VOL. 12 , NO 2, 2024 (105-122)

JURNAL NATAPRAJA:
Kajian Ilmu Administrasi Negara

2406-9515 (p) / 2528-441X (e) https://journal.uny.ac.id/index.php/natapraja

Mapping the New Components of People with Disabilities in Public Transportation: Systematic Literature Review

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ARTICLE INFO

Article history:
Received 19 August 2024
Received in revised form 17 December 2024
Accepted 30 December 2024

ABSTRACT

People with disabilities have long been marginalized in the development process, such as the lack of access to public transportation. However, literature studies on accessibility of persons with disabilities on public transportation are still limited. Therefore, this research aims to produce new components that affect the accessibility of persons with disabilities in public transportation. Sources of research articles are taken based on a 20-year period (2001-2021). The research method used in this study is the Systematic Literature Review (SLR) method. The data source that used to search for selected articles comes from the Scopus database. Based on the results of the inclusion criteria that have been used, 45 articles were found that were in accordance with the research topic and were used further in this paper. The results showed that there was a fluctuation in the trend of research on accessibility of persons with disabilities during the 20-year period (2001-2021). Based on the results of the literature mapping, it was found that new components that affect the accessibility of persons with disabilities in public transportation include spatial distribution, technology, situational, socio-economic, and political, vehicle design and service quality. The six elements are related and influence each other. The future research agenda in this study contains several components that can be used as a basis for future research to see the accessibility of persons with disabilities in public transportation.

Keyword:
Accessibility, People with Disabilities, Public Transportation, Accessibility Components of People with Disabilities, Systematic Literature Review

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https://doi.org/10.21831/natapraja.v12i2.77129

INTRODUCTION

Diffable or people with disabilities, are community groups with limitations that can prevent them from participating in social life (A Diono, 2014) . Globally, one billion people or 15% of the world's population experience some form of disability, and the prevalence of disability is higher in developing countries (World Bank, 2023). Persons with disabilities have long been placed in an incapacitated condition due to environmental factors and physical limitations, which are not recognized as a health condition, placing these people in separate positions without a solution (Parmenter Ba, n.d.). In 2006, the United Nations (UN) Convention on the Rights of Persons with Disabilities proposed several initiatives to ensure equality based on the human rights of persons with disabilities. But throughout the 20th century, the real condition is that minority groups such as persons with disabilities have struggled to obtain their right to equal access to education, employment, health care, and public transportation (Ermagun & Tilahun, 2020).

Studies related to public services for persons with disabilities have been widely discussed in various publications. However, Vanderschuren & Nnene (2021) mention that in the last two decades, research reports related to public services in the field of transportation for persons with disabilities are still limited and have not received more attention. Transportation connects people with work, social life and services. Transportation is an integral part of the urban system as a whole or an aspect that cannot be separated from other components (Sze & Christensen, 2017a). Most of the research on access to public transport for persons with disabilities has focused on issues related to accessibility and experience of using public transport (Hine & Scott, n.d.; Lindqvist & Lundälv, 2012) design issues as barriers to transportation facilities and environments for people with disabilities (Park & Chowdhury, 2018; Sze & Christensen, 2017); implementation of a universal disability design policy (Visnes Øksenholt & Aarhaug, 2018)

The results of the literature search above show that until now the literature on transportation accessibility models has not been much discussed. Therefore, to fill the existing research void, the authors conducted a study to map the required accessibility models for persons with disabilities in public transportation. The purpose of this literature mapping is to identify and analyze the literature development map from 2001-2021 on the accessibility of persons with disabilities in public transportation and identify new models in providing accessibility for persons with disabilities. The year 2001 was chosen as the starting point for the publication period because there is very little literature on access to disability in transportation and available full text published before that year. By using a systematic literature review method, it allows the author to synthesize based on previous studies, strengthen the conceptual building, and design future research needs (M Petticrew, 2008). Systematically reviewing previous research can identify, evaluate, and synthesize relevant findings to address research problems (Lubis & Aryansah, 2023). This approach is used to map new components that affect the accessibility of people with disabilities in public transportation. This research is expected to contribute to enriching the development of studies on public transportation that explore aspects of accessibility for persons with disabilities.

