THE STRUCTURAL BARRIERS TO UNIVERSALLY ACCESSIBLE TRANSPORT: THE TSHWANE (ZAF) METROPOLITAN AREA STUDY CASE

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ABSTRACT
People with disabilities face many obstacles in accessing public transport and their needs are often overlooked. The transport systems in many countries including South Africa do not meet the basic requirements of universal design, despite the awareness, support from different organisations and inclusion in policy. The purpose of the study was to investigate the structural barriers experienced by people with disabilities in accessing transport. A structured questionnaire was used to collect data from people with disabilities. The findings of the study reveal that infrastructure is generally poorly designed and there is a lack of accessible infrastructure, which consequently compromises the safety of people with disabilities. Most people with disabilities find it difficult to cross roads or intersections. The results also reveal that public transport vehicles do not comply with universal access principles. The study recommends regular accessibility audits of infrastructure which involve the participation of people with disabilities. This study contributes to literature on transport barriers experienced by people with disabilities not only in Tshwane but in other African cities. The barriers experienced by people with disabilities established in this study could inform decision makers and thereby help to improve policies and legislation regarding the provision of universally accessible transport infrastructure and services.
Keywords: developing country, people with disabilities, public transport, structural barriers, universally accessible transport.

1 INTRODUCTION

Worldwide, cities struggle with the complex nature of transport [1]. Urban transport management is complicated as it deals with other transport sectors, coordination and integration of different transport systems and co-produces transport services jointly with urban land use development [2]. Transport is not equally distributed; 'some people have more transport possibilities than others and some can travel much faster than others and, in more directions' [3]. A group of transport users severely affected by transport inequalities is people with disabilities. In many countries, especially developing countries, the public transport that is available to the general public is not always accessible to people with disabilities [4], yet accessible public transport can significantly improve the quality of life of people with disabilities and their families [5,6]. Because of the low presence levels of people with disabilities on public transport, there is a misconception that there is little demand for public transport amongst people with disabilities [7].

The Convention on the Rights of Persons with Disabilities (CRPD), Article 9, requires '*all signatories to provide equitable access to the physical environment, transportation and information, communication and other services, as well as to public areas, urban and rural*' [8]. To address the issue of accessibility in transportation, the concept of universal access can be adopted by governments. Universal design (also known as inclusive design, universal access or accessible design) refers to equal access enabled through designing products and spaces in a way that is accessible to everyone including people with disabilities, elderly and many

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other groups usually left out of traditional design [9]. It is well documented that universally accessible transport has a positive impact on people with disabilities and other vulnerable groups of transport users [5,6,10].

Universally accessible transport 'creates a system that maximises the possibility to meet, via mobility, the needs of all sorts of people and is basically about the power of joint experiences, dialogue and creating community via transport and transport services' [10]. Universally accessible transport is regarded as the key to social inclusion of people with disabilities in society, and lack of it can increase the risk of poverty, exclusion, inequality or poor quality of life among people with disabilities [11-13]. According to Coxon et al. [7], provision of universal accessibility to mobility is an indication of a progressive society.

People with disabilities face many obstacles in accessing public transport [7] and their needs are often overlooked [11,13]. Research shows that transport systems in many countries do not meet the basic requirements of universal design, despite the awareness and support from different organisations [14]. South Africa is one the countries in which people with disabilities experience significant problems in accessing public transport [15-17]. The City of Tshwane, a metropolitan municipality in South Africa, shows an increase in the number of people with disabilities [18], yet there is little research focused on transport problems experienced by people with disabilities. It is inevitable that they will experience transportation problems, given the lack of inclusivity in transport provision in South Africa [17,19]. Therefore, the transport needs of people with disabilities should be understood, so that they can be addressed and integrated into city policies.

Transport barriers for people with disabilities are typically classified as structural, psychosocial, socio-demographic, service quality and institutional barriers [4,11,13,20-23]. Structural barriers are widely documented as critical barriers that affect people with disabilities in developing countries [4,15,24]. This study only focusses on people with mobility, vision and hearing disabilities because they are among the groups that face severe transport problems compared to other groups with disabilities [25]. Although people with mental disabilities are also among people who face significant transport barriers [5,20,26], the researchers do not have the requisite skills to interact with people with mental disabilities. It is not recommended to conduct research in such circumstances [27,28]; as such, people with mental disabilities were excluded from the study.

