

REVIEW

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Handling social considerations and the needs of different groups in public transport planning: a review of definitions, methods, and knowledge gaps

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Abstract

This paper analyses the integration of social considerations into public transport planning. It addresses the challenge of balancing social benefits against objectives such as efficiency and cost minimization. Through a literature review, this paper examines methods for assessing public transport accessibility for potentially disadvantaged groups and identifies knowledge gaps in existing research. The analysis reveals a predominant focus on post-implementation (ex-post) accessibility assessments and a lack of research examining potential impacts (ex-ante) during planning stages. Furthermore, the paper identifies a lack of research on how to weigh social benefits against other more conventional objectives such as efficiency and cost minimization and also against environmental considerations. Research usually proposes changes ex-post based solely on a desire to improve accessibility for potentially disadvantaged groups. Therefore, there is a need for more research on how to manage conflicting interests in planning, for example through composite methods. The paper also highlights the tendency of research to overlook the practical usability of methods developed. The relevance of methods to policy makers and planners responsible for planning public transport systems remains largely unexplored. To develop practically useful methods, research needs a better understanding of the norms governing planning practices. It is common to discuss how the mobility needs of potentially disadvantaged passenger groups should be met in isolation from policy contexts. More research is needed about how the potential tensions between social, economic, and environmental considerations play out in public transport planning practices. All of this leads to a risk of a theory–practice gap, marked by a disconnect between research and the practical needs of the public transport providers. By proposing a more nuanced research approach that better reflects the complexity of real-world planning and the different needs of user groups, research can enable public transport planning for what we term ‘sustainable accessibility’.

Keywords Public transport, Planning, Equity, Accessibility, Assessment, Methods

1 Introduction

In today’s rapidly urbanizing world, public transport has emerged as an essential component of modern urban life, facilitating economic vitality, mitigating environmental problems, and fostering societal cohesion. Public transport systems are the arteries of cities, transporting millions of people daily, yet their planning and optimization are intricate tasks as planning includes making trade-offs between goals within the framework of limited resources

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and divergent stakeholder interests. For example, decisions regarding the design of public transport systems involve difficult trade-offs such as area coverage versus frequency of service, speed of service versus the number of stops, operating hours versus frequency – that directly impact users [1–4]. In conventional public transport planning practice, the process of balancing goals and system design options typically focuses on planning systems to achieve:

- *Efficiency*: conventional public transport planning emphasizes efficiency in resource allocation, striving to maximize the capacity utilization of existing infrastructure and services. The primary focus is on optimizing routes and schedules to minimize costs while meeting demand.
- (Operational and capital) *cost minimization*: this often involves decisions related to service frequency, route length, and fleet management to ensure cost-effective operations.
- *Service quality*: this includes factors such as punctuality, reliability, and passenger comfort, all aimed at attracting and retaining ridership [5].

These aspects of public transport system planning have come to shape the perception of what is understood as ‘best practice’ planning [6–9]. However, what can be considered ‘best practice’ is open to discussion. What is ‘best’ in relation to one goal will not necessarily be the best system design option for a different goal. Importantly, a public transport system can be seen as successful if it attracts many users, but it might be less successful if judged on the basis of other goals, such as equity or accessibility. What can be considered ‘best practice’ is also influenced by the regulatory and organizational context within which public transport planning operates. For example, in European countries, we can see a development towards customer-oriented planning within the framework of several different organizational forms varying from public monopolies to open markets [10]. In some European countries where there has been a market orientation of public transport, such as Sweden, best practice has come to mean a prioritization of patronage goals over area coverage. Public transport providers have designed public transport systems accordingly. Consequently, public transport providers in Sweden mainly invest in services that have the most passengers and the greatest potential to increase the number of passengers, the so-called high-demand routes [9], as part of a network-oriented planning and management approach of transport modes within multimodal networks [11]. The network-oriented approach ensures that every route effectively and directly serves specific passenger flows

and is interconnected within the system to provide maximum transfer accessibility [6].

However, what is considered best practice may be changing. The public transport industry sees a need for knowledge of, and greater consideration for, social aspects and the needs of different groups in public transport planning. Such an approach would entail understanding and accommodating the varying transport needs of different groups, such as the elderly, people with disabilities, and families with young children, ensuring that facilities and services address their needs. To be able to do that, useful methods are needed that can be used to analyze the functioning of public transport systems for different groups of users. It would also promote social equity by connecting communities underserved by public transport to essential services and employment centres, enhancing overall accessibility and connectivity within the public transport network. Such a holistic approach to public transport planning would aim to create a system that is not only efficient but also equitable, serving diverse needs.

The increasing interest shown by the industry in social aspects and the needs of different groups in public transport planning is matched by a growing focus on the same issues in research as well. There is a growing body of research on the social consequences of transport planning, social exclusion and transport equity [12–16]. This research compels researchers to consider the social impact of transport planning, that is, who benefits from public transport services and who is disadvantaged by them. Given the increasing research interest in the social aspects of transport planning, there is a need to summarize the state of the art in research and reflect on how the research contributes to the growing need for knowledge and methods to be used in planning by the industry. This paper directs its focus towards a pressing challenge in public transport planning: how can public transport planning better weigh social benefits in comparison with other public transport planning objectives, such as efficiency and cost minimization, when deciding about the design of public transport systems?

The aim of this paper is to summarize the state of scientific knowledge regarding the inclusion of social considerations in public transport planning, and to suggest directions for future research. To understand how research can contribute knowledge about the inclusion of social considerations in public transport planning, one needs an overview how the existing research defines the social benefits of public transport (for example, its contribution to accessibility), which methods can be used to measure social benefits, and when public transport planning should change to become more supportive of the needs of different user groups. Therefore, through a

review of existing research, the paper seeks to answer the following research questions:

- How can accessibility provided by public transport be defined as a social benefit?
- Which methods can be used in public transport planning to assess accessibility for different user groups when deciding about the design of public transport systems?
- How and when should greater emphasis be given to meeting the mobility needs of potentially disadvantaged passenger groups or providing a fair spatial distribution of services in public transport planning?

The paper is expected to contribute to a discussion of the usefulness of existing research to real-world public transport planning. The paper is also expected to identify gaps and limitations in approaches in the literature that can be used to formulate a research agenda.

The outline of the paper is as follows: the method is presented in Sect. 2. Section 3 describes and summarizes the literature research question by research question. The conclusion section discusses the research literature as a whole and describes some central research gaps that future research should fill.

2 Method and data

There are several types of reviews and associated methods [17, 18]. In transport research, a literature review has been defined as an academic work that adds value by providing a comprehensive overview of the literature in a specific area, presented in a structured way [19]. This paper presents a qualitative and descriptive review of research with the ambition to critically evaluate and synthesize it. This method makes no claim to identify a complete list of all research or to present a quantitative synthesis, which is done in systematic literature reviews [20]. The implementation of the literature review has included several steps, including bibliographic database searches, identification of potentially relevant publications, definition of the criteria used for selecting publications, and qualitative analysis and synthesis of the available research.

2.1 Bibliographic database searches

The literature searches were made in Scopus. Scopus is a multidisciplinary database with a focus on peer-reviewed scientific articles. To retrieve literature within the scope of this work, three sets of search terms were used – one set with terms for public transport, one with terms for social considerations, and one with terms for methods for investigating and measuring. Our choice of these three sets of search terms was based on careful consideration

and our expertise in the field, ensuring a comprehensive capture of relevant studies to review and analyze.

