

1 Searching for standards of fairness in the transportation 2 literature

3 AAA, BBB

4 Abstract

This work provides a synthesis of how transportation fairness, justice and equity literature has operationalized standards. We first outline a flexible framework for engaging fairness questions and then apply it to collate the literature review's results. We find most articles were published within the last half decade and center urban areas, with 40% exploring Global South case studies. Income groups, followed by specific age groups (i.e., older adults) and people with disabilities, are most commonly the subjects of justice. Transit and pedestrian modes are the most frequently studied mobility tools; with many analyses being multimodal and comparative in nature. The benefits and burdens, the "What" of mobility, focuses on movement (i.e., quality of trips taken) or the potential for movement (i.e., accessibility). How the reviewed works conceptualize fairness is varied (e.g., Vertical Equity, Wellbeing, Rights-Based); but is often delineated with a supporting opportunity standard (37%) (i.e., number of parks within a 30-minute travel time) or population standard (36%) (i.e., bottom income quartile), though Infrastructure (i.e., level of service) and Environmental+ (i.e., air pollution) standards are also prominent. While the reviewed literature is extensive, we conclude with calls to action for researchers, practitioners, and transportation advocates to drive meaningful change. These include developing standards based on rigorous conceptualizations, advancing systems-thinking approaches to fairness, ensuring data accessibility as a matter of justice, strengthening the connection between standards and lived experiences, and rigorously evaluating interventions and policies.

5 *Keywords:*

6 transportation; equity; justice; fairness; standards; transportation planning;
7 literature review

8 1. Introduction

9 Transportation systems are technologies essential for social inclusion and activ-
10 ity participation, and therefore important from an equity perspective ([Martens,](#)
11 [2016](#); [Karner et al., 2024](#); [Vecchio et al., 2020](#)). Beyond ethical motivations,
12 tracking objective and perceived inequalities is of interest for governing bodies to

respond to popular and needed demands for fairness. However, this has proven to be a challenging task: transportation systems are notoriously complex, with benefits and burdens that are diffuse over space and time. To compound matters, emerging technologies and service models can swiftly change the balance of benefits and burdens among a population (Guo et al., 2020). Transportation systems that are engineered to offer higher mobility for people *somewhere* can simultaneously cut others off from essential opportunities *elsewhere* (Raje, 2004). The shades of policies cast long shadows, as shown by the legacy of U.S. urban highways (Archer, 2020) and impacts of transportation-related climate change (Markolf et al., 2019).

Responding to this topic, a plethora of academic literature has emerged in recent decades. For instance, much research has been devoted to the issues of *measuring* equity in transportation (e.g., Delbosc and Currie, 2011b; Martens et al., 2019; Pritchard et al., 2022). Further, there are multiple works that discuss the conceptual and philosophical foundations of equity and fairness in transportation (e.g., Martens, 2016; Pereira et al., 2017; Vanoutrive and Cooper, 2019). Previous reviews of equity in planning documents have been tightly scoped to cover accessibility (e.g., Boisjoly and El-Geneidy, 2017-04) or a particular mode of transportation (e.g., cycling in Doran et al., 2021). While these efforts are valuable, there remains a gap in terms of understanding *how* standards for equity are developed and implemented for transportation systems.

The objective of this work is to broadly scan the state of this knowledge. Through a distributive justice lens (Pereira et al., 2017; Pereira and Karner, 2021), our work seeks to make two contributions. First, it outlines a conceptual and flexible framework for engaging and analysing transportation fairness questions, based on the questions “Why?”, “Where?”, “When?”, “Who?”, “What?”, and “How?” (5WH). Second, it applies the framework to collate the existing knowledge about fairness standards. To achieve this, we scan the state of academic knowledge in defining standards of fairness in transportation. In contrast to previous reviews on measuring inequality in transportation systems, this work is concerned with the implicit or explicit standards used to judge whether inequalities are fundamentally “fair” or unacceptable.

2. Background

2.1. Definitions

Fairness, equity and justice are closely related and often colloquially used interchangeably. In this section, we clarify these concepts’ definitions to facilitate their precise use throughout the manuscript.

Fairness is a subjective and moral assessment of a treatment, outcome, or both, in relation to a given state of affairs. Within the transportation domain, the fairness of the distribution of transportation “goods” and “burdens” (e.g., access to opportunities, transportation-related externalities) for individuals, groups and society is often at issue (Pereira and Karner, 2021). For ex-

ample, congestion pricing schemes could be unfair if they disproportionately disadvantage lower income groups (Eliasson, 2016), systems designed to service “mandatory” destinations like employment or commercial retail that are not as relevant to all populations like those entangled in caring -work (Ravensbergen et al., 2023; Hail and McQuaid, 2021), or even the application of justice such as Title VI of the U.S. Civil Rights Act of 1964 for the purpose of accessibility planning as discussed in Martens and Golub (2021). Individuals may feel certain situations are unfair, processes can be seen as unfair, or even outcomes of these processes and situations can be unfair.

There are a multitude of aspects to **fairness** in transportation (Hail and McQuaid, 2021), namely because the distribution of transportation “goods” and “burdens” are often ambiguous. Individuals’ ability to access and benefit from transportation-related outcomes varies continuously, often in ways that are unrecognized (implicitly or explicitly) or inadequately considered by transportation planners and other influential actors in the system. To put it briefly, when it comes to the distribution of “goods,” fairness can be understood as a *moral* appraisal concerning the amount and strength of moral claims to those goods (Wintein, 2024). Hence, in this manuscript, we define **fairness** as the moral evaluation of the rightness or wrongness of a given state of affairs (e.g., the impartiality and consistency of treatment or associated outcomes). In other words, fairness serves as a yardstick for justice.

Relatedly, **justice** can be viewed as the formalized goal of fairness, an analytically reasoned *fair* state of affairs. Justice is attained when people “give and receive whatever they are due” (Jaggar, 2009, pp. 1-2), and it ceases to exist when there are persons or groups that are denied “access to the opportunities they need to lead a meaningful and dignified life” (Karner et al., 2020, p. 440). Different scopes and approaches to justice have been developed, as formalizing fairness depends on the desirability of different states of affairs, which depend on populations, places, times, and different scopes. For instance, several forms of justice can be distinguished (Jaggar, 2009; Pereira et al., 2017; Karner et al., 2020):

- **Retributive justice** is concerned with the proportional retribution of wrongdoers relative to legitimate punishers and the innocent (Walen, 2023).
- **Reparative (or restorative) justice** focuses on the reparation of caused harm; it centers the needs and voices of victims to restore wrongdoers and the community according to moral values (Tyler, 2006; Braithwaite et al., 2003). In planning and policy contexts, reparative justice involves accountability mechanisms (material, powers, rights, processes) to compensate victims (Safransky, 2022; Williams and Steil, 2023).
- **Procedural justice** strives to ensure that the views and preferences of all stakeholders are fairly accounted for in the decision-making and interpersonal procedures affecting their lives and communities (Tyler, 2006).

98 • **Distributive justice** is perhaps the most studied form of justice in trans-
 99 portation (Pereira et al., 2017) and elsewhere (see Jaggar, 2009, p. 2). Its
 100 main concern is the collection of benefits and burdens of the tangible and
 101 intangible products of society by different segments of a population. The
 102 just distributive aspects of transportation systems is also of focus in this
 103 work.

104 While justice (i.e., formalized fairness) is a broad moral concept, **equity** and
 105 **standards** can be understood as the ‘instruments’ of justice- the tools through
 106 which society moves towards a just state of affairs.

107 **Equity**, as conceptualized alongside distributive justice, tends to encompass
 108 tools to understand the distribution of benefits and burdens of things among
 109 a population (e.g., disparities), emphasizing those with the least advantage or
 110 most disadvantage. In the transportation domain, equity analysis often flows
 111 from the top: stemming from the authority of the state and meant to assist with
 112 decisions about regulating and financing spending (Karner et al., 2020). As in
 113 Karner et al. (2020), equity and disparity analysis should not be seen as an
 114 end in and of itself, but rather as a means to gather information about actual,
 115 observed, and perceived inequities.

116 And lastly, in this work’s context, a **standard** is a concrete statement about
 117 fairness; it is a formalized threshold in understanding disparities (i.e., related to
 118 equity) as part of the goal of formalized fairness (i.e., justice). A standard es-
 119 tablishes criteria for how benefits or burdens should be distributed or allocated
 120 in a way that aligns with moral or formalized principles. For example, a weak
 121 standard might be a Pareto improvement, where benefits may be concentrated
 122 in certain groups (even those already advantaged), as long as no group is made
 123 worse off compared to the existing situation (Tan et al., 2016; Xu et al., 2018).
 124 As another example, a more strict standard could be based on egalitarian prin-
 125 ciples (e.g., proportional equity) where the benefits or burdens are weighted by
 126 population; in the consistent application of this standard, each group would give
 127 or receive in proportion to their relevant ‘size’ (Bills and Walker, 2017; Martens
 128 et al., 2012). In contrast, an affirmative action standard (i.e., those related to
 129 restorative justice) could be an even stricter standard, requiring the benefits to
 130 be distributed in a non-egalitarian way to favour people still harmed by past or
 131 present discriminatory practices (Bierbaum et al., 2021).

132 To summarise, in this work we use **justice** to describe a moral target, **fairness**
 133 as an evaluation or yardstick of justice, **equity** as a set of related disparity
 134 measurement tools, and **standards** as concrete statements of fairness.

135 2.2. A framework to analyze questions of justice: 5WH

136 Having defined justice, fairness, equity and standards, we approach the litera-
 137 ture with an analytical apparatus inspired by the framing of Jaggar (2009) for

philosophical questions of justice.¹. According to Jaggard (2009), Western philosophy has approached the issue of justice by asking “Why?”, “Where?”, “When?”, “Who?”, “What?”, and “How?” (5WH), applying them to a particular domain or sphere of life relevant to justice.

In the case of transportation, the question of “**Where?**” is paramount as transportation by its very nature concentrates the benefits (e.g., access points to the system are not ubiquitous). The burdens, in contrast, are often diffuse: they are incrementally paid, for example, by a distributed population in the form of taxes, or by a (possibly different) population in the form of poor health. As such, the answer to “Where?” is the definition of the spatial boundaries.

Conventionally, the question of “**When?**” refers to the temporal circumstances within which the demands of justice apply. When it comes to transportation, questions regarding temporality are important in different domains: *when* did the analysis take place and under what historical policy context; *when* is *the right time* to invest in infrastructure and as a result *when* to generate a spatial inequality (Rabello Quadros and Nassi, 2015); for *how long* the burdens and benefits can be associated to a specific intervention; or even the *timeline* of reparative justice to reconcile the shadows of past transport-related injustices.

When asking “**Who?**”, we think about the entities that should be regarded as subjects/arbiters of justice. For tractability, this question is often approached through the filter of population groups, which may include several concurrent traits, including gender identity, ableness, ethnicity, age, caste, and income. Often, it is appropriate to consider the intersections between traits, given differences in a person’s lived experiences. A complication in the case of transportation is that disentangling the “Who” from their mobility tools is not always straightforward. Although a person is not their mode of transportation, there are large segments of the population who cannot extricate themselves from the mobility tools they use, either because they have driven themselves out of choices (Lavery et al., 2013), or have been driven out of choices by factors beyond their control (Jacques et al., 2012). While it is important to avoid conflating the “Who” with the “What”, we need to be mindful of the connection between a person and their mobility tools for analytical purposes.

