

Searching for standards of fairness in the transportation justice literature

Introduction

Transportation systems, as a class of essential technologies that facilitate or impede social inclusion and activity participation, have increasingly come into focus from the perspective of equity and associated standards. In response to this focus, a lively and rapidly growing literature has emerged on the topic Vecchio, Tiznado-Aitken, and Hurtubia (2020). Aside from an ethical motivation, keeping track of objective and perceived inequalities could be of interest for governing bodies to respond to popular demands for fairness. However, transportation systems are notoriously complex: they simultaneously move people, goods, and information. Emerging technologies and service models can swiftly change the balance of benefits and burdens among a population (Guo et al. 2020), turning both users and service providers into digital rentiers (Birch and Cochrane 2022). The benefits and burdens of transportation systems are diffuse over space and time posing a challenge in evaluating and tracking inequities. Over space transportation systems engineered to offer higher mobility for people *somewhere*, can simultaneously cut others off from essential opportunities *elsewhere*, as Raje (2004) poignantly illustrated with examples of infrastructure in the UK. Over time, the shades of policies past can continue to haunt a region and the planet as shown by the legacy of displacement and decay caused by urban highways all across the US (Archer 2020) and the time horizon for the impacts of climate change (Markolf et al. 2019).

The objective of this work is to scan the state of knowledge in terms of defining and operationalizing “fairness” in the transportation domain. Much research has been devoted to the issues of *measuring* equity in transportation, including (among many others) Ramjerdi (2006), A. Delbosc and Currie (2011a), T. F. Welch and Mishra (2013), Karel Martens, Bastiaanssen, and Lucas (2019), and Pritchard, Zanchetta, and Martens (2022). Further, there are multiple works that discuss the conceptual and philosophical foundations of equity and fairness in transportation (e.g., Karel Martens 2016; R. H. M. Pereira, Schwanen, and Banister 2017; Vanoutrive and Cooper 2019). There have also been, previous reviews of planning documents have investigated equity from narrowly scoped perspectives, such as accessibility (Boisjoly and El-Geneidy 2017) or a particular mode of transportation [e.g., cycling; Doran, El-Geneidy, and

Manaugh (2021)]. These efforts are valuable to scholars, the public, and decision-makers alike. In our estimation however, there remains a gap in the literature in terms of understanding *how* standards for equity are developed and implemented within the transportation domain.

To illustrate the identified gap, we note how Oswald Beiler and Mohammed (2016) in their exploration of transport equity, cite the following strategies identified by the US DOT to address matters of justice [p. 287]:

- Reduce adverse human health and environmental effects on minority and low-income populations.
- Include all potentially affected communities in the transportation decision-making process.
- Ensure that minority and low-income populations receive equitable benefits.

While commendable, the strategies are too vague, which means it is possible to implement them in a myriad ways, either genuinely to comply with the spirit of justice, or else performatively to deceive it (McCullough and Erasmus 2023). Some relevant questions include: how much should the adverse effects be reduced? To zero? Or to some tolerable level of adversity greater than zero? What should that level be? What are the criteria for deciding that a community is “potentially affected”? What benefits should be distributed? Should the benefits be based on simple population weights? Or, contrariwise, should more deprived individuals be eligible for a larger share of the benefits? These questions boil down to the development and use of *standards* for transportation justice. In this work, we choose to focus exclusively on the academic domain as we know that adoption of equity concepts in planning practice has lagged developments in academic work (R. H. M. Pereira and Karner 2021; Boisjoly and El-Geneidy 2017; Linovski 2020,).

Supporting the creation of (more) just transportation systems involves understanding the production and management of transportation benefits and costs; how they are distributed and what values are implemented (and by whom) in the form of standards (R. H. M. Pereira, Schwanen, and Banister 2017; Sheller 2018; R. H. M. Pereira and Karner 2021). Thus, this review aims to collate the existing academic knowledge on the matter, and present it in a manner useful to support the development and implementation of standards for equity in transportation planning and policy. In this, we aim to provide relief to planners, especially in those places where calls for justice are explicitly made through legislation (Karel Martens and Golub 2021).

