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Citation for the published version (APA 6th)
Bjerkan, K. Y., & Øvstedal, L. R. J. T. (2018). Functional requirements for inclusive transport.
doi:10.1007/s11116-018-9939-7

Functional Requirements for Inclusive Transport

Transport related social exclusion is one aspect of people with disabilities' marginal position in economic, social and civic life. This study aims at presenting main tendencies in empirical research on transport and disability, and therein defining functional requirements that transport solutions must comply with in order to facilitate social inclusion. Based on review of thirty-four empirical studies, this study presents eight functional requirements for inclusive transport. Aspects of each requirement are described and links to social exclusion are explored. Further, the strengths and limits of the review as well as relevance for practice is discussed. Although the study is limited to research in English and Scandinavian languages, the authors believe that the transferability of the results beyond the geographical scope of this study is not challenged by the requirements themselves, but rather to what degree and in what ways these requirements are championed and pursued. The functional requirements are defined without reference to particular travel purposes or mode of transport and represent a systematic approach for making discretional assessment of transport solutions.

Keywords: disability, transport, social inclusion, functional requirements

Introduction

The equal participation of people with disabilities in economic, social and civic life has been on the political agenda for decades. Yet, people with disabilities remain a marginalised group. Research has increasingly regarded this as a result of social exclusion, and the related concept of capabilities; the inability to facilitate wide economic and social participation which is basic for acting as full citizens (Nussbaum 2011; Levitas et al. 2007; Sen 2000; Lee & Murie 1999; Bhalla & Lapeyre 1997).

Transport is one of the factors influencing exclusion (Church et al. 2000; Schwanen et al. 2015; Currie et al. 2010; Preston & Rajé 2007; Lucas 2012), and mobility related exclusion has become increasingly relevant as overall levels of mobility have increased. This implies that the relative disadvantage of not accessing important social arenas increases, as increased mobility increases the access of the general population (Farrington 2007; Urry 2007; Kellerman 2006). Kellerman (2006) points to mobility as the ability to move between different activity sites, and as such includes actual and potential travel, the freedom to travel as you wish. He refers to mobility as a "social construct", and argues that mobility and control over mobility both reflects and reinforces

power. Mobility is also viewed as a basic human right (Kellerman 2006; Farrington 2007; Imrie 2000). A number of studies investigate the use and experiences with transport which might underpin exclusion processes (Velho 2018; Bezyak et al. 2017; Lucas et al. 2016; Falkmer et al. 2015; Nordbakke 2011; Delbosc & Currie 2011; Daniels et al. 2005; Currie et al. 2010; Grut & Kvam 2001; Hammel et al. 2015).

This study aims at presenting main tendencies in empirical research on transport and disability, and therein defining functional requirements that transport solutions must comply with in order to facilitate social inclusion. The research question of this study has been *what functional requirements in transport can facilitate social inclusion of people with disabilities?* Based on review of existing literature, with mainly Scandinavian and Western perspectives, this paper suggests eight functional requirements for facilitating relevant and satisfactory transport solutions which promote social inclusion. For the purpose of the study, the definition of disability in *International Classification of Functioning, Disability and Health* is used: "Disability is an umbrella term for impairments, activity limitations and participation restrictions. It denotes the negative aspects of the interaction between an individual (with a health condition) and that individual's contextual factors (environmental and personal factors)" (WHO 2013).

Social exclusion and transport

Transport has historically not been considered an essential factor of social exclusion (Hine & Mitchell 2001). Burchardt and colleagues (1999) identify five dimensions which describe activities occurring under social inclusion. *Consumption activity* is the ability to buy and take into use a minimum level of goods and services considered normal in a given society. *Savings activity* is the ability to accumulate savings and investments to fulfil own aspirations and provide security for times of economic uncertainty. *Production activity* is the ability to take on economic and/or socially valued activity, contributing to self-respect. *Political activity* includes engaging in efforts to improve or protect the social or physical environment, such as voting and joining political parties, national or local campaigns. Finally, *social activity* implies engaging in social interaction with family or friends, and identifying with a cultural group or community.

Although not recognised as an independent dimension of social inclusion, transport provides support for other dimensions of social exclusion (Wixey et al. 2005). Kenyon and colleagues (2002) define mobility-related exclusion as

> the process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility.

Thus, the mobility dimension relates to poor or inaccessible transport. As such, transport induced exclusion occurs when participation is obstructed by inadequate or inaccessible transport. The relation between transport and social inclusion is, however, many-faceted and the literature includes several different approaches to understanding transport related processes of inclusion. According to Schwanen and colleagues (2015), transport disadvantage derives from i) lack of access to resources, ii) lack of cognitive knowledge,

iii) lack of autonomy in travel, and iv) lack of influence over transport policy and governance.

Similar notions are presented by Kaufmann (2002), who relates social exclusion and transport to the concept of Motility. Motility is the product of interactions between i) movement options with certain constraints (temporal, spatial, economic), ii) the individual's competence to recognise and use access, and iii) the individual asserting access through interpreting and acting on a particular option. As such, Kaufman underlines the importance of individual resource and capital.

A different approach is represented by Stanley and colleagues (Stanley et al. 2011), who relate mobility to three fundamental human needs as presented in Self-Determination Theory, namely the needs for competence, relatedness and autonomy. They find these to be associated with social exclusion, resulting from for instance reduced mobility. They conclude that there is a significant value of improved mobility and upgrading transport services to prevent social exclusion in risk groups.

