabilities, and even less on those with cognitive or psychosocial impairments (Meissonnier & Dejoux, 2016). The limited research that does exist suggests that people with mental health issues make fewer journeys than others (Mackett, 2017). It has also been demonstrated that good mobility is an important recovery factor for people with psychological disorders, while poor access to public transport leads to social isolation and a worsening of symptoms (Mental Health Action Group, 2011).

Mackett (2017) classifies psychological disorders in four groups:

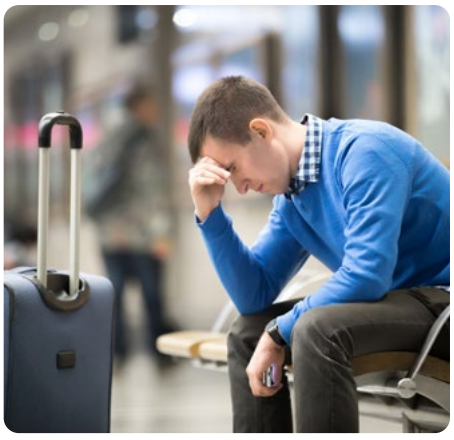
1. Disorders that affect concentration and learning (various forms of neurological disorders, dyslexia, dyscalculia)
2. Disorders that affect memory (e.g. Alzheimer's and dementia)
3. Psychological disorders (e.g. anxiety, depression and personality disorders)
4. Social and behavioural disorders (e.g. Asperger's syndrome and ADHD)

In the sections below, we have grouped disorders that affect concentration, learning and memory in one category, while psychological afflictions and social and behavioural disorders are grouped in another.

Disorders that affect learning include various forms of brain damage, dyslexia, dyscalculia, etc. Learning disabilities can include anything from linguistic processing problems, attention deficit and memory issues. Memory problems are also a feature of disorders that specifically affect memory, e.g. Alzheimer's and dementia. Psychological disorders include a wide range of diagnoses: anxiety, depression, bipolar disorder and a number of personality disorders. Behavioural disorders include Asperger's, autism and ADHD.

All information below is sourced from Penfold et al. (2008), Mental Health Action Group (2011) and Nielsen and Skollerud (2018), unless otherwise specified.

Disorders that affect concentration, learning and memory



People with disorders that affect their capacity to concentrate, learn or remember can encounter barriers that are caused by a **combination of their disorder and external factors.** People with a learning disability can experience challenges associated with the attitudes and behaviours displayed by drivers and fellow passengers, by overcrowding, route changes and timetable alterations. They can also find it difficult to understand rules and procedures (Mackett, 2017). In addition, interviewees reported that travelling is associated with emotional problems like frustration, nervousness, lack of confidence and a feeling of shame. Chandaria and O'Hara[4] have identified a number of factors that make travel difficult for people with dementia: frustration due to finding it hard to process information, poor balance and spatial understanding, perception problems

4 Reported from stage at the Community Transport Association's annual conference in 2014. https://www.busandcoachbuyer.com/cta-2014-annual-conference-england/

that make it difficult to deal with change, new journeys and problems associated with fellow passengers – dementia sufferers can easily go into fight-or-flight response mode, which makes them come across as aggressive.

People with cognitive impairments need **information and navigation systems** (guide lines, signage etc.) to be consistently designed so that they do not have to figure out how different systems work for every part of the journey. Guide lines, tonal contrasts and other interventions originally intended for the visually impaired will be useful for those with cognitive impairment as well and can make navigation simpler for them. Distractions that are not specifically associated with the journey should be kept to a minimum, so as to lessen the need to focus on several things at once. Information should be displayed in a single section, as 'rolling' text can be difficult to read for those with cognitive impairments (Krogstad and Skartland, 2016). People with dyslexia can find it difficult to read (especially block capitals), process information whilst listening, understand and process numbers, and spell words correctly when typing into journey planners and wayfinders (Lamont et al., 2013).

Psychological afflictions and social and behavioural disorders

People with psychological afflictions and behavioural disorders can encounter barriers that cannot be addressed by technical interventions. These may include cost, overcrowding, a lack of understanding from service personnel, poor access to public transport in rural areas, inadequate information when unforeseen events occur, and stigma.

