urban science

MDPI

Article

Accessibility Barriers and Perceived Accessibility: Implications for Public Transport

Lars E. Olsson [1,2], Margareta Friman [1,2,*] and Katrin Lättman [1,3]

[1] CTF Service Research Center, Karlstad University, SE-65188 Karlstad, Sweden; lars.e.olsson@kau.se (L.E.O.); Katrin.Lattman@hig.se (K.L.)
[2] Department of Social and Psychological Studies, Karlstad University, SE-65188 Karlstad, Sweden
[3] Department of Occupational Health Science and Psychology, University of Gävle, SE-80176 Gävle, Sweden
* Correspondence: margareta.friman@kau.se

Abstract: The ability to live the life one wants with public transport is one of the key factors of sustainable and inclusive societies. Given the current trend in the transport domain, providing accessible public transport is necessary in order to allow people to participate in their day-to-day activities without using a car. Using survey data obtained from Sweden, this study investigates factors that may have a negative effect on the perceived accessibility of public transportation in major city areas and other areas. Overall, regression analyses show that time and economic resources, organizational and temporal functions, frequent travel by public transport, and geographical context all act as accessibility barriers. These findings highlight the need not only to target increased mobility in urban environments, but also to turn the focus to the citizenry's perceived accessibility. These findings point to implications for policies, planning and interventions targeted at accessible public transport. Adopting an accessibility-oriented approach to urban development, including the individual perspective, could be a pathway for creating a socially sustainable transport system.

Keywords: accessibility barriers; perceived accessibility; public transportation; regression; survey data; Sweden

Citation: Olsson, L.E.; Friman, M.; Lättman, K. Accessibility Barriers and Perceived Accessibility: Implications for Public Transport. *Urban Sci.* **2021**, *5*, 63. https://doi.org/10.3390/urbansci5030063

Academic Editor: Neil Sipe

Received: 6 July 2021
Accepted: 20 August 2021
Published: 25 August 2021

1. Introduction

Although new and innovative options for sustainable travel are emerging on a regular basis, public transport remains the dominant option for motor-driven sustainable daily travel, both in Sweden and in several other European countries. Thus, the performance and accessibility of public transport systems remains an important target when planning sustainable and inclusive societies. However, in order to develop attractive and inclusive public transport, more knowledge is needed of the links between barriers that can hinder or limit an individual's ability to access activities using public transport, and of the individual's perceptions of his/her accessibility. A focus on the individual dimension of accessibility can be expected to bring benefits to several areas related to the social dimensions and consequences of transport planning, e.g., social inclusion, transport disadvantage, and transport-related wellbeing [1–4].

In order for public transport to constitute a realistic and attractive alternative for day-to-day travel, it needs to be able to offer sufficient accessibility to the activities and destinations that are of relevance. This paper, in contrast to most previous accessibility research, will focus on individual perceptions of accessibility, defined as "how easy it is to live a satisfactory life with help of the transport system" [4] (p. 36). Individual perceptions have a potent influence on experiences and understandings of public transport, also being the main drivers of travel behavior. Thus, an examination of accessibility barriers to participation in activities, and their potentially negative effect on the individual's perceived accessibility to public transport, is much needed.

Public transport plays a major role in giving people access to activities, regardless of gender, age, or other socio-economic background. Equal opportunities for accessibility and mobility can be seen as a fundamental right for everyone, and something that should be an offer regardless of where people live [5]. However, as pointed out by Tiznado-Aitken et al. [6], it is important to focus not only on opportunities for daily travel, but also on the potential barriers that may impact individual opportunities for travel, subsequently also affecting accessibility. From a psychological perspective, we argue that the social aspect of accessibility is best captured via the individual's perceptions of his/her accessibility, depending on how he/she travels, which is in contrast to calculated accessibility. It is, therefore, relevant to investigate how accessibility barriers to physical mobility are associated with the perceived accessibility of public transport. By focusing on the individual's experience of accessibility, this study will contribute to the ongoing discussion on how to think about socially sustainable transport planning.

The paper is structured as follows: Section 2 focuses on previous research and accessibility barriers, as well as on the research objectives. In Section 3, the material and methods used are presented, while Section 4 describes the findings from two multiple regression models. In Section 5, the results are discussed in relation to implications for transport planning and policy and future research on perceived accessibility.

2. Previous Research

For a long time, accessibility has been a key concept of both public transport planning and evaluations of the performance of public transport systems [7]. It can be defined as access to public transport systems, or as access to destinations reached by public transport systems, or both. We use the latter definition. In the current shift toward sustainable and inclusive societies, providing an accessible public transport system has become an essential goal in offering individuals opportunities to participate in their day-to-day activities without having to rely on private cars. In evaluating the performance of public transport on the basis of the individual's perspective, perceived accessibility plays a key role. Unlike conventional conceptualizations and understandings of accessibility, perceived accessibility is about the individual's experience and evaluation of his/her accessibility, as originally described by Geurs and van Eck [8]. Perceived accessibility is thus not only influenced by the environmental conditions and the transport system per se, it is also based on the individual prerequisites and preferences shaping the overall experience of accessibility [9,10]. As a concept, perceived accessibility was first recognized in the 1970s [11]; however, it was only recently that studies of perceived accessibility started gaining ground in the field of public transportation, as a complementary dimension to conventional understandings of accessibility and as a means of planning for a socially sustainable transport system [7,12,13].

In the following section, we discuss accessibility barriers, focusing on those included in this study. Existing accessibility research suggests a number of barriers that can limit people's mobility [14–17]; however, our knowledge remains limited of how these potential barriers are related to perceived accessibility.

2.1. Accessibility Barriers

Reducing or eliminating accessibility barriers will improve accessibility to the activities and destinations that are of relevance. In order to plan a socially inclusive society, it is also of relevance to know how previously identified accessibility barriers relate to perceived accessibility. This section focuses on well-established accessibility barriers, e.g., time and economic resources, organizational and temporal functions, insecurity and unsafety, and geographical accessibility barriers.