The search terms used were:

- (1) Public transport, transit.
- (2) Social considerations: Equity, justice, injustice, social factors, social change, social class, social diversity, social inclusion, social impact, social service, ethnic, low income, poverty, minorities, socioeconomic, disadvantaged, inclusion, exclusion, socio-spatial effect, spatial equity, spatial inequity, spatial analysis.
- (3) Methods for investigating and measuring: Method, tool, indicator, strategy, identify, mapping, GIS, geographical, measuring, measure, measurement, assessment, evaluation, best practice, follow up, definition, policy, planning, network, design, ridership, coverage, patronage, service.

The three sets were combined so that at least one term from each set had to be included in the search results. Truncation was used to retrieve different word endings, such as 'social*'. The expression 'transit desert' was searched on its own, and 'transit dependency' was searched only in combination with set 2. Previous research has analysed individuals' access to services or destinations through public transport (see findings). In this article, accessibility is considered one of several potential social benefits we aim to investigate through the social considerations search set. By using the search words described in the social considerations search set, we cover research that analyses accessibility as a social benefit and limit the literature search by filtering out research that deals with physical accessibility adaptations of public transport services (ramps, low-floor buses, etc.).

The literature search included publications dating from 2000 to October 2023.

2.2 Search hits, the selection of publications, and analysis

The searches resulted in 177 hits. In a first step, all publications were compiled as abstracts in a Word document, which was then reviewed. Following a thorough reading of all abstracts, publications that were judged to be of potential relevance were selected. In a second step, all selected publications were read in full and summarized in a Word document using a coding scheme consisting of the above-mentioned research questions. More publications were sorted out in this step. In addition to the literature identified through the database search, we manually included three additional papers known to us for their relevance to our topic of study. These papers were selected based on our expert knowledge of the field and were integrated into our analysis to ensure a

comprehensive review of the subject matter. In the end, 64 publications (spanning from 2010 to 2023) were chosen for inclusion in the analysis that is reported in the findings section (see Table 2 in the [Appendix](#) for a list of publications).

During the analysis, themes or trends in the literature were identified. Such themes consist of reasoning, or ways of describing public transport and social considerations, which recurred in several publications. The themes can be discerned after a complete review of all selected publications. These themes are used in the findings section (Sect. 3) to describe the existing research literature research question by research question. During the

analysis, we also looked for reasoning or factors that are potentially important for public transport and social considerations but not addressed in the literature. The lack of reasoning or factors is the basis for what is referred to in the findings and conclusion sections as research gaps.

2.3 CiteSpace analysis

Leveraging the analytical capabilities of CiteSpace [21] – a software tool that visualizes patterns and trends in scientific literature – we have undertaken a systematic exploration of the selected literature (Table 1) addressing the interplay of social considerations within public transport planning. The timeline visualization from CiteSpace (Fig. 1) presents a chronological progression of keywords in transportation planning from 2010 through to the near present. The clusters identified represent key thematic areas that have garnered attention within the academic community. It is important to note that only the selected 64 publications are visualized here in CiteSpace.

The silhouette values associated with these clusters suggest varying degrees of internal cohesion, indicating how tightly the research within each cluster is thematically bound. Clusters with higher silhouette scores, as explained by Chen (2021) [21], are more likely to represent well-established research fronts, whereas lower scores may indicate emerging areas or more diverse sets of topics within a cluster.

Cluster #0, with a silhouette value of 0.944, focuses on themes such as social exclusion and transport disadvantage. The high silhouette value suggests that the research

Table 1 Summary of clusters by size from CiteSpace [21] based on the selected literature

Cluster ID	Name	Size	Silhouette	Mean (Year)
0	Social Exclusion	31	0.944	2016
1	Public Sector	27	0.918	2016
2	Sustainability	26	0.865	2017
3	Linear Programming	26	0.863	2019
4	Gini Index	22	0.799	2019
5	Utility-based Accessibility	22	0.889	2014
6	Travel Time	21	0.853	2017
7	Lorenz Curve	20	0.803	2014
8	Service Gaps	17	0.955	2019
9	Regional Analysis	13	0.965	2020
10	Horizontal Equity	12	0.895	2018

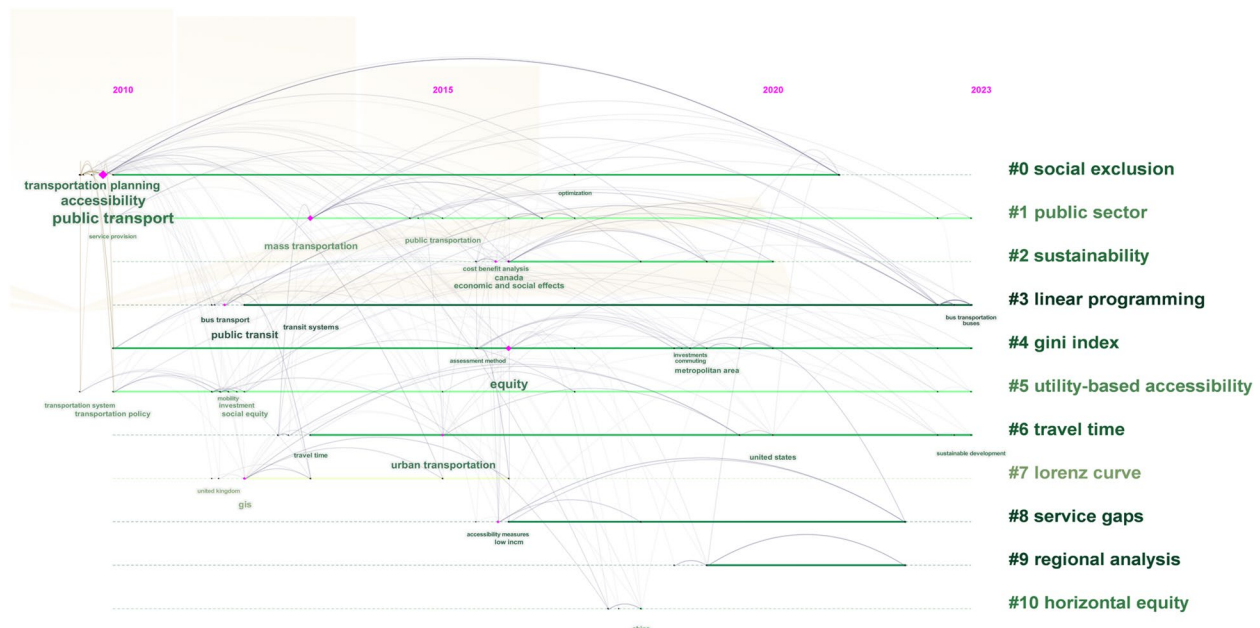


Fig. 1 Timeline visualization of the selected literature generated by CiteSpace [21]

within this cluster is thematically consistent and represents a well-established area of study, reflecting significant internal cohesion and clarity in this research theme.

Cluster #1 with a strong silhouette score reflects a cohesive body of research focused on public transportation and its social dimensions, including equity and accessibility—themes that have evidently maintained relevance over the years. This cluster's prominence in the timeline suggests sustained and perhaps growing interest, likely driven by urbanization and the ongoing discourse on social justice.

Cluster #8, with the second-highest silhouette score among the clusters, is particularly noteworthy as it highlights comprehensive transport and the analytical methods used to assess and optimize it. The emergence of this cluster in 2019 may indicate a methodological shift or innovation in the field, emphasizing the need for holistic approaches to transport systems.

Cluster #9 from 2020 brings to the fore the interplay between demand and supply, land use, and regional analysis, pointing to an interdisciplinary approach that considers economic, geographical, and sociopolitical factors in transport planning. Its position in the timeline aligns with a global push towards smarter, more sustainable urban development.

Overall, the clusters and the timeline together reveal a narrative of increasing sophistication in transport research, with a pivot towards integrated, equitable, and methodologically rigorous approaches to transport planning. This narrative is punctuated by moments of methodological innovation, renewed emphasis on social issues, and the integration of diverse analytical perspectives, reflecting the field's responsiveness to societal needs and technological advancements.