METHODS

This study uses a systematic literature study method, mapping with the aim of analyzing the concept of accessibility for persons with disabilities, especially accessibility in public transportation. Moher et al. (2009) stated that a systematic literature review is a review of questions that have been clearly formulated with

reference to systematic steps to identify, select, and assess relevant previous studies. Researchers use the Scopus database as a data source in obtaining data and information that are in accordance with the research topic. Database Scopus was chosen as the data source because Scopus is one of the largest databases and has a high reputation. Search for articles in the Scopus database using the keywords ("Accessibility") AND ("Public Transport" OR "Bus" OR "Tram" OR "Train" OR "Ferry" OR "Plane" OR "Air Transport") AND (" Disability" OR "Disabled Person" OR "Wheelchair" OR "Device Mobility" OR "Visual Impairment" OR "Hearing Impairment").

Table 1. Inclusion and exclusion criteria screening process

Criteria	Inclusion	Exclusion	Number of Articles
Article Year	2001-2021	Apart from 2001-2021	336
Article Category	Peer-reviewed journal articles with Q1-Q4 levels	Proceedings, institutional reports, books or book series, and journal articles that do not include Q1 to Q4	200
Language	English	Other than English	186
Article Availability	Full open access	Abstract only	84
Article Contents	Only access to public transportation	Outside access to public transportation	45

Source: Author Analysis, 2022

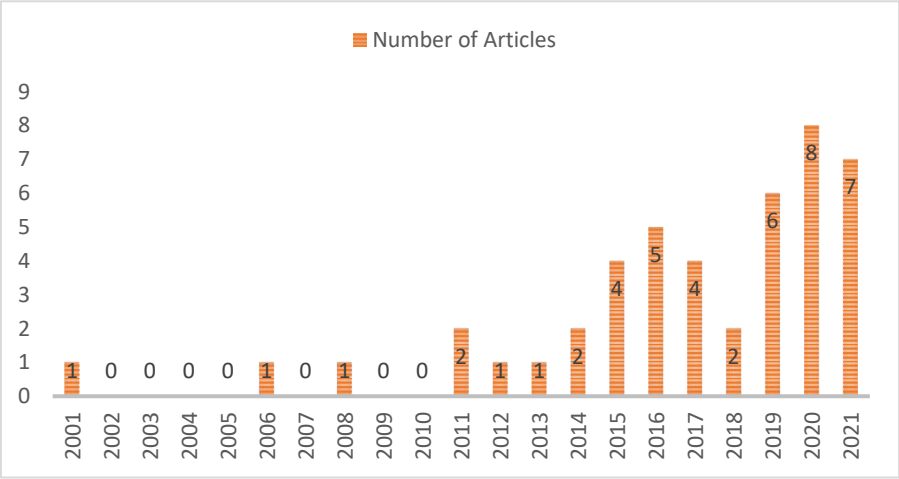
In screening articles, the authors apply inclusion and exclusion criteria. First, inclusion is based on the period of publication of scientific articles, 2021 as the initial period of analysis based on the very little literature on access to disability in public transportation before that period. Second, this study only uses peer-reviewed articles with quartiles or quartiles of very good ratings Q1 to Q4 due to a strict scientific process in publication so that it will affect the quality and reliability of research results. Third, exclude articles using languages other than English. Fourth, inclusion is based on the availability of articles in the Scopus database. The author uses articles that are open access without any restrictions on the content of the research document. Fifth, inclusion is based on article content, where the articles that are screened are only articles that discuss access to public transportation, and exclude access outside of this, such as access to education to access to health.

Based on the article search stages above, articles that have gone through a screening process based on inclusion and inclusion criteria, resulted in a total of 45 articles that became part of the study and will be analyzed further in the results and discussion chapter.

RESULT AND DISCUSSIONS

This section presents the identification of research trends in transportation accessibility and identification of new accessibility models for persons with disabilities in public transportation based on research in the period 2001-2021. The study was obtained from the Scopus electronic database using keywords as presented in the methodology section. During

