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Track 07: Environment And Climate **1042**

The role of urban planning in perceived accessibility to public transport

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Abstract
The integration of urban and transport planning is strongly supported in the literature, and the transit stop is an element common to both fields. Stops provide accessibility, which can be measured objectively (section 1) or evaluated from the user's perspective (section 2). This paper reads the topic by exploring the factors that influence perceived accessibility in the literature (section 3), with particular attention to the elements included in the domain of urban planning, like places of residence and urban design (section 4). Results (section 5) show some inconsistencies about the role of spatial factors in shaping accessibility perceptions, as well as a lack of relevance of the issue of transit stops. Therefore, some new approaches are suggested to fill the gaps in future research.

Keywords: Urban planning, transport planning, perceived accessibility, public transport, transit stop

1. Accessibility as a common theme for urban and transport planning
The integration of urban and transport planning is a concept that has been well-documented in academic literature (Bertolini, le Clercq and Kapoen, 2005). This integration lays the foundations for sustainable city planning (Barbarossa and La Greca, 2014) by providing viable alternatives to car transport (Nigro, Bertolini and Moccia, 2019). Such an approach can take different forms, from micro-scale actions such as community involvement in traffic calming measures (Boglietti and Tiboni, 2022) to transit-oriented development (TOD) (for a review see Taki *et al.*, 2017). The term TOD was first coined by Peter Calthorpe (1993) to describe a "mixed-use community that encourages people to live near transit services and to decrease their dependence on driving." However, citizens can use these services only in presence of an element of interchange between the place of activities and the service itself. This element is the transit stop, which varies according to the mode of transport (e.g. bus stop, metro station, train station). In the context of a transport network that resemble a mesh of arcs and nodes, stations serve as nodes. The transit stop plays a crucial role both in urban and transport planning realms. Its positioning and design considerations encompass transport aspects (e.g., supply and demand) and urban planning elements (e.g., land use) (Tira, 2011). Consequently, the stop serves as a critical interface between these two domains, facilitating access not only to public transport (PT) systems but also to nearby activities. Accessibility emerges as a key conceptual

focus for this integration, bridging transport attributes (e.g., speed and travel costs) with the land use system (e.g., density and functional mix) (Straatemeier and Bertolini, 2020).

1.1 Accessibility: definitions

The term “accessibility” may encompass various interpretations. A wide variety of definitions of accessibility can be found in the literature, but there are also many commonalities. One widely cited definition defines accessibility as “the extent to which land use and transportation systems allow activities or destinations to be reached through combination of transportation modes” (Geurs and Ritsema Van Eck, 2001). This sentence recalls the interaction models between land use and mobility (Wegener and Fuerst, 1999) and between accessibility and land use (Hansen, 1959). According to the latter, accessibility is the ease with which places (or activities) can be reached in relation to one or more starting points in a given space. A definition that focuses on mobility sees accessibility as “the extent to which the land-use and transport systems enable individuals to reach activities by a (combination of) transport mode(s)” (Geurs and Van Wee, 2004 p. 2). However, Handy (2002) emphasised that accessibility is the measure of interaction potential, distinguishing that term from “mobility”, which is instead the ability to move or to be moved. In summary, accessibility can be defined as the ease of reaching a destination (Litman, 2011). Some common points emerge from this overview, which were established by Geurs and Van Wee (2004) as the four theoretical components of accessibility: transport network (supply), land use (supply, demand), temporal factors (demand), and individual characteristics (demand). Given the importance played by transport and mobility networks, PT can thus have a fundamental role in ensuring sustainable accessibility. Referring to accessibility and PT, can be interpreted as access to the PT system itself, or as access to the destination reached by the systems, or both (Olsson, Friman and Lättman, 2021). Accessibility to PT is becoming increasingly important in the design and evaluation of transport systems (Saif, Zefreh and Torok, 2018).