3 Findings

3.1 How can accessibility provided by public transport be defined (and assessed) as a social benefit?

It is common for research to analyse public transport as a social benefit in relation to equity and justice. For example, Bruzzone [22] discuss equity in transport and its connection to social sustainability and accessibility. To them, equity in transport is more about fairness and justice than equality, which is tied to a distributive approach of providing the same level of service to all residents. This recalls conclusions in much other research [15, 23, 24].

Research often focuses on potentially disadvantaged passenger groups' access to work, healthcare, education, etc. by public transport, although access to transport itself is sometimes seen as a 'distributive resource', unrelated to the purpose of the mobility (see [25]). Research seldom highlights the importance of unplanned, spontaneous travel [26, 27]. Space and time are the focus in

most of the research (e.g. [27–31]). For example, Currie [29] analyses the relative quality and spatial distribution of public transport supply (e.g. bus stops and bus frequency) in relation to transport disadvantage, while Ermagun [32] use the spatial mismatch concept to discuss how disadvantaged groups (with lower education and in low-income households) sometimes live in areas with less access to job-related transport. Ryan [33] add a gender analysis by describing the balancing activities and struggles particularly evident in women's lives. Ryan [33] also illustrate how commuter flows of lower-income groups can be more geographically dispersed than those of middle- and high-income groups.

Research also shows that potentially disadvantaged passenger groups are particularly affected by the design of public transport systems. An example of this is Robbenholt and Witmer [27], who analyse geographic differences and temporal changes in accessibility, addressing a need for transport service at off-peak hours and for spontaneous trips. Also, Kolkowski [34] discuss how accessibility, in this case for people with low incomes, is influenced by time variations in public transport supply. Kolkowski [34] identify increasing segregation around some transport hubs, indicating rising social segregation in 'pockets of poverty', especially on Sundays, when there is a lower supply of public transport. Finally, research shows the importance of considering the entire journey [35], and that the individual's perception of accessibility needs to be taken into account in analyses of accessibility as a social benefit. For example, Lättman [26] argue that measures such as travel time or distance are often too simplistic and fail to capture accessibility as it is perceived by individuals or specific groups. Similarly, Lee and Kim [31] criticize conventional travel time measurements for being overly optimistic regarding reliability of timetables and the time it takes for users to change between different routes and vehicles (cf. chain trips), and they propose a time-geography-based model for more realistic time budgets, mobility options, and activity schedules, cf. [33].

The research described contributes knowledge in several important ways, but it is quite general and lacks detail regarding the unique characteristics and needs of different demographic groups. This is particularly evident in the treatment of social categories, such as the elderly population. For example, Cao et al. [37] mentioned four factors representing the need for public transport in a community: a population over 65, children and teenagers aged 6–19, unemployed individuals, and illiteracy levels. Similarly, Asgharpour et al. [38] use the number '65+' to categorize a large and diverse population group, separating them from other intersecting categories and stating that 'the elderly, Hispanic, Asian and people with disabilities are underserved by transit services' ([38], p.649). The

assumption that individuals over a certain age uniformly constitute a vulnerable group is a simplification that overlooks the diversity within this group. Questions such as the specific public transportation needs of a 65-year-old compared to other adult age groups, or the age at which walking long distances to bus stops becomes hard, are not sufficiently explored. This indicates a tendency towards generalization in categorizing population groups, which could be addressed by incorporating more detailed and localized knowledge into research methodologies.

To conclude, research underscores that defining and assessing accessibility in public transport as a social benefit requires a multifaceted approach, one that considers not just physical accessibility but also equity, justice, and an understanding of the diverse needs of individuals and user groups. The research implies a need for a shift from traditional metrics (such as conventional travel time measurements) to more activity-based analyses, emphasizing the critical role of public transport in promoting social equity and inclusion. Most research does not consider travel uncertainties, such as delays and other disturbances, in relation to users and potential users. Exceptions are Lee and Kim [31], who strive to measure accessibility in a more realistic way by including travel time uncertainties and people's combination of buffer time strategies and route-finding plans to avoid the risk of arriving too late or being left behind, and Lättman et al.'s [26] analysis of perceived accessibility. Otherwise, the research is quite general and would need to be more nuanced when it comes to its definition and treatment of social categories.

3.2 Which methods can be used to assess accessibility for different user groups when deciding about the design of public transport systems?

The majority of publications focus on developing methods to estimate accessibility, particularly targeting potentially disadvantaged groups, such as the economically disadvantaged, various ethnicities, etc. These methods are commonly demonstrated through mapping the distribution of accessibility within a public transport system, either in specific cities or urban areas. Research primarily examines accessibility in an existing public transport system or ex-post, i.e. after implementing changes in, for example, bus stop locations, route layouts, or ticket prices [36, 39]. There are only a few articles that analyse the effects on accessibility ex-ante, that is, embedded in the public transport network design process e.g. [40, 41]. Further, research is predominantly quantitative. Blair [42] presents a rare exception concluding:

whilst certain assumptions can be made from statistical analysis, experience in Belfast shows that the

actual impact of network change on society is measurable only through qualitative engagement with stakeholder groups. (p. 198)

The publications dealing with methods can be divided into two main categories, described below (subSects. 3.2.1 and 3.2.2).

3.2.1 Analyses of accessibility: developing or improving existing methods

This main category of publications consists of two subcategories. The first subcategory *develops methods for assessing accessibility in time and space*. These methods typically evaluate how effectively a city's public transport system enables access to key services and employment opportunities, viewing accessibility through the lens of equity. This approach often employs Lorenz curves in conjunction with the Gini coefficient [43], originally a tool to measure economic inequality and distributional disparities, to assess equity. It emphasizes the intrinsic value of equitable access to public transportation and associated destinations. In this context, it is noteworthy that a few articles, such as Rubensson [44], extend this approach by developing methodologies for analysing when disparities in accessibility are justifiable within a system, providing a nuanced understanding of equity in public transportation.

The use of the Gini coefficient not only highlights the importance of equitable access as a fundamental goal in itself but also underscores the commitment to fairness and equality in public policy and urban planning. In practice, these publications often propose a methodology that begins with an evaluation of the supply side of public transport services in a city. This evaluation is then juxtaposed against the demographic and spatial distributions of the population, categorized by factors such as age, ethnicity, education, income, or car access. Such an analysis often leads to the production of 'transit gap indexes', which are critical in identifying disparities in (availability and quality of) public transportation services across different areas or experienced by different population groups [45–47].

The second subcategory of publications consists of works that aim *to improve or refine existing methods*. For example, Langford [48] describe a novel approach to assess access to public transport systems using a new algorithm that incorporates existing transport modelling metrics, such as service quality (number of buses in any chosen time frame), potential service demand (population count within service area catchments of bus stops), cumulative opportunity (sum of service provision-to-population ratios for significant bus stops), and proximity ('tolerable' walking distance). Another example is Sharma

[49], who provide a method for assessing equity using open data sources as opposed to the often-used transit assignment models and ridership tracking tools, which are seldom available to small- or mid-sized cities.

Several publications also attempt to refine existing methods by including various conditions, such as travel time and costs, in their analyses. For instance, Ben-Elia and Benenson [50] analyse door-to-door travel times for commuting to work by public transport at a more detailed spatial level, using individual buildings as origin and destination pairs, a more granular approach than previous research using Traffic Analysis Zones (TAZs). They test their method by analysing changes in a bus network reform in Tel Aviv, Israel, and assess these changes from an equity perspective using Lorenze curves and the Gini coefficient. Accessibility losses and gains are plotted on maps, allowing for a visual comparison of changes in space. Another example is El-Geneidy et al. [51], who develop a method for assessing how transit fares act as a constraint to job accessibility. They do this by combining transit fares and travel time into a monetary value to calculate the number of jobs reachable at different departure times within defined wage thresholds. The accessible jobs are measured based on the travel time fares of the public transport network in Montreal, Canada, with the results illustrated on maps. A final example is Ryerson et al. [52], who analyse income in combination with individuals' access to vehicles and household size. Based on these categories, they identify areas of Philadelphia, USA, that should be prioritized for improved public transportation services, particularly targeting individuals living in low-income areas with limited vehicle access.