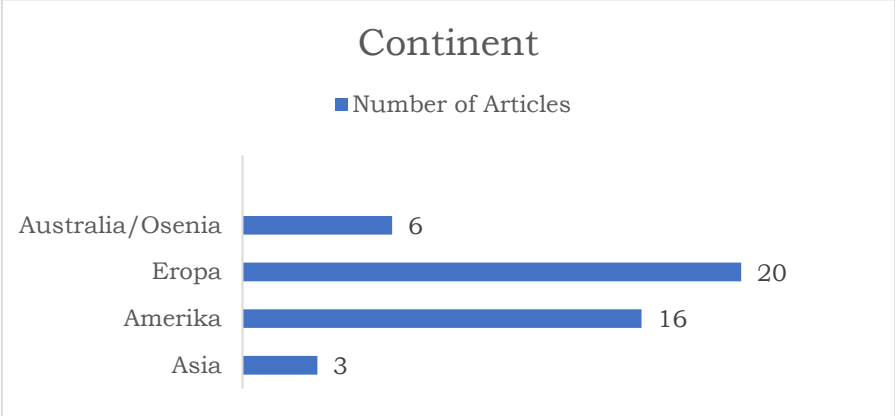
the last 20 years, publications related to accessibility for persons with disabilities in transportation have been quite volatile. This can be seen in figure 1, which shows the rise and fall of the number of publications in several periods. In 2017-2018 publications related to this research topic experienced a drastic decline. However, in 2019-2021 there will be a significant increase again, where 2021 will be the year with the highest number of publications compared to previous years, which amounted to 10 publications. Meanwhile, there were years without publication in 2002, 2003, 2004, 2007, 2009, 2010.



Source: Author Analysis, 2024

Figure 1. Publication of Accessibility Model Articles in Public Transportation

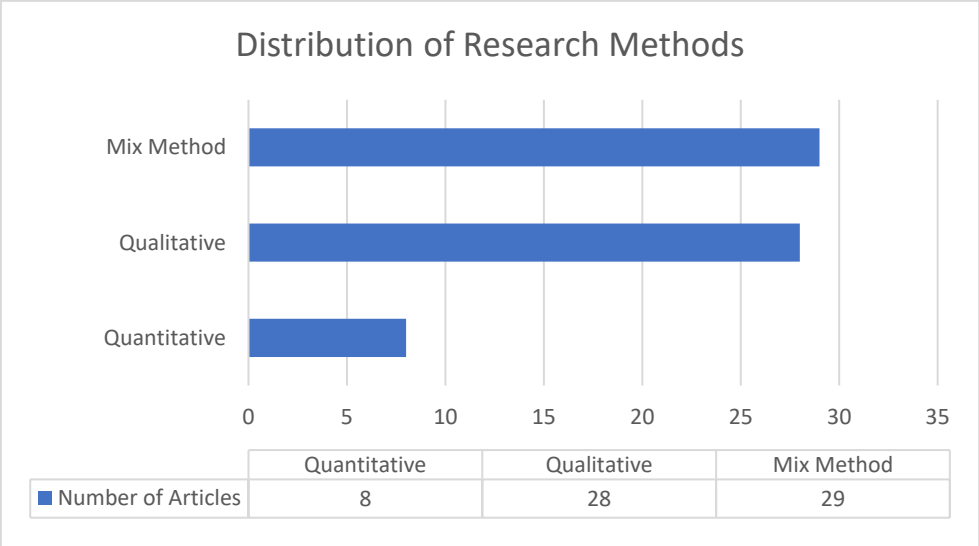
The next analysis is the origin of continents and countries that contribute to research on the accessibility of public transportation for people with disabilities. The next analysis is the origin of continents and countries that contribute to research on the accessibility of public transportation for people with disabilities.



Source: Author Analysis, 2024

Figure 2. Number of Publications by Continent

Furthermore, the distribution of research methods used during research on accessibility models of persons with disabilities in public transportation. Broadly speaking, the research methods used by researchers are divided into qualitative, quantitative, and mixed methods. Qualitative methods become the dominant method because they are most widely used by researchers in the vulnerable years 2001-2021. Research using qualitative methods contained 29 articles, while for quantitative research methods and the mix method had the same number of articles, namely 8 articles. The table for the distribution of research methods is shown in the table below:

