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Perceived accessibility: Literature review and future prospects

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Abstract: Perceived accessibility can fully present the cognitive status of different individuals and produce potential positive results. However, the literature on perceived accessibility is scattered across disciplines, which leads to problems of inconsistency in research paradigms and unclear mechanisms in perceived accessibility research. Moreover, the literature has not reached a consensus on the conceptual definition and measurement of perceived accessibility. Given this, the article first introduces the concept and measurement methods of perceived accessibility from four aspects: transportation modes, specific locations, particular things or activities, and activity participation opportunities. Next, it summarizes the antecedent variables of perceived accessibility from two perspectives, namely, objective factors and subjective factors, and the outcome variables from two perspectives, namely, behavioral factors and psychological factors. This reveals the practical impact of perceived accessibility on the cognition and behavior of urban managers. Finally, the study proposes four research directions with theoretical value and practical significance.

Keywords: Perceived accessibility, accessibility, literature review, transportation

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1 Introduction

Over the years, accessibility has been widely used in the fields of urban planning, transport planning, and environmental geography because of its key role in addressing social exclusion and improving the health and well-being of urban residents (Curl et al., 2011; Morris et al., 1979; Yang et al., 2020). Accessibility refers to how easy it is to obtain from one location to another and is measured mainly by objective factors such as proximity, travel time, and travel cost (Dalvi & Martin, 1976). Given the objective measure of accessibility, accessibility usually assumes that people who are in a particular location have the same accessibility, which ignores the ability of different individuals to overcome economic and environmental barriers as well as different individuals' behavioral preferences (Dalvi & Martin, 1976; Hansen, 1959). As technology advances and people's daily lives become progressively richer, interindividual variability becomes increasingly apparent. However, as the concept of accessibility itself does not adequately consider individual differences due to factors such as economic ability and individual preferences, it does not provide enough information for people to make decisions in favor of enhancing their well-being (Lättman, Olsson et al., 2016).

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Scholars are increasingly interested in the concept of perceived accessibility, which emphasizes interindividual variability and reflects individuals' physical abilities, mobility means (e.g., having a public transport subscription), attitudes, and preferences (e.g., perceptions of safety in public transport, having a privacy preference) (Pot et al., 2023). In addition, perceived accessibility focuses on the subjective feelings of individuals, which can more adequately present the cognitive states of different individuals than accessibility, which relies only on objective factors. Additionally, unlike accessibility, perceived accessibility evaluates the aspects that are most important to individuals based on their perceptions of their surroundings (Handy & Niemeier, 1997), which enhances potential positive outcomes such as social inclusion (Jamei et al., 2022).

Although the literature has identified an important role for perceived accessibility in distinguishing itself from accessibility, the current understanding of perceived accessibility is still very limited due to the lack of a systematic conceptual framework. The number of relevant studies on perceived accessibility is currently growing at an accelerated rate, attracting an increasing number of researchers in the fields of transport planning, urban planning, and tourism (Du et al., 2014; Lättman et al., 2019; Yasumoto et al., 2021). However, there is no consensus on what perceived accessibility refers to and how it should be measured; at the same time, research on perceived accessibility is still scattered across different disciplines, such as urban transport and tourism, and there are problems such as inconsistent research paradigms and unclear mechanisms. Exploring these issues can enrich research on perceived accessibility and help urban managers formulate reasonable management strategies, which have important theoretical and practical value.

This paper explores the conceptual connotations and mechanisms of perceived accessibility through a systematic review of the relevant literature. Specifically, first, it explains the concept and measurement of perceived accessibility from four perspectives: transport modes, specific locations, particular things or activities, and activity participation opportunities. Second, it analyzes the antecedents of perceived accessibility in terms of subjective and objective factors, as well as the outcomes in terms of psychological and behavioral factors. Then, the practical implications of perceived accessibility for city managers' perceptions and behaviors are revealed. Finally, this paper proposes future research directions on perceived accessibility based on existing studies.

2 Methodology

This paper uses a literature review method to systematize the results of research on perceived accessibility. Web of Science is the world's largest and most trusted publisher-neutral citation indexing database and independent research information platform, which contains more than 22,000 authoritative and high-impact academic journals in 254 disciplines, dating back to 1900 at the earliest. The Web of Science database can satisfy the research content of this paper in terms of authority and breadth.

Thus, this paper is based on the WOS database, and "perceived access*" and "perceived accessibility*" are used as search terms for subject examination. A total of 847 documents were obtained after deleting duplicates. We carefully reviewed the titles and focused on articles exploring the topic of perceived accessibility, and a total of 204 articles were screened. Furthermore, the articles most closely related to perceived accessibility were further identified by reviewing the full text of the literature and based on the following criteria: (1) The concept of perceived accessibility is based on an individual's subjective perception. (2) This article focuses on an individual's social activities (e.g., transport, travel, etc.). (3) The article belongs to one of the categories of

literature review or empirical research. (4) This article explores one of the concepts, measurements, antecedent variables, and outcome variables of perceived accessibility. A total of 46 target articles were obtained for this study based on the above criteria.