“**What?**” refers to which entities should be regarded as objects of inequities, meaning which categories of things should be distributed in a just manner. To understand the distributional implications of transportation systems, it is essential to understand what they *produce*. Transportation systems rely on technologies to improve the rate at which space is traded for time by increasing the speed of movement. But as the adage goes, travel is derived demand (Mokhtar-

¹Similar questions are found peppered throughout the literature. This is done either explicitly, as for example in Karner et al. (2020), who ask “of what”, “for whom,” and “how much” in reference to equity; or implicitly, as in Gössling (2016), who asks of the outputs (“what?”) of transportation (exposure, space, access) and “for whom?” (gender, age, ethnicity).

ian et al., 2001). For this reason, we cannot stop at considering only mobility but must consider its ulterior goal-reaching destinations. Coupled with land use, mobility creates accessibility to opportunities as well as varied burdens. For instance, some are direct and paid by the traveler (e.g., travel time, out-of-pocket costs), but many others are indirect and related to network externalities (e.g., exposure to pollution). Transportation justice, thus, involves proximate (mobility tools and mobility) and ulterior (accessibility and activity opportunities) objectives.

The next question is “**How?**”, and it relates to the allocation of various objects of justice (“what”) to various subjects of justice (“who”) in various circumstances (“when” and “where”). Fairness standards are an equity tool for answering this distributive question. The thresholds can be quantitative (e.g., square meters of green space per capita), qualitative descriptions (e.g., do not knowingly discriminate) or a mix of the two. Some examples include: maximum travel distance/cost/time to or from key destinations, levels of maximum exposure to externalities (i.e., noise or air pollution), un/fulfilled needs, and dis/satisfaction with travel. To support us when approaching this question, we draw from concepts in transport-related social exclusion, transport disadvantage, and transport poverty, which are typically based on utilitarian or sufficientarian philosophies. The “How?” is supported by fairness conceptualisations along with standards.

Above all, convincing answers to the above questions require a supporting rationale: a “**Why?**” (Jaggar, 2009). This is perhaps the most slippery of 5WH. Justice is inherently a social construct. Asking **Why?** amounts to asking what sort of social contracts regulate human interactions, that is, the self-imposed rules that result from our collective will to believe. These contracts can be defined by constitution, but there are often unwritten and possibly contested variants. In this way, analyzing the “Why?” in the corpus is not the focus of this review, partly because answers to “Why?” are seldom explicitly stated. Instead, our focus is on the standards of fairness that, combined with the use of analysis, can help us understand how better to move towards just transportation systems and better formulate answers to “Why?”.

2.3. Review methods

This work examines the academic literature on transportation to identify the extent to which standards for equity are defined and employed. In this task, we follow the Joanna Briggs Institute (JBI) approach to the conduct of scoping reviews, an approach that builds upon the Arksey and O’Malley (2005) framework (Peters et al., 2020). The review is also guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, particularly the extension for scoping reviews (PRISMA-ScR) which is consistent with the JBI approach (Tricco et al., 2018).

The primary research question and the protocol were initially defined by the authors, a group of experts in the field of transportation. The initial draft

of the protocol was refined from preliminary searches of related reviews (e.g., Zhang and Zhao, 2021; Pereira et al., 2017; Vecchio and Martens, 2021) and in consultation with research services librarians. The final protocol was released on OSF [redacted for double-blind review], and the methods are summarised as follows.

The search strategy was developed iteratively using **inclusion** and **exclusion** criteria (Peters et al., 2020). For the inclusion criteria, the mnemonic PCC (population, concept, and context) was adopted. The search strategy was refined by adding search terms. The terms were bundled by means of Boolean operators. These stages are summarised as follows (see Appendix Section 6.1 for details):

1. An initial limited search of Web of Science (WoS) Core Collection (containing journals, conference proceedings, and books published all over the world) was undertaken to identify key documents. Separate searches using the terms ‘transportation’ and ‘equity’ were generated. From these searches, we examined the text contained in the titles and abstracts, the index terms, and subject heading searches when available. As we developed a clearer outline of the literature, we refined the terms used for the search. This took the form: (“Transport” OR “Transit” OR “Car*” OR “Walk” OR “Bike”...**1**) AND (“Equity” OR “Justice” OR “Fair”...**2**), where **1** and **2** signify additional terms relating to ‘transportation’ and ‘equity’, respectively.
2. Upon inspection of the preliminary search results and after achieving a consensus among the authors, the set of search terms related to ‘equity’ was expanded into three sets of terms. The first describes theories and concepts of equity, the second describes the object of justice (i.e., the “what” in our analytical framework), and the third describes terms referring to standards (i.e., the “how”). These sets of terms were augmented iteratively. The final search query took the following general form: (“Transport” OR “Transit” OR “Car*” OR “Walk” OR “Bike”...**1**) AND (“Equity” OR “Justice” OR “Equity” OR “Fair”...**2**) AND (“Accessibility” OR “Mobility” OR ...**3**) AND (“Standard” OR “Threshold” OR ...**4**) where **1,2,3**, and **4** signify additional terms included in the sets combined with “OR” operators.

After testing the search strategy on WoS Core Collection, we applied it to an augmented list of databases. The databases used were: WoS General Collection-Science Citation Index Expanded, WoS Social Sciences Citation Index, and Transportation Research International Documentation (TRID). The definitive version of the search was completed and exported by the lead author on March 21st, 2021. The number of documents identified in this was 6,382.

The semi-automated nature of the search strategy was overly inclusive, thereby reducing the risk of omitting relevant material. The next stage was to trim the corpus; the authors worked with a group of previously trained undergraduate research assistants to scan the documents and assess their relevance based on

titles and abstracts. Two research assistants voted on each document, and a third vote from the authorship team broke ties. After this step, 1,710 documents were assessed based on full-text, again with each being voted on by two research assistants and an authorship team member tie-breaker. Next, using a data extraction template and workflow that was pilot-tested with a subset of papers, the authorship team extracted data from the eligible documents using *Covidence* (Covidence, 2023), an online application for literature screening. The evidence selection workflow, flow diagram, data extraction template, and some sample data extractions can be consulted in Appendix Figure 4. The end result of this scan was a corpus of 165 documents retained for data extraction.

3. Synthesis of findings

This section threads together the trends identified from the reviewed transportation literature. Specifically, a thematic overview of “When?” and “Where?” transportation fairness is considered, “Who?” are the subjects of justice, “What?” could be considered the objects of justice, and lastly “How?” is fairness measured. As an overview, Figure 1 illustrates the prominence of each thematic category for “When?”, “Where?”, “Who?”, and “What?”, while Figure 2 presents an overview of the types of fairness conceptualizations and thresholds, addressing the “How?”.

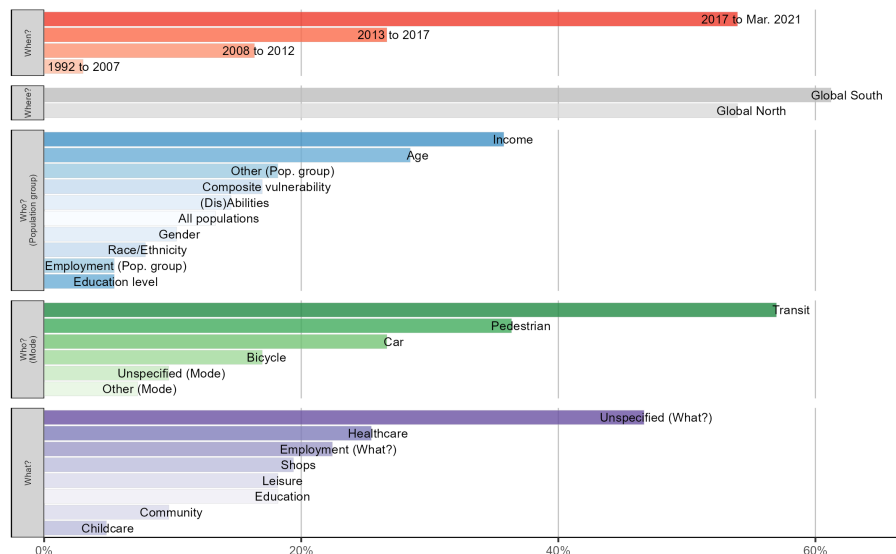


Figure 1: The proportion of papers in each When, Where, Who, and What by topics in each category. Topic categories were generated by the authors based on the reviewed literature.

3.1. “When” and “Where” is transportation fairness considered

Within our corpus, most papers (60%) focus on studies in the Global North, with many studies from North America (particularly U.S. and Canada), Europe

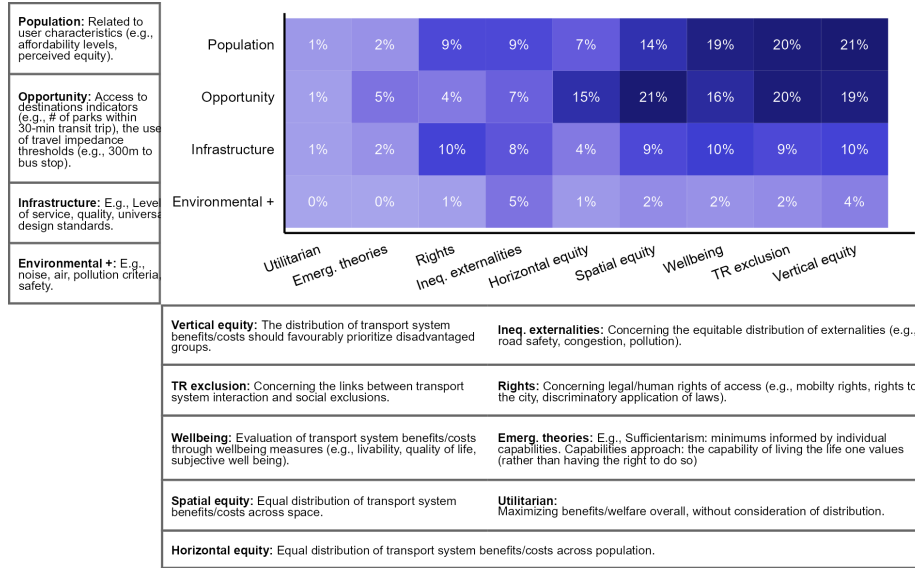


Figure 2: The proportion of papers by topics in the How categories. How is split into two categories: topics related to fairness conceptualisation (horizontal axis) and topics related to standards (vertical axis). Topic categories were generated by the authors based on the reviewed literature.

(France, Spain and Northern Europe), Oceania (Australia and New Zealand), and Asia (Japan and Israel). Though their subject matter is varied, their spatial context mainly pertains to North America and Europe, and thus more often than not deals with more developed and formal government transport planning apparatuses and technologies e.g., planning for equitable high-speed rail (Monzon et al., 2013), autonomous vehicle technology (Eppenberger and Richter, 2021), or on the public consultation processes (Reddy et al., 2010).

Of note, work included in the reviewed literature does not often explore the historical or temporal aspects of transportation fairness in depth. Therefore, in this section we provide a thematic overview of the temporal and spatial contexts associated with the studied case studies and the publication location.