According to literature, structural barriers are obstacles that prevent transport users from accessing the service because of the condition of the built environment, transport infrastructure and vehicle design [13,22]. The barriers created by the built environment are interlinked with architecture and design [29]. The barriers that are created by vehicle design include vehicle space, steps in vehicles and seating, while barriers related to transport facilities include bus and train stations which are not universally designed [20]. To summarise barriers which are related to structural barriers, Table 1 shows a list of the barriers established from literature.

Structural factors established from the literature include the pedestrian environment, ramps, stairs, elevators, vehicles design, platforms and toilets. Literature indicates that people with mobility and visual disabilities experience severe structural barriers compared to people with hearing disabilities [15,29].

2 RESEARCH METHOD

The study site is the metropolitan area of the City of Tshwane, which is located in the Gauteng province of South Africa. The City of Tshwane has a coverage area of about 6 298 km^2 and a population of approximately three million people [38]. In the metropolitan area of the City of Tshwane, there are approximately 184,434 people living with some form of disability

Table 1: Summary of barriers that affect accessibility.

Disability	Barriers
Mobility	Stairs and steps [7,30]
	Insufficient space for wheelchairs [31]
	Inaccessible toilets [6,13]
	Vehicle design [32,33]
	Building entrance and exits [6]
	Pedestrian environment (uneven surfaces, kerbs, street furniture, open manhole, street vendors) [34]
Visual	Tactile surfaces [6]
	Stairs and steps [6]
	Pedestrian environment (uneven surfaces, kerbs, open manhole, street vendors) [13,15]
	Navigating unfamiliar environment [20]
	Stops [5]
	Voice announcements [9,35]
Hearing	Display information [36)
	Traffic lights [37]

[18]. This population includes people with disabilities over the age of five, and includes all the types of disabilities. The study was focused on three types of disabilities: mobility disability, hearing disability and vision disability and participants were adults between the age of 18 and 65 years.

A quantitative method was adopted in this study using a survey-research design. Similar studies have also used the quantitative research method [12,39,40,41,42]. Using Raosoft [43], the sample size was estimated to be 384 to achieve 95% confidence level with margin of error of 5%. Snowball and purposive sampling were used to select people with disabilities participating in the study. Purposive sampling can be described as non-probability sampling in which a researcher intentionally selects participants in the study [44]. Snowball sampling can be described as a non-probability sampling method in which research participants recruit other participants in a study [45]. Data from people with disabilities was collected through a self-administered questionnaire. A sample size of 384 could not be achieved because there is no database of people with disabilities in the City of Tshwane. It was difficult to access people with disabilities as data was collected during the time of COVID-19. However, the responses were sufficient. For the purpose of this study, the sampling size of the people with disabilities was N = 214. A sample size of about between 30 and100 is considered to be sufficient to perform basic statistical procedures [46]. 'Statistical techniques have minimum threshold of data cases for each cell' [47]. For the purposes of this study, the sample size was therefore considered to be sufficiently large to provide meaningful results.

The two types of statistical methods used to analyse data are descriptive statistics and inferential statistics. SPSS statistical software package version 26 was used to perform inferential statistics. The results of the study are presented in section 3.

3 STRUCTURAL BARRIERS

Using a five-point Likert scale, respondents were asked to rate the extent to which they agree or disagree with the effect of structural barriers of public transport in terms of their disabilities. Table 2 presents item mean and standard deviation of structural barriers.

The items in Table 2 are arranged from highest to lowest score to give a perspective on the main concerns. The results show that the highest score (M = 4.43, Mdn = 5) was on Item D1.14 'It is difficult for me to cross busy intersections' while the lowest score was Item D1.3 'With my disability, I cannot use a minibus taxi' (M = 2.23, Mdn = 2).