In contrast to previous reviews on how to measure inequality in transportation systems, this work is concerned with the implied or explicit standards that are used to judge whether the measured inequalities are fundamentally “fair” or unacceptable. The present study achieves this objective by scanning the state of academic knowledge in defining “fairness” in the transport domain. Borrowing from philosophers of justice (Jaggar 2009), we ask the following questions:

- **What** are those benefits and burdens of transportation systems? Are they qualified in sidewalk widths, bus frequency, travel times, accessibility, or some other consideration?
- **Who** benefits and is burdened by transportation systems? Along which lines of identity are transportation inequities examined?
- **Where and when** are equity standards applied? What are the differences between the research depending on location, context-specific planning processes and time of publication?
- **How** are equity standards and inequities measured? Are they infrastructure provision thresholds, acceptable pollution levels, or some other kind of cut off? How are these studies born out of broader notions of justice, i.e. disability rights, environmental justice, egalitarianism, or something else?

The structure of this review is as follows. After this introduction, the stage for our investigation is set by laying out some important definitions and describe the methods used for searching, selecting, and reviewing the relevant literature. This is followed by a summary of the findings and their critical appraisal. We conclude with some calls for action to improve the practice of setting and using standards of fairness for transportation justice.

Setting the stage

Justice, equity, fairness, and standards

In the introductory section the terms “justice”, “fairness”, and “equity” are used relatively loosely. This was done purposefully. As noted, people often have strong intuitions of what is “fair”, “just”, and “equitable” which may or may not match those of the authorities who set the standards of fairness. But in democratic societies, the authority of political leaders, civil servants, and all those charged with the business of governing, derive from the will of the people. It is therefore important to explicitly state how we plan to use these words, to clearly spell out what we mean by “justice”, “fairness”, and “equity”.

Justice is an end goal, a desirable state of affairs that we are morally obligated to achieve. Justice is attained when people “give and receive whatever they are due” (Jaggar 2009, 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, 440). Justice is a fluid concept, because it depends on the desirability of different states of affairs, which may change between populations, over space and time. That said, it is possible to distinguish several forms of justice (Jaggar 2009; R. H. M. Pereira, Schwanen, and Banister 2017; Karner et al. 2020).

- **Retributive justice** is concerned with the proportional retribution of wrongdoers with relation to legitimate punishers and the innocent (Walen 2023).

- **Reparative (or restorative) justice** focuses on the reparation of caused harm; it centers ‘reintegrative shaming’ to restore victims, wrongdoers, and the community according to moral values (Tyler 2006).
- **Procedural justice** strives to ensure that the views and preferences of all stakeholders are fairly accounted for in the decision-making and inter-personal procedures affecting their lives and communities (Tyler 2006).
- **Distributive justice** is perhaps the most commonly studied form of justice (see Jaggar 2009, 2; R. H. M. Pereira, Schwanen, and Banister 2017), and its main concern is the way the benefits and burdens of the tangible and intangible products of society are collected by different segments of a population.

It might be argued that all of the above touch on forms of distributive justice. Retributive justice, is usually achieved is by distributing intangibles of a society’s moral values like “freedom” (e.g., of movement, of association) as benefits, and/or the distribution of tangible resources as burdens (e.g., fines as a punishment). Reparative justice could look like the distribution of benefits and burdens to redress past wrongs, for example by asking those who have benefited from said wrongs, even if unwittingly, to shoulder a bigger fiscal burden in order to cover programs that mete benefits to those who are still harmed by past wrongs. Procedural justice could be the distribution of the benefits (e.g., the right to voice an opinion as a recognized stakeholder in the process) and burdens (e.g., the effort required to develop an educated opinion) of the processes that lead to decisions with collective consequences.

Equity and fairness are the “instruments” of justice, the tools by which society advances towards the end goal of justice.

Equity, as conceptualized alongside distributive justice, tends to encompass various tools to understand the distribution of benefits and burdens of things among a population; there is a particular emphasis on those with the least advantage and equality in their outcomes. In the transportation domain, the term is somewhat loaded because it is perceived as stemming from the authority of the state and is meant to assist with decisions about regulating and financing transportation spending (Karner et al. 2020). Here, we are in agreement with Karner et al. (2020) that equity analysis should not be seen as an end in and of itself, but rather as a means to gather information about actual and perceived inequities. In this respect, the analytical tradition of equity, at least in transportation planning, means that the relevant models become embedded in the “political ecology of the estimated truth” (King and Kraemer 1993): in principle their assumptions and scope must be open and transparent, or else they may be more vulnerable to misuse and even abuse as tools of subjugation.