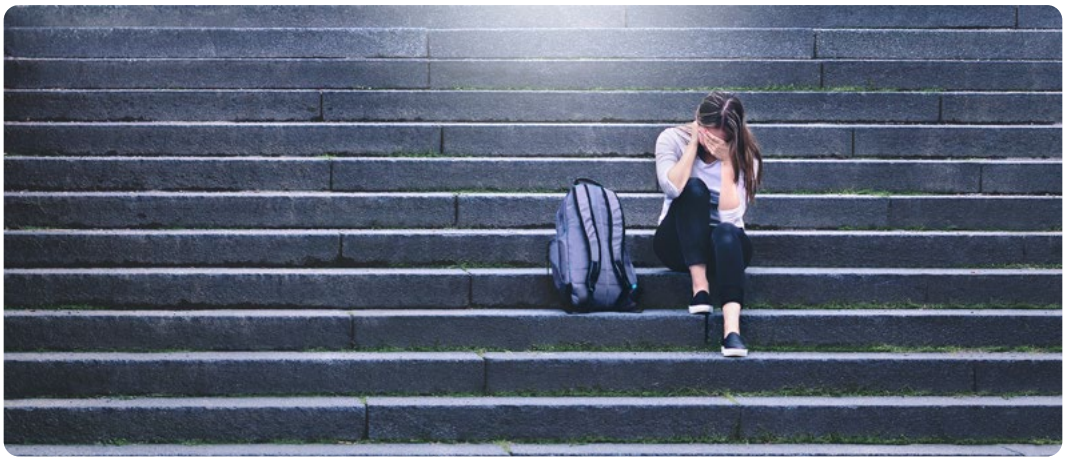
The social environment associated with the journey is very important for people with mental health impairments. The passenger's sense of safety is heavily affected by the attitudes of service personnel. Many feel ignored by staff because their disability is not visible, and there is a call for greater awareness of mental health issues among bus drivers. There are often no staff on hand to provide assistance, which can be problematic when booking tickets and using new technology. In England, passengers with psychological impairments often say they have been stigmatised by fellow passengers, but there are few similar reports in Norwegian studies.

Access to public transport will significantly affect the mobility and everyday life of people with mental health impairments. Poor access to public transport in rural areas makes everyday travel difficult for many. Anxiety can stop someone from catching the intended bus, and if the next service is a few hours away, this will have a severe impact on the passenger. In areas with infrequent services or poor coordination between different modes of transport, many will opt for alternatives like a car or bicycle. *Long waiting times caused by poor connections* can increase the sense of anxiety, and timetables should, therefore, be structured to simplify modal shifts if possible.

There should be adequate **seating** aboard vehicles and in station areas, as standing is considered an extra burden. Overcrowding on public transport means that many try to avoid travelling at peak times. Many would like seats that are screened to avoid the sense of having too many people at close quarters. Using seats reserved for pregnant women, the elderly and people with disabilities can be challenging, as most people consider these seats to be reserved for those with a 'visible need' to sit. If someone with an invisible disability takes such a seat, it can be difficult for them to decide what to do if someone with a visible disability indicates a need to sit down. On the one hand, it may be considered rude and disrespectful if the person without a visible disability does not give up their seat, while on the other hand, this person may feel 'forced' to give up their seat to someone who may well have less of a need for it. This is a problem that has no specific solution, but it may be a useful intervention to run information campaigns to highlight the fact that not all disabilities are visible.

'Solutions such as real-time systems are interventions that give a better overview of the travel situation. This greater sense of control can sooth anxieties.'

It is very important to have access to *information* that makes it possible to plan the journey and turns it into a routine, particularly for long journeys and journeys with multiple legs, as these are found to be particularly onerous.



Lack of information creates confusion and causes loss of confidence and control. Solutions such as real-time systems can ease such situations and give a better overview of the journey situation. This increased sense of control can alleviate anxieties. Real-time systems are not available in all parts of the country, and if a real-time system does not work as it should, this can cause stress. For some, various travel apps can help to reduce stress and anxiety levels. It is important that information channels are largely standardised and designed to make them easy to read. If your level of anxiety is high, it can be difficult to ascertain where there is available information at a given station or for a given mode of transport, and it can be hard to read small print. Information about a ticket's validity and duration should also be clearly visible on paper tickets as well as on their electronic counterparts.

Access to toilet facilities is a concern for people with mental disorders. A lack of toilet facilities can create problems for those who suffer from anxiety and perhaps have problems with food allergies, food intolerances or IBS (irritable bowel syndrome) – all of which can cause an urgent need to use the toilet.

Table 4: Examples of barriers associated with cognitive and psychosocial barriers, with suggested interventions.

BARRIERS	INTERVENTIONS
Overcrowding	Adequate seating, screened seating areas, information that not all disabilities are visible (seats reserved for disabled people are currently perceived to be reserved for the visibly disabled), increase the number of seats for disabled people
Lack of understanding among staff	Training of drivers and station staff
Difficult to ask for help	'Travel assistance card' to be shown to staff if required
Behavioural problems and stigma	Information campaigns on the underground/buses etc.
Poor access to public transport and long waiting times between services	Increase the number of services, increase the number of direct services, better coordination of services
Difficulties with technology (ticket purchases etc.)	Staff on hand
Processing of numbers and letters	Alternative pictograms, avoid rolling text, avoid excessive distracting information, large fonts to increase readability when stressed
Lack of information	Real-time systems, standardised information, information about ticket validity and duration
Journey changes	Staff on hand
Lack of toilet facilities	Toilets in station areas/on long bus or train journeys