The relationship between exclusion and transport is substantiated by Church et al. (2000), who suggest seven categories that limit the mobility of socially excluded people. *Physical exclusion* refers to aspects of the transport system and the built environment that inhibit accessibility and associated physical and/or psychological difficulties. These barriers might influence the participation of many groups, such as small children, the elderly and people with disabilities. *Geographical exclusion* relates to poor transport provision and resulting inaccessibility, whereas *exclusion from facilities* is an expression of the distance between the location of people and the location of the facilities (education, health care, pubic services, shopping, leisure) which are essential for the equal participation in normal activities (ref. Burchardt et al. 1999). *Economic exclusion* refers to the inability to bear monetary or temporal costs related to transport, reducing transport options and mobility. Whilst *time-based exclusion* occurs when responsibilities and activities restrict the time available to travel, *fear-based exclusion* occurs when travel is restricted by concern, fear and worry. Finally, *space exclusion* refers to the discouragement of socially excluded people from using public and quasi-public (transport) spaces by the design, surveillance and management of these spaces.

Transport, disability and participation

The concept of transport induced social exclusion emphasises the interaction between factors which lie with the individual, the local areas and with the national and/or global economy (Lucas 2012). One individual factor heavily associated with mobility-related social exclusion is disability. The consequences of limited transport provision reduces access to services and activities in labour markets, financial services, education and training, health care, food shops and participation in social, cultural, political and religious activities (Wixey et al. 2005). Rosenbloom (2007) emphasises the crucial nexus of direct transportation provision and a variety of other delivery systems for people with disabilities, highlighting the importance of seeing transportation services as inextricably linked to decisions made about many interrelated services and facilities. Research shows that the participation of people with disabilities is relatively low in many areas: education

(Borg 2008), employment (Botticello et al. 2012; Boman et al. 2015), leisure activities (Schreuer et al. 2014; Badia et al. 2011), and civic participation (Guldvik et al. 2010; Kingston 2014).

A range of empirical research has pointed to the relation between transport and participation among people with disabilities (Rimmer et al. 2004; Bodde & Seo 2009; Reynolds 2002; Shields et al. 2012; French & Hainsworth 2001; Smith et al. 2015). However, although several studies report on the role of transport, few studies are explicitly devoted to understanding barriers in the travel chain.

The structure of the paper

The following section of this paper describes the literature review, its scope, included studies and procedure for identifying functional requirements. The next section presents the functional requirements; each functional requirement is described by reference to relevant studies in the review. The final section first discusses the functional requirements in relation to the theory of transport related social inclusion (Church et al. 2000), before discussing strengths and limitation of the study. Finally, the section concludes on the applicability of the results.

Literature Review

This study aims to extract findings from empirical research identifying transport barriers, to define a set of general functional requirements which are useful for assessing to what degree a given transport solution is likely to promote equal use, and thus social inclusion among people with disabilities.

Scope of review

The purpose of the literature review is to identify empirical studies investigating barriers towards use of transport among people with disabilities. Studies describing barriers to transport in general are also relevant.

The search was limited to publications in English and Scandinavian languages, published between 2000 and 2017. Relevant studies were targeted through literature searches in Web of Science and Google Scholar. The following search words were used:

Transport* AND barrier*

Transport* AND barrier* AND disabilit*

Transport* AND disabilit*

The searches on Web of Science in particular generated an extensive number of studies. The majority of these related to medical research and engineering, and were excluded from review.

The selection of literature to be reviewed also included studies not focusing on people with disabilities in particular, because many of the difficulties and potential barriers in transport experienced by travellers in general will also apply for people with

disabilities. Given the strenuous and energy consuming task transport represents to this group, transport challenges experienced by the overall population of travellers are assumed even more prominent to travellers with disabilities. Further, incompliance with functional requirements for transport might have a greater impact on the travel habits, and thus inclusion, of people with disabilities.

Some studies are identified through the personal knowledge and experience of the researchers and brainstorming with experts in the fields of transport and disability. Relevant studies are also identified through snowballing, i.e. identifying new sources from the reference lists of already reviewed studies.

Studies included in review

Thirty-four studies are included in the review (table 1). Most studies (15) are Scandinavian. Another fourteen come from the US and the UK, and the remainder from Australia, the Netherlands and Croatia.

Most studies explicitly investigate barriers in transport as experienced by people with disabilities. Some of these focus on a particular type of disability: autism (3), cognitive and developmental disability (3), and physical disability (3). The remainder focus on transport schemes directed towards people with disabilities, overall use of public transport, or use of public transport among the elderly.

Approximately half of the studies addresses public transport (18), while eight relate to paratransit services. A substantial share (10) investigates barriers in transport generally, for instance related to pleasure travel or as a component of travel surveys. Three studies also address barriers relating to car use.

Many studies use method triangulation. However, most studies are based on surveys or interviews: surveys are used in twenty studies, and interviews are used in eighteen studies. A few studies (6) use other qualitative methods, such as participatory observation and observational trips.

Table 1 also gives an overview of which studies substantiate the different functional requirements (func.req) discussed in the next section, where 1=Accessible, centralised information, 2= Flexibility, 3=Safety and security, 4= Physically accessible design, 5=Reliability, 6=Economic predictability, 7= Minimised administration and 8=Short, predictable travel times.