Exploratory factor analysis (EFA) was conducted to uncover the underlying structure of the variables and to interpret the results [48]. The Kaiser-Meyer-Olkin (KMO) measure of sampling [49] and Bartlett's test of sphericity [50] were conducted first to evaluate the strength of the linear association between the 15 items in the correlation matrix. The results for KMO showed a value above 0.6 and Bartlett's test of sphericity was statistically significant ($p < 0.001$) thereby confirming viability to conduct factor analysis.

An inspection of the scree plot suggested that the first four factors as 'strong factors'. The second stage was to determine the number of factors from the individual statements. The results showed that the four factors in the solution had eigenvalues greater than 1 and accounted for 69.6% of variability in the original variables.

Table 2: Structural barriers.

	Items	**Mean (M)**	**Std. Dev**
D1.14	It is difficult for me to cross busy intersections	4.43	0.837
D1.8	Crossing busy streets is difficult for me	4.42	0.824
D1.9	There is no space for wheelchairs in public transport I use	4.27	0.896
D1.15	There are no bus shelters (bus sheds) in my community	4.16	0.798
D1.6	There are poor or no sidewalks/pavements where I live	3.99	1.015
D1.5	Bus stops in my community are not located within walking distance/short distance	3.87	1.026
D1.10	Toilets at stations are inaccessible for people in wheelchairs	3.83	0.994
D1.12	There are no lifts/elevators to platforms at train stations	3.81	0.965
D1.11	Train platforms are inaccessible e.g. no ramps	3.76	0.997
D1.13	Steps or stairs make it difficult or impossible for me to move	3.66	1.697
D1.7	Pavements/sidewalks which are in my community make it difficult for me to walk or move	3.65	1.420
D1.1	In my community, public transport is not accessible to people with my disabilities	3.36	1.223
D1.4	Boarding or exiting a transport vehicle is difficult for me	3.05	1.546
D1.2	With my disability, I do need specialised vehicles	2.67	1.537
D1.3	With my disability, I cannot use a minibus taxi	2.23	1.350

The highest communality value in Table 3 was 0.945. Item D1.1 was included although the communality value was slightly below 0.3 because the measure of sampling adequacy (MSA) value (0.807) was above 0.6. Using these criteria, three items were found loading on the first, second, third and fourth factor, which were subsequently labelled: (1) Station accessibility, (2) Vehicle accessibility, (3) Mobility barriers and (4) Transport facilities respectively. Items D1.6. D1.8 and D1.14 were omitted since the values for MSA were below 0.6 and no further

Table 3: Rotated factor pattern and final communality.

Items	**Rotated component matrix**				**Communalities Extraction**
	Component				
	1	**2**	**3**	**4**	
D1.11 Train platforms are inaccessible	**0.945**	0.177	0.137	0.132	0.960
D1.12 There are no lifts/elevators to platforms at train stations	**0.835**	0.245	0.137	0.247	0.838
D1.10 Toilets at stations are inaccessible for people in wheelchairs	**0.588**	−0.155	0.135	0.440	0.582
D1.2 With my disability, I do need specialised vehicles	0.295	**0.717**	0.162	−0.084	0.635
D1.3 With my disability, I cannot use a minibus taxi	0.078	**0.555**	0.234	0.038	0.371
D1.1 In my community, public transport is not accessible to people with my disabilities	−0.011	**0.433**	0.122	0.268	0.275
D1.13 Steps or stairs make it difficult or impossible for me to move	0.184	0.143	**0.819**	0.077	0.731
D1.4 Boarding or exiting a transport vehicle is difficult for me	−0.098	0.468	**0.601**	0.079	0.596
D1.7 Pavements which are in my community make it difficult for me to walk or move	0.221	0.208	**0.553**	0.156	0.422
D1.15 There are no bus shelters in my community	0.138	−0.050	0.040	**0.579**	0.358
D1.5 Bus stops in my community are not located within walking distance/short distance	0.164	0.355	0.151	**0.502**	0.428
D1.9 There is no space for wheelchairs in public transport I use	0.368	0.286	0.136	**0.501**	0.487

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization[a].
a. Rotation converged in eight iterations

items were excluded thereafter. The communality values of the structural barrier items were all above 0.2; therefore, items were considered to belong to the respective factor structures.