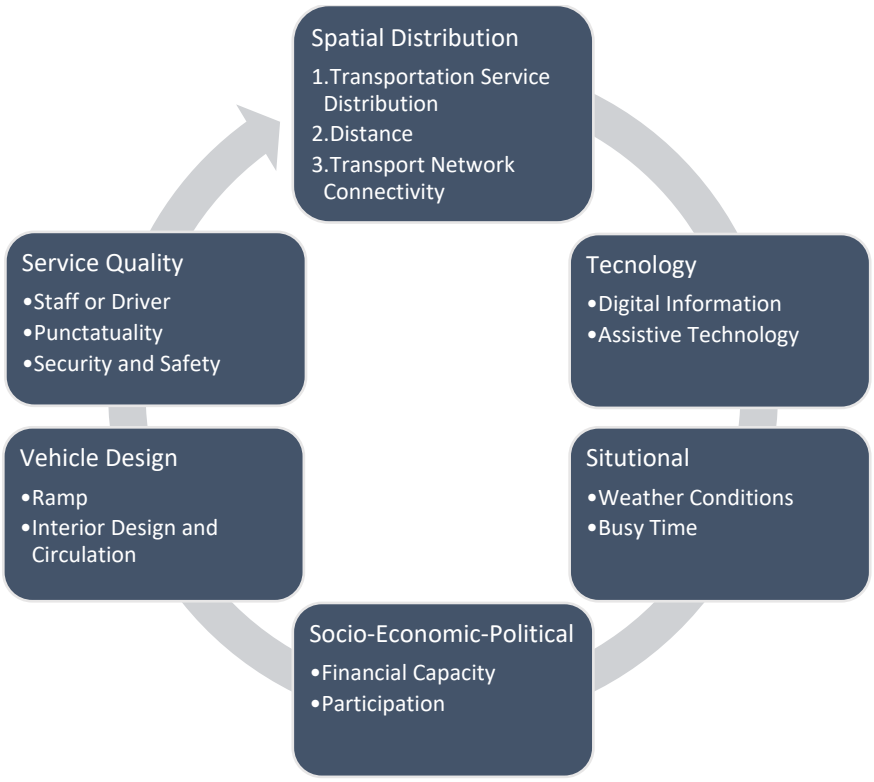


Source: Author Analysis, 2024

Figure 3. Distribution of Research Methods

New Components of Disabled Accessibility

The new component acts as a set of recommendations for the previous model because it does not have a detailed description. This study uses 45 articles that have gone through a screening process through inclusion and exclusion criteria. Based on the results of the article mapping, it was found that several components must be met to create accessibility for persons with disabilities in public transportation. Found 6 components that can affect accessibility. New components also convey sub-elements and are grouped according to their function and similarities to their components. Therefore, the interpretation of the mapping of its components and subcomponents is recommended for public transportation providers to design new strategies to create accessibility for persons with disabilities.



Source: Author Analysis, 2024

Figure 4. New Components of Disabled Accessibility

Spatial Distribution

1. Transportatioan Service Distribution

People with disabilities are more likely to live in socially disadvantaged areas than those without a disability (Emerson, 2012; Kavanagh et al., 2016; O'Rance & Australian Institute of Health and Welfare., 2009). Fortune et al. (2020) also found that the prevalence of people with disabilities was more in areas with lower walking ability and lower local availability of various public facilities such as transportation. Inequality in the distribution of public infrastructure services for mobility can contribute to the production and reproduction of social inequality and high rates of exclusion (Lucas, 2012). Lack of distribution of public transport results in longer trips and consequently longer travel times, higher costs, and increased risk situations such as pollution, to traffic accidents (Oviedo Hernandez et al., 2014) not to mention this possibility is drastically reduced when the user condition involves people with mobility impairments or persons with disabilities.

2. Distance

There is much agreement that the distance involved (i.e., the distance from one's residence to the nearest train stop/station) indicates the extent to which public transport systems and geographic housing developments have developed (Falkmer et al., 2015a). Kim & Ulfarsson (2004) stated that the distance between the place of residence and the nearest bus stop affects the choice of the elderly and persons with disabilities in using public transportation. The distance and travel time required to walk or from residence to access public transportation are the reasons for most of this group (disabled and the elderly). Fortune et al. (2020) assumes that the percentage of residences is within 400 meters of a public transport stop, and is available at least every 30 minutes especially during working days and hours (07.00-19.00). While Wu et al. (2012) assume the standard minimum walking

distance to a transit stop for persons with physical disabilities is at least a quarter mile or about 400 meters.

3. Transport Network Connectivity

Spatial distribution is also related to transportation connectivity, the extent to which transportation networks can connect one public facility to other public facilities. Spatial distribution which is correlated with the location of services such as transportation, education and other public services is an aspect that opens up opportunities in development plans to increase their efficiency, which will have implications for a wider coverage of community needs (Colmenero-Fonseca et al., 2021). Improving connectivity depends on the needs of the region and can affect spatial equity. For example, high or good connectivity between populated locations and areas with employment and higher education opportunities will stand out compared to areas without such connectivity (Hughes et al., 2012). In addition, improving connectivity related to transportation networks will also improve accessibility for users with disabilities by reducing the need for difficult multi-modal intersections and can even benefit other users by reducing the time required to safely hop on and off at bus stops (Ferrari et al., 2014).