In summary, the research described so far provides methods for estimating accessibility, and in some cases also methods for determining the extent to which improved accessibility actually leads to groups taking part in more activities, e.g. Allen & Farber [53]. This research contributes knowledge about existing public transport systems and the effects of investments, including how to direct them to the places and groups in greatest need. The primary interest and rationale for the research in this category are equity, accessibility, and methods that can be used to measure these aspects, applied to public transport as the chosen empirical field. This might explain why the research is relatively introspective in its ambitions to develop new methods or refine existing ones. Overall, there is substantial research that provides methods for assessing equity by analysing accessibility in public transport provision. However, this research often occurs in isolation from other public transport system design aspects. This is a limitation that can result in important research gaps. We discuss the implications of the research focus in more detail below, after describing

the next main category of publications, which deals with accessibility in relation to other policy goals.

3.2.2 Analyses of accessibility in public transport provision in relation to other policy goals

The second main category of publications provides methods for evaluating accessibility in relation to other public transport policy goals, or it attempts to balance potentially competing aspects of network design. Relatively few publications have this orientation, at least compared to the number of publications described in the previous Sect. 3.2.1. Common to the publications that analyse accessibility in public transport provision in relation to other policy goals is their development of methods to optimize a public transport system. These methods often consider both operational efficiency and accessibility for disadvantaged user groups. The rationale sometimes stems from previous research that has not adequately considered the costs and economic inefficiencies involved in achieving social equity when proposing changes to public transport planning.

For example, Wei et al. [54] develop a method that integrates operational efficiency and access equity using a combination of mathematical programming methods, GIS-based analysis, and spatial optimization techniques. This method evaluates operational efficiency (e.g. average number of passengers per day, operating buses per day, etc.) and assesses equity (service coverage for disadvantaged populations) in a way that identifies the best- and worst-performing routes in a metropolitan area case study. The claim is that, with this knowledge, public transport providers can make more informed trade-offs between competing design objectives, which will vary according to each organization's priorities.

Following this theme, Camporeale et al. [40] develop a method of analysing trade-offs between equity and costs. They propose a model that minimizes social costs (by balancing user, operator, and unsatisfied demand costs) while addressing both horizontal and vertical equity, incorporating the Gini coefficient, crafting a more equitable service distribution, especially for disadvantaged areas. Wang and Chen [55] introduce a method that balances economic efficiency with equity, using a Geographically Weighted Regression (GWR) model within a multi-objective optimization framework. Through this approach, their research aims to maximize overall accessibility while simultaneously reducing disparities. It leverages local statistical estimates and a multi-objective optimization model to inform decisions on active transportation investments, highlighting the complex interplay between economic and social factors in urban planning.

Park et al. [41] add another layer to this discussion. They propose a multi-objective approach (employing the Nondominated Sorting Genetic Algorithm-II and neighbourhood local search methods within a logit-based mode-choice model) that weaves together system efficiency, user inconvenience, and equity. By applying advanced algorithms and modelling to both hypothetical and real-life networks, the study showcases how varied solutions can be generated to meet different urban planning objectives, emphasizing the importance of adaptability in public transport network design. Lastly, Wang et al. [56] delve into the relationship between equity and service effectiveness in urban transport. Employing spatial analysis tools such as the Lorenz curve and Data Envelopment Analysis (DEA), they uncover the disparities and mismatches in service provision within Shanghai. This study provides critical insights into how spatial factors influence transport effectiveness and equity, advocating for more geographically detailed approaches in urban transport planning.

In summary, the research discussed in this section highlights a need for holistic methodologies. The use of tools such as GIS, mathematical programming, and multi-objective optimization reflects a research effort aiming for a more nuanced understanding of how to weigh different policy goals in public transport planning. Importantly, research has illustrated the essential balancing act of operational efficiency, equity, and accessibility in public transport planning. However, there is surprisingly little research about this given the number of research publications on public transport and social considerations in general. The overall assessment of all the research described so far is that the surprisingly small amount of research that analyzes accessibility in relation to other policy goals is a clear shortcoming.

We claim that the conditions for answering the question of when greater emphasis should be placed on meeting the mobility needs of potentially disadvantaged passenger groups are affected by this. We elaborate on this in the next section.

3.3 How and when should greater emphasis be given to meeting the mobility needs of potentially disadvantaged passenger groups?

Overall, research demonstrates a bias towards mapping accessibility in specific cities without further developing the analysis beyond that. As a result, many studies do not provide detailed answers to questions about how and when greater emphasis should be given to meeting the mobility needs of potentially disadvantaged passenger groups; they only point out that some groups should be given better accessibility. For example, Cao et al. [37] conclude that there is a ‘spatial mismatch’ between public

transport services and communities’ demand in Guangzhou, China. They suggest that ‘the government can improve services of existing public transit in communities with particularly high needs but low supply (such as building more bus stops or increasing service frequency) or optimize existing transit networks (such as providing new means of transportation like minibuses or giving subsidies for other types of public transit)’ ([37], pp. 13f). The research that does provide answers to these questions does so primarily by offering methods to identify groups that would benefit most from improved accessibility through public transport. A piece of research already discussed is that of Ryerson et al. [52], who use their framework to pinpoint areas and communities in Philadelphia, USA, where transport interventions would be most vital, specifically areas and communities with low income and accessibility levels (see previous section).

The contribution of research to public transport planning praxis therefore largely depends on the usefulness of the methods developed to assess accessibility, tested on specific public transport systems in specific cities. Claims are regularly made about the usability of the developed methods. For instance, El-Geneidy et al. [51] – who developed a method to analyse accessibility and social disparity using total travel cost – conclude that:

The suggested method provides a simple, replicable accessibility measure that can be used to assess the performance of the land use and transportation system. If planners can explain to policy makers the number of jobs a resident can reach for a given cost, then fare structures and hourly wages can be judged against the cost of commuting. (p. 314)

The above quote illustrates how research typically makes recommendations about changes in planning and design based solely on improving accessibility for potentially disadvantaged passenger groups, without considering factors other than accessibility or equitable outcomes. A common assumption in research is that accessibility should be the same for all users, or at least that changes in public transport design should aim to provide better accessibility for potentially vulnerable and disadvantaged passenger groups. If research focuses ‘only’ on how changes in public transport systems can achieve more equitable outcomes, or benefit potentially disadvantaged groups of users, then proposals such as reducing fares become easy to make (as described in the above quote in terms of discussing trade-offs between social benefits and fares). Trade-offs in public transport planning are seldom discussed.

Additionally, discussions about the policy context within which the trade-offs occur are usually lacking. By public transport’s ‘policy context’ we mean the public

transport organization and the various policy goals – not only improved equity and accessibility but also environmental and economic goals – that it needs to consider when designing public transport systems.