3 Conceptual connotations and measurement of perceived accessibility

3.1 Conceptual connotations of perceived accessibility

Perceived accessibility evolved primarily from accessibility. Accessibility was first proposed by Hansen (1959) to describe potential interaction opportunities, i.e., the opportunities that individuals in a characteristic location have to potentially engage in one or more activities, such as work, shopping, and socializing, reflecting the degree of spatial separation of the location of a particular service facility. Since then, scholars have extensively explored the concept of accessibility, resulting in different definitions. For example, Dalvi and Martin (1976) emphasized factors such as proximity and time spent to reach a destination from an origin, describing accessibility as the ease of moving from one location to another using a particular transportation system (Dalvi & Martin, 1976). Although this enriches the conceptual connotation of accessibility to a certain extent, the existing definitions tend to focus on one aspect of accessibility, such as spatial distance, time spent, or transportation system, which cannot explain accessibility comprehensively. On this basis, Geurs and van Wee (2004), through a review of the literature, identified four important components of accessibility—land use, transportation systems, time constraints, and individuals—and covered them in their definition of accessibility: the ease with which a land-use transportation system enables (groups of) individuals or goods to reach an activity or a destination by (combinations of) transportation modes (Geurs & van Wee, 2004).

Over the years, this definition has been widely used in fields such as transportation planning and urban planning, but accessibility is still considered a misunderstood, ill-defined, and poorly measured concept (Jamei et al., 2022). This is mainly because accessibility treats people as passive individuals and tends to assess how easy it is for people to reach the location of an activity, taking into account land use (the distribution of services around a given location), transportation systems (distance from origin to destination, time taken, etc.), temporal constraints (availability at different times of the day), human beings (age, income, physical condition, earnings, etc.), and other objective factors, ignoring individual needs and abilities. To be useful in practice, accessibility should be based on how individuals perceive their surroundings and how they assess the aspects that are most important to them (Handy & Niemeier, 1997). However, only objective factors are considered in the conceptualization of accessibility, and subjective factors reflecting individual perceptions are lacking (Jamei et al., 2022). Although Morris et al. (1979) proposed the difference between perceived accessibility and accessibility in the 1970s, scholars have only recently begun to focus on the concept of perceived accessibility (Morris et al., 1979).

A review of the relevant literature reveals that the conceptual definition of perceived accessibility (PA) focuses on four main aspects: transportation modes, specific locations, particular things or activities, and activity participation opportunities. In this paper, the definitions of the commonly used types of perceived accessibility are listed in detail in Table 1.

Table 1. Common definitions of perceived accessibility in the literature

Domain	Construct	Definition
Transportation modes	Andersson et al., 2023; Friman and Olsson, 2023; Friman et al., 2020a; Friman, et al., 2020b; Lättman et al., 2019; Lättman, Friman et al., 2016; Lättman, Olsson et al., 2016; Márquez et al., 2019; Olsson et al., 2021; Pot et al., 2024; Van der Vlugt et al., 2019; Van der Vlugt et al., 2022; Watthanaklang et al., 2024	"how easy it is to live a satisfactory life us system"
		"how easy it is to live a satisfactory life co people travel"
Specific locations	Nordh et al., 2024; Yasumoto et al., 2021	"perceived accessibility to A describes the people perceive to have access to A within distance"
	Scheepers et al., 2016; Vafeiadis and Elldér, 2024	"accessibility can be defined as how easily can pursue an activity of a desired type, at location, by a desired mode, and at a desire
	Cheng and Chen, 2015	"the ease with which a given destination ca from an origin or a set of origins"
Particular thing or activity	Doubeni et al., 2008; Liu et al., 2021; Liu et al., 2022	"…the ease with which particular things ar daily necessities, key public services, and s essential to living a satisfactory life can be
	Cole et al., 2019	"access to physical environment, to inform activities, programs and services"
Activity participation opportunities	Burns, 1979	"accessibility is most generally about the p engage in activities distributed across spac
	Hu and Ettema, 2023; Mustafa et al., 2023; Pot et al., 2021	"perceived accessibility is defined as the p potential to participate in spatially disperse
	Du et al., 2014	"perceived accessibility is defined as the ir perception that he or she had physical acce volunteering opportunities"

3.1.1 Perceived accessibility of transportation modes

This perspective usually defines perceived accessibility as the ease of using the transportation system to live a satisfying life, including the accessibility of using the transportation system itself, the ease of obtaining the transportation system, and the perceived likelihood and ease of living the desired life with the help of the transportation system (Lättman, Olsson, et al., 2016). This concept is widely used in research related to transportation. For example, studies on the perceived accessibility of a particular mode of transportation, i.e., the perceived likelihood and ease with which an individual can lead a satisfying life through travel modes such as walking (Van der Vlugt et al., 2022), carpooling (Friman et al., 2020a), and public transportation (Friman et al., 2020b; Márquez et al., 2019), and the perceived accessibility of daily trips, Lättman et al. (2019) explored how easy it is for older adults to lead a satisfying life with the help of daily transportation modes to live a satisfying life. Márquez et al. (2019) focused on the ease with which people with disabilities have access to and use the transportation system in their daily trips.

3.1.2 Perceived accessibility of specific locations

The perceived accessibility of specific locations generally refers to an individual's knowledge of the accessibility of specific locations for a particular purpose. For example, the perceived accessibility of a park is the degree to which people perceive that they can enter the park within a reasonable distance (Yasumoto et al., 2021). Perceived accessibility has also been described by scholars in terms of how easy it is to reach a location (e.g., stores, public natural spaces, green spaces and sports facilities) (Scheepers et al., 2016; Nordh et al., 2024).