1.2 Accessibility: measures

Given the importance of accessibility, it is clear that the measurement of this concept is a fundamental issue. The traditional assessment methods are based on mathematical models and tools known as accessibility instruments (a collection of which can be found in Hull, Silva and Bertolini (2012)), which, however, encounter some limitations in the literature. Firstly, despite their usefulness, low use is detected, due to several barriers, namely political (focus on mobility instead of accessibility), organisational (lack of integration between transport and mobility planning), and institutional (lack of institutional framework) (Silva *et al.*, 2017). Secondly, these tools make aggregate measurements, seeing people as homogeneous, without considering individual capabilities (Pereira *et al.*, 2017). In fact, they evaluate objective measures such as (average) travel time and distance, not capturing the perceived accessibility of certain individuals or groups of people (Lättman, Friman and Olsson, 2016). Indeed, if travel time does not accurately reflect lived reality, spatial accessibility measures can hide access inequalities (Curl, 2018). Notably, such limit can also be considered as a limit to the concept of the "city of x minutes", as the actual travel times to reach a specific service can vary depending on the individual. These considerations have led to a growing interest in the user's point of view, and in the concept of "perceived accessibility". Given the importance that PT stops play in providing accessibility, both in urban and transport planning, the current paper reviews how the issue has been treated in research about perceived accessibility, with particular attention to the elements that can be included in the domain of urban planning.

2. Perceived accessibility: accessibility by the citizen's perspective

Citizen's perspective is not a brand-new subject. A paradigm shift has been called for by Handy and Niemeier (1997), who emphasised how accessibility must be based on how individuals perceive their surroundings and evaluate the aspects that are most important to them. Although various definitions of accessibility centre on transportation (see section 1), people-focused definitions do not lack. For instance, Kwan (1998) defined accessibility as "a property of people revealing how easily an individual can reach activity locations" (p. 192), while Bertolini (1999), describing "accessible areas", referred to places in which many people arrive and can perform different activities. Burgio and Maritano (2012) defined accessibility as "the capacity to access goods and services by a person" (p. 2), while Curl, Nelson and Anable (2015) referred to "the ability for people to reach destinations" (p. 87). These definitions, together, focus on people's ability to satisfy their needs (Huisman, 2005). Such concept has been expressed in various way in literature. Jehle *et al.*, (2022) identified four: "Experienced Accessibility" (Chorus and De Jong, 2011); "Self-Reported Accessibility" (Curl, Nelson and Anable, 2015; Ryan and Pereira, 2021); "Subjective Accessibility" (Damurski, Pluta and Zipser, 2020), "Perceived Accessibility". As the latter is the most used term (i.e. Lättman, Friman and Olsson, 2016; Ryan et al, 2016; Pot, Van Wee and Tillema, 2021), it will be used in this paper via the abbreviation PA. If centred on PT, PA can be referred as "how easy it is to live a satisfactory life using the transport system" (Lättman, Friman and Olsson, 2016, p. 36); while a broader definition can be "how individuals or groups of individuals understand or experience their own accessibility" (Jamei *et al.*, 2022, p. 4).

2.1 Perceived accessibility: implicit references

Although, as seen, the topic has been considered relevant for at least fifteen years, 85% of the research was carried out only in the last 10 years (ibidem). Research investigating PA can address the topic implicitly or explicitly. For instance, Delbosc and Currie (2011), investigated "transport disadvantage (…) measured using subjective, self-reported measurements" (p. 557). That is, how people report (and therefore perceive) the transport supply (and thus, the accessibility provided by it) of their area of residence in comparison with other regions. Additional implicit mentions are in research about the propensity to use specific transport modes (Roy and Basu, 2020; Raghuram Kadali, 2021), given that the intention of use PT is in fact directly linked to the accessibility of the system itself (Guglielmetti Mugion *et al.*, 2018). A greater propensity to use PT may imply a greater propensity to walk to the PT stop, thus further implicit references to PA may be found in research which compare the standard catchment areas of PT stops versus the ones perceived by the users (El-Geneidy, Grimsud and Wasfi, 2014). Broadening the concept of PA to the act of walking, implicit mentions of PA can be also traced back in the topic of perceived walkability (for a review, see De Vos *et al.*, 2023).