People's time and economic resources are well-known accessibility barriers. Time resources can be described as travel time budgets that include the time people have available for travel. A travel budget can be extensive or more restricted, depending on scheduling constraints. Common scheduling constraints include work and household and child-care duties [18,19]. Traveling by public transport also includes travel time

uncertainties related to transfers and unreliable services [20]. Economic resources include the monetary costs of travel [14,16], and often depend on income, household size, and housing. Previous research indicates that satisfaction with travel time and trip coordination are positively associated with perceived accessibility to public transport [4]; however, to our knowledge, no study conducted thus far has explored the links between perceived accessibility and barriers related to socioeconomic status (e.g., access to a car, household status), or time management barriers (e.g., difficulties engaging in spontaneous travel).

In this study, accessibility barriers relating to the organizational and temporal functions of public transport are categorized as the functionality of public transport. A few studies conducted thus far have investigated the association between the functionality of public transport and perceived accessibility. One study, conducted by Tiznado-Aitken [6], shows that limited access to metro services, inadequate bus services and walking environments, and access to public transport stops all negatively affect perceived accessibility. These scholars also found that traffic disruptions, in terms of operational failures, were negatively related to perceived accessibility. In Sweden, Lättman et al. [4] found that improvements in the functionality of public transport services (e.g., announcements onboard vehicles, improved boarding and exiting, and the visible information provided at bus stops) increased the perceived accessibility of bus travelers. Similarly, across five northern European cities, Friman et al. [21] observed that level of satisfaction with information, comfort and functionality were all positively related to perceived accessibility. These findings indicate that the characteristics of the travel environment, in terms of the organizational and temporal functions of public transport systems, are related to the individual's perceived accessibility.

Another accessibility barrier is experiencing insecurity and unsafety, which negatively relates to the fear of being exposed to crime or verbal abuse [22]. In addition, the risk of collision and injury and/or the transmission of infections can be an accessibility barrier that prevents or limits people's mobility. Thus, accessibility is not just about having the opportunity to live the life you want with the help of public transport, it is also about feeling safe enough to travel. Although previous studies have found that safety is generally positively related to perceived accessibility [4,21], this study, as far as we know, is the first to examine whether or not experiencing violence is negatively related to perceived accessibility.

Finally, there are geographical accessibility barriers which entail that where a person lives can prevent him or her from accessing transport services, e.g., rural areas or peripheral urban estates [14]. Delbosc and Currie [2] conclude that dispersed locations may limit a person's ability to carry out activities in his/her immediate area. The spatial planning carried out within a municipality or region, the lack of public transportation infrastructure, and the prioritization of cars through infrastructure all negatively contribute to geographical accessibility barriers. Furthermore, public transportation is frequently not the primary concern in the planning of new residential areas, often resulting in bus stops being situated farther away from people's homes. A study conducted in Malmö, Sweden [9], found that when the respondents were (hypothetically) limited to active travel and public transport, their perceptions of accessibility—which were similar across the geographical areas when the respondents still had the option of traveling by car—differed significantly from residential area to residential area and that, surprisingly, the city center was not considered the area with the highest level of perceived accessibility. The weather in different geographical areas can also be an accessibility barrier since most people do not like waiting at bus stops during winter, when it can be very cold. In order to plan a socially inclusive society, it is also of relevance to know how accessibility barriers relate to perceived accessibility.

2.2. Summary and Research Objectives

The perceived accessibility perspective applied to this study constitutes an individually based approach to urban science, where there has been an absence of such knowledge. Accessibility, traditionally, is about the individual's ability to travel to work, healthcare institutions, school, stores, and other services. The emphasis on mobility ignores the social aspect of accessibility, which is partly about the individual's perceived accessibility, i.e., his/her perceived possibility of living a satisfying life with help of the transport system. The level of perceived accessibility may very well be high despite limited (objective or calculated) opportunities for travel, and it may also be low despite the existence of a high level of accessibility to various mobility options [9]. The link between accessibility barriers, limiting the possibility to be mobile, and the individual's perceived accessibility needs to be further understood. Thus, we consider it important to investigate these associations as a means of providing the relevant input into the debate about how to build a socially sustainable and inclusive transport system which has public transport as an important ingredient. In our study, we thus depart from previous research by highlighting a number of accessibility barriers preventing participation in activities. Our first research objective is to establish a link between accessibility barriers and perceived accessibility; our second is to analyze which accessibility barriers are more serious than others, and our third is to analyze accessibility barriers on the basis of place of residence by means of separating outcomes from major city areas from other areas.

3. Materials and Methods

3.1. Study Setting, Participants, and Procedure

The data were collected during late 2019 by Transport Analysis, a Swedish government agency responsible for developing transport policy by reviewing, analyzing, following up, and evaluating both proposed and implemented measures as instructed by the government. The data were collected using a survey which was administered via the Internet to Swedish residents aged 18–79. In order to reach a representative sample of the Swedish population in respect to geographical region and age, a controlled quota sampling procedure was used. This quota was set at 500 participants per region (dividing Sweden into three regions) and was also stratified by age group. The survey was sent out to randomly selected, age-based groups in each region, and it was terminated when the quota for each age group had been filled. The total number of respondents was 1503. One hundred and twenty-seven surveys were later discarded from the analyses due to data being missing from the dependent variable, resulting in a final sample of 1376 participants (with minor variation in N across variables). All the sample descriptive data collected are specified in Table 1, alongside the number of participants included in each variable.

3.2. Instruments

Sociodemographic. In the first section of the survey questionnaire, the participants were asked about sociodemographic factors, including age, gender, and frequency of public transport use. The frequency of public transport use (bus, train, subway, and tram) was reported and measured on a 5-point Likert scale (ranging from 1 = never to 5 = daily).