3.1.3 Perceived accessibility of a particular thing or activity

The perceived accessibility of a particular thing or activity refers to how easy it is for individuals to perceive access to specific things (e.g., goods and services). For example, Liu et al. (2022) defined perceived accessibility as the ease with which an individual can obtain things and activities that are critical to a satisfying life (everyday necessities, key public services, and social activities). Doubeni et al. (2008) defined the perceived accessibility of cigarettes as an individual's perception of how easy it is to obtain cigarettes. Liu et al. (2021) defined perceived accessibility as an individual's perception of the availability of everyday goods and services. Cole et al. (2019) definition of perceived accessibility emphasizes an individual's satisfaction with tourism services (e.g., a waiter's attitude, food and beverage facilities, accommodation, etc.).

3.1.4 Perceived accessibility of activity participation opportunities

The perceived accessibility of activity participation opportunities refers to an individual's potential to participate in activities distributed across space (Burns, 1979). Pot et al. (2021) defined perceived accessibility as the potential to participate in spatially dispersed opportunities. Du et al. (2014) defined perceived accessibility as an individual's perception of the grant and volunteer opportunities that are actually available to them.

3.2 Measurement of perceived accessibility

Measures of perceived accessibility have mostly been developed from researchers' measurements of accessibility. Accessibility mainly measures how easy it is for an individual to reach a destination or participate in an activity through objective metrics such as time, distance, travel costs, and other spatial data (Dalvi & Martin, 1976; Geurs & van Wee, 2004). However, as research continues to evolve, Lattman, Olsson et al. (2016) reported that accessibility no longer provides sufficiently reliable information for people to make favorable decisions that ultimately benefit those who use the transportation system. Van der Vlugt et al. (2022) argued that by relying only on objective metrics and ignoring individual perceptual factors, potentially positive outcomes of accessibility (e.g., social inclusion) would not exist.

Combining these factors, scholars have begun to focus on subjective measures of accessibility. The measurement of perceived accessibility is categorized according to the definition, which mainly includes four categories: transportation modes, specific locations, particular things or activities, and activity participation opportunities. In this paper, a detailed list of frequently measured items of perceived accessibility is presented in Table 2.

Table 2. Common measurement items of perceived accessibility in the literature

Domain	Construct	Item
Transportation modes	Friman and Olsson, 2023; Lättman, Friman et al., 2016; Lättman Olsson et al, 2016; Olsson et al., 2021; Watthanaklang et al., 2024	It is easy to do(daily) activities with X; If X was my only mode of travel, I would be able to continue living the way I want; It is possible to do the activities I prefer with X; Access to my preferred activities is satisfying with X.
	Andersson et al., 2023; Lättman et al., 2018; Lättman et al., 2019; Lättman et al., 2020; Pot et al., 2024; Wolday and Bocker, 2023	Considering how I travel today, it's easy to do my daily activities; Considering how I travel today, I'm able to live my life as I want to; Considering how I travel today, I'm able to do all the activities I prefer; Considering how I travel today, access to my preferred activities is satisfying.
	Van der Vlugt et al., 2022; Watthanaklang et al., 2024;	I can access anything in my living environment; In my living environment, I can do all my everyday walks easily on foot; I am satisfied with the pedestrian accessibility of services.
	Chen et al., 2022	Having easy access to dockless bike-sharing systems; Having easy access to bus stops or metro stations.
	Márquez et al., 2019	I access the transportation system easily; I move easily in the transportation system; I move in the system without risk of accident; I do not need the help of others to move in the system.
Specific locations	Yasumoto et al., 2021	Are there any green spaces or freely accessible open spaces, such as parks, in your immediate area?
	Wang et al., 2015	How would you rate your overall ease of access to this park?
	Scheepers et al., 2016	Perceived shops, public natural spaces and sports facilities to be accessible in their neighbourhood(a) by car,(b) by bicycle and(c) by foot.
	Zhang et al., 2019	I think I can easily get to the park which I visit most often; I think my access to parks influences my decision to visit parks.
	Nordh et al., 2024	How do you view access to parks, green spaces, and nature(in your municipality)?
	Vafeiadis and Elldér, 2024	It was easy for me to [perform a specific trip purpose] using [a specific mode of transportation] during/since [a specific time period].
Particular thing or activity	Doubeni et al., 2008	It would be easy for me to get a cigarette.
	Liu et al., 2022	It is difficult to get the food I want; It is difficult to get toilet paper; It is difficult to get facemasks; It is difficult to get medicines. I cannot visit the hospital easily; I cannot visit the pharmacy easily; I do not have sufficient access to the social security system; I do not have sufficient access to educational resources. I cannot participate in leisure activity easily; I cannot interact with friends easily; I miss the cardroom; I cannot go out for a party if I want; I cannot go to the gym if I want.
	Liu et al., 2021	It is easy to get food I want; I can participate in leisure activity easily; I can interact with friends easily.
Activity participation opportunities	Du et al., 2014; Sargeant et al., 2007;	The site offers different ways to give support; It was easy to make a donation; Making a donation was a fast process; It was really easy to offer my support.
	Hu and Ettema, 2023	It is easy to access neighborhood stores by car; It is easy to access neighborhood recreation facilities by car; It is easy to access neighborhood restaurants by car; It is easy to access neighborhood restaurants by bike/e-bike; It is easy to access neighborhood recreation facilities by bike/ebike; It is easy to access neighborhood stores by bike/e-bike; It is easy to access neighborhood restaurants by foot; It is easy to access neighborhood stores by foot; It is easy to access neighborhood recreation facilities by foot.