2.2 Perceived accessibility: explicit references

Given that PA research aims to address how accessibility is perceived by the users, explicit research on PA often focused on specific categories of citizens, namely weak users, including the elderly (i.e. Hess, 2012; Vitman-Schorr, Ryan and Pereira, 2021); women (Al-Rashid et al., 2021), disabled people (Sze and Christensen, 2017), reduced mobility people (Andrade et al., 2024) and minority (Chen, Wang and Wu, 2022). Another line of research aims to recognize the gaps between measured accessibility and perceived accessibility, having found the existence of such a gap (i.e. Curl, Nelson and Anable, 2015;). However, even research focused on PA

attempts in some way to describe the phenomenon by measuring it, loyal to Peter Drucke's the statement that "only what gets measured, gets managed" (Klaus, 2015, p.81). For such purpose, the most used measurement units are perceived travel time (i.e. Börjesson, 2012; Tiznado-Aitken *et al.*, 2020; Ryan and Pereira, 2021) and abstract indexes of PA such as the PAC (Perceived Accessibility Scale) developed by Lättman, Olsson and Friman (2016). However, it is possible to find additional methods in literature. For instance, some research describe PA through proxies like perceived distance (Hess, 2012) perceived utility (Coppola and Silvestri, 2018); probability to face a certain barrier (Sundling *et al.*, 2013); perceived Level of Service (LOS) (Campisi *et al.*, 2022). Such approaches to study PA are quantitative, but some exceptions emerge. In Andrade et al. (2024), the material collected from the interviews was analysed obtaining first-level categories and then organized by making a narrative description. Tiznado-Aitken *et al.*, (2020) applied a convergent mixed approach: a quantitative analysis, which resulted in accessibility maps based on origin/destination matrices, was accompanied by focus groups, the results of which were analysed with word clouds. Curl (2013) chose a qualitative approach, with extensive use of interviews and cognitive maps drawn by the interviewees.

2.3 Perceived accessibility and public transport

Since the strong relationship between accessibility and transportation (see section 1), unsurprisingly PT play a significant role in research about PA, both in PA *through* the PT or *towards* the PT. For instance, Lättman, Friman and Olsson (2016) asked to their surveyee their satisfaction degreed in reaching daily activities with PT, while Jehle *et al.* (2022) asked information about how train users reach train stations. Otherwise, if the PT is not the focus of the study, transportation in broader term play a role in research. Friman, Lättman and Olsson (2020) looked over PA to carpooling, while in Lättman, Friman and Olsson (2020), car use restriction effects on PA has been investigated. Vreeswijk *et al (*2014) explored route selections linked to the role of environment demonstrating that people choose their routes based on subjective considerations, like preferring linear or already known routes, even if longer.

3. Elements that influence perceived accessibility to public transport

Factors which influence PA can be clustered into four typologies: sociodemographic, transport related, personal, spatial. Research conducted so far demonstrate a clear correlation between PA and perceived safety and security of PT (i.e. Jones and Lucas, 2012; Lättman, Olsson and Friman, 2018; M. Friman, Lättman and Olsson, 2020), as well as between PA and perceived quality of PT (i.e. Lättman, Friman and Olsson, 2016; M. Friman, Lättman and Olsson, 2020; Lukina *et al.*, 2023). A positive correlation has also been demonstrated with personal aspects such as: attitude towards PT (van der Vlugt, Curl and Wittowsky, 2019; Pot, Van Wee and Tillema, 2021; van der Vlugt, Curl and Scheiner, 2022); the social narrative towards the different PT systems (Tiznado-Aitken *et al.*, 2020); emotions and memories (Curl, 2013); environmental consciousness (Cheng and Chen, 2015).

3.1 Sociodemographic factors

Some sociodemographic conditions have shown a certain correlation to PA, like the existence of disability conditions (i.e. Curl, 2018; Márquez, Poveda and Vega, 2019; Campisi *et al.*, 2022). Other factors, instead, show contrasting results. For example, some studies demonstrate that an advanced age is associated with a worsening of PA (i.e. Ryan *et al.*, 2016; Lättman *et al.*, 2019; Liu *et al.*, 2021). This result is not surprising, especially in studies where PA is

measured in perceived time and perceived distance (like in Curl, 2018 and Tiznado-Aitken *et al.*, 2020), as older people walk slower than youth. Yet, in some studies (i.e. Cheng and Chen, 2015; Lättman, Friman and Olsson, 2016; Campisi *et al.*, 2022) even young people perceive worse PA, while other studies do not see a correlation between PA and age (i.e. Ryan *et al.*, 2016; Lättman, Olsson and Friman, 2018; van der Vlugt, Curl and Wittowsky, 2019).