Perceived accessibility was measured using the Perceived Accessibility Scale (PAC), which was developed for assessing levels of perceived accessibility with different modes of travel, e.g., public transport [4]. The scale consists of 4 questions which are each evaluated on a scale from 1 (I do not agree) to 7 (I completely agree), and then indexed into an overall score of perceived accessibility per participant. The 4 questions are: "It is easy to do daily activities with public transport", "If public transport was my only mode of travel I would be able to continue living the way I want", "It is possible to do all the activities I prefer with public transport", and "Access to my preferred activities is satisfying with public transport".

Accessibility barriers. The last section included a number of questions regarding different accessibility barriers divided up into time and economic barriers, insecurity and unsafety barriers, organizational and temporal barriers, and geographical barriers.

Time and economic barriers included questions about family size (number of members of the household), car ownership (yes/no), driver's license (yes/no), employment status (employed, retired, unemployed, student, off duty, on sick leave, or other), and university studies (yes/no). Employment status was added to the analysis as a dummy variable for each category, while "employed" was used as a reference category.

Insecurity and unsafety barriers included two questions related to safety, one about experiencing violence while traveling (yes/no) and one measuring disruption, phrased as: "It's easy to know what to do when there are service disruptions", with the option of answering yes, no, or sometimes.

Organizational and temporal barriers included eleven questions related to spatial orientation and time resources. One question was about whether or not participants had refrained from travel due to difficulties planning trips or carrying them out (yes/no). Nine questions aimed at capturing perceptions of the ease or difficulty associated with planning and performing a trip by public transport, e.g., "It's easy to understand maps and timetables" or "It's difficult to bring things along when traveling", with the options of answering yes, no, or sometimes (see Table 1). In order to include these questions as variables in our analysis, dummy variables were created for each of the different attributes, with the category "no" being used as a reference category (and thus excluded from the analyses). The last question was aimed at capturing the time resources/use related to public transport travel ("It's easy to make spontaneous trips and to change travel plans"). As with the above questions, this was answered using the options yes, no, and sometimes, and included as dummies in the analysis.

Geographical barriers were operationalized in the form of residential area. The participants resided in 9 pre-specified geographical areas which were divided up into "major city areas" and "other areas" prior to analysis due to the population density and opportunities for using public transport differing between Sweden's three major city areas and the rest of the country.

Table 1. Sample descriptives and number of participants for all variables included.

	Variable	Range	Major City Sample *N* = 453	Other Areas Sample *N* = 923
Sociodemographic	Age	18–79	Mean (sd) 46.01 (17.08)	Mean (sd) 47.62 (16.72)
	Gender		N (%)	N (%)
		Female	203 (44.8)	493 (53.4)
		Male	250 (55.2)	430 (46.6)
	Public transport travel frequency	Daily	173 (38.2)	89 (9.7)
		Several times a week	66 (14.6)	88 (9.5)
		Several times a month	102 (22.5)	142 (15.4)
		More seldom	86 (19)	444 (48.1)
		Never	26 (5.7)	159 (17.2)
Perceived accessibility (PAC)	PAC Index (mean PAC 1–4)	1–7	Mean (sd) 4.05 (1.83)	Mean (sd) 2.85 (1.75)
	PAC 1: It's easy to do daily activities with public transport	1–7	4.54 (2.12)	3.16 (2.03)
	PAC 2: If PT was my only mode of travel, I'd be able to continue living the way I want		4.02 (2.15)	2.90 (2.01)
	PAC 3: It's possible to do all the activities I prefer with PT		3.72 (2.06)	2.61 (1.89)
	PAC 4: Access to my preferred activities is satisfying with PT		3.89 (1.98)	2.70 (1.84)

Table 1. *Cont.*

	Variable	Range	Major City Sample $N = 453$	Other Areas Sample $N = 923$
Time and economic barriers	Number of members in household (family size)		Mean (sd) 2.16 (0.85)	Mean (sd) 2.13 (0.82)
			N (%)	N (%)
		1	112 (24.7)	217 (23.5)
		2	176 (38.9)	409 (44.3)
		3–4	145 (32)	253 (27.4)
		More than 4	19 (4.2)	43 (4.7)
	(Household) car ownership	Yes	318 (70.2)	822 (89.1)
		No	135 (29.8)	100 (10.8)
	University degree	Yes	268 (59.2)	444 (48.1)
		No	184 (40.6)	479 (51.9)
	Driver's license	Yes	393 (86.8)	874 (94.7)
		No	60 (13.2)	49 (5.3)
	Employment status		N (%)	N (%)
	Employed		302 (64.1)	663 (64.2)
	Retired		93 (19.7)	228 (22.1)
	Unemployed		5 (1.1)	10 (1.0)
	Student		48 (10.2)	78 (7.6)
	Off duty		5 (1.1)	12 (1.2)
	On sick leave		10 (2.1)	18 (1.7)
	Other		7 (1.5)	23 (2.2)
Insecurity and unsafety barriers	It's easy to know what to do when there are service disruptions	Yes	42 (9.3)	69 (7.5)
		Sometimes	194 (42.8)	322 (34.9)
		No	180 (39.7%)	376 (40.7%)
	Experiencing violence while traveling on public transport	Yes	119 (26.3%)	129 (14%)
		No	326 (72%)	773 (83.7%)
Organizational and temporal barriers	Refrained from/avoided travel (on PT)	Yes	187 (41.3%)	549 (59.5%)
		No	258 (57%)	356 (38.6%)
	It's difficult to bring things along when traveling	Yes	64 (14.1%)	127 (13.8%)
		Sometimes	250 (55.2%)	482 (52.2%)
		No	124 (27.4%)	243 (26.3%)
	It's easy to find your way at stations and terminals	Yes	206 (45.5%)	330 (35.5%)
		Sometimes	214 (47.2%)	443 (48%)
		No	24 (5.3%)	94 (10.2%)
	It's difficult to get to PT stops and platforms	Yes	32 (7.1%)	96 (10.4%)
		Sometimes	147 (32.5%)	311 (33.7%)
		No	263 (58.1%)	451 (48.9%)
	It's easy to understand maps and timetables	Yes	284 (62.7%)	396 (42.9%)
		Sometimes	132 (29.1%)	400 (43.3%)
		No	27 (6%)	89 (9.6%)
	It's difficult to read signs or hear announcements	Yes	35 (7.7%)	98 (10.6%)
		Sometimes	201 (44.4%)	376 (40.7%)
		No	206 (45.5%)	370 (40.1%)
	It's easy to get around at stops and on platforms	Yes	254 (56.1%)	488 (52.9%)
		Sometimes	169 (37.3%)	294 (31.9%)
		No	18 (4%)	74 (8%)
	It's easy to plan trips I haven't made before	Yes	216 (47.7%)	235 (25.5%)
		Sometimes	186 (41.1%)	445 (48.2%)
		No	29 (6.4%)	139 (15.1%)
	Traveling is easy, even during rush hours	Yes	59 (13%)	134 (14.5%)
		Sometimes	242 (53.4%)	384 (41.6%)
		No	127 (28%)	242 (26.2%)
	Easy to make spontaneous trips or to change plans	Yes	127 (27%)	112 (10.9%)
		Sometimes	224 (47.6%)	338 (32.8%)
		No	79 (16.8%)	415 (40.2%)
	Traveling is easy, even during the winter	Yes	141 (29.9%)	236 (22.9%)
		Sometimes	263 (55.8%)	493 (47.8%)
		No	46 (9.8%)	165 (16%)