3.2.1 Perceived accessibility measurement of transportation modes

Measures of the perceived accessibility of transportation modes focus on the accessibility of individuals to the transportation system itself, the ease of access to the transportation system, and the likelihood and ease with which people can lead a satisfying life with the help of the transportation system. Among them, the scale developed by It should be Lattman, Olsson et al. (2016) has been widely recognized by scholars in the field of transportation. Based on previous studies and on four basic indicators of accessibility—ease, potential opportunities for interaction, the likelihood of engaging in activities of interest, and satisfying activities— be Lattman, Olsson et al. (2016) developed the Perceived Accessibility Scale (PAC), which consists of four quantifiable expressions with specific question items (see Table 2). The scale has been applied in studies related to transportation to measure individuals' perceived accessibility to specific modes of transportation (e.g., carpooling, public transportation, and private car) (Friman et al., 2020a; Lättman et al., 2018; Olsson et al., 2021).

Furthermore, Lättman et al. (2018) reported that the PAC is only applicable for measuring an individual's perceived accessibility to a single mode of transportation, ignoring the complexity of people's daily travel. In reality, people use more than one mode of transportation for their daily trips, which may involve two or more modes. Therefore, Lättman et al. (2018) made further improvements to the original scale of perceived accessibility, and the improved scale also contains four quantifiable expressions, with the specific questions shown in Table 2. The improved scale is often used to measure the perceived accessibility of transportation options available to people on daily trips. For example, Lättman et al. (2019) explored the perceived accessibility of transportation modes for daily travel among older adults in a survey study using this scale in an urban setting. Additionally, the scale was used in a Swedish study to analyze changes in the perceived accessibility of transportation modes for daily travel among urban residents (Lättman et al., 2020).

Some scholars have constructed different perceived accessibility scales based on the PAC according to the research purpose. For example, Van der Vlugt et al. (2019) developed a perceived accessibility scale for measuring non-fixed destinations and non-fixed modes of travel, which contains three items: ease of getting to the place I want to get to, local facilities that can satisfy my requests, and accessibility to places I want to visit frequently. They also constructed a perceived accessibility scale for non-fixed destinations and fixed modes of travel, which includes the following items: I can do everything well in my living environment, I can accomplish my daily walking tasks by walking in the environment I live in, and I are satisfied with the accessibility of services of general interest to pedestrians.

3.2.2 Location-specific perceived accessibility measurements

Perceived accessibility to a particular location is often measured using a single question that emphasizes how easy it is to access that location. For example, a Japanese study assessed individuals' perceived accessibility to urban parks by asking, "Are there any green spaces or freely accessible open spaces, such as parks, in your immediate area?" (Yasumoto et al., 2021). Similarly, Wang et al. (2015) measured perceived accessibility to urban parks with the question "How would you rate your overall ease of access to this park?"

3.2.3 Measures of perceived accessibility to specific things or activities

This category of perceived accessibility measure emphasizes an individual's perceived likelihood or ease of access to a particular thing or activity. A study in Massachusetts reflected individuals' perceived accessibility to cigarettes by asking respondents how much they agreed with a single question: "It is easy for me to get cigarettes" (Doubeni et al., 2008). Liu et al. (2022) obtained key information from interviews with family members to construct a scale of perceived accessibility to daily necessities, key public services, and social activities, as shown in Table 2, which is applicable to the new crown epidemic. The perceived accessibility of daily necessities, key public services, and social activities was constructed for the New Crown epidemic scenario, and the specific measurement dimensions are shown in Table 2. Similarly, in the context of the new crown epidemic, Liu et al. (2021) constructed an individual's perceived accessibility to online services on smartphones based on information from interviews with 28 family members and 44 experts in the fields of psychology and sociology, with specific measurement dimensions shown in Table 2. Cole et al. (2019) assessed the level of satisfaction of people with disabilities with the attitudes of staff, dining facilities, accommodations, programs/services, transportation, and other aspects of satisfaction to measure individuals' perceived accessibility to tourism services.

3.2.4 Perceived accessibility measures of activity participation opportunities

Perceived accessibility measures of activity participation opportunities focus on the likelihood and ease with which individuals can obtain opportunities to participate in activities. Sargeant et al. (2007) constructed a scale of individuals' perceived accessibility to opportunities, which contains three question items, as shown in Table 2. Using this scale, Du et al. (2014) measured individuals' perceived accessibility to gifting and volunteering opportunities. In the measurement of perceived accessibility to event participation opportunities, fewer and narrower studies are available, and the topic of research covers only the charity sector.

In summary, the conceptual connotation and measurement scale of perceived accessibility have been explored from four aspects (i.e., transportation modes, specific locations, particular things or activities, and activity participation opportunities). Specifically, the conceptual meaning and scale of perceived accessibility are more widely used in transportation modes than in specific locations, particular things or activities, and activity participation opportunities. In addition, although many scholars have explored the definition and measurement of perceived accessibility, there is still no consensus among existing studies on the conceptual definition and measurement of perceived accessibility. For example, some studies have used definitions and scales that focus only on the impact of a particular mode of transport on people's lives (Friman and Olsson, 2023). However, some studies consider the reality that people may use multiple modes of transport in their lives and use perceived accessibility definitions and scales that focus on multiple modes of transport (Andersson et al., 2023). This may be due to differences in research focus, i.e., some studies focus on perceived accessibility for a particular mode of transport, whereas others study perceived accessibility for a particular type of transport. Overall, the conceptual connotations and scales of perceived accessibility are constantly being enriched and improved.