Technology

1. Digital Information

Satisfaction with public transport travel is closely related to the information available to persons with disabilities (Verbich & Ahmed, 2016). Technology can enable destinations to meet accessibility demands, including the accessibility of the physical environment, information about accessibility and information that can be accessed *online is* also needed for groups with mobility impairments (Ferreira et al., 2020). The use of technology in particular that is integrated with smartphones can convey travel information, from trip planning and service status updates to *real-time information* about bus and rail services can significantly affect access to transport services (D'Souza et al., 2017; Low et al., 2020).

2. Assistive Technology

The term assistive technology is used to designate various products, features, services, devices, strategies, and systems that are basically aimed at expanding the functional capacity of individuals who have physical or cognitive difficulties, disorders, and disabilities that cause activity restrictions and social participation restrictions (Mello, 2006). The form of using technology again for each type of person with a disability can be different. For the visually impaired, there are forms of assistive technology such as GPS, *Blind Square* and *Seeing Assistant-Move* to screen reading applications that can provide navigation for visually impaired people and have a significant impact on their lives (Balachandran et al., n.d.; Bhowmick & Hazarika, 2017; Hara et al., 2015).

Technological developments also give rise to opportunities for the creation of "smartcard" technology. Integrated *smartcard* tickets provide an opportunity to simplify fare payment and can play an important role in creating convenient services (Nelson & Mulley, 2013). Another form of utilization, Zhou et al. (2012) adopted the concept of advanced information & communication technology (ICT) and *green technologies* (GT), called Mobi+. This technology can find out information on the position of passengers with disabilities and types of people with disabilities to be forwarded to bus drivers so that facilities and services can be adjusted based on the type of disability. The performance of the Mobi+ prototype system can meet design expectations and can provide effective bus access services for persons

with disabilities by minimizing the total bus route time significantly (Zhou et al., 2012). Then Hara et al. (2015) also presents an application using a tool called Bus Stop CSI (Crowdsourcing Street View Inspections) by utilizing the online crowdsourcing feature and Google Street View (GSV) which can provide real-time or scheduled arrival information, and help passengers determine which bus to take they (persons with disabilities) use.

Situational

1. Weather Conditions

Meteorological conditions can also impact the public transport system in a number of ways and potentially reduce the number of passengers transported (Hofmann & O'Mahony, 2005). Rain is one of the weather conditions that directly affects everyone, especially people with disabilities and the elderly (Azevedo et al., 2021). Persons with disabilities and the elderly are particularly affected by the condition when trying to reach public transportation. The increase in rainfall causes a decrease in the number of passengers with disabilities and the elderly on some bus lines and various areas of the city, with different impacts on the number of passengers using the public bus system due to rainfall (Azevedo et al., 2021). Lenker et al. (2016) in their publications, it was also found that manual wheelchair users, electric wheelchair users and visually impaired users are concerned that their productivity will be reduced in adverse weather conditions, such as rain, ice, or snow.

2. Busy Time

Persons with disabilities tend to schedule trips to travel at off-peak times when buses or trains are full of people because staff are more likely to be available (Bigby, Johnson, et al., 2019; Colmenero-Fonseca et al., 2021b; Falkmer et al., 2015b). Furthermore, Kostyniuk & D'Souza (2018) mentions that passengers with mobility aids and large items are less likely to travel during the morning rush hour, and wheelchair users are more likely to travel during the morning and evening rush hours between peak hours. 09.00 and 15.00. While people with autism report that they don't feel safe when traveling at busy times, such tactile input from other service users on public transport during peak hours can overload the sensory systems of some individuals with autism who have hypersensitivity. This inability to filter sensory information can also lead to significant distress and general impairment of functioning (Falkmer et al., 2015b).

Users of wheeled mobility devices mostly choose to travel in the morning and evening during off peak hours perhaps because they prefer to travel in less busy and crowded conditions, or that their activities are scheduled at these times, or that they travel during peak hours to be difficult and they may feel that they are disturbing other passengers due to long waiting times (Kostyniuk & D'Souza, 2020). Whereas for people with Autism Spectrum Disorders the tendency to avoid rush hour can be associated with possible sensory problems and/or anxiety in this group (Falkmer et al., 2015b).