4. Results

Statistical Analyses

The data were analyzed by geographical area (major city areas vs other areas). The use of linear multiple regression analyses is justified by the aim of establishing a link between accessibility barriers and perceived accessibility, as well as by the aim of exploring

which types of accessibility barriers are more important than others. By conducting separate analyses for major city areas and other areas, it was also possible to compare and draw conclusions regarding possible geographically related or conditioned barriers. Splitting the sample into two geographical areas was also justified by the difference in the reported level of perceived accessibility, whereby those living in major city areas reported a substantially higher perceived level of accessibility than those living in other areas (M = 4.05 vs. M = 2.85).

Two linear multiple regressions (enter method) were used to analyze how perceived accessibility to public transport is affected by different accessibility barriers in major city areas versus other areas. An index of perceived accessibility was used as a dependent variable. Before conducting the regressions, Cronbach's alpha analyses were performed by area for the perceived accessibility index, resulting in satisfactory reliability in both indexes (major city areas $\alpha = 0.905$, N = 453; and other areas $\alpha = 0.919$, N = 923), with no improvement in item deletion. Some of the included independent variables had missing data; however, as the percentage of missing observations was low, pairwise deletion was selected in order to maintain as much information as possible and to run the analysis on all the cases available [23].

The significant estimates of the relationships between each of the included barriers and the perceived accessibility are presented in Table 2 (major city areas) and Table 3 (other areas), with the remaining non-significant variables in the Appendix A (Tables A1 and A2). Below, we present the findings for the major city areas and the other areas.

Major City Areas. All the included variables were simultaneously added to the model. As shown in Table 2, the model came out as significant, with 60% explained variance. Of the sociodemographic variables, being female was significantly positively related to perceived accessibility, indicating that women (M = 4.19) generally experience a higher level of perceived accessibility than men (M = 3.87). The public transport frequency was significantly negatively related to perceived accessibility to public transport, which means that more frequent travel by public transport is associated with lower levels of perceived accessibility in major city areas. Of the time and economic barriers, two came out significant in the model. Being retired was positively related to perceived accessibility (in reference to working), whereas car ownership had a negative effect on perceived accessibility to public transport (in comparison to those not owning a car). Of the accessibility barriers regarding the organizational and temporal functions of public transport, a number came out as significantly related to perceived accessibility to public transport. Finding it easy (at least sometimes) to plan a new trip using public transport was positively associated with perceived accessibility. In addition, having had to refrain, at some point, from traveling by public transport was negatively associated with perceived accessibility. Experiences with maps and timetables yielded some contradictory findings; at times, experiencing maps and timetables as simple to understand was associated with a higher degree of perceived accessibility than either often or never experiencing it as easy. However, if people experience travel during wintertime as easy, either always or even only at times, this is beneficial for perceived accessibility. Bringing things along on trips was found to be negatively associated with perceived accessibility. The insecurity and unsafety accessibility barriers do not appear to be negatively related to perceived accessibility to public transport in major city areas since no significant relationships were observed.

Other Areas. Similar to the first regression analysis, all the included variables were simultaneously added to the model for the other areas sample. As shown in Table 3, the model came out as significant, with 48% explained variance. Of the sociodemographic variables, age and public transport frequency were both significantly negatively related to perceived accessibility of public transport in other areas. This implies that older people and high-frequency travelers experience a lower level of perceived accessibility with public transport. Of the time and economic barriers, being retired or off duty were both positively and significantly related to perceived accessibility. Car ownership, on the other hand, can be defined as a barrier to perceived accessibility of public transport since a negative

relationship was found. Of the organizational and temporal functions of public transport, a number came out as significant in the model. Finding it easy (at least sometimes) to plan a new trip by public transport was positively associated with perceived accessibility. Having refrained from travel due to difficulties planning or carrying out a trip was negatively related to perceived accessibility. Finding it easy to travel during rush hours (always or sometimes) was beneficial for perceived accessibility, in contrast to not finding it easy to travel during rush hours. Regarding insecurity and unsafety, no significant associations were observed.

Table 2. Significant variables in the regression analysis of perceived accessibility of public transport in major cities (N = 453).