40% of studies from the Global South are predominately from Asia, notably China, but also India, Thailand, Iran, Philippines, and Indonesia. The next most common focus within the literature from the Global South is from South America. Many of these studies mention a systemic absence of evidence relevant to the region (Vecchio et al., 2020). Despite a growing recognition of the interconnections between transport development, social exclusion, and poverty (Benevenuto and Caulfield, 2020), a number of studies underscore ongoing neglect of the social dimension of transport during the planning stage (Benevenuto and Caulfield, 2020; Boisjoly et al., 2020). Many studies also point at affordability as one of the main mobility barriers in the region (Falavigna and Hernandez,

2016; Rivas et al., 2018), while some highlight multi-dimensional concerns such as public transport accessibility and quality of walking environments that contribute to mobility inequalities (Tiznado-Aitken et al., 2018). Studies pertaining to Africa are even less numerous.

A shared characteristic among studies from Africa and South America is a scarcity of official transport data (Fried et al., 2020). These studies also incorporate the use of informal transportation options and tensions in developing road network infrastructure (which tends to support car dependency) over meeting the mobility/accessibility needs of citizens more equitably and sustainably (Thondoo et al., 2020). To address these challenges, researchers compile databases based on open and geo-referenced data, calculate objective and/or subjective measures (Berhe et al., 2014), and focus on advancing transport justice for low to medium income countries by aligning their goals with external policy guidelines such as the Sustainability Development Goals (SDG), particularly those related to universal accessibility (Fried et al., 2020).

Of all the studies reviewed, 85% focus on urban and suburban settings and are highly varied in their research aims. To give an example, Cox and Bartle (2020) qualitatively examine cycling as a mode of travel for people with disabilities in a typical mid-size town in the U.K. Ampe et al. (2020), on the other hand, work to identify the lateral clearance that motorists should maintain when passing cyclists with children seats. The remainder of the studies focus on rural regions (14%), or remote regions, such as those that rely on inter-island ferry trips in the Philippines (Cao and Stanley, 2017). Similarly, Parry et al. (2018) studied remote communities in the Amazonian region, and suggest that “increasing accessibility through road building would be maladaptive, exposing marginalized people to further harm and exacerbating climatic change by driving deforestation” (pp. 125).

Overall, studies from the Global South often have some key differences in focus compared to the Global North:

- affordability as a barrier at the user- or policy maker- level is more often the motivation in work from the Global South;
- the expression of greater tensions in investing in new transportation infrastructure, such as roads in rural/under-developed areas, compared to prioritization of non-car modes. Studies centered in the Global North often focus on the later; and
- more significant data availability limitations and reliance on ‘informally’ collected data.

These differences center on the direct economic outcomes tied to transport infrastructure. Often, work from the Global South does not engage as intimately with emerging mobility technologies. As well, the informal aspects of transport planning are more overbearing. Clearly, countries in the Global South still struggle with the consequences of past colonialism, which has left them more

reliant on primary sector exports (lower efficiency, lower national GDP) under growing global financial markets, and with more fragile democracies. Due to lower data availability, reliance on crowd-sourced or ‘informally’ collected data, and more extreme needs for ‘sufficient’ transport, analysis of transportation inequities is often cast along economic lines in the Global South.

We gather that the literature on the Global North and South tend to focus on different aspects of transport inequities, related to the level of their transportation infrastructure. Formal planning processes in the South operate under greater financial precarity, they rely on more informal processes to address unmet needs. This turns out to be a significant source of equity concerns, e.g, informal transit (Fried et al., 2020), and populations living in informal settlements (Sharma and Patil, 2021). International standards are more highly relevant in literature from the Global South, such as the WHO noise and air pollution standard (Apparicio et al., 2021), while not as frequently featured in the Global North literature. For example, in Carrier et al. (2014), disadvantaged populations are disproportionately impacted by higher NO_2 pollution near roadways in Montreal, but these levels are still consistently below the WHO standard. This difference in focus presents interesting opportunities for the Global South, to adopt potentially successful enhancements from Global North formal equity planning processes (e.g., indicator creation for disadvantaged groups (Cui et al., 2020)) and to avoid past and ongoing mistakes (e.g., from entrenched car-centric development (Warren et al., 2015) to the disproportionate contribution to carbon-intense mobility (Chancel and Piketty, 2015)). For the Global North, there is an opportunity to reckon with its own contributions to uneven development globally and environmental impacts as well as adopt relevant aspects from informal planning processes.

3.2. “Who” are the subjects of transportation justice and their mobility tools

3.2.1. Population groups

Turning to the question of “Who?” in Figure 1, the focus of the literature tends to be on “Income”, especially the lowest-income groups who simultaneously face lower mobility and accessibility *and* higher costs and exposure (Peunghumsai et al., 2020; Zhao et al., 2020; Falavigna and Hernandez, 2016). Evidence suggests that low household income is a significant determinant of transport-related inequities e.g., urban access to public transport (Peunghumsai et al., 2020), access to urban employment opportunities (Boisjoly et al., 2020), and unfavorable rates of environmental noise, air pollution, and green space (Kruize et al., 2007). Yet, low-income is not universally associated with lower transport-related benefits for every object of justice. For instance, in Sheffield, U.K., Mears et al. (2019) demonstrate that historically working-class (lower-income) neighbourhoods have *more* access to green space than other neighbourhoods, but of lower quality, likely due to historic urban planning approaches. Similarly, Bertrand et al. (2008) find that the granularity of the analysis matters, and lower income groups do not always have lower accessibility, something echoed in other spatial and temporal contexts (Foth et al., 2013; Allen and Farber, 2019)

391 “Age” is the second most common “Who?” focus. In this regard, [Martinez-](#)
392 [Jimenez and Salinas-Perez \(2019\)](#) and [Arranz-Lopez et al. \(2019\)](#) investigate
393 travel distances/times to various opportunities, demonstrating how age is as-
394 sociated with differences in opportunity access. School-aged children and older
395 populations are a common focus. For children, analysis of wellbeing ([Laszkiewicz](#)
396 [and Sikorska, 2020](#)), safety and access to schools ([Sharma and Patil, 2022;](#)
397 [Corazza et al., 2020](#)), and promoting active travel ([Mackie, 2009;](#) [Mehdizadeh](#)
398 [et al., 2017](#)) are common-place. Papers that focus on older adults similarly in-
399 vestigate transport-related wellbeing ([Chen et al., 2020](#)), access to age-specific
400 destinations ([Cheng et al., 2019](#)), and options to reduce unmet travel needs
401 ([Nordbakke and Schwanen, 2015](#)).

402 Many papers focus on intersecting characteristics. As an exception, we clas-
403 sify some studies as focusing on “(Dis)abilities” or “All Populations”. Studies
404 with a “(Dis)abilities” focus assess travel capabilities, namely through physi-
405 cal accessibility and universal design guidelines ([Park et al., 2017;](#) [Chiscano,](#)
406 [2021;](#) [Orellana et al., 2020](#)). “All Populations” papers make no distinction in
407 population. This is done, for instance, by [Kita et al. \(2020\)](#), who investigates
408 disparities in accessibility to food stores and self-reported capability/frequency
409 of going outdoors. Often, the implicit or explicit motivation of these papers is
410 access (to necessities and desired destinations) for all.

411 A large proportion of papers apply composite vulnerability indices that com-
412 bine several individual traits like low income, unemployment, and/or immigrant
413 status. These indices are generated from government sources or author-informed
414 census data creation methods. As an example, the Neighbourhood Equity Index
415 is a measure of vulnerability created by the City of Toronto and used in [Awuor](#)
416 [and Melles \(2019\)](#) to examine disparities in premature death. Other works
417 use national census indicators such as the social and housing deprivation index
418 ([Pucci et al., 2019](#)) or explore transport disadvantage, equity in policy implemen-
419 tation, or transport-related mortality burden by means of census measures (e.g.,
420 household poverty) and transport-related accessibility indicators ([Aldred et al.,](#)
421 [2021;](#) [Iungman et al., 2021;](#) [Sun and Thakuriah, 2021;](#) [Scheurer et al., 2017](#)).
422 Similarly, Environmental Justice (EJ) indicators have been used in the U.S.
423 literature to identify neighbourhoods that have a higher than average propor-
424 tion of low-income and non-white populations and evaluate the equity impacts
425 of transportation projects ([Rowangould et al., 2016;](#) [Park et al., 2021;](#) [Reddy](#)
426 [et al., 2010](#)).

427 Multi-dimensional considerations are so prevalent in the reviewed literature
428 that “Gender”, “Race/ethnicity”, “Education”, or “Employment” are infre-
429 quently studied in isolation. Only a few papers focus exclusively on gendered
430 differences in active transportation ([Adlakha and Parra, 2020;](#) [Xie and Spinney,](#)
431 [2018](#)), race/ethnicity’s relationship to green space proximity ([Silva et al., 2018](#)),
432 and culturally-appropriate opportunities ([Wang and Roisman, 2011](#)). Papers
433 that focus *solely* on “Employment” status or “Education” level are completely
434 absent in the corpus. Furthermore, “Other” population groups are also

frequently considered: this is a catch-all category that includes populations less commonly targeted by research e.g., veterans and access to specific-healthcare needs (Mooney et al., 2000), pregnant people and access to maternity services (Vadrevu and Kanjilal, 2016), and youth who live in foster care (Batsche and Reader, 2012). Overall, the diversity of population groups considered in the corpus demonstrates the variety of transportation-equity concerns addressed.

3.2.2. Modes (mobility tools)

Travel mode, though modifiable, is intertwined with individual identity, presenting challenges for the analysis of disparities. In this subsection, we choose to view the mode of travel primarily as those who use the mode, hence as subjects of justice (i.e., the “Who?”). However, at times, travel mode will also be considered as an object of justice (i.e., a “What?”, such as disparities in rural transit service).

To begin, transit characterises the majority of the reviewed literature (Figure 1), reflecting some intuitive sense. Despite transit being perceived unfavourably by some (e.g., Mella Lira and Paez (2021)), it is often viewed as the only or primary mobility option mode for many (Jacques et al., 2012). Overall, we can infer that transit is largely considered a public good and, therefore, a natural object of justice. As such, public transportation is especially amendable to being modified to meet the demands of justice by ensuring adequate funding to provide barrier-free transport for most, despite challenges such as low densities, fiscal constraints, and political will (Markard et al., 2023). As such, papers that focus on transit assess a variety of related topics, including food deserts (McKey et al., 2020) and barrier-free transportation for people who face disabilities (Jiménez-Espada and González-Escobar, 2021; Liu et al., 2019; Lim et al., 2021; Feeley, 2019).

Transit also plays a central role in multimodal comparisons in transport disparities, especially comparing “Walk”, “Car”, or some other category in Figure 1. For instance, Brussel et al. (2019) compares transit, pedestrian and road network accessibility measurements in the context of SDG 11.2. Renne and Mayorga (2018) reviews natural disaster evacuation plans, focusing on carless households and emphasizing transit and pedestrian networks. A few papers also frame transit as a direct competitor of car travel or use it as a benchmark (Golub and Martens, 2014; Martens et al., 2012). For instance, Warren et al. (2015) proposes car ownership standards while acknowledging the tension between mobility needs in transit under-served areas and emission reduction goals. However, this framing is not universal, and transit is sometimes seen as a mode to fulfill individual capabilities. As an example, Smith et al. (2012) explores perspectives about transport needs and costs to achieve perceived sufficient living standards for those living in rural areas. Notably, papers vary in the importance they place on climate urgency, with some focusing more on satisfying *all* sufficient individual needs while planning for less car-dependent cities in the future.