Socio-Economic-Political

1. Financial Capacity

Socio-economic characteristics also have control over the backwardness status of transportation including low income, disability (Di Ciommo & Shiftan, 2017; Schmöcker et al., 2008), and minority status (Karner & Niemeier, 2013). Szewczyk (2020) also mentions several factors that contribute to a person's propensity to travel, including high income levels and low travel costs. The modes that generate higher costs will also have a lower likelihood of use (Schmöcker et al., 2008). Lucas & Jones (2012) mention nearly every National Travel

Survey (NTS) identifying significant inequalities in travel patterns and transport access of low-income populations compared to their higher-income counterparts. More severe conditions are also experienced by people with wheelchair users. Wheelchair users report incidents where they have to pay additional fees for mobility devices, or have been denied access to public transport because of the extra space required for their devices (Kleinitz et al., 2012; Savill et al., 2003).

2. Participation

According to Bezyak et al. (2017) without a better understanding of the problems and practices of persons with disabilities to remove barriers, users with disabilities will continue to face difficulties in accessibility to and within the public transport system. Gebauer et al. (2010) revealed that transportation improvements can not only be made through expensive investments, but also by promoting the creation of *public value* through active user participation. Furthermore, as Sabella and Bezyak (2019) point out, revealing that a more targeted approach can contribute to removing transportation barriers. It is interesting that it is only by considering the opinions of persons with disabilities in meetings to improve their transport experience to get the expected results and also generate enriching insights about transport accessibility (Azevedo et al., 2021; Buhalisa & Michopouloub, 2011; Cerdan Chiscano, 2021). Intensification of this communication can result in better adaptation outputs in improving the transportation experience for persons with disabilities and reducing perceptions of transportation barriers for persons with disabilities (Cerdan Chiscano, 2021).

Vehicle Design

The sub-components of vehicle design include the design of ramps when *getting* on or off the vehicle, payment of tariffs, and interior circulation. The following describes the details regarding the vehicle design components:

1. Ramp

The slope of the ramp is one aspect that has been widely discussed in various articles. Lower ramp slopes can reduce the difficulty of using the ramp, paying fares, and traveling to security areas, especially when climbing at the front door. Lenker et al. (2016) recommend a 1:8 slope for access points as a best practice although achieving this will require improving the ramp design and/or conditions at the bus stop (e.g., raised concrete platforms). Further, current federal accessibility regulations for transit vehicles in the US allow a maximum slope of 9.5 degrees (US Department of Transportation, 2025). However, access ramps or ramps vary in field settings often exceeding the maximum permissible slope, with one study reporting ranging from 4 to 15.5 degrees (Bertocci et al., 2016).

2. Interior Design and Circulation

In the interior circulation sub-component, the location of priority seats in the vehicle close to the driver and the door is very important (Gallagher et al., 2011). This allows passengers with disabilities to receive announcement information from the driver if audio announcements are not available. In addition, current accessibility standards mandate that large public transport vehicles must have at least two dedicated spaces for wheeled mobility devices. Interior seating configuration and location of wheeled mobility safety areas relative to road access (e.g., front vs. center of a bus) can greatly affect available floor space and ease of circulation within the vehicle, especially in crowded conditions (D'Souza et al., 2017; Kostyniuk & D'Souza, 2020). The design and maneuvering characteristics of wheeled mobility devices also combined with the user's operating skills affect the efficient

interior circulation of transit vehicles (Pass, 2004). Therefore, in addition to the layout of the space in the vehicle, maneuvering skills are required for successful ascending and descending and are translated into training objectives and interventions to increase the functional capacity of wheeled mobility device users to meet the demands of using public transport vehicles in a safe and efficient manner (Lim & D'souza, 2021).

Service Quality

1. Staff or Driver

Payne et al (2008) stated that service is a component that involves user interaction with other users and transportation staff, including drivers and others. The presence of someone to support their journey is considered to be able to build the confidence and skills of persons with disabilities, and can enhance their experience (Bigby, Whiteside, et al., 2019). Public bus drivers are a relevant part of social networks that support persons with disabilities in using public transport independently because their support can increase social inclusion (Tillmann et al., 2013). The level of communication and coordination with the driver, as well as cooperation from other passengers (for example, to vacate folding chairs located in wheelchair safety areas) can help improve access and shorten the time required without the assistance of others (Kostyniuk & D'Souza, 2020; Stjernborg, 2019). This is because the bus driver acts as a bridge between the built environment and the public transport system.