Significant Variables in Major Cities						
	b	β	t	*p*	95% Confidence Interval of b	
Sociodemographic						
PT frequency	−0.408	−0.292	−7.100	<0.001	−0.520	−0.295
Gender (female)	0.262	0.071	1.996	0.047	0.004	0.521
Time and Economic barriers						
Employment status						
Retired	0.634	0.136	2.504	0.013	0.136	1.131
Car ownership (yes)	−0.432	−0.108	−2.416	0.016	−0.783	−0.080
Insecurity and unsafety barriers				*ns.*		
Organizational and temporal barriers						
Easy spontaneous trips or changing plans (yes)	1.336	0.334	5.982	<0.001	0.897	1.775
Easy spontaneous trips or changing plans (ST)	0.513	0.140	2.799	0.005	0.152	0.873
Avoided travel (yes)	−0.833	−0.224	−5.739	<0.001	−1.118	−0.547
Easy maps/timetables (ST)	0.666	0.166	2.256	0.025	0.086	1.247
Easy during wintertime (yes)	0.621	0.158	2.336	0.020	0.098	1.144
Easy during wintertime (ST)	0.476	0.128	2.013	0.045	0.011	0.941
Difficult to bring things along (yes)	−0.594	−0.114	−2.592	0.010	−1.044	−0.143
		Model: R = 0.78; R^2 = 0.60, $F(37,358)$ = 14.68, $p < 0.001$				

Notes: Dependent variable = perceived accessibility, ST = sometimes, *ns.* = none of the variables related to insecurity and unsafety barriers were significant. Statistics for the non-significant variables can be found in Appendix A Table A1.

Table 3. Significant variables in the regression analysis of perceived accessibility of public transport in other areas (N = 923).

Significant Variables in Other Areas						
	b	β	t	*p*	95% Confidence Interval of b	
Sociodemographic						
PT frequency	−0.352	−0.235	−6.874	<0.001	−0.452	−0.251
Age	−0.011	−0.106	−2.294	0.022	−0.020	−0.002
Time and Economic barriers						
Car ownership (yes)	−0.746	−0.133	−3.801	<0.001	−1.131	−0.361
Employment status						
Retired	0.416	0.095	2.313	0.021	0.063	0.769
Off duty	1.036	0.061	2.141	0.033	0.086	1.986
Insecurity and unsafety barriers				*ns.*		
Organizational and temporal barriers						
Easy spontaneous trips or changes of plan (yes)	1.379	0.263	7.553	<0.001	1.021	1.738
Easy spontaneous trips or changes of plan (ST)	0.674	0.188	5.644	<0.001	0.440	0.909
Avoided travel (yes)	−0.561	−0.157	−4.855	<0.001	−0.788	−0.334
Easy during rush hours (yes)	0.525	0.115	2.823	0.005	0.160	0.890
Easy during rush hours (ST)	0.287	0.082	2.201	0.028	0.031	0.542
		Model: R = 0.69; R^2 = 0.48, $F(37,663)$ = 16.38, $p < 0.001$				

Notes: Dependent variable = perceived accessibility, ST = sometimes, *ns.* = none of the variables related to insecurity and unsafety barriers were significant. Statistics for the non-significant variables can be found in the Appendix A Table A2.

5. Discussion

This study set out to explore the association between accessibility barriers and perceived accessibility of public transport (bus, subway, tram, and train) in Sweden. Specifically, we addressed time and economic resources, organizational and temporal functions, insecurity and unsafety, geographical accessibility barriers, and how these relate to perceived accessibility. The study was based on two geographical contexts—major city areas and other areas. Overall, our analyses showed that there are relationships between some accessibility barriers and perceived accessibility. This was demonstrated in both major city areas and in other areas, with some overlapping findings and some exclusive findings in each area. One main finding was that frequent travel by public transport, owning a car (household level), and the experience of refraining from taking trips were all negatively related to perceived accessibility to public transport in both areas. Being retired (as opposed to being employed) and not experiencing temporal barriers, on the other hand, was positively associated with perceived accessibility, regardless of geographical area. Organizational and temporal functions, on the other hand, appeared to be more common barriers in the major city areas than in the other areas, which indicates the existence of some geographical barriers. The findings partially support previous findings reporting that travel experiences [6,21], public transport frequency [4], and residential area [9] are all related to perceived accessibility. In what follows, we discuss in more detail the direction of influence between significant accessibility barriers and perceived accessibility, the correspondence with previous research findings, and potential policy implications.

Regarding background factors, traveling less on public transport and the household not owning a car were both positively associated with perceived accessibility of public transport. One conclusion here is that increased mobility does not automatically mean that the level of perceived accessibility will increase. Interestingly, age and gender were related to perceived accessibility, both confirming and contradicting previous findings. For instance, Lättman et al. [4] found an age effect on perceived accessibility with public transport (bus), whereas a study of the overall perceived accessibility (including public transport) found no effects of either gender or age on perceived accessibility [9]. In the present study, age was not related to perceived accessibility in major city areas (in line with the findings of Lättman et al., 2018 [9], from one of Sweden's major Swedish city areas), but it was negatively related to perceived accessibility in other areas (in line with the findings of Lättman et al., 2016 [4], from a minor city area). These findings indicate that the provision of public transport outside of the major city areas still does not sufficiently address the needs of older people.

Being a woman was positive as regards to the perceived accessibility of the major city areas, but no gender effects were observed in other areas, where the levels of perceived accessibility were lower for both men and women, compared to the major city areas. This implies that potential geographical barriers are present outside the major city areas, and perceived similarly across the genders. Given that larger, urbanized areas are generally prioritized in the implementation, development, and expansion of public transport systems, individuals living in these areas are more likely to have access to, knowledge of, and the advantage of choosing from more frequent and more reliable public transport modes. Hence, the context of a non-major city area is generally (still) negative as regards to perceived accessibility of public transportation, in line with previous conclusions by Delbosc and Currie [2]. Our findings are also in line with a recently published study by van de Coevering et al. [24], showing that distance to the nearest railway station is strongly associated with attitudes toward public transport. The study shows that a great distance has a strong negative influence, whereas a short distance has a positive influence on perceptions of public transport. Given our own findings regarding geographical differences, we conclude that public transport services need to be developed and increased in non-major city areas in order to dampen the negative influence on perceived accessibility to public transportation.