6. Asthma and allergies

In Norway, 1.4 million people suffer from asthma, allergies or eczema, or a combination of all three. The numbers are increasing. Asthma is a chronic inflammation or irritation of the airways that may cause coughing fits, chest tightness, etc. An allergy is hypersensitivity to specific substances in the environment and can cause a number of symptoms: hay fever; runny nose; itchy eyes; hypersensitivity; asthmatic reactions; eczema; headache; and in a worst-case scenario: anaphylactic shock and death (Espedal and Jaatun, 2002; NAAF, 2011). In a public transport setting, potential environmental allergens are associated with: release of gases like formaldehyde on board vehicles and in station areas; the use of nickel and chrome as materials on board vehicles and in station areas; mould in station areas; pollen from trees and plants around the station area and on the station access/egress route; general air pollution from road traffic; animals or allergenic animal substances on board the vehicle; allergy to perfume and chemicals, etc. (Espedal and Jatuun, 2002).

There are guidelines to assist with **choosing materials and servicing and maintaining** built environments so as to avoid challenges caused by the release of gaseous substances, formation of mould, etc. A good indoor climate will help to reduce symptoms for people who suffer from asthma and allergy (NAAF, 2011).

Exposure to allergens may be an unavoidable barrier to using public transport. When booking flights, it is possible to reserve seats that guarantee non-exposure to animals in the cabin, and the airline and cabin staff can be forewarned about extreme food allergies (e.g. nuts). Necessary precautions can be put in place, and the cabin staff will inform the other passengers. Trains have dedicated zones for animals,[5] but this is not the case for buses, trams and metro rail. It is therefore conceivable that some people with severe animal allergies will not be travelling by these modes. People who are allergic or

5 https://www.vy.no/kundeservice/sporsmal-og-svar/sporsmal-og-svar-om-tog/bagasje-og-spesielle-behov

hypersensitive to chemicals can find it difficult to avoid being exposed to the substances they react to.

In areas around bus stations, railway stations and airports, **landscaping** can create a pleasant atmosphere. To some extent, vegetation can also serve as an air filter and as a biotope for pollinating insects. On the Oslo underground, indoor plant walls have been installed at the Nationaltheatret station to improve the air quality. Plants absorb particulates, thereby making it less stressful for asthmatics and other vulnerable groups to spend time there. However, some varieties of plants and trees can be troublesome for large sections of the population. Birch, hazel and willow in particular are varieties that many are allergic to. A 100-metre buffer zone, free of trees that are high in pollen, is recommended for places where people need to spend time, because a large proportion of the pollen from these varieties will fall within this radius (Bjerke et al., 2005).

Table 5: Examples of barriers associated with asthma and allergies, with suggested interventions.

BARRIERS	TILTAK
Animal hairs	Dedicated animal zones
Pollen from trees enroute to the stop/station stasjonsområder	Plant hypoallergenic tree varieties
Particulates	More landscaping
Gases released from materials, or allergies	Choose hypoallergenic materials with low levels of gas release
Perfumes and chemicals	Awareness campaign on public transport and for frontline staff

7. How to accommodate as many as possible

There are many similarities between the barriers encountered by different groups and the interventions proposed to assist them. Designs that are primarily intended to ease the travelling for some will, in many cases, improve the travel experience for all. This is precisely what universal design of the transport system is all about, ensuring that everyone can use the services, irrespective of their level of functionality and age. There are many specific examples. For instance, studies show that interventions like the raising of platforms, originally intended to make it easier to board for people with impaired mobility, in fact benefit all passengers (Fearnley et al., 2009; Aarhaug et al., 2009; Ruud et al., 2005). Guide lines and high tonal contrasts are other examples. These measures are often associated with design for the visually impaired, but they can also be helpful for those with cognitive impairments, for people who are unfamiliar with the location, and those who do not know the language, etc. Appropriate non-glare lighting is particularly important for those with partial vision or hearing, but good lighting is important for all of us and can make us feel safer (Meyer et al., 2019).

'Universal design is all about designing the transport system so that everyone can use the services, irrespective of their level of functionality and age.'

Footways and squares must be well built, maintained and serviced in winter. They should be logically and holistically designed with clear walking corridors and dedicated zones for street furniture and landscaping. Paving should be even and non-slip, and materials should be durable and of high quality. Excessive variation of underfoot surfaces can make it challenging to move and navigate with both wheels and canes. Furthermore, non-existent or poor winter servicing, and slippery conditions underfoot can cause problems and challenges for

all of us, but the elderly and those with impaired mobility or vision are particularly vulnerable in such circumstances. Footways should be kept clear of snow and ice, and gravel and dirt must never be allowed to cover guide lines. This puts a heavy responsibility on those who maintain these facilities. Paving must be non-slip at the very least, and people using wheels (e.g. wheelchairs, walkers, prams and buggies) should be able to move effortlessly without encountering obstacles. In places where good natural guidelines have been incorporated into the layout, these should be available throughout the winter. This can be achieved either by keeping the natural guidelines clear or by planning for temporary features (e.g. banks of snow) to be used instead. It is important, however, that these do not represent obstacles to the free movement of wheels and those who walk with difficulty.