Furthermore, few publications analyse the practical implications and feasibility of changes in public transport planning aiming to improve accessibility for potentially disadvantaged passenger groups. In a rare analysis of the equity of accessibility provision and ‘legitimate’ factors that warrant differentiation in accessibility, Rubensson et al. [44] conclude that:

Providing public transport with the same accessibility and performance for all citizens is practically infeasible in all but very generalized and simplified cases. In all actual cities, land use patterns, network geometry, and economies of scale make it very expensive to provide the same level of accessibility to all. It is even questionable if this is a desirable goal to have, given the significant differences in production cost per accessibility unit in different parts of the network. (p. 1)

However, research rarely discusses results in relation to real-world planning conditions and practices, and the conditions for implementing proposed changes in planning praxis. References to what decisions ‘planners’ or ‘policy makers’ should make are most often made without indicating how the organizational and legislative conditions they operate within may shape decision-making practices and what is considered best practice in planning. It is also often unclear who these politicians and planners are and which organizations they represent.

For example, there is little discussion about how, in some countries, public transport is a service supplied on a market or involving profit-driven organizations. An illustration of this is how private transport providers in so called market initiative regimes are entitled to create new transport services autonomously from requests by (transport) authorities [57, 58]. One can use the deregulation of the British bus sector (outside London) as an example of how organizational and legislative conditions may shape decision-making practices. The deregulation led to a stronger focus on service attractiveness (for example straightening routes) and it introduced a clear split between the commercial focus of the operators and the social focus of authorities [57]. This shows that the organizational and legislative conditions can be assumed to affect how public transport organizations weigh the mobility needs of potentially disadvantaged passenger groups against other policy goals at different planning levels. However, in research, it is common to discuss how the mobility needs of potentially disadvantaged passenger groups should be met in isolation from

the organizational and policy context of public transport. Without taking this policy and organizational context into account, conclusions that there is a need to improve accessibility for potentially disadvantaged passenger groups appear rather simplistic and based on value-free judgements.

In addition, the changes proposed in the public transport system design would, in practice, involve major changes to existing systems. Research rarely discusses how possible or practically feasible the proposed changes are for public transport organizations. An example is how Allen and Farber [53] conclude that:

[...] policies that extend the rapid transit network into transit-poor inner suburban neighbourhoods [in the Greater Toronto and Hamilton Area, Canada] should be pursued with priority. [...] We see two avenues for cost-effective and immediate interventions on the horizon. The first is the adoption and delivery of new transit paradigms such as demand-responsive transit, where the abandonment of the fixed route, and sometimes the use of smaller vehicles, can potentially achieve far greater levels of ridership, higher levels of user satisfaction, and efficiencies in delivery compared to traditional means of transit coverage [...]. (p. 15)

In summary, the research provides some answers to the questions of how and when more emphasis should be placed on meeting the mobility needs of potentially disadvantaged passenger groups, but it does so in a fairly simplistic way. The research primarily analyses accessibility without taking other factors into account, and it often suggests changes in public transport design without discussing their feasibility. It is a result of the fact that the policy context of public transport is rarely part of the analysis. Neither is the context of people’s everyday life part of the analysis, informed knowledge on the social context is lacking, most of the analyses are based on rather rough population categories and simplified assumptions about them.

4 Conclusions

The starting point for this paper was the need to summarize and discuss the contribution research makes to the question about how public transport planning can better weigh social benefits in comparison with more conventional public transport planning objectives such as efficiency and cost minimization. The ambition has been to summarize public transport research on social considerations and discuss the research’s potential contribution to planning practice.

Overall, research contributes knowledge about public transport systems and the effects of investments,

including how to direct them to places and groups in greatest need. Research also offers an abundance of methods that can evaluate potentially disadvantaged passenger groups' access to work, healthcare, education, etc. by public transport when deciding on an equitable design of public transport systems. These methods can also determine the extent to which improved accessibility leads to more active participation in various activities (see Sect. 3.2). However, the extent to which existing research can contribute knowledge about how public transport planning can better weigh social benefits in comparison with other public transport planning objectives is limited. It is biased towards developing methods used to analyse the accessibility of potentially disadvantaged groups through existing public transport systems in individual cities. Additionally, research often takes place from a perspective of equity or justice, usually suggesting changes in the design of the public transport system to improve accessibility for potentially disadvantaged groups in a way that is judged to be equitable. Our claim is that this main direction of the research results in a lack of knowledge in at least five areas.

First, there is a lack of detail when it comes to the unique characteristics and needs of different demographic groups in various districts and cities (e.g. [35, 37, 45], see also [25] for a problematization). This indicates a tendency towards generalization in categorizing population and user groups, which could be addressed by incorporating more detailed and localized knowledge into research methodologies.

Second, the predominant focus of the research is on analysing the accessibility of user groups in existing public transport systems or assessing the impact of changes post-implementation (ex-post) (e.g. [36, 39]). There is a notable scarcity of studies that proactively examine (ex-ante) the potential impacts on accessibility during the planning stages of public transport systems [40, 41]. More such studies are needed because of the importance of considering the needs of potentially vulnerable groups early in planning processes within the established routines and amidst the conflicts of interest that characterize public transport planning.

Third, relatively few publications analyse how public transport planning can better weigh social benefits in comparison with objectives other than accessibility or equity, such as efficiency and cost minimization. Notable exceptions are [40, 41, 54–56]. Research usually proposes changes ex-post based solely on a desire to improve accessibility for potentially disadvantaged groups. There is a lack of research on aspects other than equity and accessibility that influence planning practices. For example, little research focuses on public transport's contribution to ecologically sustainable transport systems and

how environmental issues should be weighed against social considerations, or on the accessibility needs of potentially disadvantaged groups. Conventional public transport planning's prioritization of services that have the most passengers and the greatest potential to increase the number of passengers has been developed not based solely on the need for public transport providers to plan for efficiency and cost minimization. It has also been developed because of the need to strengthen public transport's competitiveness vis-à-vis car traffic and because of political ambitions for more (ecologically) sustainable transport systems. How all these interests are weighed in policy and planning also affects how social considerations are and should be handled. Additionally, it is not obvious that investment in public transport for potentially disadvantaged groups is the most effective way of conducting social policy, especially if social needs are to be weighed against other benefits that public transport contributes. Sometimes there are 'legitimate' factors that warrant differentiation in accessibility given the differences in production cost per accessibility units in different parts of the networks [44]. In summary, there is a need for more research on how to manage conflicting interests in planning, for example, through composite methods. Such methods should consider how environmental factors can be integrated into planning and be weighed against other factors, such as the social contribution of public transport.

Fourth, research often overlooks the institutional norms and objectives that govern planning practices. The planning practices of public transport providers appear to be a black box, lacking transparency regarding their internal dynamics. For instance, much of the research adopts a 'technical orientation,' focusing on the development and description of quantitative methods for assessing accessibility. This approach frequently presumes that public transport planning is a rational and non-political activity. Consequently, the methods developed seem to assume 'a rational decision-making process, while the decision to include equity considerations in these evaluations is ultimately a political one' ([59], p. 77). This assumption raises questions about the relevance of these methods to policy makers and planners responsible for planning public transport systems.

Fifth, a critical observation is that the practical applicability of the methods discussed in the research is rarely addressed. The relevance of these methods to policy makers and planners responsible for planning public transport systems remains largely unexplored. This raises questions about the real-world utility of the research. For example, are the necessary resources (such as expertise, data access, and time) available to the public transport providers expected to use the methods? Overall, the

research seems more aimed at contributing to academic discourse and enhancing individual researchers' merits in academic publishing than providing usable methods and insights to the industry.

To conclude, there is a risk that the prevailing orientation of the research creates a theory–practice gap, either because of a disconnection between research and the practical needs of the industry, or because of differences in the goals of researchers and public transport providers. This gap highlights the need for research that is more attuned to the complexities and goal conflicts of real-world public transport planning. A better understanding of real-world planning also requires an analysis of how the division of responsibilities and organizational structures of public transport in different countries may affect or facilitate a cohesive, system-wide approach to public transport design where social considerations are an integrated part. Our hope is that, if the research can become better at analysing how the potential tensions between social, economic, and environmental considerations play out in real-world public transport planning, it can make a greater contribution to what can be called 'sustainable accessibility'. The scholarly implications of our results thus point to a need for more nuanced definitions and treatment of social categories, more in-depth analyzes of potential social impacts during the planning stage of public transport systems that consider conflicting objectives in planning and that develop methods useful for the industry. Finally, to be able to do the above, research needs to get better at analyzing social factors within the framework of public transport's policy context.