Surprisingly, insecurity and unsafety barriers were not associated with perceived accessibility in our study, although previous research has indicated that safety is related to

perceived accessibility (e.g., [21]). As we included only one item for measuring each barrier, it is possible that a different kind of operationalization would have led to different findings (e.g., measuring the level of insecurity). Another plausible explanation is that—given that 74% of the sample in major city areas and 86% of the sample in other areas had not experienced violence while traveling by public transport—these events are rare enough not to become associated with perceptions of accessibility even if experiencing violence is likely to be unpleasant. Moreover, other aspects related to insecurity and unsafety (other than actually experiencing violence) may be of greater relevance and should thus be included in future studies.

Being retired was associated with higher levels of perceived accessibility in both areas, whereas being off duty (e.g., on parental leave or similar) was only associated with higher levels of perceived accessibility in other areas, which may be due to retirement and being off duty representing situations which "require" less travel or less complicated travel due to commuting to work or making multi-purpose trips being likely to occur less frequently. In particular, these types of trips are likely to be more complicated outside of the major city areas, thus explaining the minor differences in findings between the areas. No significant relationships as regards to driver's license, family size, or education (university degree) were found in either of the areas, indicating that these variables are not relevant to perceived accessibility, at least when other variables are accounted for (e.g., car ownership, employment status, age, and gender). This slightly contradicts other studies which found that childcare and household duties were accessibility barriers [18,19], given that these duties automatically increase with family size.

Regarding the organizational and temporal barriers, it appears that difficulties planning new trips and refraining from travel due to travel difficulties are associated with lower levels of perceived accessibility regardless of geographical area. Interestingly, finding it difficult to travel during rush hours was only negatively associated with perceived accessibility in other areas, indicating, perhaps, that residents of major city areas have adapted to their specific circumstances while residents outside of the major city areas are less exposed to traffic congestion or crowded public transport services and thus have not adapted. Finding it difficult to travel during wintertime was, on the other hand, negatively associated with perceived accessibility in major city areas, but not in other areas. Using the same line of reasoning as above, it is likely that winter conditions are more prominent outside of the major cities, and thus not linked to perceptions of accessibility due to the residents having adapted to these conditions, whereas major city dwellers have not. Another possible explanation is that residents of major city areas are more frequent users of public transport and thus more likely to come across disruptive weather-related conditions while waiting for public transport than residents of other areas are. Bringing things along while traveling on public transport was negatively associated with perceived accessibility in major city areas, but not in other areas. Given that major cities are more densely populated, with more people using public transport at all hours of the day, this finding is less surprising, albeit important to recognize, because in order for public transport to constitute a realistic substitute for, or alternative to, private car travel, we need to identify and work with the barriers that individuals experience.

Everybody having access to desirable activities, regardless of how they travel, is a matter of equity and justice and crucial when planning a socially sustainable transport system. Those who plan and make decisions about public transport may not always have the requisite knowledge of this issue. In line with Pot et al. [10], we argue that self-reported measures of perceived accessibility may be especially helpful as a tool constituting an alternative to conventional indicators of accessibility. In our study, the participants also self-reported the perceived strength of the objective accessibility barriers. This method of working could beneficially be developed and integrated into some form of open-source data platform. The concept of encouraging citizens to report accessibility barriers and provide information for others has been tested previously; see, for instance, [25,26], where focus has been on adding and rating physical barriers in order to gather information

about the accessibility of public places. Places with major accessibility weaknesses should give rise to initiatives for change. Adding perceptions, as suggested in this study, would produce additional information, as it is still unclear to which extent objective accessibility barriers affect perceptions of accessibility. Previous data projects generated by European citizens show how open-source platforms focusing on co-production can increase the level of engagement and responsibility of the citizens, who then become a constructive aid in solving urban problems such as accessibility to preferred activities [27].

This study provides knowledge of the individual dimension of accessibility, e.g., how individuals perceive their own accessibility with public transport, as well as which attributes can act as barriers to this. In order to plan for sustainable societies, we need to focus on the individuals using these systems, since individual perceptions also determine individual travel behaviors. This study provides fresh insights that can be used in planning a socially sustainable public transport system.

6. Conclusions

We have shown that accessibility barriers relate to people's perceived accessibility to desirable activities. This association makes visible how transport is woven into people's everyday lives, albeit on partly different terms in different groups. If public transport is to become socially sustainable, more attention will have to be paid to developing equal and fair conditions in order for everyone to find this mode accessible. One policy implication here concerns developing transport services taking into account people's varying perceptions of their opportunities to live the lives they want to, regardless of how they travel. Transport planning processes often focus on improving mobility rather than on improving accessibility [28,29]. This study shows that a high frequency of travel is not equal to a high level of perceived accessibility. Thus, adopting an accessibility oriented approach in urban development, including the individual perspective, could be one pathway toward achieving a socially sustainable transport system.

Author Contributions: All authors (L.E.O., M.F., and K.L.) contributed equally to the conceptualization, methodology, formal analysis, investigation, data curation, writing—original draft preparation, writing—review and editing; L.E.O. and M.F. were responsible for the project administration and funding acquisition. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Swedish Energy Agency (SWEA), grant No. 46918-1.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Karlstad University (HS 2021/638).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available from the authors upon request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The Appendix consists of two complementary tables showing findings from the non-significant variables during the regression analyses: Table A1, Non-significant variables during regression analysis of the perceived accessibility to public transport in major cities (N = 453), and Table A2, Non-significant variables during regression analysis of the perceived accessibility to public transport in other cities (N = 923).