Table 1 Studies included in literature review: overview

Year	Author	Country	Title	Publication type	Functional requirements
2017	Bezyak et al.	USA	Public Transportation: An Investigation of Barriers for People With Disabilities	Journal article	2,3,4,5,8
2016	Deka et al.	USA	Travel patterns, needs and barriers of adults with Autism Spectrum Disorder – report from a survey	Journal article	2,4
2016	Lubin & Feeley	USA	Transportation issues of adults on the autism spectrum: findings from focus group discussions	Journal article	1,2,3,

2016	Nordbakke & Skollerud	Norway	Transport, unmet activity needs and wellbeing among people with physical disabilities	Report	1,2,4,
2016	Verbich & El-Geneidy	UK	The pursuit of satisfaction: variation in satisfaction with bus transit service among rider with encumbrances and rider with disability using a large-scale survey from London, UK	Journal article	1,8
2015	Babic & Dowling	Croatia	Social support: the presence of barriers and ideas for the future from students with disabilities in higher education system in Croatia	Journal article	2,4
2015	Falkmer et al.	Australia	Viewpoints of adults with and without Autism Spectrum Disorders on public transport	Journal article	3
2014	Leiren et al.	Norway	Integration of special passenger transportation services in Akershus and Oslo	Report	2,3,5
2013	Bjerkan et al.	Norway	Transport to employment	Journal article	2,4,6,7
2012	Deloitte	Norway	Evaluation of car support scheme *(Norwegian, auth. transl.)*	Report	5
2012	Lubin & Deka	USA	The role of public transport as a job access mode: lessons from a survey of persons with disabilities in New Jersey	Journal article	1,6,7
2012	Rambøll	Norway	Evaluation of trial with paratransit services *(Norwegian. auth. transl.)*	Report	2,3,7
2012	Risser et al.	Sweden	How do people with cognitive functional limitations post-stroke manage the use of buses in local public transport?	Journal article	1,3,4
2012	Solvoll & Anvik	Norway	Transport scheme for employment and education travel. 10 years of experience *(Norwegian, auth. transl.)*	Report	2,5,6
2011	Aarhaug et al.	Norway	Enhanced accessibility to public transport: a before study	Report	1,3,4,5,6
2011	Delbosc & Currie	Australia	Transport problems that matter – social and psychological links to transport disadvantage	Journal article	1,2,5
2011	Nordbakke	Norway	Persons with physical impediments to travelling. Extent, characteristics, activity pattern, and barriers.	Report	4,6
2009	Bjerkan	Norway	Disabling public transport? *(auth. transl.)*	Report	4
2009	Buffart et al.	The Netherlands	Perceived barriers to and facilitators of physical activity in young adults with childhood-onset physical disabilities	Journal article	5, 6
2009	Nordbakke & Hansson	Norway, Sweden	Mobility and welfare among people with physical disabilities – the role of the car	Report	2,5,8
2009	Rosenkvist et al.	Sweden	The challenge of using public transport: descriptions by people with cognitive functional limitations	Journal article	3
2008	Penfold et al.	UK	Travel behaviour, experiences and aspirations of disabled people	Report	2,4
2007	Wasfi et al.	USA	Measuring the transportation needs of people with developmental disabilities	Conference paper	1,2
2005	Voorhees & Bloustein	USA	Meeting the Employment Transportation Needs of People with Disabilities in New Jersey	Report	1,2,3,4,5,7,8
2005	Daniels et al.	USA	"Travel tales": an interpretive analysis of constraints and negotiations to pleasure travel as experienced by persons with physical disabilities	Journal article	3,4
2004	Gladwell & Bedini	USA	In search of lost leisure: the impact of caregiving on leisure travel	Journal article	6

2004	Logan et al.	UK	Using an interview study of transport use by people who have had a stroke to inform rehabilitation	Journal article	1,3
2002	Carlsson	Sweden	Catching the bus in old age	Thesis	3,4
2002	Gilhooly et al.	UK	Transport and ageing. Extending quality of life for older people via public and private transport	Report	3,5
2001	Beart et al.	UK	Barriers to accessing leisure opportunities for people with learning disabilities	Journal article	1,5
2001	Grut & Kvam	Norway	A qualitative interview about disabled's' experience of participation and barriers in daily activity *(Norwegian, auth. transl.)*	Report	1,2,4,5,7,8
2001	Lodden	Norway	Simplifying public transport. Barriers against using public transport and measures to make public transport easier	Report	4
2001	The London Transport Users Committee	UK	Easing the trip. Meeting the needs of disabled rail users	Report	4
2000	Denson	USA	Public sector transportation for people with disabilities: a satisfaction study	Journal article	5

Identifying functional requirements

Functional requirements are identified from the empirical findings of the literature described above. The literature was revised through conventional content analysis (Hsieh & Shannon 2005) and coding of data (i.e. Charmaz 2006). Findings were first sorted through open coding. To get a comprehensive overview of the literature, we conducted an *explorative mapping* of empirical data, through identifying and describing problems, barriers and difficulties associated with travel among people with disabilities. The explorative mapping also included the literature's perspectives on the causes of barriers and difficulties, and how to overcome them. The explorative mapping provided a comprehensive *outline of tendencies* in the literature and allowed us to identify prominent and consistent findings. Through axial coding, prominent, consistent empirical findings from the explorative mapping were bundled and used to define preliminary *categories*. Categories included interrelated barriers, causes and potential solutions, and as such provided a comprehensive problem description which allowed for defining functional requirements. Both categories and the placement of findings were continuously revised, especially when new bulks of literature were included. However, given the consistency in the literature, revisions were minor and, for the most part, semantic.