Fairness, in contrast to equity, is somewhat more complicated to define. The concept does not have the same history of development as an analytical tool, and can be interpreted in numerous, and possibly discordant ways. This is convincingly demonstrated by Karel Martens and Golub (2021) in their study of the application of Title VI of the Civil Rights Act of 1964 in accessibility planning in the US. Title VI explicitly talks about the distribution of benefits derived from Federal funding: “[n]o person in the United States shall, on the ground

of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.” However, as Karel Martens and Golub (2021) show, there are several ways to comply with regulations while achieving different outcomes, ranging from the banal (do not *knowingly* discriminate), to the substantive (compensation for past discrimination within a societal context that recognizes harm was done, i.e., reparative justice). What kind of justice does fairness serve in each case? It depends on the rationale for seeking justice in the first place. Our reading of Karel Martens and Golub (2021) is that fairness is a yardstick that is best deployed *a priori* than *a posteriori*, for doing the latter risks rationalizing the outcomes rather than driving them.

Standards are a way of making concrete statements about fairness. Returning to the ambiguities in Title VI discussed by Karel Martens and Golub (2021), the attainment of justice depends on the standard used to indicate fairness. For example, explicit non-discrimination constitutes a very weak standard that takes aim at the actions of agencies instead of the recipients of the benefits. Accordingly, any distribution of benefits would be considered fair, as long as the agency does not explicitly and knowingly target or deny benefits to particular groups. The standard provides conditions to determine whether a situation is *fair*. A similarly weak standard is a *Pareto improvement*, whereby it is possible to concentrate the benefits as long as no group is worse off compared to the status quo. A policy is fair as long it does no harm. A somewhat more strict standard, a Pareto-Plus improvement, stipulates that an intervention is fair when all groups receive at least *some* (non-trivial) benefits; the size of the benefits for each group is irrelevant. In contrast to the notion of “do no harm”, such a standard embodies the ideal that no one is denied benefits. An egalitarian standard would weigh the benefits or burdens by population, and fairness is achieved when each group gives or receives in proportion to their size. In contrast, an affirmative action standard is even stricter, since it requires the benefits to be distributed in a non-egalitarian way that favors those who are still harmed by past or present discriminatory practices.

A framework to analyze questions of justice

To summarise the discussion of definitions, justice is a goal of social progress. But to understand what that goal is, we must clearly define standards of fairness. Equity analysis is tool to measure where the actual or perceived distribution of the burdens and benefits of the products of transportation systems stand with respect to the standard, in other words, instruments to see how close or far we are from a just situation.

Give these definitions, we approach the literature with an analytical apparatus inspired by the framing of Jaggar (2009) for philosophical questions of justice.¹ According to Jaggar

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).

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

In the case of justice in transportation, the question of “Where?” is paramount, as it might be argued that transportation generates inequalities by their very nature. By concentrating the effects of space-time convergence (for instance, by providing access to a transit system or a highway), an inequality is automatically generated. The burdens of transportation, in contrast, are often diffuse. They are incrementally paid, for example by a distributed population in the form of taxes, or by a population with a different spatial distribution 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 have application. In the cause of transportation justice, we ask about the temporal aspects of transportation systems, as examples: *when* did the equity analysis take place and under what historical policy context; *the right time* to invest in transportation infrastructure and as a result when to generate a spatial inequality (e.g., Rabello Quadros and Nassi 2015); for *how long* the burdens and benefits can still be associated to a specific transportation intervention; or even *timelines* of reparative justice interventions that reconcile the shadows of past transportation-related injustices.