After transit, pedestrian travel (“Walk”) is the second most studied object

478 of justice. Pedestrians represent a unique convergence of “what” and “who,”
 479 utilizing their own bodies for mobility. Papers focusing primarily on walking
 480 often use walkability scores to assess neighbourhood quality (Evans, 2015), mo-
 481 bility by different demographics (Towne et al., 2016; Kim et al., 2016), or urban
 482 peripheral regions (Blecic et al., 2021). Some use walkability to gauge public
 483 health and urban vitality (Sung and Lee, 2015; McCormack et al., 2012). Papers
 484 with a pedestrian focus also often see walking as a bridge to connect multiple
 485 modes: they discuss ‘walkability’ as part of active transportation, which focuses
 486 on both walking, bicycle and/or transit. Concepts discussed include how ac-
 487 tive transport contributes to children’s physical activity levels (Mammen et al.,
 488 2014), walkability as an alternative to car predominance (Bertrand et al., 2008)
 489 or tension that exists between modes, creating unsafe conditions for walking
 490 (Siu, 2019; Ferencsik and Marshall, 2019).

491 The third most studied mode in the reviewed literature is “Car”. Unlike transit
 492 and walking, these studies rarely feature car as the mode of primary focus. Car
 493 is often assessed against transit and active modes (e.g., low traffic neighbour-
 494 hoods Aldred et al., 2021) or in areas with inadequate transit service (Kimmel
 495 et al., 2018; Aljoufie, 2016). Under our appraisal, transit and walk modes are
 496 of most interest because they represent a reckoning with automobility’s legacy
 497 and ongoing demands for space, public subsidies and government supports that
 498 underestimate their true cost (Gössling et al., 2019; Timperley, 2021). Upon
 499 the rise of the automobile, pedestrian spaces were distinguished, non-car modes
 500 came to be seen as a hindrance to full automobility, and transit seen as a social
 501 service. We ascertain that for these reasons, “Car” is often compared against
 502 non-car modes and never put forward as the only mode that should be expanded.
 503 Furthermore, some papers reflect on “Other” forms of mobility (Figure 1), in-
 504 cluding wheelchair-accessible taxi and/or paratransit services (Marquez et al.,
 505 2019; Wilkinson-Meyers et al., 2015), travel on waterways (Vadrevu and Kanji-
 506 lal, 2016; Cao and Stanley, 2017; Parry et al., 2018), motorcycle or other micro-
 507 mobility (Berry et al., 2016; Schmitz et al., 2019; Tiwari and Phillip, 2021), or
 508 emergency vehicles (Pedigo and Odoi, 2010; Patel et al., 2007).

509 Papers that pay no particular attention to any mode are “Unspecified”: as
 510 examples, a focus on road infrastructure or road network distances (Wismadi
 511 et al., 2014; Mishra et al., 2014), travel needs generally (Titheridge et al., 2008;
 512 Benevenuto and Caulfield, 2020), realized travel (Abasolo et al., 2001), or exter-
 513 nalities of realized travel (Iungman et al., 2021).

514 3.3. “What” could be the objects of transportation justice

515 The objects of fairness assessment, the “What”, are often motivated by con-
 516 cepts encompassed by either mobility or accessibility. A fundamental benefit
 517 of transportation systems is mobility (enabling or impeding movement). This
 518 benefit is sometimes valued by itself but is often seen by the literature as instru-
 519 mental to achieve an ulterior goal (e.g., activity participation and associated
 520 benefits). For example, although vehicle kilometers traveled (VKT) is some-
 521 times seen as a useful policy instrument (Zhao and Li, 2021), travelling more is

not necessarily a sign of advantage when accessibility is low, and short trips may actually be a sign of advantage (Park et al., 2021). For this reason, although the right to the road (and transportation systems more generally) is important, the literature leans heavily on the ulterior object, namely accessibility to (the ease of reaching) destinations. In tandem, themes of existing transportation system burdens associated with mobility and accessibility can be interpreted: for instance, these could be environmental (e.g., potential for GHG emissions reductions relative to the status quo (Bocarejo and Urrego, 2022)), or human-health and traffic-related externalities (e.g., decreased wellbeing due to transport poverty (Churchill and Smyth, 2019) or reduction in potential road-related fatalities (Bocarejo and Urrego, 2022))

3.3.1. Mobility

Most papers in the reviewed literature take a broad approach, with 47% focusing on “Unspecified” destinations (Figure 1), examining various equity dimensions across different transportation modes. Many of these papers are ‘mobility’ focused and examine the impact of the trip itself on the individuals, groups or the environment. These benefits and burdens include safety (Zhe et al., 2008), infrastructure quality and service levels (Prasertsubpakij and Nitivattananon, 2012; Fürst and Vogelauer, 2013; Lattman et al., 2016) or air and pollution levels (Apparicio et al., 2021). Others analyze trips taken by specific groups like women or people with disabilities (Russell et al., 2021; Wilkinson-Meyers et al., 2015), often with a consideration of what constitutes ‘sufficient’ quality of life (Churchill and Smyth, 2019). In sum, these papers reveal the multifaceted nature of transportation systems: they serve utilitarian purposes related to travel while also shaping user experiences, expressing some aspects that can be summarized as societal and/or planetary benefits and burdens.

3.3.2. Access to opportunities

Generally, papers that focus on a particular destination can be construed to interpret “accessibility” as the “What?” as the object of fairness, with access to opportunities being the benefit. When analyzing access to particular destinations, “Healthcare” services (18%) and “Employment” (25%) are the most common in the reviewed literature (Figure 1). Papers on healthcare often highlight disparities in services, like Wang and Roisman (2011), who assess access to Mandarin speaking family physicians for Mainland Chinese immigrants in Toronto. Similarly, papers focusing on employment are often aimed at identifying transportation-poor neighbourhoods (Allen and Farber, 2019; Churchill and Smyth, 2019). Employment is frequently used as a proxy for overall accessibility since it is the most common trip purpose and employment is usually co-located with destinations like shops, recreation, and other services. These studies typically use travel surveys, census data, and point-of-interest databases, and benefit from well-developed institutional data. This especially holds in the Global North where these data are more readily available.

Other destinations have received less attention despite serving essential needs.

“Shopping” destinations (19%) often aim to identify food deserts (Choi and Suzuki, 2013; Jiao et al., 2012; McKey et al., 2020; Kim and Park, 2020). “Education”-related papers (18%) explore children’s active transportation to school (Larkins et al., 2011) or universal design (Larkins et al., 2011). Places of “Leisure” (18%) prompt questions about their spatial distribution (Xu et al., 2017) and accessibility (Mavoa et al., 2015). Fewer papers cover “Community” destinations (e.g., public service centres, places of community support or worship) (10%) or “Childcare” (5%), but they are integral to holistically study activity participation (Alberts et al., 2016; Smith et al., 2012). The lack of information about community destinations in the reviewed literature, especially for children, is noticeable (Desjardins et al., 2022). In sum, these works that focus on ‘accessibility’ can be seen to frame access and its related externalities as benefits, while the lack of access (or associated externalities) as burdens.

3.4. Standards: “How” fairness is measured

3.4.1. Conceptualisations of fairness

The conceptual foundations of fairness are often not made explicit within the reviewed literature, they have to be inferred. Though not exhaustive, the following categories emerged from our review and in broad terms are (Figure 2 details definitions):

- Vertical equity (27%)
- Transport-related social exclusion (27%)
- Well-being (27%)
- Spatial equity (26%)
- Horizontal equity (17%)
- Inequitable externalities (17%)
- Rights (14%)
- Emerging theories (5%)
- Utilitarian (1%)

A slice of the reviewed literature is supported by broader “Rights” conceptualisations of fairness: these papers often focus on equity for people with disabilities or non-car users and associated challenges accessing transport infrastructure (Jiménez-Espada and González-Escobar, 2021; Daamen et al., 2008; Bharathy and D’Souza, 2018). While many papers are underpinned with the right to the city (the *right* to participate in the production of urban space (Lefebvre, 1967; Adli and Donovan, 2018)), others emphasize legal *Rights* like regulations aligned with The Americans with Disabilities Act (ADA) (Bharathy and D’Souza, 2018) or the goal of *access for all* in land-use transportation master plans (Lim et al., 2021).

In another subset of the reviewed literature, distributions are examined through concepts of “Horizontal” and “Spatial equity”, often using quantitative methods to assess distributional disparities without explicit justice rationales. Examples include setting travel impedance thresholds (Shen et al., 2020) and mapping accessibility indices spatially across populations (Monzon et al., 2013) or population-groups (Sharma and Patil, 2021). These papers may also address burdens such as traffic-related air and noise pollution or urban temperatures. In these papers, equity is theoretically achieved if similar levels are attained for all populations (horizontal equity) or spatial areas (spatial equity). This egalitarian perspective rarely delves into minimum or maximum levels associated with harm or need satisfaction.

Papers that center “Well-being” assess what constitutes a satisfactory life in relation to transportation; mixed-methods are often used and, in contrast to the last set, the objects of injustice are often identified. Some papers use physical activity guidelines and surveys to understand the effect of active transportation infrastructure (Adlakha and Parra, 2020; Auchincloss et al., 2020; McCormack et al., 2012). Mixed or qualitative methods combined with health-related outcome standards lead to more concrete statements of fairness e.g., travel times for emergency treatment (Schmitz et al., 2019) or premature mortality (Awuor and Melles, 2019).

Another research branch, often quantitative with some qualitative or mixed-methods studies, focuses on “Transport-related social exclusion”, “Vertical equity”, and/or “Sufficientarian/capabilities”. Here, the objects of justice are often clearly identified and link standards to tangible welfare-informed outcomes. They focus on groups from perspectives of disadvantage such as: social exclusion and transport poverty (Allen and Farber, 2019; Delbosc and Currie, 2011a; Churchill and Smyth, 2019), food deserts (McKey et al., 2020), and energy poverty (Robinson and Mattioli, 2020; Berry et al., 2016; Berry, 2019).

3.4.2. Standards and methods of measuring fairness

We identify several categories of standards that overlap with at least one of the conceptualisations of fairness discussed above (see Figure 2 for definitions):

- Opportunity standards (66%)
- Population standards (64%)
- Infrastructure standards (41%)
- Environment+ standards (7%)

Papers with “Opportunity” standards often employ quantitative methods to analyze disparities and assess distributional fairness. Many deal with travel impedance thresholds based on speed, distance, or cost (Chen and Haynes, 2017; Yenisetty and Bahadure, 2020; Shen et al., 2020). Inequality measures like the Gini coefficient and poverty measures are used to empirically define travel impedance thresholds (van der Veen et al., 2020; Tiznado-Aitken et al.,

2018). Further, methods tangential to travel impedance, like limiting transport expenditure to 10% of monthly income (Rivas et al., 2018), addressing spatial mismatch (Mulley et al., 2015), or pinpointing areas of relative regional inequities are also used. Notably, many papers with “Opportunity” standards consider multiple dimensions, employing similar methods but tailored to different focal points. For instance, Peunghumsai et al. (2020) suggest service benchmarks of equal supply and demand of transit, revealing horizontal inequities as well. Others conceive the externalities of transportation system as trade-offs and aim to maximize transport-related benefits (i.e., time savings, emissions reductions, congestion reductions, user fares) through optimization/location-allocation methodologies (Fakhrmoosavi et al., 2021; Zheng and Geroliminis, 2020; Wismadi et al., 2014).