Functional Requirements

Findings in the review are consistent regarding critical issues for making transport available, accessible and usable to people with disabilities. The following presents eight functional requirements that must be met for a particular transport service to represent a real alternative for people with disabilities and thus facilitate social inclusion. The requirements are relevant in most social and cultural context, but the preconditions for implementing and pursuing such requirements can be dissimilar between different socio-cultural, transport and mobility systems. The requirements relate exclusively to the particular transport solution and not to the physical and psychological conditions of the individual. Yet, different individuals will experience different requirements differently in different contexts and situations. As further discussed below, the requirements are relevant for a set of fairly similar socio-cultural transport and mobility systems, and the importance and relevance for each requirement may differ on a global scale. The requirements are presented in order of prominence in the literature.

Accessible, centralised information

This functional requirement relates to making necessary information easily available. Providing information on all available transport services is essential, and many are not aware of the transport options they have (Beart et al. 2001; Grut & Kvam 2001; Logan et al. 2004). Information also plays a vital role for preparing for travels (Nordbakke & Skollerud 2016), both in terms of practical arrangements, but also mental preparedness and trust in own ability to master the travel. Difficulties with finding information on particular services are reported by several studies (Delbosc & Currie 2011; Aarhaug et al. 2011; Lubin & Deka 2012), and Lubin & Feeley (2016) also stress the need for information on real-time vehicle arrival when using paratransit services. In a more practical sense, studies show that information also must be both available and understandable at stops (Verbich & El-Geneidy 2016) and while travelling (Risser et al. 2012; Wasfi et al. 2007). Other studies emphasise the need for information on whether the vehicle will be accessible, allowing disabled travellers to estimate what type of assistance they might need (Aarhaug et al. 2011; Voorhees & Bloustein 2005).

Thus, it is important for users and potential users of transport services that information about the transport service is easily accessible, understandable, relevant and easy to find. Information being understandable includes the presentation on accessible formats. Still, none of these studies make explicit reference to requirements for readability and comprehension, such as braille, high-contrast lettering, screen-readable websites, comprehensible wording or maps. A recent study reviews guidelines and practices concerning the design and planning of transport facilities that influence the travel of people with disabilities (Sze & Christensen 2017) and summarises that route guidance, contrast colouring, audio information, clear and large signage, and timetables in large print are important to include vulnerable groups.

Information should further be clear on eligibility and level of accessibility.

Centralised information points are crucial, i.e. that all relevant information for entire travel chains can be accessed from a single point, regardless of who the transport

provider is, where the travel is made, who subsidises travel costs etc. A centralised point of information on routes and schedules, accessibility levels, eligibility criteria, available assistance, travel times etc. allows the traveller to plan for and anticipate all parts of the travel chain. People with disabilities are often eligible for different support schemes, price schemes, assistance etc, but different criteria might apply on different parts of the travel chain, depending on the transport provider or in what municipality or county the travel is conducted (Bjerkan et al 2015).

The information should be available at a single point, for several reasons. An evident reason is that it is necessary to be assured that the whole trip can be carried out according to trip purpose before making reservations or buying tickets for any part of the trip. Providing a central point of information may therefore reduce time and energy spent searching for information. If travellers with disabilities must consult with several information sources to identify their travel options and associated information on accessibility, eligibility and travel conditions, they will spend more time planning their trips than other travellers (see also func. req. on reduced administration). They might also miss out on opportunities because of not having information about all relevant travel options. These are both aspects of transport disadvantage (Schwanen et al 2015).

However, even relevant, understandable, easy-to-find information in accessible formats, may not be sufficient for some travellers with cognitive disabilities. For them to travel without a companion the information may need to be presented in a tailor-made way as well as sequenced and timed for each relevant step in the travel chain (Carmien et al. 2005).

Flexibility

Flexibility is decisive for performing the activities each person wishes to perform, and as a functional requirement it refers both to flexibility within a transport solution and between different transport solutions. As people with disabilities often have difficulties using several means of transport (see for instance Bjerkan et al 2013), a specific transport solution must accommodate the needs of the individual traveller. Many prefer one particular transport solution, which involves strategies for enabling employment, education or socialising. This solution thus becomes decisive for social inclusion.

Flexibility *within the preferred solution* relates to when and where you can travel. Studies on para-transit services report defined limitations to when you can travel and within what geographic area (Lubin & Feeley 2016; Voorhees & Bloustein 2005; Leiren et al. 2014; Solvoll & Anvik 2012; Nordbakke & Hansson 2009). Similar limitations obviously apply for public transport (Deka et al. 2016; Lubin & Feeley 2016; Delbosc & Currie 2011; Nordbakke & Skollerud 2016; Bezyak et al. 2017). Although routes and schedules pose the same limitations on all travellers, the time and energy consumed in planning, organising and carrying out travel might lead to inflexibilities which particularly impact travellers with disabilities. Most para-transit services also place explicit restrictions on what trip purposes the service can be used for (Lubin & Feeley 2016; Solvoll & Anvik 2012), which limit the possibility for efficient travel chains.

One study shows that inflexibility in a transit service for students arises from shortage of vehicles operating the service, leaving the users without a functioning service (Babic & Dowling 2015). Other inflexibilities in transport services derive from travellers not being allowed to change pick-up points or times (Solvoll & Anvik 2012), having to book the return trip before even having made the outbound trip, and making reservations within a certain time (Wasfi et al. 2007).