The reliability of the constructs was established through Cronbach's alpha coefficient. Constructs 1 to 3 had a coefficient of above 0.8 while Construct 4 had a coefficient of 0.592 which indicated uncertain reliability. As recommended by Pallant [48], the level of consistency was reported through the mean inter-item correlation. The inter-item correlation mean value was 0.326, indicating that construct 4 had an acceptable level of consistency. The four constructs for structural barriers were therefore found to be reliable.

To check for similarities and differences in the structural barriers experienced by the three groups of people with disabilities, a one-way analysis of variance test (ANOVA) was conducted. An ANOVA test is a type of statistical test used to determine if there is a statistically significant difference between different groups by testing for differences of means using variance [48]. However, to assess whether specific differences exist between the groups of people with disabilities in terms of the barriers related to the four factors, a multiple comparison test (Scheffe) was performed, and the results are shown in Tables 4 to 7. Scheffe test is post-hoc test used to make comparisons in an ANOVA test; it explores the differences between each of the groups in the study [48].

Table 4 shows that there is a statistically significant difference in barriers related to station accessibility between people with mobility and hearing disabilities ($p = 0.001$), as well as between people with mobility and vision disabilities ($p = 0.003$). However, there were no significant differences between the people with vision and hearing disabilities ($p = 0.978$).

The results for 'Vehicle accessibility' are presented in Table 5. Scheffe's post hoc test shows that there is a statistically significant difference in barriers related to vehicle accessibility experienced between groups with mobility and hearing disabilities ($p < 0.001$), groups with mobility and vision disabilities ($p < 0.001$), as well as groups with vision and hearing disabilities ($p < 0.001$).

Table 6 summarises the results for multiple group comparison concerning 'Mobility barriers'

The results in Table 6 show that there is a statistically significant difference in mobility barriers experienced between groups with mobility and hearing disabilities ($p < 0.001$), mobility

Table 4: Station accessibility.

Dependent variable:	SecD1_F1					
Scheffe						
(I) B3		Mean Difference (I-J)	Std. Error	Sig.	Lower 98,33%	Upper
Mobility	Hearing	.589*	0.154	**0.001***	0.14	1.04
	Vision	.552*	0.158	**0.003***	0.10	1.01
Hearing	Mobility	−.589*	0.154	**0.001***	−1.04	−0.14
	Vision	−0.036	0.173	0.978	−0.54	0.46
Vision	Mobility	−.552*	0.158	**0.003***	−1.01	−0.10
	Hearing	0.036	0.173	0.978	−0.46	0.54

*The values in bold are (*p*-value is smaller than 0.05).

Table 5: Vehicle accessibility.

Dependent variable:	SecD1_F2					
Scheffe						
(I) B3		Mean Difference (I-J)	Std. Error	Sig.	Lower 98,33%	Upper
Mobility	Hearing	2.087*	0.130	**0.000***	1.71	2.46
	Vision	1.488*	0.133	**0.000***	1.10	1.87
Hearing	Mobility	−2.087*	0.130	**0.000***	−2.46	−1.71
	Vision	−.599*	0.146	**0.000***	−1.02	−0.18
Vision	Mobility	−1.488*	0.133	**0.000***	−1.87	−1.10
	Hearing	.599*	0.146	**0.000***	0.18	1.02

*The values in bold are (p-value is smaller than 0.05).

Table 6: Mobility barriers.

Dependent variable:	SecD1_F3					
Scheffe						
(I) B3		Mean Difference (I-J)	Std. Error	Sig.	Lower 98,33%	Upper
Mobility	Hearing	2.918*	0.114	**0.000***	2.59	3.25
	Vision	.579*	0.117	**0.000***	0.24	0.92
Hearing	Mobility	−2.918*	0.114	**0.000***	−3.25	−2.59
	Vision	−2.339*	0.128	**0.000***	−2.71	−1.97
Vision	Mobility	−.579*	0.117	**0.000***	−0.92	−0.24
	Hearing	2.339*	0.128	**0.000***	1.97	2.71

*The values in bold are (p-value is smaller than 0.05).

and vision ($p < 0.001$), as well as groups with vision and hearing disabilities ($p < 0.001$). Table 6 presents results for multiple group comparison concerning ‘Transport facilities’.