“Population” standards are often founded on “Well-being” conceptualisations from a variety of socio-demographic and spatial angles. Methods include: establishing thresholds based on questionnaires and comparisons to recommended physical activity levels (Auchincloss et al., 2020; McCormack et al., 2012; Kim et al., 2016; Timperio et al., 2015), region-relative comparisons in health outcomes in a spatial unit such as premature mortality rates (Awuor and Melles, 2019), spatial access benchmarks based on population-related characteristics like supermarket access (Murphy et al., 2017) and hospital access (Pereira et al., 2021), summative per capita benchmarks such as decent living energy consumption levels (Rao and Baer, 2012), and community-informed spatial boundaries like EJ defined communities (Rowangould et al., 2016). While most of these papers use quantitative or mixed-methods approaches, some employ exclusively qualitative methods (Berhe et al., 2014).

Papers that feature both “Population” and “Opportunity” standards are often founded on “Vertical equity”, “Well-being”, and/or “Transport-related social exclusion” conceptualisations. They feature mixed-methods, with questionnaires and qualitative approaches for “population” standards and quantitative methods like accessibility indices for “opportunity” standards. Census data and household estimates within specific travel distances or times to key destinations identify social exclusionary situations (Chen, 2010; Daniels and Mulley, 2011; Sun and Thakuriah, 2021; Sharma and Patil, 2021), linkages between transport disadvantages (Delbosc and Currie, 2011a), areas experiencing transport poverty (Allen and Farber, 2019; Churchill and Smyth, 2019), food deserts (McKey et al., 2020), or transport-related energy poverty (Robinson and Mattioli, 2020; Berry et al., 2016; Berry, 2019). They employ various methods, such as clustering techniques (Mohri et al., 2021). Some exclusively use qualitative methods to analyze survey data on travel willingness/barriers or conduct interviews on unmet activity needs (Chen, 2010; Mehdizadeh et al., 2017; Nordbakke and Schwanen, 2015).

“Infrastructure” standards offer another perspective on fairness, commonly grounded in “Rights” conceptualisations, which are twice as frequent in this segment of the corpus compared to other conceptualisations. These papers most

frequently address the rights of non-car users and populations with disabilities. Though various methods are applied, infrastructure and environmental audits as well as qualitative approaches are most prominent. Infrastructure audits compare existing infrastructure against universal design best practices (Odeck et al., 2010; Larkins et al., 2011; Jiménez-Espada and González-Escobar, 2021; Perez-delHoyo et al., 2021) or investigate elements correlating with mode use by specific population groups (Moniruzzaman and Paez, 2016). Qualitative methods include interviews/surveys on perceived access (Marquez et al., 2019; Mateo-Babiano et al., 2017; Fürst and Vogelauer, 2013; Velho et al., 2016; Park et al., 2017; Lim et al., 2021; Stjernborg, 2019; Desjardins et al., 2021) and assessment of standards under best-practice criteria (Daamen et al., 2008; Velho et al., 2016; Bharathy and D’Souza, 2018).

Additionally, “Infrastructure” standards papers sometimes encompass multiple dimensions, moving beyond rights (to the infrastructure) to provide “Opportunity” and/or “Population” standards. These papers often employ “Vertical”, “Horizontal”, and “Spatial equity” lenses. These papers often refer to guidelines and propose composite indices. For example, (Rachele et al., 2017) integrate various transport network properties to define an indicator supporting walkability and public transport access. Others evaluate infrastructure quality (Xu et al., 2017), accident severity (Benevenuto and Caulfield, 2020; Appleyard et al., 2017), and user-groups, especially disadvantaged ones with respect to vertical equity of multi-criteria indicators (Prasertsubpakij and Nitivattananon, 2012). Some focus explicitly on affordability and barriers, proposing infrastructure enhancements for better inclusivity, especially for the most disadvantaged (Basu and Alves, 2019; Song et al., 2019; Welch, 2013), grounded in transport-related social exclusion (Kent and Karner, 2019) or capabilities approaches (Smith et al., 2012).

“Environmental+” standards are featured less prominently in the reviewed literature, possibly because the environmental burdens of transportation are addressed more broadly in other literature (e.g., environmental justice). However, the papers included in our corpus present some interesting insights. They often use traffic-related air and noise pollution, green space, urban design, urban air temperature, health outcomes, and physical activity guidelines to assess transport-related “inequitable externalities”. Methods employed are primarily quantitative or mixed-methods, identifying inequalities through Gini coefficients (Feng and Timmermans, 2014) or composite indices (Agost-Felip et al., 2021; Miranda and da Silva, 2012; Corazza et al., 2020), occasionally incorporating spatial analysis (Jephcote and Chen, 2013; Carrier et al., 2014). Many use established thresholds or health guidelines e.g., WHO guidelines for Active Aging and targets included in the United Nations’ SDG (Agost-Felip et al., 2021) and OECD or WHO standards for traffic noise level, NO_2 levels, available green space and $PM_{2.5}$ levels (Kruize et al., 2007; Iungman et al., 2021; Apparicio et al., 2021; Khomenko et al., 2020; Mueller et al., 2018). These metrics are sometimes criticized for their general applicability. Nonetheless, their use provides interpretable values for tracking progress, offering comparability across

733 communities, unlike accessibility measures, which vary in methods and assump-
734 tions.

735 Appendix Section 6.3 presents detailed examples of various standards, outlined
736 within the 5WH framework, as derived from the examined corpus.

737 4. Moving forward: discussion and calls for action

738 As previously noted, this work makes two contributions to the literature. First,
739 it outlines a conceptual and flexible “Why”, “Where”, “When”, “Who”, “What”
740 and “How” (5WH) framework with supporting definitions for approaching ques-
741 tions about transportation justice. Second, it applies the framework in synthe-
742 sizing and appraising of 165 academic articles drawn from the transportation
743 justice literature; these studies use equity analysis as instruments to gauge prox-
744 imity to their context’s just situation. Based on the preceding sections of what
745 is in the literature, and what is lacking from our perspective, we conclude with
746 the following five calls to action. Based on the preceding sections of what is in
747 the literature, and what is lacking from our perspective, we conclude with the
748 following five calls to action.

749 4.1. Call 1: Underpin tailored standards based on rigorous concepts of justice

750 The conceptual grounding for standards is often left implicit within the liter-
751 ature. For example, Mueller et al. (2018) suggests the relative risk of mortality
752 from transport-related air pollution should not be higher in deprived groups
753 than the general population. While the conceptual justice foundations are not
754 explicitly declared, we infer an egalitarian focus. But, what level of relative
755 risk is acceptable for the general population? What purpose does mortality risk
756 serve and who benefits from it? To move equity analysis outputs towards just
757 transport futures, explicit inclusion of justice rationales (the “Why?”) should
758 become more common place. We must be clear with our terms—what is equity
759 and for whom?

760 Standards are statements of fairness, yet some standards are seemingly arbi-
761 trary in the reviewed literature—in other words, set arbitrary justice goals. For
762 example, Cao and Stanley (2017) proposes 20 ferries per day to avoid social ex-
763 clusion for inter-island transport planning, though acknowledging the standard
764 should be politically determined. It is unclear if selecting a different benchmark
765 such as 10 or 30 ferries would make a difference in any specific object of justice
766 (e.g., accessibility to particular destinations) or if that number is tied to fund-
767 ing or resource constraints. Another example is the conceptual underpinnings
768 of the 15-minute city, where 15 minutes is the standard for travel times. Is
769 this sufficientarianism? Or egalitarianism? The standard can be interpreted in a
770 multitude of ways. We argue that conceptualization of justice must guide the
771 selection of the standard. As Martens and Golub (2021) demonstrate, being
772 explicit about “Why” is important. Recent work by Karner et al. (2024) pro-
773 vides several concrete examples for developing standards that follow directly
774 from different justice conceptualizations.

775 Additionally, there is a need to go beyond the focus on low-income transit rid-
 776 ers, as clear “Who?”-specific standards are lacking. Positioning intersectional
 777 considerations within the creation of community-based equity definitions and
 778 tailored standards are critical, as the act of delineating equity-deserving com-
 779 munities impacts results (e.g., Rowangould et al. (2015)). Standards should
 780 be sensitive to evolving community-based definitions of inequities. Are issues of
 781 economic inequity at the root of transport inequities for a particular community?
 782 Are inequities in access provided by certain modes emphasized because access
 783 offered by other modes are *relatively* better? Access to what types of opportu-
 784 nities are driving transport inequities? How do populations, travel modes, and
 785 opportunities sought intersect to define the “who” of inequities? A community-
 786 informed understanding of inequities and tracking how they change are needed.

787 For decision-makers, setting standards, measuring inequities, and develop-
 788 ing flexible guidelines for standards that are also compatible with community-
 789 informed calls for justice, are the next steps for transportation equity planning.
 790 If we assume that one function of the academic literature is to recommend stan-
 791 dards, researchers must connect compatible conceptualisations and standards
 792 to justice frameworks. Currently, these fundamental connections are mostly
 793 missing.

794 *4.2. Call 2: Develop creative methods for systems-thinking approaches to fair-* 795 *ness*

796 On the methodological side, transportation justice research would benefit from
 797 a wider use of mixed-methods. Concepts and standards are often discussed from
 798 purely qualitative or quantitative approaches. This is a missed opportunity to
 799 combine the strengths of both approaches, whether by diving deeper into some
 800 particular experiences or perceptions through qualitative methods or tailoring
 801 more meaningful quantitative analysis after qualitative explorations. As mixed-
 802 method examples, Xie and Spinney (2018) find through interviews and go-alongs
 803 with women cyclists that the standard Cycling Level of Service tools used by
 804 engineers to plan cycling infrastructure misses a critical gendered perspective.
 805 Further, Somenahalli and Taylor (2007) survey older adults to understand their
 806 mobility issues, revealing factors that are unseen in standard daily travel sur-
 807 veys.

808 While disparity analysis is frequently used, the resulting standards do not
 809 often align with practical applications. For example, metrics of accessibility
 810 (usually measured with travel impedance cut-offs of between 15 to 60 minutes
 811 depending on the destination, population group and mode) are used to show
 812 descriptive differences among areas and groups but with scarce implications as
 813 to the experience of travelers. How low must an accessibility index be before it
 814 is too low? Relatedly, once sufficient accessibility levels are reached, excessively
 815 high accessibility values can result in high inequalities. Are inequalities of a
 816 certain level an issue? A lack of discussion poses a challenge to translating
 817 results from these analyses into policy and practice. Creative methods and
 818 discussions of quantitative accessibility metrics should be paired with results;

819 they should yield interpretable results. The explicit discussion of minimum *and*
820 maximum values in the distribution of the object of justice (the “What?”), as
821 applicable, is critical.

822 Other times, when analysis engages with metrics that may be tied to particular
823 concepts of equity (like the Gini coefficient or Theil index), they fall short in
824 assessing whether the results are good or bad (Mijares et al., 2013). For example,
825 a Gini coefficient of 0 would mean that all people have the same access to public
826 transport stops. But is this level of access good enough or lacking? And what
827 does it mean if the result is 0.2, 0.3, or 0.4? Is this good or bad news? How
828 should a decision-maker interpret this? Are new policies needed to reduce that
829 number to a certain threshold, orienting future interventions? These questions
830 usually remain unanswered in the literature despite their importance. These
831 measurements can also bring some challenges and pitfalls as summarised by
832 Karner et al. (2024) but are necessary for more effective equity analyses.