Access to seating is important. All of us have days when we feel particularly weary, have developed a painful blister or pulled a muscle and need to sit down. The elderly and people with mobility impairments will have a greater need to sit down more often, and people with mental health impairments may need to sit down to calm their symptoms of anxiety, etc.

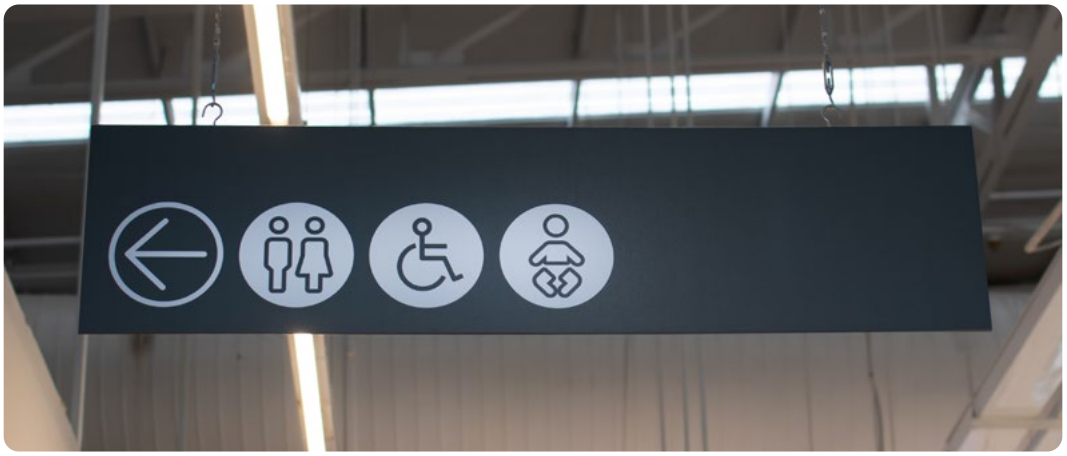
Access to seating is important along the walk to the station or stop (particularly if this involves a long distance), in waiting areas and on board vehicles. A study has found that willingness to pay increases among all passenger groups if waiting shelters with seating are provided and if there are seats available on board (Fearnley et al., 2009; Veisten et al., 2020). Overcrowding at stops/platforms and on board the vehicle can be problematic, as this can make it difficult to find a seat. Because some disabilities are invisible (anxiety, hearing loss, pain, some forms of vision and balance problems, etc.), it can be problematic that seats reserved for the elderly, pregnant women and disabled people are currently perceived to be reserved for those with a 'visible need' to sit. Whether a person wants to give up their seat for someone with a 'visible need' will always be a matter of personal discretion, but information campaigns can raise awareness that some people may be in great need of a seat – even if it is not immediately apparent.

'The willingness to pay increases among all passenger groups if waiting shelters with seating are provided and if there are seats available on board.'

Because some disabilities are invisible (anxiety, hearing loss, pain, some forms of vision and balance problems, etc.), it can be problematic that seats reserved for the elderly, pregnant women and disabled people are currently perceived to be reserved for those with a 'visible need' to sit.

Standardised information across regions and modes is an intervention that will benefit everyone. It is important that information is provided both visually and audibly, and that the sound reproduction and the readability of text is of a high standard. Information in writing should be provided in complete sections of text that are sufficiently legible for anyone to have enough time to read. Fonts must be sufficiently large to ensure universal readability and block capitals should be avoided. Children who cannot yet read, and tourists who are unfamiliar with the language can benefit greatly from alternative visual presentation, such as pictograms, as can people with cognitive impairment.

Real-time systems in station areas and on board vehicles are positive interventions that benefit all passengers. In station areas they can provide information about delays and the time of the next service. On board vehicles, screens and audio information can make orientation simpler. Blind and partially sighted people who find it difficult to read will be able to hear the name of the next stop and therefore be less dependent on the driver. People who suffer from anxiety will feel that this boosts their sense of control of the journey, and people who are unfamiliar with the location will find it easier to keep track of where they are getting off. Wheelchair users, who tend to be seated below window level on buses, or are not facing the direction of travel, will also find that this makes it simpler for them to keep track of where they are.