3.2 Spatial factors

People are guided by their perceptions, and perceptions of the environment shape mobility decisions representing the "lived reality" of accessibility (Van der Gluct ey al., 2022, p.1). Therefore, it could be expected that spatial context plays a fundamental role on PA. When referring to PA to PT, some research investigate the context through the concept of "barriers" (i.e. Sundling *et al.*, 2013). By "barriers to PT" are generally meant all those elements that impact accessibility to PT (Olsson, Friman and Lättman, 2021). They can be material (geographical location, location of stops, weather conditions) and immaterial (insecurity) (Tiznado-Aitken *et al.*, 2020). Van der Gluct et al., (2019) also stated that perceptions are influenced by aspects such as safety, atmosphere, a barrier-free environment. Since this review focuses on the spatial variables, a more comprehensive explanation is provided in the next section.

4. Spatial factors and their influence on perceived accessibility

Effects of spatial variables on PA can been clustered into three categories: perceived distance as a proxy of PA; place of residence; urban design. The first group include all the studies that focused on the concept of perceived distance, which in section 2 was described as one of the proxies for measuring PA. In fact, if perceived distances are shorter than actual ones, travellers can be encouraged to take trips towards destination, meaning that the destination is perceived as more accessible. In addition, even if studies often do not explicitly focus on PA, the approaches they use provide key findings regarding the influence of spatial variables on PA. The second group includes studies that have focused on differences between geographical areas (parts of cities, different cities, different types of settlements) while the third group contains research on the role of urban design elements such as sidewalks, furniture and lighting.

4.1 Perceived distance as proxy of perceived accessibility

Some research does not explicitly mention PA but investigates the gap between real distances and perceived distances. This approach can be particularly useful for determining the effective catchment area of PT stops. The conventional used radii (e.g. 400 m. for bus, 800 m. for metro) may in fact not correctly reflect the distances that people are willing to travel to reach a station. Therefore, a perceived catchment area larger than a traditional one may in fact indicate greater perceived accessibility to PT stops itself. Such approach has been carried out by El-Geneidy, Grimsud and Wasfi (2014), developing a methodology taking into account transportation, socio-demographic and neighbourhood variables. About the last category, they found that network density (e.g. number of nodes in the road graph) increased the service area, while density and vicinity to downtown decreased it. Other studies have been carried out by O'Sullivan and Morrall (1996) and by Sarker, Mailer and Sikder (2019), both demonstrating that stops in urban areas have a shorter range of action than those in extra-urban areas. Hess (2012) also investigated walking distance to PT stop, demonstrating that characteristics of built environment like density and network intersections have a strong impact in encouraging people

to walk further to reach the transit stop. Krizek, Horning and El-Geneidy, (2012) linked perceived distance to place of residence, showing that urban residents underestimate distances, while suburban residents underestimate them.