Flexibility *between transport solutions* implies not depending on a single solution. Relying on a single transport solution involves great vulnerability, as that solution might not always be available. Thus, flexibility implies several, available transport solutions for the same trip. The literature does to little extent address these issues, although some studies (Bjerkan et al. 2013; Lubin & Feeley 2016; Nordbakke & Hansson 2009; Grut & Kvam 2001) describe the strong position of the car and challenges with finding transport options that are as flexible and user-friendly as travelling by car. Penfold and colleagues (2008) refer to public transport as being a less desirable option, especially in peak hours and when overcrowded, with a potentially large impact on work travel.

Although no studies explicitly weigh and juxtapose different transport options, one can deduce from literature that there are fewer equal alternatives available to people with disabilities when considering the effort involved in taking them into use. This disallows for choosing the transport solution that is more appropriate in a given situation or a given day.

Safety and security

Safe and secure travel is addressed by fifteen studies. Some present the physical aspects of safety, where constraints in transport relate to fear of falling or getting injured (Logan et al. 2004; Rosenkvist et al. 2009), personal security (Gilhooly et al. 2002; Leiren et al. 2014), and vehicle safety (Voorhees & Bloustein 2005; Logan et al. 2004). This includes personal safety through being secured in the vehicle, the state of the vehicle, and the driving behaviour of the driver.

The majority of studies, however, treat safety as a more psychological construct and the fears and expectations regarding transport as a social arena. Safety and security relate to the individual's *experiences* while travelling. In using paratransit services, some depend on a regular driver who knows their needs and can accommodate transport accordingly. As they know the travellers and local conditions, drivers are essential for the travellers' experience of feeling safe and secure and for establishing appropriate solutions. For instance, Risser and colleagues (2012) argue that communication and interaction with the (bus) driver is imperative, and Aarhaug et al. (2011) present the lack of service minded drivers and/or personnel as problematic. Bezyak and colleagues (2017) also emphasise the significance of the drivers knowledge and attitudes.

The behaviour of other passengers, or particular groups of passengers, might also be intimidating. Daniels and colleagues (2005) describe barriers relating to interactions with other people as interpersonal constraints. Lubin and Feeley (2016) say anxiety in travellers with Autism Spectrum Disorder (ASD) is often caused by passengers who are

acting out. Similar findings are reported by Falkmer and colleagues (2015), where travellers with ASD experience discomfort with travelling on crowded buses and dislike contact with other passengers. In other studies, reluctance towards travelling with others relates to lack of confidence in other passengers (or drivers) providing support or assistance if needed (Rosenkvist et al. 2009). In addition to worrying about being disturbed by others, travellers also worry about being a disturbance to others (ibid.). This lack of confidence and fear of embarrassment (Logan et al. 2004) relate to the complexity of handling a number of tasks, typically on-board, in a time efficient manner (Rosenkvist et al. 2009; Carlsson 2002), such as paying, finding a seat, signalling to get off etc.

Physically accessible design

Most of the studies that address physically accessible design examine public transport or paratransit services. For any person travelling with public transport, certain factors influence willingness of use: departure frequency, avoiding transits and delays, travel costs, travel time etc. To people with disabilities, additional factors relate to the design of the means of transport (Bjerkan et al. 2013; Daniels et al. 2005; Risser et al. 2012; The London Transport Users Committee (LTUC) 2001; Lodden 2001) and the design of the waiting area (The London Transport Users Committee (LTUC) 2001; Babic & Dowling 2015; Penfold et al. 2008). A particular challenge relates to getting on and off transport (Nordbakke & Skollerud 2016; Bjerkan 2009). In addition to inadequate design of stops and terminals, many people with disabilities experience difficulties with getting to and from stops and terminals (Deka et al. 2016; Voorhees & Bloustein 2005; Nordbakke 2011; Bezyak et al. 2017). In some countries, the access to for instance bus stops can further be reduced through slipperiness in streets and pavements and insufficient clearance of snow and ice (Aarhaug et al. 2011; Nordbakke & Skollerud 2016; Carlsson 2002). As long distances to stops can reduce willingness to use public transport, getting to and from public transport can be an issue of park-and-ride possibilities (Lodden 2001). Given the prominent position of the car in the lives of some groups of people with disabilities, accessible, available and designated parking can be crucial for travel (Bjerkan et al. 2013; Babic & Dowling 2015; Grut & Kvam 2001).

Several studies emphasise the design of the on-board environments. In a Norwegian survey, 62 % of disabled public transport users experience problems on-board, such as space, toilet facilities and air quality (Bjerkan 2009). Difficulties further relate to manoeuvring on-board (Daniels et al. 2005), location of designated seats (Risser et al. 2012) and getting seated (Penfold et al. 2008), cleanliness (Voorhees & Bloustein 2005), and ticket-validation (Risser et al. 2012). The literature also mentions the importance of accessibility throughout the travel chain (Bjerkan et al. 2013; Lodden 2001).

Reliability

Transport solutions need to be reliable and robust over time. According to Solvoll and Anvik (2012), delays are a prominent source of stress for people with disabilities, and the

significance of delays is discussed in several studies (Aarhaug et al. 2011; Gilhooly et al. 2002; Grut & Kvam 2001). Similarly, Denson (2000) describes promptness as the feature most appreciated in an evaluation of a paratransit service.