Appendix

Table 2 Publications chosen for inclusion in the analysis

Author(s)	Title	Journal	Keywords ≤6	Coyntry / Region, City
1 Allen & Farber (2020) [53]	Planning transport for social inclusion: An accessibility-activity participation approach	Transportation Research Part D, 78, 102212, https://doi.org/10.1016/j.trd.2019.102212	accessibility; activity participation; public transit; social equity; transport planning	Greater Toronto and Hamilton Area (GTHA), Canada

Author(s)	Title	Journal	Keywords ≤6	Coyntry / Region, City
2 Asghar-pour et al. (2023) [38]	Investigating equity of public transit accessibility: Comparison of accessibility among disadvantaged groups in Cook County, IL	ASCE. International Conference on Transportation and Development 2023: Transportation Planning Operations and Transit, https://ascelibrary.org/doi/abs/10.1061/9780784484883.055	accessibility; equity; public transit; spatial analysis; transport disadvantaged persons	Cook County, Illinois, US
3 Bejlari et al. (2018) [45]	Analytical Method to Determine Transportation Service Gaps for Transportation Disadvantaged Populations	Transportation Research Record, 2672 (8): 649–661, https://doi.org/10.1177/0361198118794290	motor transportation; taxi cabs (on-demand service); accessibility measures; analytic method; comprehensive transportation	Alachua County, Florida, US
4 Ben-Elia & Benenson (2019) [50]	A spatially-explicit method for analyzing the equity of transit commuters' accessibility	Transportation Research Part A, 120: 31–42, https://doi.org/10.1016/j.tra.2018.11.017	accessibility; accessibility loss; equity; Gini index; public transit	Metropolitan area of Tel Aviv, Israel
5 Bhattacharya et al. (2013) [60]	Restructuring from a Central Business District-Focused to a Decentralized Transit System. Case Study of Star Metro in Tallahassee, Florida, to Determine Restructuring Effects on Riders and Accessibility to Destinations	Transportation Research Record: Journal of the Transportation Research Board, 2350: 17–25, https://doi.org/10.3141/2350-03	bus stop; bus system; college students; transit networks; transit systems	Tallahassee, Florida, US
6 Blair et al. (2013) [42]	Analysing the impact of network change on transport disadvantage: a GIS-based case study of Belfast	Journal of Transport Geography, 31: 192–200, http://dx.doi.org/10.1016/j.jtrangeo.2013.06.015	disadvantage; GIS; low income; methodology; network change	Belfast, Northern Ireland

Author(s)	Title	Journal	Keywords ≤6	Coyntry / Region, City	Author(s)	Title	Journal	Keywords ≤6	Coyntry / Region, City
7 Bocarejo & Oviedo (2012) [46]	Transport accessibility and social inequities: a tool for identification of mobility needs and evaluation of transport investments	Journal of Transport Geography, 142–154, https://doi.org/10.1016/j.jtrangeo.2011.12.004	accessibility; developing countries; social equity; social exclusion; urban transport	Bogotá, Colombia	14 Campo-reale et al. (2019) [64]	Modeling horizontal and vertical equity in the public transport design problem: A case study	Transportation Research Part A, 125: 184–206, https://doi.org/10.1016/j.tra.2018.04.006	equity indicator; network design; public transport; route set generation procedure; social inclusion	Molfetta, Italy
8 Bonner & Miller-Hooks et al. (2023) [61]	Achieving equitable outcomes through optimal design in the development of micro-transit zones	Journal of Transport Geography, 112: 103696, https://doi.org/10.1016/j.jtrangeo.2023.103696	accessibility; equity; micro transit; mobility; on-demand transit	Washington, D.C., US	15 Cao et al. (2018) [37]	Measurement and spatial differentiation characteristics of transit equity: A case study of Guangzhou, China	Sustainability, 10(4), 1069, https://doi.org/10.3390/su10041069	horizontal equity; public transit; supply-demand gaps; vertical equity; demand analysis	Guangzhou, China
9 Braga et al. (2023) [28]	Evaluating the impact of public transport travel time inaccuracy and variability on socio-spatial inequalities in accessibility	Journal of Transport Geography, 109: 103590, https://doi.org/10.1016/j.jtrangeo.2023.103590	access; equity; social impacts; travel time reliability; urban transit	Fortaleza, Brazil	16 Chen et al. (2018) [37]	Spatial gaps in urban public transport supply and demand from the perspective of sustainability	Journal of Cleaner Production, 195: 1237–1248, https://doi.org/10.1016/j.jclepro.2018.06.021	public least squares (PLS) path modelling; public transport; seniors; social equity; sustainability	Edmonton, Canada
10 Breau et al. (2023) [62]	Inclusive growth, public transit infrastructure investments and neighbourhood trajectories of inequality in Montreal	Environment and Planning A: Economy and Space, 55(8): 2009–2030, https://doi.org/10.1177/0308518X231162091	accessibility; inclusive growth; neighbourhood income disparities; public transit infrastructure	Montreal, Canada	17 Chen & Jiao (2022) [65]	Are There Transit Deserts in Europe? A Study Focusing on Four European Cases through Publicly Available Data	Sustainability, 14(20): 13182, https://doi.org/10.3390/su142013182	demand and supply; land use; regional analysis; transit desert; transit equity	Grand Paris, France; Greater London, UK; Madrid, Spain; and Milan, Italy
11 Bruzzone et al. (2023) [22]	The definition of equity in transport	Transport Research Procedia 69: 440–447, https://doi.org/10.1016/j.trpro.2023.02.193	accessibility; decision making; definitions; equity; public transit	Rome, Italy	18 Cottrill et al. (2020) [66]	Can multi-modal integration provide enhanced public transport service provision to address the needs of vulnerable populations?	Research in Transportation Economics, 83, 100954, https://doi.org/10.1016/j.retrec.2020.100954	demographics; flexible public transport; geographies; inclusion; public transport	Europe
12 Bueno Cadena, et al. (2016) [63]	Social and distributional effects of public transport fares and subsidy policies: Case of Madrid, Spain	Transportation Research Record, 2544(1):47–54, https://doi.org/10.3141/2544-06	economic analysis; mass transportation; regression analysis; transportation charges; disadvantaged groups	Madrid, Spain	19 Currie (2010) [29]	Quantifying spatial gaps in public transport supply based on social needs	Journal of Transport Geography, 18(1): 31–41, https://doi.org/10.1016/j.jtrangeo.2008.12.002	accessibility; public transport; social exclusion; transport needs; disability	Melbourne, Australia
13 Campo-reale et al. (2017) [40]	Quantifying the impacts of horizontal and vertical equity in transit route planning	Transportation Planning and Technology, 40(1): 28–44, https://doi.org/10.1080/03081060.2016.1238569	accessibility; equity network design; transit planning; costs; highway planning		20 Cuthill et al. (2019) [67]	The association between Urban Public Transport infrastructure and social equity and spatial accessibility within the urban environment: An investigation of Tramlink in London	Sustainability, 11(5), https://doi.org/10.3390/su11051229	geographic weighted regression; light railway; social equity; spatial accessibility; transport infrastructure investment	London, UK