4.2 Place of residence

Interactions between spatial factors and PA has been, indeed, investigated through the urban/extraurban dichotomy. Such approach has been used by Curl, Nelson and Anable (2015): aiming at comparing objective and subjective measures of accessibility in the UK, they performed a GIS-based research using national census areas as study areas. The result showed that in urban areas, PA is higher than measured accessibility, while in rural areas the opposite situation occurs. Such result is consistent with Olsson, Friman and Lättman (2021) findings, who demonstrate that who live in urban areas perceive double accessibility than those who live outside. However, Vitman-Schorr, Ayalon and Khalaila (2019) obtained opposite results. They explored the direct and indirect effects of settlement type on PA, comparing urban and rural (kibbutzim) locations in Israel. They found a higher PA in rural areas due to higher security perception and more social participation, in turn due to a greater "sense of place" among the inhabitants. This suggests that the sense of belonging of particular communities such as Israeli kibbutzim may be a powerful determinant of perceptions of accessibility. Centre/periphery is another dichotomy that has been explored, for instance, by Lukina *et al.* (2021), who conducted a survey aimed to investigate possible links between PA and place of residence in Moscow, Russia. As reference study area, they used the 12 districts into which the Russian capital is divided. The results show that, contrary to what was expected, PA was not higher in the city centre district. Similar results were found by Chen, Wang and Wu (2022), who investigated role of built environment in perception among three disadvantage population (minority, poverty, elderly) in South Carolina, USA. Their analysis indicated that high and low values of PA can be found in both central and rural areas. However, the results change if the mode of transport is differentiated. Ceccato *et al*. (2020) compared perceived and measured accessibility in Turin, Italy, comparing cars and PT and visualizing data on a map. They pointed out that PA by car is greater in the periphery, while public transport PA is greater in the centre and along the metro corridors. The result confirms the strong role of the PT supply. Studies specifically focused on studying differences between neighbourhoods have not highlighted significant findings, as stated by Lättman, Olsson and Friman (2018): they compared PA between different residential areas of Malmö, Sweden, without finding significant differences between areas. Liu *et al.* (2021) conducted a survey in Kumning, China, investigating the relationship between the ease of using smartphone-based services, perceived accessibility, and perceived transport equity during COVID-19. Sociodemographic variables like age and car ownership showed a significant correlation, while place of residence no. These outcomes may be the result of a residential sorting mechanism, in which people tend to choose, as a place of residence, environments in which they can meet their preferences, as proposed by Pot, Koster and Tillema (2023). In fact, in their research focused on Dutch rural areas, they found that, across different regions, PA is five times less variable than measured accessibility. On the other hand, significant effects with place of residence were found by Tiznado-Aitken, Muñoz and Hurtubia (2021). The results of their survey in Santiago de Chile showed that distribution of opportunities is positively correlated to PA to PT. In fact, residents of areas with fewer opportunities experience lower levels of accessibility, having to make longer and less comfortable journeys. Other significant results can be found in Tiznado-Aitken *et al.* (2020). Their survey, always in Santiago de Chile demonstrates the a big impact of isolation: those who live in isolated areas

prefer to use the car or a combination of car and metro, rather than walking. Areas with few services or little traffic are in fact perceived as dangerous to cross. They also argue that a safe, friendly and attractive environment can therefore encourage PA. This argument leads to the next topic covered in the paper, that of urban design.

4.3 Urban design

Numerous studies highlight how urban design elements influence perceived accessibility. Security of built space has been investigated by Börjesson (2012) who, in order to assess the elements that contribute to security, focused on how secure people felt in urban environments when walking. Findings show that security is a significant component to PA to PT, particularly for women. This result is consistent with Lotfi and Koohsari (2009), who analysed PA to neighbourhood activities in two different districts of Teheran, finding that fear and crime have strong impacts to PA. Another element that has a positive impact on PA is directness, i.e. how direct a path from A to B is. Vreeswijk *et al.* (2014) demonstrated that the perception of travel time depends on road hierarchy and route directivity, as the most direct routes and those higher in the hierarchy were perceived as relatively fast. Curl (2013) identified some factors which links environment and the sphere of emotions and sensations, such as pleasantness and beautifulness, finding positive correlation with PA. On the other hand, complexity of urban space has a negative influence, as due to a more complex landscape, travellers remember more elements of their route, leading them to perceive longer distances (Krizek, Horning and El-Geneidy, 2012). Notably, according to Jehle *et al.* (2022), a "stimulating" surroundings has no effect in encouraging people to walk. However, an important role is played by the quality of pavements and pedestrian paths,