4 Antecedent variables and outcome variables of perceived accessibility

4.1 Antecedent variables of perceived accessibility

The antecedent variables of perceived accessibility were categorized into two groups on the basis of the literature: objective and subjective factors.

4.1.1 Objective factors

The objective factors mainly include demographic characteristics and external objective factors. In the case of the former, people with different genders, ages, incomes and years of education significantly differ in their perceived accessibility (Friman et al., 2020a; Lättman, Friman, et al., 2016; Márquez et al., 2019; Olsson et al., 2021; Wang et al., 2015; Yasumoto et al., 2021). However, Van der Vlugt et al. (2022) reported no significant effects of gender, age, or education on perceived accessibility.

With respect to external objective factors, such as population density and the frequency of travel, a Swedish study investigating users' carpooling experience revealed that areas with high population density are more conducive to choosing carpooling as a mode of travel, which promotes individuals' perceived accessibility to carpooling (Friman et al., 2020b). Olsson et al. (2021) reported that the frequency of trips on copublic transportation, both in major urban areas and in other regions, significantly and negatively affects people's perceived accessibility to public transportation. Ma et al. (2023) investigated the perceived accessibility of parks for residents of Chengguan District in Lanzhou city and reported that distance to parks, park coverage, and park quality affect people's perceived accessibility to parks.

4.1.2 Subjective factors

In terms of subjective factors, existing studies have focused on both positive and negative forward causal mechanisms of perceived accessibility. With respect to positive forward causal mechanisms, Van der Vlugt et al. (2022) reported that positive attitudes can improve perceived accessibility for walking. In daily travel, the service quality of public transportation (e.g., functional aspects, information aspects, comfort aspects, cost aspects), and perceived safety during transportation also affect residents' perceived accessibility (Friman, et al., 2020b; Lättman, Friman et al., 2016). Yasumoto et al. (2021) reported that the perceived number of parks and the perception of safety positively affect the perceived accessibility of parks. Liu et al. (2021) noted that the perceived ease of use of smartphones during the New Crown epidemic affected the perceived accessibility of food and social services. Negative antecedent mechanisms of perceived accessibility have also been explored; for example, Yasumoto et al. (2021) reported that traffic risk, perceived crime risk, and the degree of impairment of landscape aesthetics in the surrounding area significantly reduce residents' perceived accessibility to urban parks. Furthermore, through a survey of community residents, it was found that the expected travel time and proximity distance also affect residents' perceived accessibility to parks. Friman & Olsson (2023) found that travel autonomy promotes residents' perceived accessibility to travel through a web-based questionnaire survey of residents living in Sweden. Watthanaklang et al. (2024) found that service quality affects individuals' perceived accessibility to the public transport system through a survey of people using the public transport system in Nakhon Ratchasima.

In summary, articles have explored the antecedent variables of perceived accessibility from two main aspects: objective factors and subjective factors (see Table 3). Objective factors include demographic characteristics (e.g., gender, age, etc.) and external objective factors (e.g., population density, frequency, etc.), and subjective factors include positive factors (e.g., safety perception, perceived quality, attitudes, etc.) and negative factors (e.g., traffic risk, perceived crime risk, etc.). There is still no consensus among existing studies on the antecedent variables of perceived accessibility, despite the large number of studies focusing on the issue. Some studies have shown that demographic variables such as gender and age cause differences in perceived accessibility (Friman et al., 2020a), but others have noted that demographic variables such as gender do not have a significant effect on perceived accessibility (Wang et al., 2015). This may be due to differences in the samples. Overall, such studies expand our understanding of how to improve people's perceived accessibility.

4.2 Outcome variables of perceived accessibility

4.2.1 Behavioral factors

Perceived accessibility affects individuals' behavioral intentions and behavioral choices. Van der Vlugt et al. (2022) reported that higher perceived accessibility for walking promotes individuals' choice of walking as a mode of travel. Scheepers et al. (2016) reported that when the accessibility of a private car (vs. a bicycle) is high, people are more likely to use a car (vs. a bicycle) for transportation; conversely, people are more likely to use a bicycle (vs. a private car) mode of transportation when the accessibility of a bicycle (vs. a private car) is high. Cole et al. (2019) surveyed 258 people with mobility impairments in their leisure travel over the past 12 months and reported that the perceived accessibility of leisure travel services (e.g., food and beverage facilities, programs/services) affects the number of leisure tourism activities they have participated in and their behavioral intentions to participate in future leisure activities. In addition, perceived accessibility to parks significantly affects residents' actual park use behavior (Zhang & Tan, 2019).