When answering “**Who?**”, we inquire about which entities should be regarded as subjects/arbiters of justice, meaning those entitled to make claims of moral consideration from the perspective of justice. To make it tractable, this question is often approached through the filter of population groups, which may include several concurrent traits, such as gender identity, ableness, ethnicity, age, caste, and income. Often, it is appropriate to reflect on the intersections between traits, given differences in a person’s lived experiences. A possible 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 live in situations where they cannot extricate themselves from the mobility tools they can use, either because they have driven themselves out of choices (Lavery, Paez, and Kanaroglou 2013), or have been driven out of choices by factors beyond their control [e.g., captive users of a single mode (Jacques, Manaugh, and El-Geneidy 2012; Cheranchery and Maitra 2018)]. While it is important to avoid conflating the “Who” with the “What”, for analytical purposes we need to be mindful of the connection between aperson and their mobility tools.

“**What?**” asks which entities should be regarded as objects of inequities, meaning which kinds or categories of things should be distributed in a just manner. To understand the distributional implications of transportation systems, it is essential to understand what do they *produce*?

Transportation systems can be seen as space-time convergence technologies, tools that improve the rate at which time is traded for space. They can increase the speed of movement: for instance, sidewalks and traffic lights enable potential movement of pedestrian and vehicles (i.e. mobility) and the realization of mobility through travel to needed/desired destinations.

But as the adage goes, travel is derived demand. For this reason, we cannot stop at considering mobility but must consider its ulterior goal—reaching destinations. Coupled with land use, mobility creates accessibility to needed or desired activities. 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”). **Equity standards** are a tool for answering this distributive question: how do we allocate burdens and benefits? Standards are thresholds that, when operationalized effectively define what is fair. The thresholds can be quantitative (e.g., square meters of green space per capita), or they can be 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. A number of conceptualisations exist to support us when approaching this question, and we can draw from concepts in transport-related social exclusion, transport disadvantage, and/or transport poverty, which are typically based on equity principles, such as utilitarianism, Sen’s capabilities approach, or Sufficiencyarianism.

Lastly, convincing answers to the above questions require a supporting rationale: a **“Why?”** (Jaggar 2009). This is perhaps the most slippery of all the questions posed here. Justice is an inherently social construct. Asking **Why?** amounts to asking what sort of social contracts regulate human interactions, or in other words, what are the rules that our collective will to believe imposes on each of us. These contracts can be defined by constitution, but there are often unwritten and possibly contested variants. In this way, analyzing the “Why?” in the reviewed literature is not the focus of this review, partly because answers to “Why?” are not explicitly stated and challenged inference. As such, our focus is on the standards of fairness that, combined with the use of equity analysis, can help us understand how better to move towards just transportation systems and better formulate answers to “Why?”.

Scanning the lay of the land: methods

This review examines the breadth and depth of 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 use of these methods allows us to explore, in a consistent and organized manner, a relatively specialized topic within the broader transportation literature.

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; R. H. M. Pereira, Schwanen, and Banister 2017; Vecchio and Martens 2021), and in consultation with a University of Toronto Research Services Librarian and a Liaison Librarian in City Studies.

The search strategy was first 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 iteratively, adding topic search terms by stages (e.g., terms in the title, abstract or key words). The terms were bundled by means of logical connector terms “AND” and “OR”. These stages are summarized as follows (see Appendix section Section 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”). All three sets of terms were augmented following an iterative process of refinement. 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” logical connectors.

After testing the search strategy on WoS Core Collection, we proceeded to apply 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 nature of the search strategy tended to be overly inclusive since we aimed to reduce the risk of omitting relevant material. The authors and a team of research assistants trimmed the initial corpus of documents from 6832 down to 165. All documents were first excluded based on title/abstract relevance where two research assistants voted, and a third from the authorship team broke ties. Then, 1710 documents were assessed based on full-text eligibility, 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. *Covidence* (Covidence 2023), an online application for literature screening, was used for all steps of selection and data extraction on the full export of literature. Covidence is designed for collaborative work, and helps to document the work of multiple reviewers. The evidence selection workflow, (PRISMA) flow diagram (Page et al. 2021), data extraction template, and some sample data extractions can be consulted in Appendix Figure 4.

To summarize, 6832 documents entered screening and ultimately 165 were retained for data extraction as part of the evidence corpus. These 165 pieces of evidence are relevant to the transportation domain and contain an explicit or inferred equity conceptualisation and standard.