Apart from public transportation drivers, transportation staff are also an important part in improving the quality of transportation services. Transportation staff is one component that can affect the experience of persons with disabilities in using public transportation. Availability of staff assistance prior to boarding was the most common reason given for choosing public transportation. In addition, positive interactions with staff who are skilled in adapting their communication style and willing to provide assistance are essential to their travel experience (Bigby, Johnson, et al., 2019).

2. Punctatuality

One important variable that affects the level of service is dwell time (Fernández et al., 2015). Run time, reliability, and the number and frequency of services available all contribute to service quality (Eboli & Mazzulla, 2008). Travel time or waiting time is an important measure of transit performance (Kostyniuk & D'Souza, 2020). Shorter waiting times are universally more desirable for transport users. Waiting times can have a major influence on a user's transit experience (Litman, n.d.). Long waiting times also make accessing too long a challenge for transportation users, including people with disabilities (Low et al., 2020). Accurate waiting time estimates are important for designing efficient and reliable transit operations and policies (Kittelson et al., 2013; HMC, 2010; Jayaprakash et al., 2015). Passengers with disabilities, users of mobility devices, or those with large objects may need more time to get on/off than fully walkable individuals, and their presence among boarding or disembarking passengers has an effect on the time the bus spends at the stop (Kittelson et al., 2013). An understanding of the waiting time variability of disabled passenger attendance and loading is necessary to guide effective and efficient operations and policies.

3. Security and Safety

Safety is defined as the absence of a threat to human health or life, as well as the lack of material, environmental and economic losses as a result of a hazardous event (Chaisomboon et al., 2020; Park & Chowdhury, 2018). The safety of persons with disabilities using urban transportation includes many things such as stopping, getting on, traveling or

getting off (Bęczkowska & Zysk, 2021). Furthermore, security refers to an individual's emotional evaluation (feelings) (Redman et al., 2013). Lattman et al. (2016) stated that quality positively affects feelings of security, the higher the perceived quality, the higher the perceived security, and security explains some of the effects of perceived quality on perceived accessibility. Security also has a direct effect on perceived accessibility. Therefore, appropriate public policies indicate the need for a safe and accessible public transportation system (Rodrigues da Silva et al., 2015).

The author identifies an accessibility model for people with disabilities that is used to look at the accessibility of people with disabilities in public transportation. From the 45 articles used in this study, 6 new components were found that affect the accessibility of people with disabilities in public transportation. The 6 components include: 1) Spatial Distribution; 2) Technology; 3) Situational; 4) Socio-economic and Political; 5) Vehicle Design; and 6) Service Quality. The results obtained after using the new accessibility model for people with disabilities in public transportation show that the accessibility of people with disabilities in public transportation can be fulfilled if the provision of public transportation can implement all accessibility components. This is because each component is linked together to make it universally accessible.

CONCLUSION

Overall, this study has mapped the existing literature on the accessibility of persons with disabilities as key actors in public transportation and has generated a new component of accessibility of persons with disabilities based on the existing literature to improve accessibility and delivery of public transportation due to resource limitations in the previous model. The author uses the Systematic Literature Review (SLR) method in this study to determine the development of literature and produce new components of accessibility for persons with disabilities in public transportation. The findings show that the research trend for 20 years (2001-2021) of publications related to research topics has a fluctuating trend. Then found a new component of accessibility of persons with disabilities in public transportation which includes spatial distribution, technology, situational, socio-economic-political, vehicle design to service quality which serves as a recommendation to ensure that public transportation is accessible for persons with disabilities. Interpreting and describing each component will add to the concept of accessibility of persons with disabilities and provide further insight into the prerequisites for effective accessibility.

The results of this study have limitations based on only one database (Scopus), so it is still possible that there will be other components that can affect the accessibility of persons with disabilities in transportation if the source of the data obtained comes from a wider database coverage. For this reason, future research is expected to produce accessibility components that have not been found in this study. In addition, based on the results of the analysis of the selected articles, there are several accessibility components that are still rarely discussed in various articles. Accessibility components that are rarely discussed include age, gender, infrastructure, resources, regulatory framework, and individuals that may have an influence on the accessibility of persons with disabilities. The findings from this study as well as the components that are rarely discussed above can be used as a reference to see other accessibility components to complement the findings in this study.

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