Toilet facilities are needed by everyone at regular intervals. To make sure that these are accessible for all, self-service paid entry systems should be discontinued (the blind and partially sighted find it really difficult to use these). Toilets must be designed in compliance with the appropriate standards and requirements to ensure that people with impaired mobility can use them. Heavily scented perfumes and chemicals in detergents and air dispensers should be avoided as far as possible within the bounds of a safe environment.

However, although there are many similarities between designs that benefit multiple groups, we also need to take account of some conflicting needs.

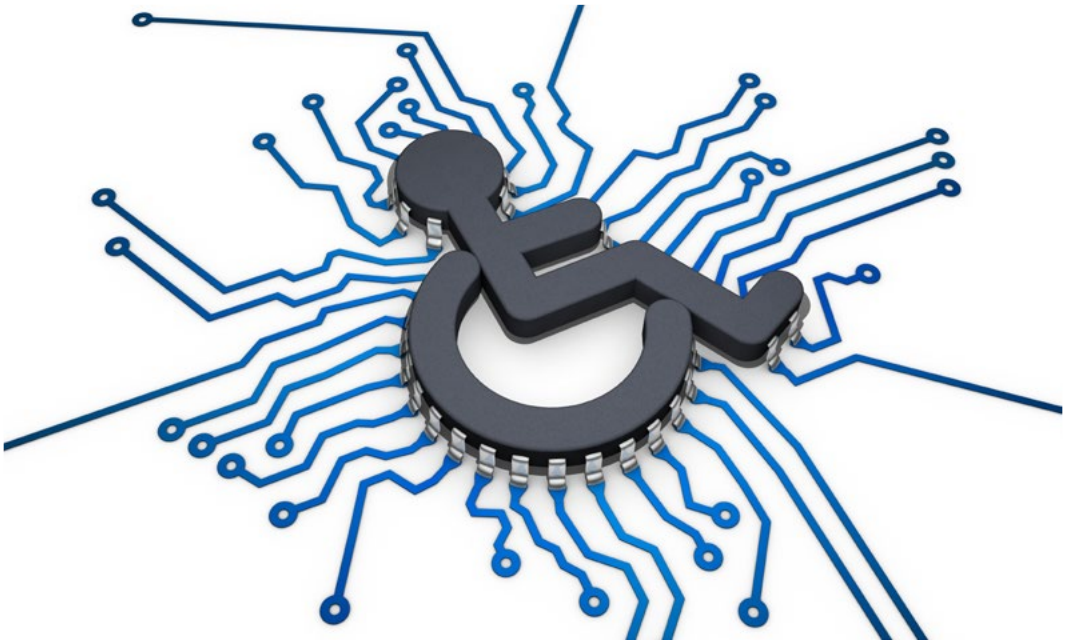
For instance, this applies in respect of the **design of paving and kerbs at pedestrian crossings.** While those with impaired mobility want as few bumps and edges as possible, people with impaired vision need such features to navigate. Those who have a guide dog will tend to prefer dropped kerbs, while those who use a white cane need a normal kerb to be able to head in the right direction across the road. To solve this problem, a compromise has been reached by agreeing a standard 2-cm kerb at pedestrian crossings. This is sufficient for the visually impaired to notice the transition between walkway and carriageway, but low enough to allow wheelchair users, prams and buggies to traverse them with ease. It is difficult to ensure that this kerb stays at 2 cm over time. Wear and tear, as well as paving deposits, and seasonal variation (i.e. leaves, winter servicing, and snow clearance) can cause the 2 cm kerb to become higher or lower, or to disappear altogether.

Correct positioning of **information screens and ticket machines** can also be challenging. Although there are statutory standards for the design and location of such machines, inspections nevertheless show widespread non-conformance (as described in the section on barriers associated with impaired mobility). Wheelchair users, people of short stature and children can find it difficult to use ticket machines if the screen or payment mechanism is too high or at the wrong angle, while people with balance issues can find it difficult to use low-level ticket machines. The partially sighted can find it difficult to see information displayed too high or too low, while wheelchair users and children may find it difficult to see information at eye level or higher – particularly if there is overcrowding or if the monitors are mounted in the wrong position or at the wrong angle. This could be solved by installing information screens and ticket machines at multiple heights.

Ee should also highlight the difficulty of balancing concerns for people with **severe dog allergies against concerns for the blind** who use guide dogs. The various operators differ in their approach to this dilemma, but those who suffer from allergies can rarely be confident of an environment completely free of allergens.

8. Concluding remarks

Universal design is about more than the design of our physical environment. The organisation of the public transport system, the social environment associated with the journey, and automated ticketing systems are all factors that can introduce barriers to using public transport for people with disabilities and for others.



How the public transport system is organised impacts its accessibility. Infrequent services make it difficult to use public transport in general. If an area has limited public transport, universal design has little impact. Several modal shifts on a single route can increase access to more parts of the town, but many will perceive multiple changes as a negative experience. If the public transport system is planned with modal shifts in mind, punctuality is imperative. These challenges will vary between geographic areas, and passengers' perceptions will be based on their individual circumstances.