A critical appraisal of the lay of the land

This section critically threads together the trends identified in the corpus through the data extraction process (Figure 4). Specifically, conceptualisations and standards (the “How”) and their applications to the objects of justice (the “What”), the subjects of justice (the “Who”), and under which situations (“When” and “Where”). As an overview, Figure 1 visualises the prominence of each category under “When?”, “Where?”, “Who?”, and “What?”. “How?” with its conceptualisations and standards is visualised in the following Figure 2.

“When” and “Where” is transportation considered a sphere of justice

Within our corpus most papers (60%) focus on case studies in the Global North, with many studies from North America (particularly USA and Canada), Europe (particularly 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, in conversation with more developed and formal government transport planning apparatuses and technologies (e.g., planning for equitable high-speed rail, as in Monzon, Ortega, and Lopez 2013; autonomous vehicle technology, as in Eppenberger and Richter 2021; or on the public consultation processes, as in Reddy, Chennadu, and Lu 2010)).

The smattering 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, Tiznado-Aitken, and Hurtubia 2020). Despite the growing recognition in the literature 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

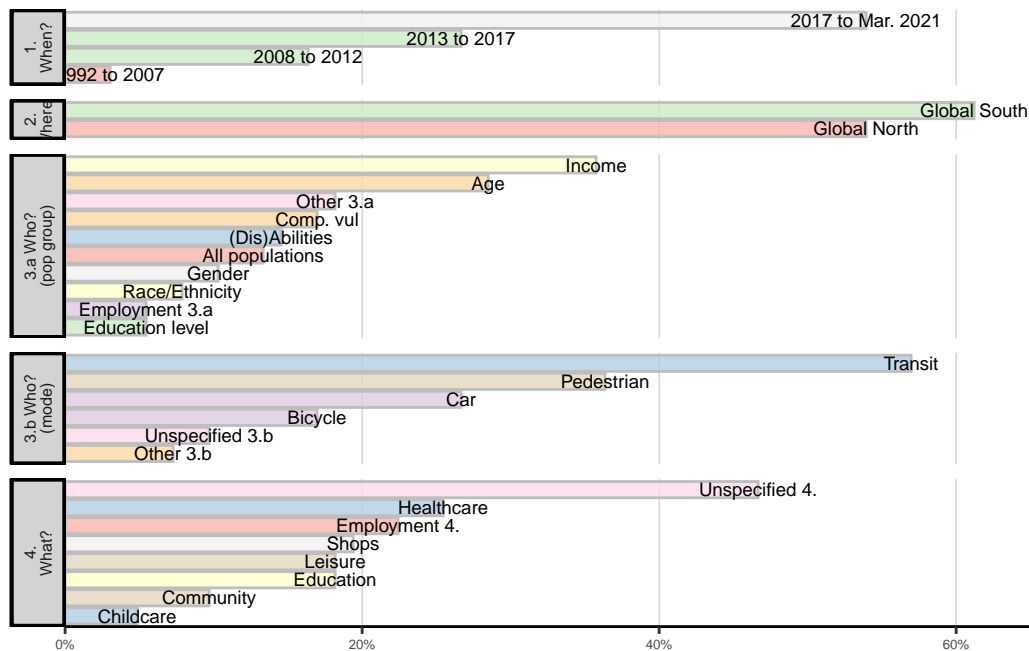


Figure 1: The proportion of category for each When, Where, Who and What; papers do often contain more than one topic and those papers are represented multiple times. Topic categories were generated upon data extraction.