The results in Table 7 show that there is a statistically significant difference in barriers related to transport facilities between groups with mobility and hearing disabilities ($p < 0.001$), as well as groups with mobility and vision disabilities (0.006). However, there were no significant differences between groups with vision and hearing disabilities ($p = 0.200$).

4 DISCUSSION

The results revealed that the highest score was found on Item D1.14 ‘It is difficult for me to cross busy intersections or roads or streets’. This result is consistent with the Gauteng Household Travel Survey which reported that the design of transport infrastructure and

Table 7: Transport facilities.

Dependent variable:	SecD1_F4					
Scheffe						
(I) B3		Mean Difference (I-J)	Std. Error	Sig.	Lower 98,33%	Upper
Mobility	Hearing	.615*	0.115	**0.000***	0.28	0.95
	Vision	.383*	0.118	**0.006***	0.04	0.72
Hearing	Mobility	−.615*	0.115	**0.000***	−0.95	−0.28
	Vision	−0.232	0.129	0.200	−0.61	0.14
Vision	Mobility	−.383*	0.118	**0.006***	−0.72	−0.04
	Hearing	0.232	0.129	0.200	−0.14	0.61

*The values in bold are (p-value is smaller than 0.05).

services remains critical in the Gauteng Province [51]. The mean score could be high because in the City of Tshwane there is not much infrastructure or assistive devices for people with disabilities at intersections. According to Arrive Alive [52], intersections in South Africa are dangerous because the constant flow of vehicle traffic is intensified by human error, road engineering and lack of design measures to ensure safe intersections. Arrive Alive [52] maintains that the first measure of safety at intersections is driver etiquette and compliance with road rules. A study done in Nigeria reveals that there is a high risk for people with disabilities to collide with fast-moving vehicles as there are many drivers who do not observe traffic rules [53]. The same is true in South Africa, where some drivers are not very law abiding on the road [52].

The lowest score was found on Item D1.3 ‘With my disability, I cannot use a minibus taxi’ (M = 2.23, Mdn = 2). The low score could be because this barrier is primarily experienced by people with mobility disabilities. In South Africa, minibus taxis are designed with a step at the entrance, thereby making it difficult for people with mobility disabilities to enter the vehicle. People with hearing and visual disabilities are marginally affected by the design of a vehicle.

4.1 Station accessibility

The items which loaded to Factor 1 ‘Station accessibility’ were D1.11 Train platforms are inaccessible; D1.12 There are no lifts/elevators to platforms at train stations; and D1.10 Toilets at stations are inaccessible for people in wheelchairs. It was found that people with mobility disabilities are significantly affected by these barriers. There was a statistically significant difference in barriers experienced between people with mobility disabilities and the other two groups. Previous research indicate that the platform-to-vehicle gap is a critical issue among people with mobility disabilities and to some extent to people with visual disabilities [6,20]. Inaccessibility of the platform is attributed by the height and width of platforms which are not compatible with train heights, as well as stairs and steps with no alternative of lifts or ramps [9]. Lack of maintenance of lifts can also affect mobility of people with mobility disabilities. In Stockholm, some lifts at the stations can be out of order for two or three months, thereby making it impossible for people using wheelchairs and others with mobility disabilities to reach platforms [54]. Whilst lifts have occasionally been reported as being out of order for several months in developed counties [54], these issues are more pronounced in developing countries where lifts often do not exist or are permanently out of order [55,56]. In Cape Town, six key Metrorail stations have lifts which are either permanently out of order or have no lifts or ramps [56].

Although ramps, elevators or lifts may not be absolutely necessary to people with visual disabilities, these elements can aid smooth mobility and reduce the risk of falling. Another barrier which only confronts people with mobility disabilities is the design of toilets. In South Africa, the National Building Regulations and Building Standards Act (103 of 1977) prescribes the design standards for accessible toilets for people with disabilities but the problem of inaccessible toilets persists. The standard requirements for these toilets are wide with easily opened doors, sufficient space to manoeuvre, sufficient space for the assistant, support handrails and washing basins and dryers within reach. In summary, inaccessibility of stations is constituted by platforms which are not compatible with train heights, lack of ramps, lifts or elevators; inadequate or inaccessible toilets and with a too steep gradient.