'In many cases, it is very important that staff are on hand to assist passengers who need it, yet the number of staffed public transport hubs in Norway is limited and falling.'

The social environment associated with the journey involves interactions between passengers and between passengers and staff. In many cases, it is very important that staff are on hand to assist passengers who need it, yet the number of staffed public transport hubs in Norway is limited and falling. This may put some people off travelling by public transport because they are unsure whether they will receive the help they need during their journey. It is important that available staff are well informed about the needs they may encounter. People with various mental health impairments felt that staff had little understanding of mental health disorders, and there was a feeling of being an inconvenience to staff reported by those with impaired mental health, mobility and vision. To ensure that drivers can provide the level of service required, it is important that schedules are timed to allow for such service provision. One out of three bus drivers report that they currently have insufficient time to offer the level of service they would like to provide (Krogstad et al., 2019). Delays and pressures of time can also cause drivers to drive more aggressively to make up for lost time and to keep to the timetable, which in turn may cause reluctance to travel by public transport among some people.

Automated ticketing systems have reduced our reliance on personal contact with service personnel. There are advantages to this, in that accessing information is easy and there is no need to contact staff if you would rather not, which can ease the situation, e.g. for those with social anxiety. At the same time, this can cause problems for those who depend on assistance.

'The partially sighted/blind, and people with various forms of mental health impairment find it difficult to read and access information and often need extra help from other people to buy tickets or to find their way within station areas.'

People who find it difficult to read or access information – the partially sighted/blind, and people with various forms of mental health impairment (anxiety, dyslexia, dementia, etc.) – often need extra help from other people to buy tickets or to find their way within station areas. Staff who are on hand to help passengers navigate and

buy tickets can be a positive measure for many, e.g. people with impaired vision or mobility, the elderly who are unaccustomed to using modern technology, or tourists. Even if station areas and public transport vehicles meet the physical requirements for universal design, this is of little use if people choose not to travel because they feel unsafe.

Universal design is about ensuring that everyone can participate in society on equal terms. As we work to achieve an ever more universally designed public transport system, the goal is to make it simpler and easier for more people to use public transport. When people with disabilities get better access to the public transport system through universal design, this can increase their opportunity to play a part in society on par with 'everybody else'. This may help to increase involvement in various political, economic and social arenas, and to reduce the sense of isolation and exclusion. Universal design is not only a strategy to increase access to the public transport system, it is also a recognition that all human beings are different and that we all have a basic right to participate in society in the way we wish.

'When people with disabilities get better access to the public transport system through universal design, this can increase their opportunity to play a part in society on par with 'everybody else'.

We hope that reading this article will have increased your understanding of the complexities involved with universal design, and that you are now ready to get started with the work of planning, developing and implementing interventions that will take society a step closer to full universal design.

9. Further reading

Aarhaug, J. and Elvebakk B. 2012. Universell utforming virker - evaluering av tiltak i kollektivtrafikken. TØI-rapport 1235/2012. Transportøkonomisk institutt, Oslo.

This report by the Institute of Transport Economics summarises the evaluation of the funding scheme for better access to the public transport services provided by local authorities. The main finding is that measures implemented through this funding strand were favourably received, and that they help to make it easier for people with disabilities to travel by public transport. At the same time, the study demonstrates that these interventions do not solve all the problems encountered by people with disabilities when they travel.

Storliløkken, M., Martinsen, H., Tellevik, J.M. and Elmerskog, B. (2012) *Mobilitetsopplæring; mobilitetsopplæring av barn, unge og voksne med synshemming.* Tapir akademisk forlag, Trondheim

This book explains how children, young people and adults with impaired vision are trained to navigate in their surroundings. It is a good introduction to the principles of mobility for the blind and partially sighted.

Mykletun, A., Knudsen, A.K. and Mathiesen, K.S. 2009. *Psykiske lidelser i Norge: Et folkehelseperspektiv.* Rapport 2009:8, Nasjonalt folkehelseinstitutt, Oktober 2009

This is the first comprehensive report on mental disorders in Norway. It describes the prevalence of the various mental disorders in different age groups, and lists the relevant vulnerability factors, risk factors and protective factors. The report also documents the most significant consequences of mental disorders for Norwegian society, and discusses treatments from a public health perspective.

Sosial- og helsedirektoratet. 2003. *Universell utforming over alt! Planlegging og utforming av uteområder, bygninger, transport og produkter for alle.* Sosial- og helsedirektoratet, Oslo.

This is a collection of multidisciplinary articles published by the Norwegian Directorate for Health and Social Affairs. It seeks to provide a broad introduction to the discipline of universal design. The articles are intended for anyone with an interest in the planning and design of environs and products, or who specifically works in this field.