Reference	**Spatial factor**	**Correlation with PA**
El-Geneidy, Grimsud and Wasfi, 2014; Hess, 2012 O'Sullivan and Morrall, 1996; Sarker, Mailer and Sikder 2019	Perceived distance from PT stops (urban areas)	Negative
Curl, Nelson and Anable, 2015; Olsson, Friman and Lättman, 2021	Place of residence (urban areas)	Positive
Vitman-Schorr, Ayalon and Khalaila, 2019	Place of residence (non-urban areas)	Negative
Chen, Wang and Wu, 2022; Lättman, Olsson and Friman, 2018; Liu et al., 2021 Lukina et al., 2021;	Place of residence	None
Tiznado-Aitken et al., 2020;	Place of residence	Positive
Tiznado-Aitken, Muñoz and Hurtubia, 2021	Place of residence	Positive

Börjesson, 2012; Lotfi and Koohsari, 2009	Urban design (Public space security)	Positive
Jehle et al., 2022 Vreeswijk et al., 2014;	Urban design (Path directness)	Positive
Curl, 2013	Urban design (Emotions and sensation)	Positive
Jehle et al., 2022; Krizek, Horning and El-Geneidy, 2012	Urban design (complexity)	Negative
Andrade et al., 2024 Campisi et al., 2022; Cheng and Chen, 2015; Jehle et al., 2022;	Urban design (Quality of pedestrian environment)	Positive

Table 1. Spatial factors affecting PA to PT

(i.e. Cheng and Chen 2015; Andrade et al. 2024), thus linking the theme of PA to that of walkability. Campisi et al. (2022) focused on factors that affect perceived level of service (LOS) of sidewalks in Thessaloniki, Greece, finding that a smooth walking environment has a positive correlation with PA. Curl and Mason (2019) examined the role of walking as a mediator between older people's mental wellbeing and their perceptions of their built and social environment in deprived urban areas. They found a relationship between neighbourhood perception and wellbeing. De Vos et al. (2023) conducted a systematic literature review on perceived walkability, finding that characteristics related to the built environment, such as neighbourhood aesthetics and paving's quality, have effects on perceived walkability. Jehle et al. (2022) explored the topic of pedestrian accessibility, which can be defined as "the ease with which certain destinations can be reached by walking" (p. 1). They conducted a survey with the specific aim to investigate PA by walk to six train stations in six German cities. Results shows that aspects related to the built environment such as the directness of the path to the station, walking comfort (e.g. wide and continuous footpaths), traffic safety and street security have strong impacts. In addition, they observed significant differences between cities according to their size: in smaller cities people are more likely to walk to reach the train station.

5. Final reflections: findings and gaps

The studies presented in this review have focused on correlations between PA and different variables, mostly through quantitative methods. In this way, significant links were identified between PA and the quality of PT, as well as between PA and perceived safety. However, correlations with spatial factors are less clear: this result is quite unexpected, given the emphasis that accessibility models give to land use (see section 1). Starting specifically from these models, some authors deduct a very strong role of land use and environment of PA: for instance, conceptualising PA as a "function of perceptions on the distribution and characteristics of

activities, transport and temporal feasibility of seizing these opportunities through the transport system" (Pot, Koster and Tillema, 2023, p. 3).

5.1 Contradictions about distance from city centre

Contradictions emerge by comparing the results of research that focus on perceived distance and studies that investigate the role of residence through the urban/extraurban dichotomy. The first group of studies highlights how, in areas further away from the city centre, the real service area of PT stops increases, while the second group highlights how, in urban areas, the PA is greater than in extra-urban areas. If perceived distance is considered as a proxy for PA, then the first group of studies seems to associate a negative correlation between urbanity and PA, while the second group of studies identifies a positive correlation. However, two aspects need to be considered. Firstly, in central areas, the PT coverage is typically more extensive, thereby reducing the necessity for individuals to walk in order to reach the stops. Secondly, the perceived distances are a function of the time it takes to travel them. Consequently, in less dense (and less congested) areas, it is possible to travel a greater distance in the same amount of time, which leads to an underestimation of perceived distances and an increase in the actual catchment areas. Consequently, the use of perceived distance as a measure of perceived accessibility may not be the most accurate approach.