4.2 Vehicle accessibility

Factor 2, 'Vehicle accessibility', consists of three items: – D1.2 With my disability, I do need specialised vehicles; D1.3 With my disability, I cannot use a minibus taxi; and D1.1 Public transport in my community is not accessible to people with my disability. These barriers mostly affect people with mobility disabilities, especially those using wheelchairs. People with visual and hearing disabilities generally do not encounter many difficulties in physical accessing of vehicles. People with mobility disabilities typically require physical help in boarding and alighting vehicles, which may require features which enable accessibility. Vehicle physical accessibility is mostly impacted by vehicle design, vehicle, steps at the entrance and seating set-up [20]. Research done by Pyer and Tucker [30] reveals that British teenage wheelchair users found it difficult to use buses with steps at the entrance. Some may fold the wheelchairs to gain access to the bus and the folding of wheelchairs is cumbersome for parents or companions [30]. Ahmad [2015] found that the boarding and alighting of people with mobility disabilities is a challenge and there is also no space to manoeuvre for wheelchairs. Although in South Africa, mini-bus taxis are the most available form of public transport, the vehicle design does not accommodate the needs of people with mobility disabilities [57,58]. The step into the entrance of the taxi makes it difficult or impossible for people with mobility disabilities to use minibus taxis and is a common problem across many cities in developing countries such Thailand, Nigeria and Ghana [34,41,59]. Overall, accessibility to public transport among people with mobility disabilities is significantly affected by 'vehicle accessibility'.

4.3 Mobility barriers

The items which loaded to Factor 3 were D1.13 Steps or stairs make it difficult or impossible for me to move; D1.4 Boarding or exiting transport vehicle is difficult for me; and D1.7 Pavements which are in my community make it difficult for me to walk or move. These barriers are related to mobility. The two groups of people with disabilities that are affected by these barriers are people with mobility and vision disabilities. People with mobility disabilities need physical assistance in boarding and exiting vehicles while people with visual disabilities may only require guidance to board and exit. Mobility of people who use wheelchairs may be completely blocked in cases where lifts or ramps are not provided. Steps and stairs pose a high risk of falling among people with visual disabilities. Steps are found in both vehicles and built environment. The results indicate that 'steps or stairs make mobility difficult' (M = 3.66). According to the World Bank [60] 'where steps are prevalent, there should be adequate grab rails and colour contrasting of steps'.

The results show that existing pavements make walking difficult (M = 3.65). The study did not establish the reasons why pavements make mobility difficult. Similar studies reveal that some of the barriers created by pavements are insufficient width, lack of pavements, unevenness of surfaces, uncovered manholes, obstructs such as bins or street lights or street vendors, broken pavement [24,34,41,61-63]. The state of pavements not only hinder accessibility of people with disabilities, but endanger everyone [34]. Walking along busy streets can be stressful for people with visual disabilities as they constantly need to negotiate pavements and try to avoid collisions [64]. In Chengdu, China, Wu et al. [23] found that there are many sidewalks for blind people but some spaces were partially blocked by parked vehicles, were poorly designed or lacked maintenance. The results also indicate that boarding or exiting transport vehicles is difficult for people with disabilities (M = 3.05), which is a significant problem. The results are in line with previous research revealing that mini-bus taxis in South Africa are not universally designed; hence they do not accommodate the needs of people with disabilities, especially people with mobility disabilities [57]. Overall, mobility barriers severely affect people with visual and mobility disabilities.

4.4 Transport facilities

Factor 4, 'Transport facilities', consists of three items – D1.15 There are no bus shelters (bus sheds) in my community; D1.5 Bus stops in my community are not located within walking distance/short distance; and D1.9 There is no space for wheelchairs in public transport I use. The results show a high score (M = 4.16) for item D1.15 'There are no bus shelters (bus sheds) in my community'. These results are consistent with study done by Ahmad [2015] revealing that terminal facilities do not have adequate shelter to protect transport users from harsh weather conditions.