Table A1. Non-significant variables during regression analysis of perceived accessibility to public transport in major cities (N = 453).

Non-Significant Variables in Major Cities						
	b	β	t	*p*	95% Confidence Interval of b	
Sociodemographic						
Age	−0.010	−0.089	−1.460	0.145	−0.023	0.003
Time and Economic barriers						
Family size	−0.136	−0.063	−1.553	0.121	−0.308	0.036
Driver's license	−0.282	−0.052	−1.380	0.169	−0.684	0.120
University degree	−0.093	−0.025	−.677	0.499	−0.365	0.178
Employment						
Student	0.200	0.034	0.822	0.412	−0.278	0.678
On sick leave	0.207	0.016	0.450	0.653	−0.679	1.111
Unemployed	−0.182	−0.010	−0.299	0.765	−1.378	1.014
Other	−0.165	−0.010	−0.300	0.765	−1.246	0.917
Off duty	−0.027	−0.002	−0.044	0.965	−1.235	1.181
Insecurity and unsafety barriers						
Experienced violence (yes)	−0.100	−0.024	−0.663	0.508	−0.398	0.198
Easy during disruptions (yes)	0.166	0.027	0.686	0.493	−0.310	0.641
Easy during disruptions (ST)	0.244	0.066	1.621	0.106	−0.052	0.540
Organizational and temporal barriers						
Difficult to bring things along (ST)	−0.266	−0.072	−1.781	0.076	−0.560	0.028
Easy to find the way (yes)	−0.202	−0.055	−0.620	0.536	−0.842	0.438
Easy to find the way (ST)	−0.281	−0.077	−0.915	0.361	−0.884	0.323
Difficult to get to stops (yes)	−0.202	−0.029	−0.808	0.420	−0.695	0.290
Difficult to get to stops (ST)	−0.292	−0.075	−1.864	0.063	−0.599	0.016
Easy maps/timetables (yes)	0.495	0.130	1.728	0.085	−0.068	1.058
Difficult reading signs or hearing announcements (yes)	0.113	0.017	0.445	0.657	−0.385	0.610
Difficult reading signs or hearing announcements (ST)	0.089	0.024	0.636	0.525	−0.187	0.365
Easy to get around (yes)	−0.197	−0.053	−0.576	0.565	−0.867	0.474
Easy to get around (ST)	−0.003	−0.001	−0.009	0.993	−0.669	0.663
Easy to plan new trips (yes)	−0.213	−0.058	−0.684	0.495	−0.827	0.400
Easy to plan new trips (ST)	−0.139	−0.038	−0.476	0.634	−0.713	0.435
Easy during rush hours (yes)	0.446	0.084	1.894	0.059	−0.017	0.909
Easy during rush hours (ST)	0.245	0.066	1.497	0.135	−0.077	0.567

Note: Dependent variable = perceived accessibility.

Table A2. Non-significant variables during regression analysis of perceived accessibility to public transport in other cities (N = 923).

Non-Significant Variables in Other Areas						
	b	β	t	*p*	95% Confidence Interval of b	
Sociodemographic						
Gender (female)	0.041	0.012	0.402	0.687	−0.161	0.244
Time and Economic barriers						
Family size	−0.075	−0.035	−1.124	0.261	−0.206	0.056
University degree	−0.015	−0.004	−0.139	0.889	−0.225	0.195
Driver's license	−0.390	−0.050	−1.612	0.107	−0.866	0.085
Employment status						
Unemployed	0.555	0.033	1.139	0.255	−0.402	1.512
Student	0.049	0.008	0.225	0.822	−0.377	0.475
On sick leave	0.061	0.004	0.154	0.878	−0.720	0.842
Other	0.060	0.005	0.173	0.863	−0.627	0.748

Table A2. *Cont.*

Non-Significant Variables in Other Areas						
Insecurity and unsafety barriers						
Experienced violence (yes)	−0.229	−0.046	−1.532	0.126	−0.523	0.065
Easy during disruptions (yes)	0.409	0.067	1.877	0.061	−0.019	0.837
Easy during disruptions (ST)	0.088	0.025	0.750	0.453	−0.142	0.318
Organizational and temporal barriers						
Difficult to bring things along (yes)	−0.202	−0.041	−1.143	0.254	−0.550	0.145
Difficult to bring things along (ST)	0.043	0.012	0.356	0.722	−0.193	0.278
Easy to find the way (yes)	−0.184	−0.051	−0.937	0.349	−0.568	0.201
Easy to find the way (ST)	−0.178	−0.051	−0.965	0.335	−0.540	0.184
Difficult to get to stops (yes)	−0.340	−0.061	−1.865	0.063	−0.698	0.018
Difficult to get to stops (ST)	−0.098	−0.027	−0.822	0.412	−0.332	0.136
Easy maps/timetables (yes)	−0.157	−0.045	−0.811	0.418	−0.537	0.223
Easy maps/timetables (ST)	−0.161	−0.046	−0.868	0.386	−0.524	0.203
Difficult reading signs or hearing announcements (yes)	−0.045	−0.008	−0.257	0.797	−0.386	0.297
Difficult reading signs or hearing announcements (ST)	0.023	0.007	0.205	0.838	−0.197	0.243
Easy to get around (yes)	0.095	0.027	0.454	0.650	−0.316	0.506
Easy to get around (ST)	0.223	0.061	1.073	0.283	−0.185	0.632
Easy to plan new trips (yes)	0.007	0.002	0.038	0.970	−0.367	0.381
Easy to plan new trips (ST)	0.213	0.061	1.360	0.174	−0.095	0.521
Easy during wintertime (yes)	0.192	0.048	1.020	0.308	−0.178	0.563
Easy during wintertime (ST)	−0.017	−0.005	−0.111	0.912	−0.326	0.291

Note: Dependent variable = perceived accessibility.