Author(s)	Title	Journal	Keywords ≤6	Country / Region, City	Author(s)	Title	Journal	Keywords ≤6	Country / Region, City
21 Dai et al. (2023) [68]	Accessibility-based ethics-aware transit design	Transportation Research Part B, 102816, https://doi.org/10.1016/j.trb.2023.102816	accessibility; equity; maximization; public transit; system design		28 Gori et al. (2020) [73]	Equity measures for the identification of public transport needs	Case Studies on Transport Policy, 8(3): 745–757, https://doi.org/10.1016/j.cstp.2020.06.006	equity measures; public transport equality; transit demand; data quality; identification method	Rome, Italy
22 El-Geneidy et al. (2016) [51]	The cost of equity: Assessing transit accessibility and social disparity using total travel cost	Transportation Research Part A, 91: 302–316, https://doi.org/10.1016/j.tra.2016.07.003	accessibility; equity; low wage; public transport; sectorial	Montreal, Canada	29 Guzman et al. (2023) [74]	How much is accessibility worth? Utility-based accessibility to evaluate transport policies	Journal of Transport Geography, 112, 103683, https://doi.org/10.1016/j.jtrangeo.2023.103683	access; public transit; socioeconomic factors; stated preferences; transportation planning	Bogotá, Colombia
23 Ermagun et al. (2023) [32]	Inequity analysis of spatial mismatch for low-income socially vulnerable populations across America	Transportation Research part D, 118, 103692, https://doi.org/10.1016/j.trd.2023.103692	equity; low-income groups; public transit; socioeconomic factors; spatial analysis	America	30 Hasan et al. (2023) [75]	Employing Geographic Information Systems in Analyzing Pedestrian Accessibility to Public Bus Stops in Halifax	Journal of Urban Planning and Development, 149(3), https://doi.org/10.1061/JUPDDM.UPENG-4268	bus routes; socioeconomic character; transit system; urban area; age groups	Halifax Regional Municipality (HRM), Canada
24 Faghihinejad et al. (2022) [69]	Evaluating Social and Spatial Equity in Public Transport: A Case Study	Transportation Letters, https://doi.org/10.1080/19427867.2022.2158541	accessibility; planning; public transportation; social equity; sustainable development	Tehran, Iran	31 Ji et al. (2015) [76]	Spatial deprivation characteristics of public transportation in rapid urbanization area	Jiaotong Yunshu Xitong Gongcheng Yu Xinxi/ Journal of Transportation Systems Engineering and Information Technology, 15(6): 33–38, http://www.tseit.org.cn/EN/abstract/abstract19113.shtml	rapid urbanization area; spatial analysis; spatial deprivation features of public transportation; transportation equity; urban traffic	Chenggong New District, China
25 Fransen et al. (2015) [70]	Identifying public transport gaps using time-dependent accessibility levels	Journal of Transport Geography, 48, 103692: 176–187, https://doi.org/10.1016/j.jtrangeo.2015.09.008	GIS; public transport; social exclusion; transport disadvantage; transport gap	Flanders, Belgium	32 Kolkowski et al. (2023) [34]	Measuring activity-based social segregation using public transport smart card data	Journal of Transport Geography, 110, 103642, https://doi.org/10.1016/j.jtrangeo.2023.103642	activity centers; public transit; socioeconomic factors; transit riders	Stockholm County, Sweden
26 Frias-Martinez et al. (2023) [71]	The BALTO Toolkit—A New Approach to Ethical and Sustainable Data Collection for Equitable Public Transit	COMPASS 23: Proceedings of the 6th ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies, 129–133, https://doi.org/10.1145/3588001.3609374	data collection; equity; public transit; sustainability	Baltimore Maryland, US	33 Langford et al. (2012) [48]	Measuring transit system accessibility using a modified two-step floating catchment technique	International Journal of Geographical Information Science, 26(2): 193–214, https://doi.org/10.1080/13658816.2011.574140	accessibility; floating catchment analysis; GIS; public transport; social exclusion	Cardiff, Wales, UK
27 Giuffrida et al. (2022) [72]	A Simplified Framework for the Equity-Based Spatial Assessment of Alternative Public Transport Networks	Sustainability, 14(24), 16606, https://doi.org/10.3390/su142416606	accessibility; equity; public transport; social inclusion; network design	Apulia region, Italy					

Author(s)	Title	Journal	Keywords ≤6	Country / Region, City	Author(s)	Title	Journal	Keywords ≤6	Country / Region, City
34 Langford et al. (2012) [48]	Using floating catchment analysis (FCA) techniques to examine intra-urban variations in accessibility to public transport opportunities: The example of Cardiff, Wales	Journal of Transport Geography, 25(1): 1–14, https://doi.org/10.1016/j.jtrangeo.2012.06.014	accessibility; floating catchment analysis; GIS; public transport; social exclusion	Wales, UK	40 Morozov et al. (2023) [79]	Assessment of Spatial Inequality Through the Accessibility of Urban Services	Lecture Notes in Computer Science, 13957, LNCS, 256–270, Gervasi, O., Murgante, B., Taniar, D., Apduhan, B.O. Braga, A.C., Garau, C. & Stratigea, A. (Eds.), https://link.springer.com.proxy.mau.se/chapter/10.1007/978-3-031-36808-0_18	spatial inequality; sustainability; sustainable mobility; transport accessibility	
35 Lättman et al. (2016) [26]	Perceived accessibility of public transport as a potential indicator of social inclusion	Transport Policy and Society, 4(3): 36–45, https://doi.org/10.17645/si.v4i3.481	perceived accessibility; public transport; social exclusion; social inclusion; subjective well-being	City of Karlstad, Sweden	41 Nazari et al. (2019) [80]	Justice in public transport systems: A comparative study of Auckland, Brisbane, Perth and Vancouver	Cities, 90: 88–99, https://doi.org/10.1016/j.cities.2019.01.031	accessibility; equity; justice; public transport; comparative study	Auckland, New Zealand; Brisbane and Perth, Australia; Vancouver, Canada
36 Lee & Kim (2023) [31]	Social equity analysis of public transit accessibility to healthcare might be erroneous when travel time uncertainty impacts are overlooked	Travel Behaviour and Society, 32, 100588, https://doi.org/10.1016/j.tbs.2023.100588	equity; health care; public transit; travel time; uncertainty	Columbus, Ohio, USA	42 Park et al. (2022) [41]	Multiobjective approach to the transit network design problem with variable demand considering transit equity	Journal of Advanced Transportation, 2022, 5887985, https://doi.org/10.1155/2022/5887985		City of Goyang, Republic of Korea
37 Li & Fan (2020) [47]	Modeling and Evaluating Public Transit Equity and Accessibility by Integrating General Transit Feed Specification Data: Case Study of the City of Charlotte	Journal of Transportation Engineering Part A: Systems, 146(10), https://doi.org/10.1061/JTEPBS.0000426	accessibility; equity; GIS; public transit; public policy	Charlotte city, North Carolina, US	43 Peungnumesai et al. (2020) [81]	A grid-based spatial analysis for detecting supply–demand gaps of public transports: A case study of the Bangkok metropolitan region	Sustainability, 12(24), 10381, 1–27, https://doi.org/10.3390/su122410382	geospatial analysis; public transport; public transport accessibility; supply–demand gaps; transport equity	Bangkok Metropolitan Region (BMR), Thailand
38 Li et al. (2023) [77]	Collective and individual spatial equity measure in public transit accessibility based on generalized travel cost	Research in Transportation Economics, 98, 101263, https://doi.org/10.1016/j.retrec.2023.101263	accessibility; equity; public transit; traffic analysis zones; travel costs	Kunming City, China	44 Pineda (2013) [82]	What Can Engineering Systems Teach Us About Social (In)Justices? The Case of Public Transportation Systems	Philosophy of Engineering and Technology, 10: 203–226, https://doi.org/10.1007/978-94-007-6350-0_10	engineering models; social justice; urban transportation projects	Bogotá, Colombia
39 Lizárraga et al. (2020) [78]	Evaluating public transport social exclusion in Guadalajara, Mexico	WIT Transactions on the Built Environment, 200: 195–203, https://www.witpress.com/elibrary/wit-transactions-on-the-built-environment/200/37814	social exclusion; access time disadvantage; transport social disadvantage	Guadalajara, Mexico	45 Pittman & Day (2015) [83]	Locating and quantifying public transport provision with respect to social need in Canberra, Australia	Australian Planner, 52(4): 326–336, https://doi.org/10.1080/07293682.2015.1101007	accessibility; public transport; social exclusion	Canberra, Australia