4.2.2 Psychological factors

Perceived accessibility affects individual psychological factors such as mood, psychological motivation, and perceived fairness. Specifically, Liu et al. (2022) surveyed Kunming residents during the COVID-19 pandemic and reported that perceived accessibility to daily necessities, perceived accessibility to key services, and perceived accessibility to social activities alleviated their negative emotions (e.g., nervousness, anxiety, and uneasiness). Cole et al. (2019) reported that the perceived accessibility of leisure tourism services (e.g., staff attitudes, dining facilities, accommodations, programs/services, and transportation) enhances individuals' psychological motivation to participate in leisure tourism activities, such as internal motivation and identity motivation. A study in Kunming, China, revealed that residents' perceived accessibility to smartphone services (e.g., using cell phone scanning on public transportation) during the COVID-19 epidemic affected the perceived equity of transportation (Liu et al., 2021). In addition, a study of older adults revealed that the perceived accessibility of daily travel has a positive effect on life satisfaction, whereas higher perceived accessibility tends to be characterized by the convenience of traveling to the destination and engaging in the necessary activities, which enhances travel satisfaction (Lättman et al., 2019). Moreover, perceived accessibility to cigarettes enhances adolescents' risk of smoking (Doubeni et

al., 2008). Friman and Olsson (2023) reported that perceived accessibility enhances residents' life satisfaction through a web-based questionnaire survey of residents living in Sweden. Sia et al. (2023) used a randomized household survey of residents across the country and reported that residents' perceived accessibility to parks enhances individuals' Park use intention. Ma et al. (2023) investigated residents' perceived accessibility to parks in Chengguan District, Lanzhou city, and reported that perceived accessibility to parks affects people's frequency of park use, duration of park use, and psychological well-being. Watthanaklang et al. (2024) reported that an individual's perceived accessibility to the public transport system enhances his or her use of the willingness to use public transport systems.

In summary, existing studies have explored the outcome variables of perceived accessibility in terms of behavioral factors (e.g., intention to use, frequency of park use, duration of use, etc.) and psychological factors (e.g., life satisfaction, perceived equity, identified, etc.) (see Table 3). Although there are many categories of outcome variables in existing research, the positive results of perceived accessibility are recognizable. Specifically, perceived accessibility enhances individual behavioral intentions as well as life satisfaction, among other factors (Friman & Olsson, 2023; Watthanaklang et al., 2024). To some extent, outcome variable research on perceived accessibility helps us understand the important role of perceived accessibility.

Table 3. Antecedent variables and outcome variables of perceived accessibility

Construct	Antecedent variables				Outcome variables		Results
	Objective factors		Subjective factors				
	Demo-graphic character-istics	External objective factors	Positive factors	Negative factors	Behavioral factors	Psycho-logical factors	
Friman et al., 2020b; Márquez et al., 2019; Wang et al., 2015	Income		Service quality; Safety perception				The higher the income level, the higher the level of perceived accessibility of the population. Service quality and traveler safety perception positively affects perceived accessibility of public transport.
Friman et al., 2020a	Gender, age, years of education	Population density					Differences in perceived accessibility due to gender, age, years of education.
Lättman, Friman et al., 2016	Age	Frequency of use	Safety perception; perceived quality				Age, frequency of public transport use, safety perception; perceived quality affect perceived accessibility of public transport.
Olsson et al., 2021	Gender, age	Frequency of trips on copublic transportatio n					Differences in gender and age cause differences in perceived accessibility. frequency of trips on copublic transportation Influencing the perceived accessibility of public transport systems.
Yasumoto et al., 2021	Income		Perceived number of parks and safety perception	Traffic risk, perceived crime risk, and the degree of impairment of landscape aesthetics			Income, perceived number of parks, safety perception, traffic risk, perceived crime risk, and the degree of impairment of landscape aesthetics significantly affects perceived accessibility of park.
Van der Vlugt et al., 2022			Attitudes		Walking behavior		Walking attitudes significantly influenced walking perceived accessibility. Walking perceived accessibility significantly influences walking behavior.
Liu et al., 2021			Perceived ease of use of smartphone s			Perceived equity of transportati on	Perceived ease of use of smartphones during the New Crown epidemic affected the perceived accessibility of food and social services. perceived accessibility to smartphone services affected the perceived equity of transportation.

Construct	Antecedent variables				Outcome variables		Results
	Objective factors		Subjective factors				
	Demo-graphic character-istics	External objective factors	Positive factors	Negative factors	Behavioral factors	Psycho-logical factors	
Liu et al., 2022						Negative emotions(e.g., nervousness, anxiety, etc.)	Perceived accessibility alleviated residents' negative emotions.
Scheepers et al., 2016					Transportation mode choice		Perceived accessibility to a transport mode facilitates the choice of that transport mode.
Cole et al., 2019					The number of leisure tourism activities, behavioral intentions	Instrinsic, indentified, amotivation	Perceived accessibility of travel services affects the number of leisure tourism activities and their behavioral intentions. Perceived accessibility travel services affects Instrinsic, indentified and amotivation.
Zhang and Tan, 2019					Park use behavior	Park use demand	Perceived accessibility of park affects Park use demand and Park use behavior.
Doubeni et al., 2008						risk of smoking	perceived accessibility to cigarettes enhances risk of smoking.
Lättman et al., 2019						Life satisfaction, travel satisfaction	perceived accessibility of daily travel has a positive impact on life satisfaction and travel satisfaction.
Ma et al., 2023		Distance to parks, park coverage, and park quality			Frequency of park use, duration of use	Mental health	Distance to parks, park coverage, and park quality affect perceived accessibility to parks. perceived accessibility to parks affects frequency of use, duration of use and mental health.
Sia et al., 2023					Park use intention		Perceived accessibility park positively affects park use intention.
Friman and Olsson, 2023			Autonomy			Life satisfaction	Autonomy affects perceived accessibility and perceived accessibility affects life satisfaction.
Watthanaklang et al., 2024			Service quality		Willingness to use the public transportation system		The quality of public transport services positively affects the perceived accessibility of public transport. Perceived accessibility of public transport positively affects willingness to use the public transport system.