References

1. Currie, G.; Stanley, J. Investigating links between social capital and public transport. *Transp. Rev.* **2008**, *28*, 529–547. [CrossRef]
2. Delbosc, A.; Currie, G. Exploring the relative influences of transport disadvantage and social exclusion on well-being. *Transp. Policy* **2011**, *18*, 555–562. [CrossRef]
3. Hui, V.; Habib, K.N. An investigation of transport-related social exclusion of the at-risk community in Toronto, Canada. In Proceedings of the Transportation Research Board 93rd Annual Meeting, Washington, DC, USA, 12–16 January 2014.
4. Lättman, K.; Friman, M.; Olsson, L.E. Perceived accessibility of public transport as a potential indicator of social inclusion. *Soc. Incl.* **2016**, *4*, 36–45. [CrossRef]
5. Litman, T. *Evaluating Accessibility for Transport Planning*; Victoria Transport Policy Institute: Victoria, BC, Canada, 2017.
6. Tiznado-Aitken, I.; Lucas, K.; Muñoz, J.C.; Hurtubia, R. Understanding accessibility through public transport users' experiences: A mixed methods approach. *J. Transp. Geogr.* **2020**, *88*, 102857. [CrossRef]
7. Saif, M.A.; Zefreh, M.M.; Torok, A. Public transport accessibility: A literature review. *Period. Polytech. Transp. Eng.* **2019**, *47*, 36–43. [CrossRef]
8. Geurs, K.T.; van Eck, J.R. *Accessibility Measures: Review and Applications. Evaluation of Accessibility Impacts of Land-Use Transportation Scenarios, and Related Social and Economic Impact*; Utrecht University, Urban Research Center: Utrecht, The Netherlands, 2001.
9. Lättman, K.; Olsson, L.E.; Friman, M. A new approach to accessibility—Examining perceived accessibility in contrast to objectively measured accessibility in daily travel. *Res. Transp. Econ.* **2018**, *69*, 501–511. [CrossRef]
10. Pot, F.J.; van Wee, B.; Tillema, T. Perceived accessibility: What it is and why it differs from calculated accessibility measures based on spatial data. *J. Transp. Geogr.* **2021**, *94*, 103090. [CrossRef]
11. Morris, J.M.; Dumble, P.L.; Wigan, M.R. Accessibility indicators for transport planning. *Transp. Res. Part A* **1979**, *13*, 91–109. [CrossRef]
12. Curl, A.; Nelson, J.D.; Anable, J. Does accessibility planning address what matters? A review of current practice and practi-tioner perspectives. *Transp. Bus. Manag.* **2011**, *2*, 3–11.
13. Van Wee, B. Accessible accessibility research challenges. *J. Transp. Geogr.* **2016**, *51*, 9–16. [CrossRef]
14. Church, A.; Frost, M.; Sullivan, K. Transport and social exclusion in London. *Transp. Policy* **2000**, *7*, 195–205. [CrossRef]
15. Lucas, K. Transport and social exclusion: Where are we now? *Transp. Policy* **2012**, *20*, 105–113. [CrossRef]
16. Urry, J. *Mobilities*; Polity: Cambridge, UK, 2007.

17. Pereira, R.H.; Schwanen, T.; Banister, D. Distributive justice and equity in transportation. *Transp. Rev.* **2017**, *37*, 170–191. [CrossRef]
18. Di Ciommo, F.; Shiftan, Y. Transport equity analysis. *Transp. Rev.* **2017**, *37*, 139–151. [CrossRef]
19. Pyrialakou, V.D.; Gkritza, K.; Fricker, J.D. Accessibility, mobility, and realized travel behavior: Assessing transport disadvantage from a policy perspective. *J. Transp. Geogr.* **2016**, *51*, 252–269. [CrossRef]
20. Chen, B.Y.; Wang, Y.; Wang, D.; Lam, W.H. Understanding travel time uncertainty impacts on the equity of individual accessibility. *Transp. Res. Part D* **2019**, *75*, 156–169. [CrossRef]
21. Friman, M.; Lättman, K.; Olsson, L.E. Public transport quality, safety, and perceived accessibility. *Sustainability* **2020**, *12*, 3563. [CrossRef]
22. Jones, P.; Lucas, K. The social consequences of transport decision-making: Clarifying concepts, synthesising knowledge and assessing implications. *J. Transp. Geogr.* **2012**, *21*, 4–16. [CrossRef]
23. Newman, D.A. Missing data: Five practical guidelines. *Organ. Res. Methods* **2014**, *17*, 372–411. [CrossRef]
24. Van de Coevering, P.; Maat, K.; van Wee, B. Causes and effects between attitudes, the built environment and car kilometres: A longitudinal analysis. *J. Transp. Geogr.* **2021**, *91*, 102982. [CrossRef]
25. Mobasheri, A.; Deister, J.; Dieterich, H. Wheelmap: The wheelchair accessibility crowdsourcing platform. *Open Geospat. Data Softw. Stand.* **2017**, *2*, 1–7. [CrossRef]
26. Mobasheri, A.; Huang, H.; Degrossi, L.C.; Zipf, A. Enrichment of open street map data completeness with sidewalk geometries using data mining techniques. *Sensors* **2018**, *18*, 509. [CrossRef] [PubMed]
27. Ponti, M.; Craglia, M. Citizen-Generated Data for Public Policy. Available online: https://ec.europa.eu/jrc/communities/sites/jrccties/files/jrc120231_citizen-generated_data_for_public_policy.pdf (accessed on 28 July 2021).
28. Solá, A.G.; Vilhelmson, B.; Larsson, A. Understanding sustainable accessibility in urban planning: Themes of consensus, themes of tension. *J. Transp. Geogr.* **2018**, *70*, 1–10. [CrossRef]
29. Ferreira, A.; Papa, E. Re-enacting the mobility versus accessibility debate: Moving towards collaborative synergies among experts. *Case Studies Transp. Policy* **2020**, *8*, 1002–1009. [CrossRef]