Husbanken/NAAF. 2011. *Universell utforming av bygg for personer med astma, allergy og annen overfølsomhet*. [URL] http://biblioteket.husbanken.no/arkiv/dok/Komp/Uu_bygg.pdf

These guidelines provide an overview of aspects that need special attention when planning, building and operating buildings that seek to be certified as universally designed for people with asthma and allergies or other hyper sensitivities.

Husbanken/Hageselskapet. 2009. *Veileder: Universell utforming av uteområder ved flerbolighus*. http://biblioteket.husbanken.no/arkiv/dok/3472/uu_uteomrader.pdf

These guidelines seek to inspire good planning for full inclusion and enjoyment in communal outdoor spaces for houses in multiple occupancy (HMO). Highlighted topics include access, parking, entrance areas, play and recreational areas and the green zone around communal spaces. The guidelines apply to ground-level areas and do not include private gardens.

References

Aarhaug, J., Leiren, M.D. og Fearnley, N. 2009. *Universell utforming: bra for alle, ikke bare for funksjonshemmede.* Samferdsel nr 10/2009

Aarhaug, J., Elvebakk, B., Fearnley, N. og Bismo Lerudsmoen, M. 2011. *Førundersøkelse. Tiltak for bedre tilgjengelighet i kollektivtransporten.* TØI-rapport 1174/2011. Transportøkonomisk institutt, Oslo.

Aarhaug, J. og Elvebakk B. 2012. *Universell utforming virker - evaluering av tiltak i kollektivtrafikken*. TØI-rapport 1235/2012. Transportøkonomisk institutt, Oslo.

Bjerke, M., Brox, K.H. (red) og Ramfjord, H. 2005. *Gode råd er grønne: et allergivennlig grønt miljø inne og ute*. Norges astma- og allergiforbund, Sør-Trøndelag fylkeslag.

Blindeforbundet. 2019. *WHOs definisjon på blind/ svaksynt.* [URL] https://www.blindeforbundet. no/oyehelse-og-synshemninger/whos-defini-sjon-pa-blind-svaksynt. Sist oppsøkt 07.10.2019.

Braarud, E. 2012. *Universell utforming av transportmidler. Tilgjengelighet til buss, bane og tog for rullestolbrukere.* Masteroppgave i Funksjonshemming og samfunn, Norges teknisknaturvitenskapelige universitet.

Espedal, K.J. og Jaatun, L.E. 2002. *Kompendium i Universell utforming.*

Fearnley, N., Flügel, S., Killi, M., Leiren, M.D., Nossum, Å., Skollerud, K. og Aarhaug, J. 2009. *Kollektivtrafikanters verdsetting av tiltak for universell utforming.* TØI-rapport 1039/2009. Transportøkonomisk institutt, Oslo

Folkehelseinstituttet. 2004. Utbredelse av hørselstap. Et viktig helseproblem blant eldre.

Hjorthol, R., Krogstad, J.R. og Tennøy, A. 2013. *Gåstrategi for eldre – kunnskapsgrunnlag for planlegging i Kristiansand.* TØI rapport nr. 1265/2013. Transportøkonomisk institutt, Oslo

Kessler, R. C., P. Berglund, O. Demler, R. Jin and E. E. Walters. 2005. Lifetime prevalence and age-of-onset distributions' of DSM-IV disorders in the national comorbidity survey replication. *Archives of general psychiatry* 62(6): 593-602, from ISI:000229628400003.

Krogstad, J.R. og Skartland, E.G. 2016. *Universell utforming av stasjonsområder – erfaringer fra brukerne.* TØI rapport 1470/2016. Transportøkonomisk institutt, Oslo

Krogstad, J.R., Phillips, R.O. og Berge, S.H. 2019. *Kollektivtransport for alle: Bussjåførenes rolle*. TØI rapport 1683/2019. Transportøkonomisk institutt, Oslo

Kummeneje, A-M., Øvstedal, L. og Engen, T. 2014. *Evaluering av sentrumsholdeplass i Trondheim*. SINTEF rapport A25419

Lodden, U. 2001. *Enklere kollektivtilbud. Barrierer mot kollektivbruk og tiltak foret enklere tilbud.* TØI-rapport 540/2001. Transportøkonomisk institutt, Oslo

Lamont D, Kenyon S and Lyons G. 2013. Dyslexia and mobility-related social exclusion: the role of travel information provision, *Journal of Transport Geography*, 26 (2013), 147–157, available from http://www.sciencedirect.com/science/article/pii/S0966692312002244.

Mackett, R. 2017. *Building confidence: Improving Accessibility for people with mental impairments*. https://www.gov.uk/government/publications/exploring-the-barriers-to-travel-forpeople-with-mental-impairments. Accessed 07.10.2019.