5.2 Inconclusive results about place of residence

Research that focuses on differences between places of residence does not highlight significant associations with PA. However, the study areas considered in such research are very large, and therefore presumably very heterogeneous within them, like the districts of Moscow (Lukina *et al.*, 2021), the Dutch municipalities (Pot, Koster and Tillema, 2023), the counties of South Carolina (Cheng and Chen, 2015). Consequentially, it is suggested that future research on this topic should be conducted in smaller study areas, selected through qualitative criteria and not using administrative subdivisions. Furthermore, future research could consider not only the place of residence (origin), but also the place of destination, focusing the surveys among subjects such as workers of specific firms, as well as school students, shop customers, and other frequenters of activities located in a defined area. Similar approach can be found in Damurski, Pluta and Zipser (2020), where the study areas were selected through an inventory process and where the survey concerned not only residents but also users of public spaces.

Figure 1. Location of the reviewed case studies

Figure 2. Location of the reviewed case studies, focus on Northern Europe

5.3 Emerging spatial factors

It has been observed that the role of spatial factors emerges under two conditions. The first condition is that PA is measured through perceived time as in Börjesson (2012), Vreeswijk *et al.* (2014), Ceccato *et al.* (2020), Tiznado-Aitken, Muñoz and Hurtubia (2021), Jehle *et al.* (2022), rather than through indexes that contain a high level of abstraction within. The second condition is the use of mixed - qualitative and quantitative - approaches, as exemplified by Curl (2013) and Tiznado-Aitken *et al.* (2020), in order to more effectively capture users' perceptions of the built environment. Indeed, the representation of the environment carried out through quantitative and numerical terms (such as density), or through dichotomies does not always demonstrate to be sufficient. It is also important to consider that the majority of the studies were conducted in Northern European cities, which are characterised by a high presence of transit-oriented development (TOD) such as Stockholm and Copenhagen (Papa and Bertolini, 2015). It is noteworthy that the role of the place of residence clearly emerges in the research conducted in Santiago de Chile, a city characterised by pronounced spatial inequalities. Future research conducted outside Northern Europe could lead to consolidate these findings. A comparison of PA between TOD and not TOD neighbourhood could lead to significant results, Additionally, a comparison between case studies in different areas of the world, perhaps including cultural characteristics of residents (as also highlighted by Lukina *et al* 2021), could be beneficial.

5.4 Lack of emphasis on public transport stop

Finally, a significant gap in the literature is the relative lack of relevance, outside of studies focused on catchment areas, of PT stop. Although numerous studies have focused on PT, or consider PT as a key element, the stop is often considered a mere element of the transport network, and not the object of the investigation (notable exceptions are Ryan *et al.*, 2016; Jehle *et al.*, 2022). This discrepancy is in contrast with the fundamental role that the stop play in the context of accessibility (see section 1), and future research could consider the PT stop as an element of urban space (and thus as a spatial element) rather than a mere transportation node (as suggested by Vitale Brovarone, 2021).

5.5 Final conclusions

The research conducted to date has highlighted a gap between measured accessibility and perceived accessibility (PA). Moreover, there is substantial evidence indicating a strong

correlation between PA and the perception of PT and perceived safety, as well as with certain sociodemographic factors (e.g., disability) and attitudinal conditions. However, the role of the spatial factors remains less clear, with some research suggesting an influence and others finding no significant correlations. It is therefore proposed that, future research should focus on the following aspects, in order to address the aforementioned gap:

- describing PA through time perceived by people rather than through perceived distance or abstract PA indexes;
- analysing study areas described with qualitative rather than quantitative terms;
- collecting data and information with mixed quantitative-qualitative methods;
- focusing not only on the place of residence but also on the destination;
- isolating the PT stop as an element in its own right, also considering its role as spatial element;
- extending the research beyond the geographical areas explored so far.

Such research could assist in elucidating the manner in which urban planning decisions can guide the perceived accessibility of PT, thereby identifying potential new ways of dialogue between urban and transport planning disciplines.

Author contributions:

The authors confirm contribution to the paper as follows: study conception and design: Michelangelo Fusi; data collection: Michelangelo Fusi; analysis and interpretation of results: Michelangelo Fusi; draft manuscript preparation: Michelangelo Fusi; manuscript supervision: Michela Tiboni.

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