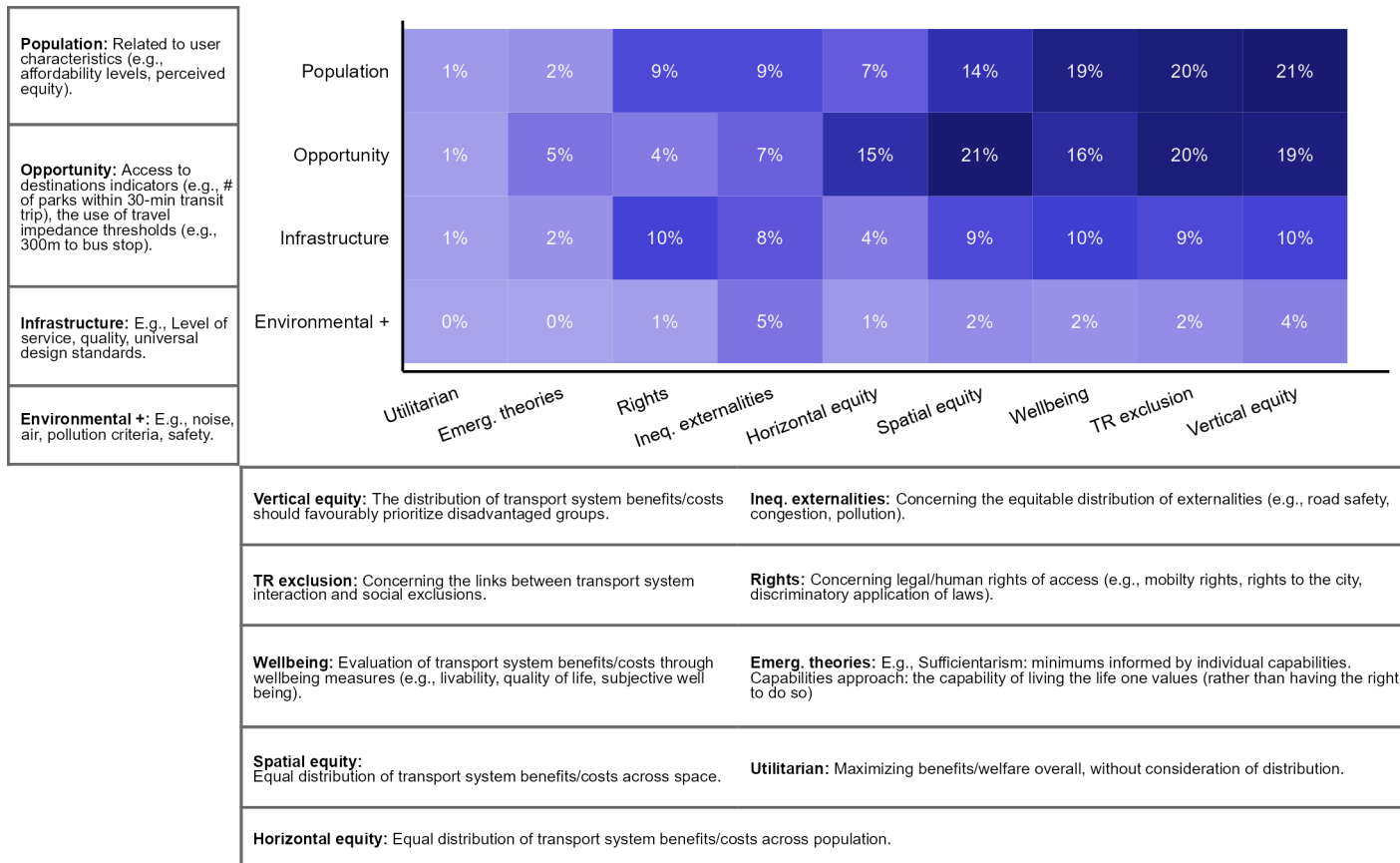


Figure 2: The prominence of Hows: the proportion of equity standards (vertical axis) within each type of equity conceptualisation (horizontal axis) category.

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, Serebrisky, and Suárez-Alemán 2018), while some highlight multi-dimensional concerns such as public transport accessibility and quality of walking environments that contribute to mobility inequalities (Tiznado-Aitken, Munoz, and Hurtubia 2018).

Studies pertaining to Africa are even less numerous compared to the South American literature. A shared characteristic among the studies from these two continents is a scarcity of official transport data (Fried et al. 2020) and a reliance on policy guidelines developed by international organizations. These studies also incorporate the use of informal transportation options and the pressures to develop road network infrastructure (which tends to support car dependency) over meeting the mobility/accessibility needs of citizens (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, Martinez, and Verplanke 2014), and focus on advancing transport justice for low to medium income countries (LMIC) 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 UK. 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 reviewed focus on rural regions (14%). We highlight the work of Cao and Stanley (2017), who examined transportation disadvantage in remote places which rely on inter-island ferry trips in the rural Philippines. 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.