833 4.3. Call 3: Making data available is a matter of justice

834 In our review of the literature, we were left wondering specifically– what are
835 the motivations for the inclusion of some destinations and the choice to not
836 include others? For instance, leisure (e.g., green space, parks, recreation) and
837 certain care destinations (e.g., community organizations, government services,
838 banking locations, daycares) are infrequently studied or missing altogether. We
839 suspect that since the methods used in the reviewed literature are predominately
840 quantitative, the reliance on commonly used point of interest databases is also
841 high. These databases typically include education, health, and occasionally in-
842 clude aggregated categories for leisure and community destinations, but are less
843 generous for points of interest that are more often associated with understudied
844 mobility patterns.

845 However, through the reviewed literature, we know that transport systems
846 are more than just facilitators to work or as a source of economic development
847 (though in underdeveloped regions, transport systems as a force of economic de-
848 velopment is pronounced, e.g., high-speed rail (Chen and Haynes, 2017; Monzon
849 et al., 2013; Kim and Sultana, 2015)). As such, data availability matters. In
850 the context of the Global South and rural geographies fewer official data sources
851 and public research resources exist relative to urban communities and areas in
852 the Global North. The operationalization of emerging conceptual theories in
853 equity analysis, such as sufficientarianism (van der Veen et al., 2020), might be
854 impacted if relevant data is not available.

855 The calls for and relevant issues of data availability are not new, but they have
856 at least three pieces. What and who is the subject of justice? When/Where/How
857 is it measured? And, who gets to consult and use the data? Deciding who is
858 the subject of justice frames the data collection activity; if it is the mobility
859 of those who do domestic work, the classification of who does this work and
860 how it changes over time/space is fundamental. How we classify mobility and

access has implications for our understanding of just who is a subject of justice, as illustrated by the history of racial classifications in the U.S. (Lee, 1993). The methods we use, the spatio-temporal boundaries for data collection, and who has (and does not have) access to the collected data, can all impact how we think about justice. In the case of transportation, the issue of data collection/availability as a matter of justice is gaining traction as digitization of data casts a starker light on these questions (Sourbati and Behrendt, 2021; Behrendt and Sheller, 2023).

4.4. *Call 4: Develop more direct and explicit links between standards and lived experiences*

Robust assessments of the implications of standards on lived experiences are still lacking in the literature, but are essential for equity analysis that translates into just practice. While the estimation of the benefits of increased mobility or accessibility, or reducing burdens is commonplace in the literature, there is a need to associate them with outcomes, including life and neighbourhood satisfaction, subjective well-being, mental and physical health, and social capital. The literature must move beyond describing inequities and their contributing factors. Instead, it should incorporate causal methods that establish clear cause-and-effect relationships, enabling policymakers to quantify the impact of various policies and infrastructure decisions on advancing justice.

Composite measures such as the transport-land-use index proposed by Appleyard et al. (2017) is an example of systems-thinking approach that links findings to quality-of-life proxies; they ground their measure in the principle of *livability* along corridors of varying levels of estimated transport-land-use integration. However, the methods could go further: they could be tied to absolute goals of integration or livability. Relatably, Higgs et al. (2019) develops an urban livability index and demonstrates the relationship between the population’s use of a certain mode in a neighbourhood and a one unit increase in the index. However, are there absolute minimums or maximums for the index or the mode-choice goals that should not be crossed?

More explicit discussion of the boundaries in the distribution of the object of justice (the “What?”) alongside these creative methods are needed. These links may be used to track progress towards justice across time and space, a critical point for practitioners.

4.5. *Call 5: Rigorously evaluate interventions and policies*

There is a need to evaluate equity interventions and policies: track their before, during, and after. In this review, a small proportion of studies assess specific transport-related policy interventions through an equity lens. Examples include mode-shift from driving to active school travel (Mammen et al., 2014), transit fare restructures (Hickey et al., 2010) and spatial analysis of Low Traffic neighbourhoods (Aldred et al., 2021). The assessment of interventions and tracking associated outcomes can be thought of as a key step towards transport justice.

903 Similarly, for how long the burdens and benefits can still be associated to a
904 specific transportation intervention remains a critical avenue to explore.

905 Outcomes of interventions can be compared within and between communities,
906 and cross community comparisons can be created that may expedite the adop-
907 tion of effective policies that move towards just outcomes; the presence of these
908 synthesis and comparative studies could support brave decision-makers in the
909 application of research into practice. Again, causal methods and mixed methods
910 approaches might serve as valuable approaches to reach this in practice.

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6. Appendix

6.1. Evidence search strategy

The evidence selection process is also represented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram

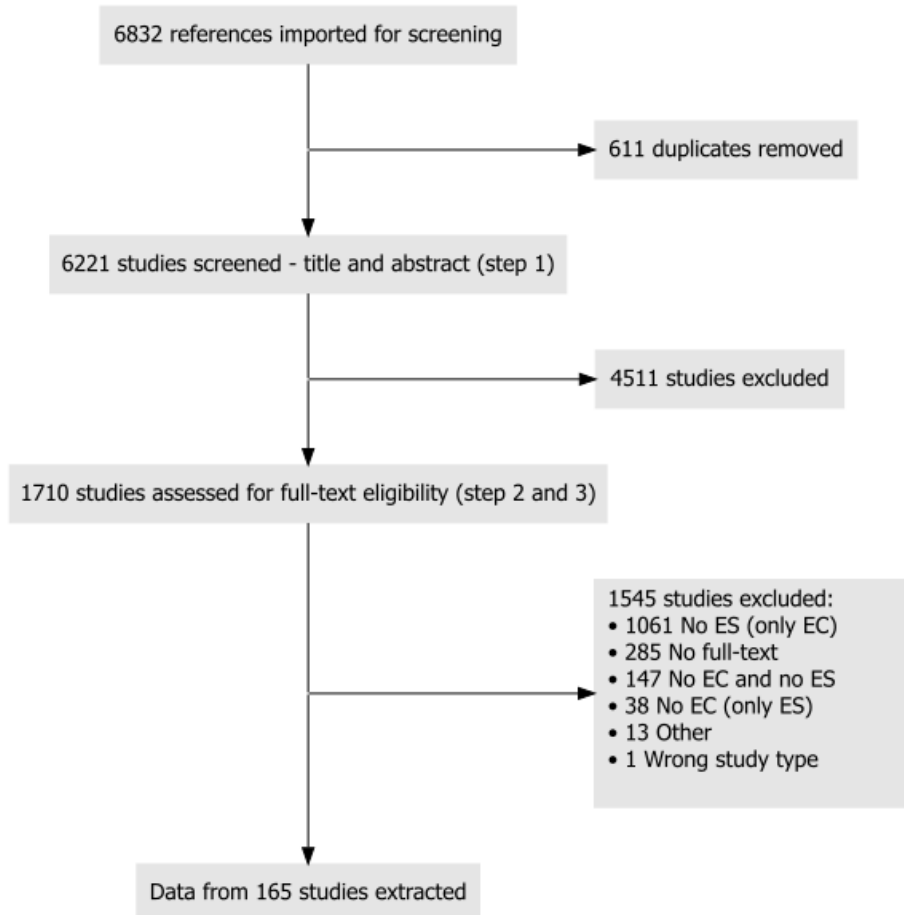


Figure 3: PRISMA flow diagram for the evidence selection process. ES signifies standards and EC signifies conceptualisations.

(Page et al., 2021) in Figure 3. Notably, two rounds of exclusion occurred during the assessment for full-text eligibility. 1710 studies entered step 2, 1223 were excluded and the remaining 487 papers entered step 3. The data extraction template used by the reviewers (authorship team) in step 3 revealed that, as expected, inclusion was initially too generous, and some papers were not sufficiently relevant, because of a lack of content on standards and/or conceptual/theoretical elements. In this fashion, 322 papers were further excluded and data extraction was completed to give a final corpus of 165 papers. A summary of the reasons for exclusion of the 1545 papers (between steps 2 and 3) are included in Figure 3.

Database/Index (Platform)	Search	Hits
Web of Science General Collection - Science Citation Index Expanded; Social Sciences Citation Index (Web of Science)	(TS=((("transport*" OR "travel" OR "paratransit" OR "microtransit" OR "micro-transit" OR "transit" OR "bus" OR "buses" OR "e-bus" OR "e-buses" OR "busing" OR "streetscar*" OR "subway*" OR "tram" OR "trams" OR "tramway" OR "public transport*" OR "rail*" OR "train" OR "trains" OR "bike*" OR "biking" OR "bike-shar*" OR "bike shar*" OR "cycling" OR "bicyclist*" OR "bicycling" OR "scooter*" OR "pedestrian*" OR "walk*" OR "active transport*" OR "active travel" OR "ride-shar*" OR "ride shar*" OR "ride-hail*" OR "car" OR "cars" OR "car-shar*" OR "car shar*" OR "taxi*" OR "motori*ed") AND (TS=((("MCA" OR "CBA" OR "wider impact*" OR "mobility" OR "accessibility" OR "access" OR "affordab*" OR "user fees" OR "user-fees" OR "poverty" OR "activity participation" OR "quality of service" OR "level of service" OR "service frequency" OR "congestion" OR "crowding" OR "safety" OR "collisions" OR "accidents" OR "crashes" OR "vulnerable road user*" OR "policing" OR "policed" OR "externalit*" OR "pollution" OR "air quality" OR "emissions" OR "energy consumption" OR "fuel consumption"))) AND (TS=((("justice*" OR "fairness" OR "fair" OR "ethic*" OR "equit*" OR "inequit*" OR "equalit*" OR "inequalit*" OR "equal" OR "unequal" OR "disparit*" OR "relian*" OR "dependent" OR "social inclusion" OR "social exclusion" OR "capabilit*" OR "marginalit*" OR "barrier*" OR "disadvantage*" OR "needs-based" OR "dissuance" OR "wellbeing" OR "well*being" OR "transport poverty" OR "social assessment" OR "equity assessment" OR "universal design" OR "captive" OR "deprived"))) AND (TS = ((("standard*" OR "threshold*" OR "indicator*" OR "criteria" OR "criterion" OR "guideline*" OR "guidance*" OR "score*" OR "equi* ind*" OR "pricing strateg*" OR "priorit*"))) and (TASCA = (Transportation or Public Environmental Occupational Health or Environmental Sciences or Transportation Science Technology or Economics or Engineering Civil or Environmental Studies or Geography or Green Sustainable Science Technology or Energy Fuels or Engineering Environmental or Geography Physical or Social Sciences Interdisciplinary or Social Issues or Social Sciences Mathematical Methods or Social Sciences Biomedical or Social Work or Sociology or Philosophy or Urban Studies or Engineering Multidisciplinary or Regional Urban Planning)))	4187
Transportation Research International Documentation - (TRID)	1992 to 2022; English; Doc type: Articles, Early Access, Book Chapters Keywords = (("MCA" OR "CBA" OR "wider impact*" OR "mobility" OR "accessibility" OR "access" OR "affordab*" OR "user fees" OR "user-fees" OR "poverty" OR "activity participation" OR "quality of service" OR "level of service" OR "service frequency" OR "congestion" OR "crowding" OR "safety" OR "collisions" OR "accidents" OR "crashes" OR "vulnerable road user*" OR "policing" OR "policed" OR "externalit*" OR "pollution" OR "air quality" OR "emissions" OR "energy consumption" OR "fuel consumption") AND ("justice*" OR "fairness" OR "fair" OR "ethic*" OR "equit*" OR "inequit*" OR "equalit*" OR "inequalit*" OR "equal" OR "unequal" OR "disparit*" OR "relian*" OR "dependent" OR "social inclusion" OR "social exclusion" OR "capabilit*" OR "marginalit*" OR "barrier*" OR "disadvantage*" OR "needs-based" OR "dissuance" OR "wellbeing" OR "well*being" OR "transport poverty" OR "social assessment" OR "equity assessment" OR "universal design" OR "captive" OR "deprived") AND ("standard*" OR "threshold*" OR "indicator*" OR "criteria" OR "criterion" OR "guideline*" OR "guidance*" OR "score*" OR "pricing strateg*" OR "priorit*" OR "equi* ind*") Subject Areas: Passenger Transportation OR Pedestrians and Bicyclists OR Policy OR Public Transportation OR Transportation (General) OR Railroads - (the use of subject areas replaces the Transport concept) Language: English Document type: Articles and papers Published: 1992 to 2014 then another search for 2015 to 2025	2645

Figure 4: The search query. TS = topic search (keywords, abstract, title). TASCA = subject categories. Green text area transportation system related terms, blue text are equity dimension related terms, purple text are equity/justice conceptualization related terms, and orange text are standards related terms. Hits corresponds the number of papers that the search yielded and was retained into the evidence selection process.