In summary, this paper summarizes the conceptual definitions, measurement items, antecedent variables, and outcome variables of perceived accessibility and presents a research framework for perceived accessibility, as shown in Figure 1.

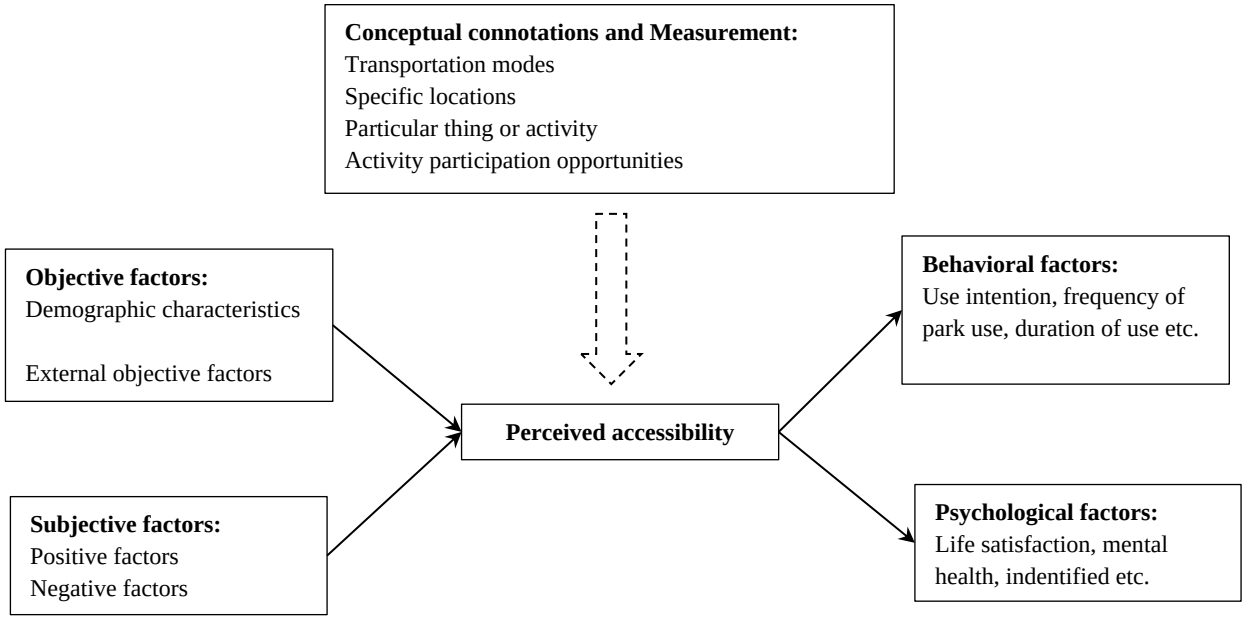

Figure 1. Research framework for perceived accessibility

5 Practical implications

Perceived accessibility has a positive impact on residents' psychology and behavior, and city managers should recognize the positive effects of perceived accessibility and take improvement measures to increase residents' satisfaction.

5.1 Implications for city managers' perceptions

City managers should recognize the positive effects of perceived accessibility on residents' psychological and behavioral factors. On the one hand, perceived accessibility plays an important role in improving residents' psychological well-being (Ma et al., 2023); for example, perceived accessibility to key services can effectively alleviate residents' negative emotions (Liu et al., 2022) and enhance their well-being. Moreover, perceived accessibility helps residents enhance their identity (Cole et al., 2019) and life satisfaction (Friman & Olsson, 2023), which is a source of motivation for advancing the harmonious development of society. On the other hand, perceived accessibility plays an important role in residents' behavioral choices. For example, the perceived accessibility of public transport systems promotes residents' choice of public transport mode (Watthanaklang et al., 2024). The proper use of public transport systems contributes to the efficient allocation and utilization of resources and promotes the sustainable development of society (Watthanaklang et al., 2024). In view of this, city managers need to pay attention to the application of perceived accessibility in urban development to

effectively utilize the important and positive role of perceived accessibility in residents' lives and urban development.

5.2 Implications for the behavior of city managers

The implication for city managers' behavior is that city managers should adopt richer behaviors than before to play the important role of perceived accessibility in city building. Since residents' perceived accessibility is affected by various factors, city managers should take targeted measures according to different types of perceived accessibility. For example, with respect to the perceived accessibility of public transport, residents are more concerned about the service quality and safety perceptions provided by public transport, and city managers should reasonably plan the number of stops, the location of waiting areas, and the size of the area to improve the convenience of residents traveling by bus (Friman et al., 2020b). In addition, city managers need to set up special medical stations and take safety measures to protect residents' safety (Watthanaklang et al., 2024); for the perceived accessibility of parks, residents are more concerned about the distance of the parks, the coverage area, and the quality of the parks, so city managers can locate parks in areas that are closer to residential areas. Moreover, when constructing parks, urban planners should make use of natural rivers and/or natural mountains as much as possible to increase the coverage area and improve the quality of parks (Ma et al., 2023).