When using public transport, walking is inevitable: for example, a walk to the bus stop or train station, a walk between transfers, a walk to the destination from the bus stop or train station [65]. Respondents in this study reported that bus stops are not located within walking distance (M = 3.87). According to the City of Tshwane [2015], most residents in the city are within a walking distance to a taxi service, however, some residents do not have access to bus services.

The results indicate that public transport vehicles that carry respondents do not have space for wheelchairs (M = 4.27), which can be difficult for people who use wheelchairs. Research done by Velho [2019] reveals a constant battle for space between wheelchair users and other passengers. Some passengers can get angry at wheelchair users because they occupy more space in a vehicle [33]. Mini-bus taxis, used by many, are not designed with space for wheelchairs [57]. Previous research shows that, in African countries such as Nigeria, Kenya, South Africa and Ghana, wheelchair users incur high transport costs, which include charges for space for wheelchairs [16,34,53, 67], thereby frequently disadvantaging or totally excluding users with disabilities, particularly those with low incomes. In summary, a lack/shortage of bus shelters, and bus stops which are not located within a reasonable distance, affect all the groups, while lack of/limited wheelchair space in public transport affect mainly people with mobility disabilities who use wheelchairs.

5 RECOMMENDATIONS AND CONCLUSIONS

The study aimed at presenting an analysis of the transport arrangements and difficulties for people with disabilities in the City of Tshwane metropolitan area. EFA was conducted to uncover the underlying structure of the variables and to interpret the results [48], 2007). The four factors retained for rotation were renamed as (1) Station accessibility; (2) Vehicle accessibility; (3) Mobility barriers; and (4) Transport facilities. From this study, it was found that, to a large extent, the existing transport infrastructure in the City of Tshwane is not widely accessible to people with disabilities. The results indicated that the extent of the structural barriers depends on the type of disability. Compared to people with mobility and visual disabilities, people with hearing disabilities do not appear to be as severely affected, which may result in their needs being overlooked.

Based on the findings on structural barriers experienced by people with disabilities in the City of Tshwane, it is recommended that the city prioritise the upgrading of infrastructure to comply with universal access principles. According to the National Building Regulations and Building Standards Act (103 of 1977) of South Africa, all commercial buildings should adhere to principles of universal access. However, design of most stations and other transport facilities do not comply with universal access principles. Regular accessibility audits of transport facilities such as stations and taxi ranks need to be conducted and people with disabilities should be actively involved in the audits. Development of new infrastructure such as stations and taxi ranks should ensure full compliance with universal access principles.

To improve physical vehicle accessibility among people with disabilities, the city should encourage private transport providers to acquire universally accessible vehicles which accommodate the needs of different groups of transport users. In Taiwan, both the public and private sectors provide low-floor buses to improve transport accessibility of people with disabilities [68], which is not true in South Africa; only the public sector provides low-floor buses (for example, A Re Yeng buses and the Tshwane Bus Service).

According to Vanderschuren & Nnene [15], transport barriers experienced by people with disabilities in general are underrepresented in the literature; therefore, this study contributes to literature on transport barriers experienced by people with disabilities not only in Tshwane but in other cities. The structural barriers experienced by people with disabilities established in this study could help the City of Tshwane to carry out condition assessment reports on existing public infrastructure to ensure compliance with universal access principles.

The government could provide incentives to transport companies, especially those contracted to provide subsidised public transport services, to acquire universally designed fleets of vehicles that accommodate the needs of different groups of transport users. Based on the results indicating that people with mobility and vision disabilities find it difficult to cross intersections and streets, the city is recommended to implement safety features at intersections, for example, traffic lights with countdown signals. In addition, future intersection design should incorporate needs of different groups of users.

Future studies could use behavioural theories in mobility behaviour research on people with disabilities to determine whether disability is a key characteristic that informs travel behaviour. This study was only focused on three groups of disabilities, future studies could investigate challenges encountered by other groups of people with disabilities.

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