We surmise 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 that have large capital costs. Informal aspects present in transport planning also have a more overbearing presence. In the present day, countries in the Global South still struggle with the consequences of past colonialism under Northern states. This has left

them more reliant on primary sector exports (lower efficiency, lower national GDP) under growing global financial markets, and with more fragile democracies. We infer, because of 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.

We characterise the Global North and South literature as laying at different points temporally on the transport inequity continuum. As Global South’ formal planning processes operate under stricter financial constraints, they rely on more informal processes to address unmet needs - a significant source of equity concerns (e.g., informal transit in Nairobi Fried et al. 2020; populations living in informal residents in Mumbai Sharma and Patil 2021). Operationalization of international standards are also more relevant (e.g., WHO noise and air pollution in Delhi Apparicio et al. 2021). In contrast, these standards are no longer as relevant in the Global North (e.g., NO_2 pollution near roadways in Montreal are under the WHO guideline Carrier et al. 2014), though perhaps being more relevant at a time of lower transport-related development. In these ways, the Global South temporally lags Global North development. However, this lag presents opportunities for all: for the Global South, to adopt relevant enhancements to Global North formal equity planning processes (e.g., indicator creation for disadvantages groups Cui et al. 2020) and not repeat their mistakes Chancel and Piketty (2015). For the Global North, reckon with their contributions to uneven development globally and environmental impacts as well as adopt relevant aspects from informal planning processes.

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

Population groups

Turning to the “Who?” of population group characteristics in Figure 1, the majority focus on “Income”, especially the lowest-income groups who face lower mobility and accessibility and higher costs and exposure (Peunghumsai et al. 2020; PJ Zhao, Li, and Liu 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 in Thailand (Peunghumsai et al. 2020), access to urban employment opportunities in Brazil (Boisjoly et al. 2020), and unfavorable rates of environmental noise, air pollution, and green space in Netherlands (Kruize et al. 2007)]. Yet, low-income is not universally associated with lower transport-related benefits for every object of justice - context matters. For instance, in Sheffield, UK Mears et al. (2019) demonstrate that historically working-class (lower-income) neighbourhoods have *more* access to green space than other neighbourhoods. This is potentially due to historic urban planning approaches, though the quality is less than average. Similarly, Bertrand, Therien, and Cloutier (2008) find that lower income groups do not always have below average accessibility depending on the granularity of analysis.

“Age” is the second most common category within population group: these papers highlight differences in age-related capabilities. For instance, Martinez-Jimenez and Salinas-Perez (2019)

and Arranz-Lopez, Soria-Lara, and Pueyo-Campos (2019) investigate travel distances/times to various opportunities, demonstrating how age is associated with differences in opportunity access. The most extreme age groups are commonly of focus: namely, school-aged children and older populations. For children, analysis of wellbeing (Laszkiewicz and Sikorska 2020), safety and access to schools Corazza et al. (2020), and promoting active travel (Mackie 2009; Mehdizadeh, Mamdoohi, and Nordfjaern 2017) are common-place. Papers that focus on older adults similarly investigate transport-related wellbeing (e.g, Y. Chen et al. 2020), access to age-specific destinations (e.g. Cheng et al. 2019), and improved options to meet unmet travel needs (e.g., Nordbakke and Schwanen 2015).

Typically, the corpus features papers that focus on intersecting (multiple) characteristics. However, the exception are what we classify as studies that focus on “(Dis)abilities” or “All Populations”. These categories are often of exclusive focus. Studies with a “(Dis)abilities” focus assess travel capabilities, namely through physical accessibility and universal design guidelines (e.g., J. Park et al. 2017; Chiscano 2021; Orellana et al. 2020). “All Populations” papers make no distinction in population. This is done, for instance in Kita et al. (2020), who investigates disparities in accessibility to food-stores and their self-reported capability/frequency of going outdoors. Often in both “(Dis)abilities” and “All Populations” focused papers, an im/explicit motivation is access (to necessities and desired destinations) for all.