Obviously, delays are tedious to any traveller, but can be particularly constraining for people with disabilities, as having to wait can in itself be tiring (Gilhooly et al. 2002; Buffart et al. 2009; Beart et al. 2001). Delays and irregularity can be especially challenging when using paratransit services, as they are often irregular and unpredictable (Voorhees & Bloustein 2005; Grut & Kvam 2001; Beart et al. 2001; Leiren et al. 2014; Nordbakke & Hansson 2009; Bezyak et al. 2017) and their users do rarely receive any notice or communication regarding delays and arrival times (Voorhees & Bloustein 2005).

Thus, it is important that users can trust the transport service to arrive at the right time and be sure that she arrives at her destination at the expected time. This implies that the transport operator has a robust system for handling unforeseen events, such as drivers calling in sick, vehicles breaking down, route changes etc. In cases of delay or cancellation, systems for promptly informing travellers should be in place. Hence, reliability very much relates to predictability and trust in transport provided by others.

To a certain degree, this functional requirement overlaps with 'short predictable travel times (see below) as delays typically increase waiting and travel time. However, the predictability of travel times is perhaps even more essential. Although long travel times make travellers unnecessarily weary, the unpredictability in travel and arrival times can be equally tiresome. Unpredictable travel times make it difficult to plan travels into one's daily schedule, and planning the coming day is, perhaps particularly people with disabilities, a prerequisite for handling transport and other strenuous tasks.

Reliability also relates to expectations regarding accessibility and reliance on others for making trips (Delbosc & Currie 2011; Grut & Kvam 2001; Buffart et al. 2009). Further, reliability is relevant for support schemes. In their evaluation of a transport service for work and education, Solvoll and Anvik (2012) find that unpredictability produces stress, and that yearly budgeting causes insecurity concerning whether the service will continue. Reliability is further a matter of accommodating needs when they occur. Deloitte (2012) shows that a substantial share of persons with disability relying on a Norwegian car support scheme are discontent with the processing time of applications for an accommodated or reconstructed car or having an accommodated car repaired. Given the time of processing the application, needs might have changed before support is granted, due to changes in for instance health or living situation.

Economic predictability

Firstly, this functional requirement relates to economic affordability. Several studies emphasise the significance of affordable tickets and transit fares (Lubin & Deka 2012; Aarhaug et al. 2011; Buffart et al. 2009; Nordbakke 2011). Similarly, research on leisure travel among people with disabilities shows that financial strength provides opportunity for providing care and support on travels (Gladwell & Bedini 2004).

To many persons with disabilities, the car represents the only realistic mode of transport (Bjerkan et al. 2013), and inability to afford an accommodated car can influence participation in different (economic, political, cultural and social) activities. In some cases, (accommodated) transport is made affordable through support schemes and subsidies. These are, however, typically subject to continuous review and their use determined by (shifting) eligibility criteria. With the public economy under pressure, the future size and contents of these schemes are unreliable.

Thus, this functional requirement holds more than affordability: the affordability must be predictable. Costs and expenses must be anticipated by the user for the foreseeable future. Not knowing whether the transport service or support will continue to exist and whether you can expect to be eligible in the foreseeable future is a significant strain. In cases where support schemes are subject to yearly budgeting this is an eminent challenge (Solvoll & Anvik 2012), particularly when first come first served principles apply. Such unpredictability might very well undermine efforts for social inclusion, especially relating to education and employment. Uncertainty about transport increases the risk of turning down job offers and study programs. In turn, a marginalised position in the labour market influences economic freedom and thus opportunities for social inclusion altogether.

Reduced administration

Getting access to and using transport services often requires extensive administration and planning (Grut & Kvam 2001; Nordbakke & Hansson 2009; Bjerkan et al. 2013; Deloitte 2012; Bezyak et al. 2017) both in using public transport, paratransit services, and support schemes for cars. Application processing is often lengthy, and the bureaucratic processes are slow and complicated. Application processes often demand comprehensive user involvement, and applicants have to educate themselves in legislation, guidelines, rights, appeal options etc. One study shows that people with disabilities find the fragmented system of different transport support schemes overwhelming, and that it is a complicated task to navigate through eligibility requirements, service availability and restrictions, geographic restrictions and reservation routines (Voorhees & Bloustein 2005). Often, available counselling or advice is not readily available or applicants are not aware that they exist.

Administration also relates to planning the individual trip. A study by Bjerkan et al. (2013) shows that organising everyday life depends on predetermined plans for transport, and traveling often entails preparing mental plans and strategies for handling unexpected situations, such as missing your stop, lack of available or accommodated parking, delays and car breakdowns. The strenuous planning and administration of transport might takes time away from other activities and make it difficult to work, take on career-moving tasks, as well as participate in social events (Bjerkan et al. 2013; Voorhees & Bloustein 2005).

To a certain degree, administration and planning of travel relates to the first functional requirement, 'accessible and centralised information', which could reduce stress in planning. Information is essential for ensuring sufficient knowledge of

alternative routes, travels and transportation, and what characterises these alternatives. However, once information is obtained, administration is a matter of deliberating and assessing options and consequences and making a decision. From there, administration involves organising and implementing a specific plan, and in many cases devising a plan B in case the preferable plan fails.