Author(s)	Title	Journal	Keywords ≤6	Country / Region, City	Author(s)	Title	Journal	Keywords ≤6	Country / Region, City
46 Pramanik et al. (2023) [84]	Equity Promotion in Public Transportation	Proceedings of the 37th AAAI Conference on Artificial Intelligence, (AAAI, 2023), 37: 11890–11898, https://doi.org/10.1609/aaai.v37i10.26403	bias; fairness & equity; transportation; optimization of spatio-temporal systems; scheduling	City of Chicago, US	52 Ryan et al. (2023) [33]	Accessibility and space–time differences in when and how different groups (choose to) travel	Journal of Transport Geography, 111, 103665, https://doi.org/10.1016/j.jtrangeo.2023.103665	access; commuters; equity; public transit; travel time	Stockholm, Sweden
47 Robbenholt & Witmer (2023) [27]	GIS-based approach to dynamic accessibility: Incorporating a user perspective to recognize social equity implications	Transportation Research Record, 2677(7): 22–33, https://doi.org/10.1177/03611981221150917	accessibility; contextual engineering; GIS; planning and development; public transportation	Cities of Champaign, Urbana, and Savoy, Illinois, US	53 Ryerson et al. (2022) [52]	Toward equity-driven planning typologies: Using accessibility and individual constraints to guide transportation investments	Transportation Research Part D, 209, 103378, https://doi.org/10.1016/j.trd.2022.103378	accessibility; cluster analysis; individual constraints; transportation equity; distribution function	Region of Philadelphia County, Pennsylvania, US
48 Rodrigue et al. (2023) [85]	An accessibility-based methodology to prioritize public-transit investments: Application to older adults in three metropolitan regions in Canada	Applied Geography, 158, 103022, https://doi.org/10.1016/j.apgeog.2023.103022	accessibility; aged; equity; investments; public transit	Montreal, Toronto and Vancouver, Canada	54 Sharma et al. (2020) [49]	Equity of transit connectivity in Tennessee cities	Journal of Transport Geography, 86, https://doi.org/10.1016/j.jtrangeo.2020.102750	connectivity; equity; Gini index; open-source-data; public transit accessibility	Metropolitan Cities in the state of Tennessee, US
49 Rubenson et al. (2020) [44]	Fair accessibility – Operationalizing the distributional effects of policy interventions	Journal of Transport Geography, 89, https://www.sciencedirect.com/science/article/pii/S0966692320309674	accessibility; equity; Lorenz curve; public transport; skip-stop	Stockholm County, Sweden	55 Stjernborg & Mattisson (2016) [88]	The role of public transport in society-A case study of general policy documents in Sweden	Sustainability, 8(11), 1120; https://doi.org/10.3390/su8111120	benefits; impacts; local governments; public values, qualitative content analysis	Sweden
50 Ruiz et al. (2016) [86]	Assessing equity of public transport: The case of Palma (Mallorca, Illes Balears)	Estudios Geograficos, 77(281), 619–646, https://doi.org/10.3989/estgeogr.201621	Gini coefficient; GIS transport; Lorenz curve; multicriteria analysis; network analysis	Palma, Mallorca	56 Tanvir et al. (2023) [35]	Equitable access to transit – Case study of transportation network company (TNC) users in Chicago	ASCE. International Conference on Transportation and Development 2023: Transportation Planning Operations and Transit, CPAPER, https://doi.org/10.1061/9780784484883.055	access; equity; metrics (quantitative assessment); mode choice; public transit	Chicago, Illinois, US
51 Ruiz et al. (2017) [87]	Improving Bus Service Levels and social equity through bus frequency modelling	Journal of Transport Geography, 58, 220–233, https://doi.org/10.1016/j.jtrangeo.2016.12.005	public transport; bus headways optimization; social equity; spatial equity; simulation GIS-T	Palma, Mallorca	57 Tomasiello et al. (2023) [89]	A time interval metric for cumulative opportunity accessibility	Applied Geography, 157, 103007, https://doi.org/10.1016/j.apgeog.2023.103007	cumulative accessibility; travel time and time interval; equity; public transport; transport policy	Fortaleza, Brazil

Author(s)	Title	Journal	Keywords ≤ 6	Country/Region, City
58 Verlinghieri & Schwanen (2020) [25]	Transport and mobility justice: Evolving discussions	Journal of Transport Geography, 87, 102798, https://doi.org/10.1016/j.jtrangeo.2020.102798		
59 Wang & Chen (2021) [55]	A multi-objective optimization approach to balancing economic efficiency and equity in accessibility to multi-use paths	Transportation, 48(4): 1967–1986, https://doi.org/10.1007/s11116-020-10117-9	accessibility; geographically weighted regression; multi-use path; optimization; transportation planning	Fresno, California
60 Wang et al. (2022) [56]	Where are equity and service effectiveness? A tale from public transport in Shanghai	Journal of Transport Geography, 98, 103275, https://doi.org/10.1016/j.jtrangeo.2021.103275	supply-demand gaps; public transport equity; service effectiveness; data development analysis	Shanghai, China
61 Wei et al. (2017) [54]	Evaluating public transit services for operational efficiency and access equity	Journal of Transport Geography, 65: 70–79, https://doi.org/10.1016/j.jtrangeo.2017.10.010	accessibility; accessibility method; equity; bus transport; data development analysis GIS	Wasatch Front, Utah
62 Wilson et al. (2023) [90]	Linking transportation agent-based model (ABM) outputs with micro-urban social types (MUSTs) via typology transfer for improved community relevance	Transport Research Interdisciplinary Perspectives, 17, 100748, https://doi.org/10.1016/j.trip.2022.100748	mathematical model; mobility; mode choice; socioeconomic factors; spatial analysis	San Francisco, New York City and Chicago, US
63 Xiao et al. (2017) [91]	Transportation Disadvantage and Neighborhood Sociodemographics: A Composite Indicator Approach to Examining Social Inequalities	Social Indicators Research, 137: 29–43, https://doi.org/10.1007/s11205-017-1616-2	principle component analysis; social indicators; social inequalities; transport disadvantage; transport opportunity	Shenzhen, China
64 Tao & Zhao (2023) [92]	Planning for equal transit-based accessibility of healthcare facilities: A case study of Shenzhen, China	Socio-Economic Planning Sciences, 88, 101666, https://doi.org/10.1016/j.seps.2023.101666	equality; location-allocation modelling; healthcare facility; equal accessibility; transit	Shenzhen, China

Acknowledgements

Not applicable.

Authors' contributions

Data collection and first analysis: R.H. and L.L.. Writing—Review & Editing: R.H., L.L. and R.C.

Funding

Open access funding provided by Malmö University. This work was supported by K2—The National Swedish Knowledge Centre for Public Transport. K2 had no involvement in the data collection, analysis, and interpretation, or in the writing of the paper.

Availability of data and materials

Not applicable.

Declarations

Competing interests

No potential conflict of interest was reported by the authors.

Received: 2 April 2024 Accepted: 9 July 2024

Published online: 29 July 2024

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