Definitions of the population-concept context (PCC) used in the creation of the inclusion and exclusion criteria for the search strategy.

- **Population:** the focus of the included studies should be on individuals, groups, communities, or entire regional areas that are impacted by passenger transportation infrastructure and systems (i.e., all modes and flows) from the perspective of equity (i.e., fair distribution, production, and re-production of burdens and benefits). This criteria is reflected in the creation of the first set of topic search terms that relate to transportation modes (e.g., “walking” OR “cycling” OR “transit” - see green text in Figure 4 for the full list).
- **Concept:** the included studies should also include equity dimensions and conceptualizes equity as discussed in the previous section. This inclusion criteria is reflected in the second and third set of topic search terms

developed in the search strategy. These terms relate to types of equity dimensions (e.g., “accessibility” OR “mobility” or “transport-related air pollution” - see blue text in the Figure 4 for the full list) and fairness conceptualizations (e.g., “Justice” OR “equity” - see purple text in Figure 4 for the full list).

- **Context:** the included studies should also be limited to publications that include types of standards. Context can be more difficult to explicitly search for with key terms so synonyms for ‘standards’ were added to the query as a four set of topic search terms (e.g., threshold, indicator, criteria - see orange text in Figure 4 for full list). Additionally, journal article and conference papers, English-language literature from any country, any study design (e.g., quantitative, qualitative, or mixed-method studies, or conceptual frameworks), and any record published within the past 30 years are included (January 1992 to March 2022). The time period is selected as the first (to the authors knowledge) peer-reviewed article which operationalized standards and fairness conceptualization was published in 1996 (Khisty, 1996); we are broadening the search by a few years for completeness. English is selected as it is the common language spoken across the authorship team. Furthermore, papers that explicitly fall within the Transportation or related topic/category is included in the query (e.g., “Transportation”, “Social Sciences”, “Geography”, “Civil Engineering”, “Philosophy” - see the Figure 4 for full query).

The **exclusion criteria** for the search are papers that are not within the inclusion criteria. Specifically:

- Literature published before January 1992.
- Papers which do not include transportation equity dimensions.
- Grey literature, as concepts contained within are frequently published in a more developed form in journals.

6.2. Evidence selection and data extraction

The following steps summarise the evidence selection process:

1. The first step (orange box in Figure 5) included screening all titles and abstracts of papers on whether they included transportation equity as defined by the PCC. Each paper was screened by two independent reviewers who then voted for inclusion, exclusion, or uncertain inclusion. All uncertain papers, conflicting papers, and papers missing abstracts were reviewed by a third person for inclusion or exclusion.
2. The second step (green box in Figure 5) included scanning all full-text papers which passed step 1. These papers were reviewed to determine if they included a relevant “how”, i.e., an standard and/or relevant theoretical or conceptual discussion. At this stage, papers were evaluated again by two independent reviewers who voted for inclusion or exclusion. If an article was voted to be excluded, it was tagged with one of five possible reasons for exclusion, namely (1) no standards included; (2) no relevant conceptual

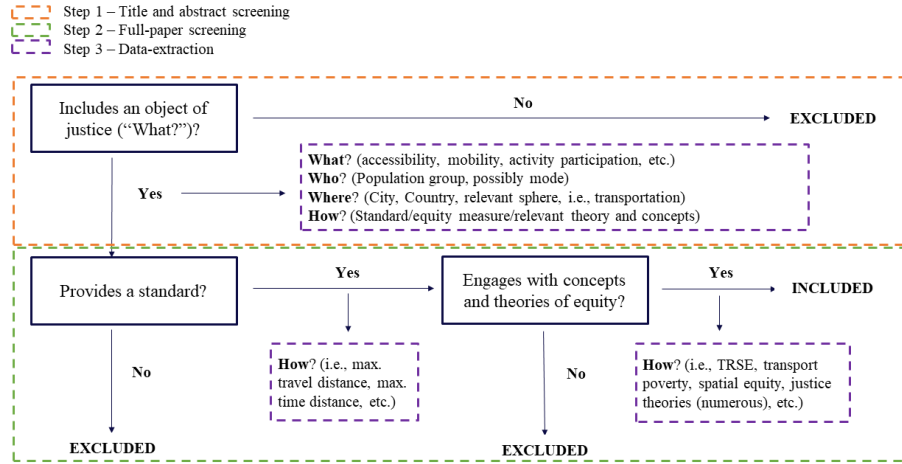


Figure 5: Evidence selection workflow. Step 1 (orange) is title and abstract screening, step 2 (green) is full-text review, and step 3 (purple) is data extraction.

elements included; (3) no standard and no conceptual elements included; (4) send back – QA issue; or (5) other. Discrepancies were resolved by a third reviewer.

3. In the last step, a data extraction template for each record was filled by one reviewer (purple box in Figure 5). The data extraction template was created with the aim of striking a balance between the complexity of categories and the simplicity of summary; information related to “Where?” (the geographical context and sphere of life), “When?” (temporal circumstances for the application of justice), “Who?” (the subject of justice), “What?” (the object of justice), and “How?” (standards and conceptualisations) was filled out for each study. The following table contains the template that was input into *Covidence* and used throughout.

Data extraction for each document that passed through all three steps was then extracted using this template:

GENERAL PUBLICATION DETAILS		Our reference definition and/or action * = definition is redundant
Author		(write in)
Title		(write in)
Publication year		(write in)
Type of publication (conference paper or conference paper)		Multiple choice
Research funding position		(write in)
EQUITY DIMENSION AND CATEGORIES		
Equity dimension (multiple choice + write in)	Accessibility	Focus on people and their ability to freely move between activities (i.e. origin to destination).
	Accessibility	Focus on people infrastructure and the potential for accessibility with activities.
	Activity participation	The ability to freely participate in activities.
	Related to work, education with transportation service and/or objective measures (i.e., service frequency, modal quality, congestion, crowding)	Related to work, education with transportation service and/or objective measures (i.e., service frequency, modal quality, congestion, crowding).
	Quality of service	Associated with socio-economic conditions of users and/or user demand (e.g., income, affordability, access to transportation).
	Adaptability	Targeted strategies, targeted user groups.
	Pollution: air, noise, visual	Pollution as a result of transportation systems or modes.
	Range	Related to transportation energy consumption and/or related impacts (e.g., fuel poverty).
	Risk	Risk of physical injury related to transportation (e.g., car crashes, bike injuries, over-pedaling related risk, sense of safety using transportation systems such as bus or tram or over-pedaling).
	Safety - Road safety/active movement of urban	Health aspects related to transportation systems (e.g., mode choice, land-use-related pollution, stress level).
Health	Health	Health aspects related to transportation systems (e.g., mode choice, land-use-related pollution, stress level).
	Community perception	A focus on the transport system's contribution and how it affects people's mobility.
	System resilience	Related to how transportation systems mitigate the severity and likelihood of future disruptions, in order to improve conditions, and to respond appropriately after the fact.
	Other	(write in)
Case study countries (multiple choice)	North America	1
	South America	1
	Europe	1
	Asia	1
Case study city and country (write in)	Country	(write in)
	City, metropolitan metropolitan area, county, state, or similar (capture multiple entries with a semi-colon)	(write in)
	Country (capture multiple entries with a semi-colon)	(write in)
	Other	(write in)
Service mode (multiple choice + write in)	Other	(write in)
	Privately owned vehicle, operating as owner's household's transportation (i.e., owned, bike-share, publicly owned)	(write in)
	Privately owned vehicle, operating as public transportation	(write in)
	Privately owned vehicle, operating as shared transportation (i.e., carshare, bike-share)	(write in)
Mode (multiple choice + write in)	Automated	(write in)
	Bus, subway, light rail, BRT	(write in)
	Heavy rail	(write in)
	Other	(write in)
Network conditions (multiple choice + write in)	Other	(write in)
	Public transit (conditions e.g., AM, PM)	(write in)
	Off-peak conditions	(write in)
	Other	(write in)
Associated intervention (multiple choice + write in)	Other	(write in)
	Policy-related	(write in)
	Infrastructure-related	(write in)
	Other	(write in)
Population group (multiple choice + write in)	Other	(write in)
	Age	(write in)
	Gender	(write in)
	Other	(write in)
Activity time/opportunity (multiple choice + write in)	Other	(write in)
	Employment	(write in)
	Education	(write in)
	Other	(write in)
Equity standards	Other	(write in)
	Other	(write in)
	Other	(write in)
	Other	(write in)
Equity conceptualization	Other	(write in)
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Table 1

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Mobility and accessibility	(Rivas, Serebrisky, and Suárez-Alemán 2018) - South America (select cities)	Analyses how affordable urban public transportation is in select Latin American and Caribbean countries. They look at the estimated average monthly cost of transit trips and average monthly household income and conceptualize transport-related affordability , especially for the most economically vulnerable (vertical equity).	The financial burden of a basket of urban public transportation trips (60 trip fares, representing 30 round-trips per month) should not exceed 10% of household monthly income.
Mobility and accessibility	(Bharathy and D'Souza 2018) - North America (USA - National)	This study designed a web-based tool and took a representative sample of wheeled mobility device (WhMD) users anthropometry measurements to determine if the minimum standard suggested by the ADA is sufficient. We understand this conceptualization as a type of Rights conceptualization that WhMD should have minimum clear floor space (as described the guidelines in line with the American Disabilities Act) to access bus shelters, bus stop pads, and transit terminals.	The clear floor area for wheelchairs: 760 mm (30 in.) wide by 1220 mm (48 in.) in length as described by the ADA standards. Of note, this minimum clear floor area is insufficient for a variety of the WhMD users.
Mobility and accessibility	(Ryan and Pereira 2021) - Europe (Stockholm, Gothenburg and Malmo cities in Sweden)	Investigates what the literature and planning process is missing when we measure accessibility by comparing objective and self-reported accounts of accessibility among older people. This paper conceptualizes accessibility as from the position of the capabilities approach and vertical equity (particularly acknowledging that older people have capabilities that differ from the general population).	Specifically for older populations (aged 65+), the following travel distances are suggested as equitable trip lengths to grocery stores per mode: Walking: less than or equal to 1500m, Combined transit and walking (less than or equal to 1000m (walking element)), Combined car and walking: less than or equal to 1000m less than or equal to 1000m (walking element)), Bicycle: less than or equal to 3000m in addition to travel time threshold of less than 15 mins.