6 Conclusions and future perspectives

6.1 Conclusions

In this paper, relevant studies on perceived accessibility are reviewed. First, starting from the four aspects of transport systems, destinations, specific things and opportunities to participate in activities, this paper summarizes the conceptual definitions and measurement items of existing studies on perceived accessibility, reveals the differences in residents' perceptions of different types of perceived accessibility, and lays the foundation for subsequent applied research on perceived accessibility. Second, this paper summarizes the antecedent and outcome variables of perceived accessibility. Both objective and subjective factors drive perceived accessibility, while perceived accessibility influences residents' psychological factors and behavioral choices. Finally, this paper summarizes the practical implications of perceived accessibility from the cognitive and behavioral aspects of city managers. For the cognitive aspect, the important role of perceived accessibility in urban development should be taken seriously by city managers; for the behavioral aspect, city managers need to adopt richer behaviors to play the important role of perceived accessibility in urban construction. By combining these dimensions, this paper provides a valuable foundation for an in-depth exploration of research related to perceived accessibility and offers practical guiding suggestions for city managers.

6.2 Future perspectives

A review of the literature related to perceived accessibility and a sorting of the influencing factors revealed that some meaningful research results have been developed around the theme of perceived accessibility in different disciplinary fields and have received extensive attention from scholars. However, the existing research related to

perceived accessibility is relatively loose, and there are also more research deficiencies. Based on the literature, this paper summarizes and proposes the following future research directions that need to be explored, aiming to provide valuable inspiration for exploring research related to perceived accessibility.

First, the conceptual content and scale of perceived accessibility should be enriched. On the one hand, it is important to enrich the conceptual content and scale measures of perceived accessibility in existing domains. Although the research on perceived accessibility in transportation modes, specific locations, particular things or activities, and activity participation opportunities is relatively mature, there is no consensus on the definition and measurement of perceived accessibility in the existing studies in their respective domains. Most existing studies focus on the perceived accessibility of only one mode of transport (e.g., a single mode of transport, a single location, etc.) (Van der Vlugt et al., 2022; Wang et al., 2015), which leads to fragmented research on perceived accessibility. Considering the complexity of social activities, it is unlikely that residents use only one mode of transport or have only one destination while traveling (Kappeler, 2019). Therefore, future research should identify more applicable definitions and measurements of perceived accessibility based on real-world contexts. For example, the perceived accessibility of travel modes during the day or the perceived accessibility to parks around the place of residence could be examined. On the other hand, existing research lacks the exploration of conceptual connotations and scales of perceived accessibility in other fields, such as urban marketing and environmental psychology, and future research on perceived accessibility in different fields can be further expanded and enriched.

Second, the influencing factors of perceived accessibility are further explored. Although existing studies have focused on the influence of objective factors and their own subjective factors on perceived accessibility, there is still a lack of exploration of significant others' influence on individuals' perceived accessibility. According to ecological system theory, human psychological development is influenced not only by individual factors but also by environmental factors (Bronfenbrenner, 2005). Among the environmental factors, significant others, such as family, friends, and coworkers, play important roles in an individual's psychological development (Hernandez, 2000). Therefore, it is particularly important to consider the influence of significant others on an individual's perceived accessibility. In the future, we can study the effects of the psychological factors of significant others, such as peer encouragement and recognition, on individuals' perceived accessibility.

Third, the boundary conditions where individual factors affect perceived accessibility are explored. Current research has explored mainly the positive effects of positive psychological factors and the negative effects of negative psychological factors. However, under certain boundary conditions, it is possible for positive psychological factors to exert negative effects and negative psychological effects to exert positive effects. Research has not yet clarified the boundary conditions of these two effects. Taking negative psychological factors as an example, an individual's perceived degree of park impairment decreases his or her park perceived accessibility (Yasumoto et al., 2021). However, individuals may judge a park's sense of age because of the degree of park impairment, with older parks having a stronger cultural heritage, thus attracting residents who are more willing to overcome financial and ability barriers to visit the park. Future research needs to further explore and clarify the role of individual factors in perceived accessibility in different contexts.

Finally, multimethod and multicultural cross-disciplinary research methods were explored to carry out the research. At present, research on perceived accessibility mostly adopts the questionnaire survey method; although the questionnaire survey method can

measure the subjective feelings of individuals, it has difficulty controlling noise interference in the application process and cannot reflect the actual state of individuals. To obtain more reliable results, the field experiment method can be used to carry out research, which can more realistically restore the display situation and exclude the interference of other factors to make the results more credible (Tong et al., 2021). Second, future research should strengthen cross-cultural, multiscenario comparative research. Owing to cultural differences such as cultural traditions and values in different regions, there are also large differences in residents' perceptions (Yam et al., 2023). This may lead to different or even opposite findings of perceived accessibility in different regional scenarios. Therefore, future research needs to pay attention to cross-cultural research and can extend the study of perceived accessibility to more universal scenarios by comparing the findings of different cultural contexts.

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Author contribution

Xiaona Ma: study design, methodology, writing. Fasheng Cui: literature review, chart design. All authors reviewed the results and approved the final version of the manuscript.

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