Short, predictable travel times

To all travellers, time spent travelling is an essential assessment point when choosing your travel mode (McKnight 1982; Wardman 2004; Hensher 2001), and a central functional requirement is thus that the travel time of each transport solution is not disproportionately long. Studies maintain that travel times might represent a significant constraint to people with disabilities (Verbich & El-Geneidy 2016; Grut & Kvam 2001; Voorhees & Bloustein 2005; Bezyak et al. 2017). When also considering the time spent planning and organising efficient door-to-door travel chains and waiting for transport to arrive, travel time not only relates to the time spent on-board, but also the time spent from making transport arrangements to reaching the final destination. Grut and Kvam (2001) provide examples of disproportionally long travel times when using public support schemes for travelling to and from work, fetching children at school and buying groceries in the course of one trip. They also show that unpredictable and long travel times force employees with disabilities to start their work travel very early in the morning just in order to arrive on time, resulting in exceedingly long workdays. As such, this functional requirement relates to flexibility, as long travel times reduce flexibility to handle other, perhaps more productive and pressing, responsibilities.

Discussion

Functional requirements for social inclusion

This study presents main tendencies in empirical research on transport barriers and disability, and therein defines functional requirements that transport solutions must comply with in order to facilitate social inclusion. The ways in which meeting these requirements contribute to reduce social exclusion are in the following exemplified through reference to transport related social exclusion as described by Church et al. (2000).

For one, Church and colleagues argue that physical barriers relate to the built environments and transport system. In assuring accessibility through design, hereunder access to stops and vehicles and an adequate on-board environment, physical exclusion can be reduced or removed.

Geographical exclusion relates to poor transport provision and geographically limited mobility. For instance, such exclusion can be imposed by geographic limitations in paratransit services. As Church and colleagues (2000) argue, geographical exclusion occurs when individuals are kept from carrying out activities outside their immediate local area. This corresponds to some degree with the measurement of individuals mobility outreach and participation as life-space diameters, inspired by Bronfenbrenner's

ecological systems theory (see i.e. Meyers et al. 2002). Hence, paratransit services which limit what types of trips the service can be used for (i.e. work trips, health care, trip length, time of day etc.) also contribute to geographical exclusion. Thus, ensuring flexibility in transport services as, described in the third functional requirement can be essential for securing social inclusion.

Geographical exclusion is further linked to exclusion from facilities located far from the individual. Church et al. underlines that combatting geographical exclusion is primarily a matter of city planning and service provision. However, as long as facilities are located far from the individual, reducing exclusion depends on increasing the attractiveness of transport to the facilities, for instance through short predictable travel times (func.req. 8), proper design (func.req. 4), reliable (func.req. 5) and safe (func.req. 2) services.

As is the case for economic exclusion. Church et al. primarily relate economic exclusion to transport limiting labour market participation, and maintain that exclusion among other things stems from problems with physical access, as well as monetary and temporal travel costs. Hence, in securing time efficient transport with short travel times (func.req. 8) and economic affordability (func.req. 6) transport induced economic exclusion can be reduced.

The literature review shows time to be a central issue. The time-based exclusion described by Church and colleagues not only includes time spent traveling, but also pertain that time constraints are higher in some groups, reducing the time *available* to travel. This is highly relevant for people with disabilities, as this group spend significant time planning and organising transport, as well as waiting for (para)transport to arrive and follow its route. Considering that people with disabilities spend more time managing and conducting daily activities, they can be more prone to time-based exclusion. This implies that people with disabilities spend time planning, organising and worrying about transport instead of spending their time on activities or actual travel. Hence, already mentioned functional requirements relating to travel times (func.req. 8), reliability (func.req. 5), flexibility (func.req. 3), administration (func.req. 7) and accessible design (func.req. 4) are highly relevant for abating this type of exclusion.

Finally, Church and colleagues describe fear to strongly influence how public spaces and transport facilities are used (2000). Several studies discuss the significance of fear. Fear can arise from insecurity with drivers or other passengers (Falkmer et al. 2015; Leiren et al. 2014), interaction with other persons or technology (Risser et al. 2012) or fear for personal safety or injury (Penfold et al. 2008; Rosenkvist et al. 2009). Others maintain that fear of travel is not considered a major constraint (Asplund et al. 2012).

Although none of the functional requirements are defined to solely ease fears and worries related to travelling, the combination of functional requirements might reduce fear-related stress. For instance, providing accessible, centralised information on accessibility levels and availability of assistance throughout the travel chain might reduce stress and worries both before and while travelling. Additionally, vehicle drivers who are trained in communication as well as in anticipating and accommodating needs of travellers with disabilities can further provide predictability and security, as well as aiding

travellers in tasks that cause stress and self-consciousness. The latter issue is also a matter of physically accessible design, and the degree to which solutions for payment, signalling etc. are appropriately designed. Finally, being able to rely on transport services (func.req.5) is crucial for reducing fear. As deviation from plan A might cause stress and anxiety, changes in routes, schedules or arrival times should be promptly communicated and accompanied by accommodated travel alternatives or solutions which aid travellers with disabilities in calculating plan B or C.

If designed well, future transport services and shared automated transport, may score well on the eight requirements. Operators still have to take careful considerations to minimise fear throughout the trip chain.

Study critique

This study aims at presenting main tendencies in empirical research on transport and disability, and therein defining functional requirements that transport solutions must comply with in order to facilitate social inclusion.