Mental Health Action Group. 2011. *Mental Health & Public Transport*. Tilgjengelig fra: [URL] http://www.derbyshiremind.org.uk/pdf/MHPublicTransportReport.pdf. Sist oppsøkt 07.10.2019.

Meissonnier, J. og Dejoux, V. 2016. The Commented Walk Method as a way of Highlighting Precise Daily Mobility Difficulties – A case study focusing on Cognitive or Mental Diseases. *Transportation Research Procedia* 14: 4403-4409

Meyer, S.F., Fyhri, A., Evensen, K., Nordh, H, og Ævarsson, G. 2019. *Hvordan skape trygge og levende byrom?* TØI-rapport 1696/2019. Transportøkonomisk institutt, Oslo.

Mykletun, A., Knudsen, A.K. og Mathiesen, K.S. 2009. *Psykiske lidelser i Norge: Et folkehelseperspektiv*. Rapport 2009:8, Nasjonalt folkehelseinstitutt, Oktober 2009

NAAF. 2011. *Universell utforming av bygg for personer med astma, allergi og annen overfølsomhet*. Hentet ned fra: https://biblioteket.husbanken.no/arkiv/dok/Komp/Uu_bygg.pdf

Nielsen, A.F. og Skollerud, K. 2018. *Universell utforming av transportsystemer for grupper med nedsatt psykisk funksjonsevne.* TØI rapport 1615/2018. Transportøkonomisk institutt, Oslo.

Nordbakke, S. og Hansson, L. 2009. *Mobilitet og velferd blant bevegelseshemmede – bilens rolle*. TØI-rapport 1041/2009. Transportøkonomisk institutt, Oslo.

Nordbakke, S. og Skollerud, K. 2016 *Transport, udekket aktivitetsbehov og velferd blant personer med nedsatt bevegelsesevne.* TØI rapport 1465/2016. Transportøkonomisk institutt, Oslo.

Norges Handikapforbund (2001) *Tilgjengelighet til offentlig transport. En eksempelsamling fra Norges Handikapforbund.*

Norges Handikapforbund. 2012. *Universell utforming og likestilling. Toalett og bad – detaljer som teller.* Tilgjengelig fra: [URL] http://biblioteket.husbanken.no/arkiv/dok/Komp/Toalett_bad.pdf. Sist oppsøkt 07.10.2019.

Penfold, C., Cleghorn, N., Creegan, C., Neil, H. & Webster, S. 2008. *Travel behavior, experiences and aspirations of disable people.* Great Britain Department of Transport, London.

Ruud, A., Fearnley, N., Kjørstad, K. N. og Hagen, T. (red., 2005) *Kollektivtransportmarkedet i by: Fakta og eksempler.* TØI-rapport 811/2005. Transportøkonomisk institutt, Oslo.

Rødseth, J. 2004. *Buss for alle.* Sintef rapport STF22 A04309 Åpen. Sintef bygg og miljø

Skjetne, B. og Zachariassen, P. 2003. Inkluderende løsninger i kollektivtransporten. I artikkelsamlingen: *Universell utforming over alt! Planlegging og utforming av uteområder, bygninger, transport og produkter for alle.* Sosial- og helsedirektoratet, Oslo.

Norwegian Public Roads Administration. 2014. *Universell utforming av veger og gater.* Håndbok V129. Statens vegvesen Vegdirektoratet.

Norwegian Public Roads Administration and The Norwegian Building Authority, 2015. *Arkitektoniske virkemidler for orientering og veifinning.* Januar 2015.

Storliløkken, M., Martinsen, H., Tellevik, J.M. og Elmerskog, B. (2012*) Mobilitetsopplæring; mobilitetsopplæring av barn, unge og voksne med synshemming.* Tapir akademisk forlag, Trondheim

Tennøy, A., Øksenholt, K.V., Fearnley, N. og Matthews, B. 2013. *Evaluering av standarder og praksis for tilrettelegging for synshemmede i transportsystemet.* TØI rapport 1260/2013. Transportøkonomisk institutt, Oslo.

Veistein K., Flügel S. , Halse A. H. , Fearnley N. , Sundfør H. B., Hulleberg N. , Jordbakke G. N. (2020). *Kollektivtrafikanters verdsetting av universell utforming og komfort*. TØI rapport 1757/2020. Transportøkonomisk institutt, Oslo.

Øksenholt, K.V., Fearnley, N. og Aarhaug, J. 2014. *Kollektivtransport for alle - hva vet vi om de som faller utenfor?* TØI rapport 1381/2014. Transportøkonomisk institutt, Oslo.

Øksenholt, K.V. og Aarhaug, J. 2015. *Kollektivtransport for personer med nedsatt funksjonsevne – erfaringer fra ikke-brukere*. TØI rapport 1433/

Institute of Transport Economics
Norwegian Centre for Transport Research