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Mobility and accessibility	(Wismadi et al. 2014) - Asia (Yogyakarta, Indonesia)	Explores the equitable provision of transport infrastructure provision: an application of Sen's capability approach . Conceptualizes equity through Sen's capability approach and spatial equity.	Areas below the relative poverty line (of its neighbours) can only be located transport resources (i.e., measure in person*kms that can be travelled at car speed, i.e., mobility) based on the following 2 benchmarks (they can be considered, together as the floor/minimum access): 1) Global: standard deviation (SD) distance to mean should be minimized. 2) Local: priority to minimise the differences with its neighbourhood
	(Zheng and Geroliminis 2020) - North America	This paper conceptualizes equity in the multimodal network (transit, car) being fair toll-pricing across differences in populations value of time (VOT). VOT is determined based on household income, with lower income households having lower VOT and thus deserving of lower tolls (vertical equity). From this perspective, a utilitarian perspective that seeks to minimize multimodal traffic congestion through introducing toll-pricing based on VOT is implemented.	Suggests that a toll-pricing scheme based on individuals travel value-of-time (lower income people have a lower VOT) is equitable.
Environmental pollution	(Carrier et al. 2014) - North America (Montreal, Canada)	This work examines the statistical association between different social groups and the concentration of air pollutants. They frame their work from the perspective of environmental equity. We interpret the conceptualizations to be along the lines of inequitable externalities , spatial and vertical equity - transport-related air pollution is a product of road transport and it impacts the air of residents in unequal spatial ways. The paper then frames this impact as unfair, particularly from the perspective of disproportionately disadvantaged residents	The literature suggests that the health implications from the transport-related air pollution from major roadways is most acute at residential distance locations of 200 m or less. Residential locations should not be located within this distance threshold from the perspective of human health. Environmental+ and Population standards : Uses the WHO NO ² threshold as a point of comparison (annual concentrations of NO ² should not exceed 40 µg/m-3). They argue that even through no neighbourhood, even those disproportionately low income, exceed the WHO limit in this case study, they still suggest that air pollution should not be disproportionately impacting disadvantaged neighbourhoods. It can be interpreted that they use the WHO threshold as a minimum threshold and suggest that air pollution levels should not be impacting disadvantaged populations disproportionately (a relative population standard)

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Environmental pollution	(Jephcote and Chen 2013) - Europe (Leicester, UK)	Geospatial analysis of naturally occurring boundaries in road-transport emissions and children's respiratory health across a demographically diverse cityscape. Emperically identifies at what distance away from major roadways children are most impacted by transport-related pollution. This is framed in the perspective of children's well-being . Children are at most risk for acute respiratory distress from elevated levels of air pollution, and as such planning should consider this point of public health.	Finds that children (most vulnerable to air pollution - related to motorized traffic) are most impacted by air pollution within 283 m of a road way. This should be the distance threshold that schools and other children's facilities are located.
Health impacts	(Adlakha and Parra 2020) - Asia (Chennai, India)	From the perspective of disparity in gendered physical activity, this paper focuses on women's cycling as both transport and exercise. They advocate for all people achieving physical activity thresholds (horizontal equity) but prioritize women and especially women in neighbourhoods with low-walkability and socio-economic status (vertical equity).	All people should get 150 min of moderate activity a week or 75 min of vigorous physical activity per week.
Health impacts	(Schmitz et al. 2019) - Africa (Select urban and rural regions in Uganda)	The well-being of mothers, this paper examines the timely access to emergency obstetric and newborn care for child-bearing aged women in Uganda.	How?: 2 hours to the nearest facility with surgical capacity with anesthesia services - this threshold is determined through the onset of bleeding to death if a women with obstetric hemorrhage does not receive adequate treatment).
Health impacts	(lungman et al. 2021) - Europe (Madrid and Barcelona, Spain)	They use environmental pollution guidelines, but from the position of health. They investigate the impact of urban and transport planning on attributable mortality burden in Madrid and Barcelona and its distribution by socioeconomic status . Pre-mature mortality is linked to the exposure to pollution and motorized vehicles (inequitable externalities). These externalities should not be impacting people disproportionately (vertical equity) and should be even across space (spatial equity).	All minimum thresholds, if exceeded this is inequitable: NO ² concentration 40 µg/m ³ ; PM 2.5 concentration 10 µg/m ³ ; Noise 53dB for average 24 hours; Living with 300 m crow-flies distance from at least .5 hectares of greenspace; and a Change of air temperature of at least 1 °C.

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Health impacts	(Mehdizadeh, Mamdoohi, and Nordfjaern 2017) - Asia (Rasht, Iran)	From the perspective of children's well-being , assesses the walking time to school. They frame walking to school as health-related.	Perceived walking time to school for students aged 7-9 yrs is 10 mins, and the longer the PWTS the less likely they were to use an active mode to travel to school.
Health impacts	(Murphy et al. 2017) - Oceania (Melbourne, Australia)	Assesses the relationship between supermarket access and transport mode used, the body mass index (BMI) of the mode-user (wellbeing) and the equity in access distribution by income (vertical equity).	All households should be sufficiently active (greater than 150 min and at least 5 sessions) and households should be within 1 km euclidean distance to supermarket (80-90% of the dwellings should meet this). Planners should prioritize socially disadvantaged areas to meeting these standards first.
Transport-related safety	(Ferenchak and Marshall 2019) - North America (Denver, USA)	Operationalizes and compares an equity analysis of proactively- and reactively-identified traffic safety issues from the perspective of Spatial equity, Vertical equity and Inequitable exposure to externalities .	Standards are suggested for both reactive and proactive analysis. First, the lower the number of collisions on the road with pedestrians/cyclists (i.e., reactive safety analysis), the better. No/minimal inequalities for general population vs. equity seeking groups (high proportion of POC and/or low income in tract). Second, the lower the perceived safety, the better (i.e., if travel to school by ped. or bike is unsafe due to traffic conditions). No/minimal inequalities for general population vs. equity seeking groups (high proportion of POC and/or low income in tract).
Transport-related safety	(Zhe et al. 2008) - Asia (Tokyo, Takamatsu, and Tokushima)	Evaluates the observed safety of shared use pedestrian and bicycle paths from the perspective of well-being .	The study suggests that the safety threshold for bicycles and pedestrians to coexist on shared infrastructure is less than 0.5 pedestrians/minute per metre of sidewalk (width) and less than 3.0 cyclists/minute per metre of sidewalk (width). The standard for pedestrian/bicycle share use in terms of hourly traffic volume is less than 26 pedestrians / hour and 108 cyclists / hour for 2m wide sidewalks.

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Mobility, accessibility and health impacts	(Alderton et al. 2019) - Asia (Bangkok, Thailand) – Mobility/ accessibility and health	Establishes short-, medium-, and long-term goals for the city in collaboration with technical leaders within the municipal government for the perspective of well-being (urban livability): the standards included in this table relate directly to transportation systems. Indicators are inspired by the Sustainable Development Goals (SDGs) as well other global planning standards.	Green space: % of residents living < 400 m from public open space, a large park (> 1.5ha), and/or local park, 2) transit access: % of residents living < 400 m of a local bus stop and <800 m of train station, 3) Facilities: % of residents living < 400 m of a community centre. The following Infrastructure standard is suggested: Canal water quality - dissolved oxygen content of equal to or less than 2.0 mL/L
Mobility/ accessibility and health impacts	(Berhe, Martinez, and Verplanke 2014) - Africa (Mekelle, Ethiopia)	Examines adaption and dissonance in the quality of life (QoL) of residents. QoL is conceptualized along the lines of well-being and aspects of QoL directly tie into transport systems. They conduct a qualitative QoL survey of residents on the topic of three QoL domains: housing quality, access to important destinations, and affordability. They also measure quantitative indicators associated with these domains. We assume the equity goal for this paper is that subjective and objective QoL measures should not be mismatched: as discussed by the authors of this study, subjective QoL is higher than objective QoL the participant is experiencing adaption and in the reverse scenario the participant is experience dissonance.	1 & 2) Access to primary or secondary education facility, percentage of households living within 1 km or 2km (walking distance), respectively from a primary school or secondary school. 3) Access to health facility, percentage of households within 40 min walking time from a health facility. 4) Access to public transport, percentage of households within a distance of 500 m from a mini-bus stop. Population standards: 1) Adequate family income, percentage of households earning more than the official poverty line. 2) Subjective QoL is constructed based on the households level of satisfaction for each of the eight indicators using a six point Likert-scale (1=very satisfied to 6=very dissatisfied).

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Mobility, accessibility, health impacts, and safety	(Agost-Felip, Rua, and Kouidmi 2021) - Europe (Castellon, Spain)	Conceptualizes equity through age-friendly urban spaces that reduce (and eliminate) conditions for transport-related social exclusion for older populations and prioritize those who are economically vulnerable (vertical equity). These guidelines are inspired by the SDGs in addition to planning guidelines used national, regional, and local guidelines used in Spain.	<p>Access to facilities needed for old age health. Minimum distance thresholds from the geometric center of neighbourhood are suggested: at least: 1000 m from health facilities (600 m or less is preferred), elderly-specific care facilities and shops should be 600 m (300 m or less is preferred). Population standards: 1) Certain neighbourhoods should be prioritized above others. From this paper's focus on age-friendly urban environment, they suggest that if the neighbourhood has an average old age indicator (i.e., greater than 64 years, and/or greater than 79 years, and/or aging ratio of persons aged greater than 64 relative to 15 to 64 age) should be prioritized. 2) Economic vulnerable and non-civically engaged neighbourhoods should also be prioritized. If the neighbourhood has a lower percentage of civic associations within the neighbourhood than average, and/or household income, and/or a higher than average interventions for dependency and/or social subsidies, they should be prioritized. Infrastructure standards : 1) Green space: should be at least 10 m2 per inhabitant in the neighbourhood, greater than 15 m2 per inhab. is the goal. 2) As related to sidewalk infrastructure at least 50% of all sidewalks (preferably 75% or greater) should: have a width of 1.5m or larger, ramps should have a grade of 8% or less, be well maintained (free from deficiencies), be paved for pedestrian use, and cover transit stops. 3) Lighting is critical for traffic-safety and a sense of safety overall. As such, at least 50% roads should: have a min. of 35 lux (road traffic) and 20 lux (pedestrian streets), and adapted traffic lights. 4) Buildings should be age-friendly. As a proxy for the quality of residential living space quality, at least 50% of residential buildings in a neighbourhood should be built within the last 50 years (preferably 75% or more). In terms of physical access into the buildings, at least 10% should have elevators and accessible entrances (preferably 25% or more). Environment + standards : 1) Noise at the street level should be less than 55 dB and 45 dB (but preferably less than 50 dB and 40 dB) in the daytime and nighttime, respectively.</p>

What dimensions?	When and where?	How is fairness conceptualised wrt Who and What?	How is the standard defined?
Mobility, accessibility and safety	(Mateo-Babiano 2016) - Asian (Manila, Philippine)	The perception of pedestrians' walking environments should be sufficient across 6 themes. Equity is conceptualized around spatial equity (equally fair walking environments for all locations) and rights (the right to mobility/accessibility for pedestrians)	Perceived pedestrian perception on protection, ease, equitable access, mobility, identity, and enjoyment must be met.