The study is based on review of existing literature, and included studies originate in Scandinavian and Western countries with fairly similar socio-cultural systems and comparable transport and mobility systems. Although the search for relevant literature has been thorough and repeated several times, it is difficult to assess whether all relevant studies have been included. It is particularly challenging to identify research not published in journals, as scientific reports are less available and difficult to identify without prior knowledge of the research projects. This is probably why much of the grey literature is Scandinavian. While restricting the review to publications in English and Scandinavian languages might have excluded relevant research, familiarity to the Scandinavian context allows for nuanced and in-depth interpreting of the findings from a wide range of Scandinavian literature. This is however balanced with more studies from other countries, adding richness and confirming relevance of findings.

Overall, the studies included in the review were heterogenic in terms of scope, samples and types of transport covered. As the search only provided a limited number of studies explicitly focusing on barriers in transport, studies which also address use of transport and transport issues in general were reviewed in order to include findings that were relevant for defining functional requirements.

A few studies in the review are concerned with transport in old age, and the scope of the review could have been expanded in this direction. As there is a certain correlation between old age and disability, additional studies on transport barriers in old age could have been included. However, given the similarities in challenges experienced by people of old age and people with disabilities, it is unlikely that expanding the literature search in that direction would have generated other results.

The scope of the review could have been expanded to also include studies focusing indirectly on transport issues. As there is a large amount of literature on obstacles to participation, a range of studies could shed light on the role of transport in participation and hence social inclusion. However, few of these studies provide detailed empirical data

on challenges and barriers, and would as such not provide substance to the functional requirements.

One challenge in defining functional requirements has been how to incorporate psychological barriers, i.e. fears, concerns, insecurities and expectations. These are highly subjective, depending on the context and the traveller herself, and can occur at different parts of the travel chain and in different situations. Hence, it is difficult to identify a functional requirement which single-handedly can alleviate the diversity of concerns and fears associated with travel. Therefore, we have chosen to include these aspects in relation to specific challenges falling under other functional requirements (i.e. information on accessibility level of transport mode) to be able to identify an actual requirement which can alleviate these types of barriers.

On a global level, it is likely that policy differences between regions influence the prevalence of and dedication of strategies for the inclusion of people with disabilities. In the transport domain, such policies might for instance be incarnated through visions and strategies for universal design, or financial and practical support for travel assistance and personal assistance. Therefore, based on the results in empirical studies included here, we cannot with certainty assume that the functional requirements presented are relevant or valid on a global scale. One could discuss whether different policies, economic, social and cultural contexts influence what barriers the literature focuses on. As such, different contexts might influence the relative weight of the different requirements, and possibly the relevance of functional requirements discussed here. Hence, comparative studies taking into account different contexts would provide additionality to the research field.

However, looking at the nature of several of the functional requirements, we believe, that these findings are relevant in societies where daily activities takes place at separate locations and according to a time schedule. Regardless of where they live, the mobility of people with disabilities depend on transport fulfilling functional requirements described here. We believe that the transferability of the results beyond the geographical scope of this study is not challenged by the requirements themselves, but rather to what degree and in what ways these requirements are championed and pursued. That can be expected to vary significantly between regions, countries and societies.

For instance, a wheel chair user in rural Finland requires a permanent paratransit service (reliability) which allows her to travel from where and to where she desires (flexibility) without worrying about eligibility criteria and scheme restrictions (economic predictability). The paratransit service vehicles must also ensure she is safe inside the vehicle (safety and security) and it must be designed in a way that allows her to enter effortlessly and to communicate with the driver (physically accessible design).

Similarly, a wheelchair user in an Indian megacity requires public transport with on-time correspondence (reliabilty) which allows her to make use of the entire transport network (flexibility) with one ticket regardless of the number of different service providers (economic predictability, reduced administration). Her autonomous mobility further requires low-step entrances, accessible stop signals and sufficient space on-board any transport mode (safety and security, physically accessible design). The same functional requirements apply in both scenarios, but their implementation and

operationalisation vary between transport systems and social systems. Nonetheless, comparative studies taking into account different contexts worldwide, and the application of the functional requirements into criteria to assess actual transport services, would add to the research field.

It is important to stress that one cannot assume that complying with these functional requirements automatically assures the social inclusion of people with disabilities. Policies of social inclusion are highly complex, and their success relies on the alignment of endeavours in education, work life, civic life, the welfare system and transport alike. Barriers obstructing social inclusion on these dimensions do vary from one society to another, both in strength and character. Social exclusion is multifaceted and mulitlayered, with parallell processes reinforcing each other (Schwanen et al 2015). As such, the functional requirements presented here are necessary, but not sufficient.

Conclusion

The purpose of this study has been to compile state-of-research on transport barriers which might undermine the social inclusion of people with disabilities. One motivation behind this study has been to provide a set of requirements which can be used to assess whether a given transport solutions is available, accessible and usable to people with disabilities. Inclusive transport represents an entrance ticket to political, economic and social arenas that are fundamental for social inclusion. Inclusive transport is also important to alleviate already pressing time constraints on activities on these arenas.

Although the functional requirements presented here are far from a practical evaluation tool, they represent a systematic approach for making discretional assessment of transport solutions. Defining functional requirements is an important step towards establishing criteria for assessing current transport solutions and for à priori evaluation of anticipated solutions. The requirements are defined without reference to particular travel purposes or mode of transport, and can be applied regardless of who the traveller is. The suggestions presented here do not present radically new knowledge, but rather synthesises and converts barriers and difficulties thoroughly documented in literature into demand oriented criteria which can be actively used to pursue improvements of current and future transport solutions.

Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Authors' contribution

KYB: literature search and review, analysis and discussion, manuscript writing
LRØ: literature search and review, analysis and discussion, manuscript writing

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