As mentioned, the corpus is largely intersectional. For instance, a large proportion of papers apply a “Composite Vulnerability Index”; an *informed* combination of several individual traits like low income, unemployment and immigrant status. These indices are generated from official government sources or author-informed census data creation methods. As an example, the Neighbourhood Equity Index (NEI) is a neighbourhood-ranked measure of vulnerability created by the City of Toronto and used in Awuor and Melles (2019) to examine disparities in premature death. Other works use national census indicators such as the social and housing deprivation index (e.g., Pucci et al. 2019) or explore transport disadvantage, equity in policy implementation, or transport-related mortality burden by means of census measures (e.g., household poverty) and transport-related accessibility indicators (e.g., Aldred et al. 2021; Iungman et al. 2021; Sun and Thakuriah 2021; Scheurer, Curtis, and McLeod 2017). Similarly, Environmental Justice (EJ) indicators have been used in the US literature to identify neighbourhoods that have a higher than average proportion of low-income and non-white populations and evaluate the equity impacts of transportation projects (e.g., Rowangould, Karner, and London 2016; K. Park et al. 2021; Reddy, Chennadu, and Lu 2010).

Intersectional considerations are so prevalent in the corpus that papers studying “Gender”, “Race/ethnicity”, “Education”, or “Employment” level are infrequently studied exclusively. Only a few papers focus exclusively on gendered differences in active transportation Xie and Spinney (2018), race/ethnicity’s relationship to green space proximity (Silva et al. 2018), and culturally-appropriate opportunities (e.g., Wang and Roisman 2011). Papers that focus *solely* on “Employment” or “Education” level are absent all together. Furthermore, “Other” population groups are also frequently considered in the corpus: this is a catch-all category that includes group populations less commonly the subject of research e.g., veterans and access

to specific-healthcare needs (Mooney et al. 2000), pregnant people and access to services (Vadrevu and Kanjilal 2016), and youths who live in foster care (Batsche and Reader 2012). Overall, the diversity of population groups considered in the corpus, often intersectionally, demonstrates the variety of transportation-equity concerns addressed in the corpus.

Modes (mobility tools)

Travel mode, though modifiable, is intertwined with individual identity, posing challenges for equity analysis. In this sub-section, we choose to view the mode of travel primarily as those who use the mode, hence the subject of justice (i.e., the “who”), but occasionally, this will be enjoined to an object of justice (i.e., a “what”).

Public transit characterises the majority of the corpus (Figure 1). Despite transit being perceived unfavourably by some (A. Paez and Whalen 2010; Mella Lira and Paez 2021), it is often viewed as the only and primary mobility option mode for many (Jacques, Manaugh, and El-Geneidy 2012; T. F. Welch and Mishra 2013; Cheranchery and Maitra 2018). The public transit focused papers assess a variety of topics such as: food desert identification (McKey, Kim, and Seo 2020), barrier-free transportation for people who face disabilities (e.g., Jiménez-Espada and González-Escobar 2021; Liu et al. 2019) and people with autism (Lim et al. 2021; Feeley 2019). We infer from the corpus that public transit is seen as a public good and hence a natural object of justice. Accordingly, public transportation is adaptable to meet the demands of justice, for example, by funding it sufficiently to provide barrier-free transport for most, despite challenges like low densities, fiscal constraints and political will (Markard et al. 2023).

Transit also plays a central role in multimodal comparisons for transport equity analysis: these papers feature “Walk” or “Car” or some other category in Figure 1. For instance, Brussel et al. (2019) compares public transit, pedestrian and road network accessibility measurements in the context of SDG 11.2 in Bogota. Renne and Mayorga (2018) reviews natural disaster evacuation plans, focusing on car-less households in the USA and emphasizing transit and pedestrian networks. A few papers also frame transit as being in direct competition with car travel or use their comparison as a benchmark (Golub and Martens 2014; K. Martens, Golub, and Robinson 2012). For instance, Warren et al. (2015) propose car ownership standards for Havana, Cuba, acknowledging the tension between mobility needs in transit under-served areas and emission reduction goals. However, this framing is not universal, transit is sometimes seen by the corpus as a mode to fulfill individual capabilities. As an example, Smith, Hirsch, and Davis (2012) explores perspectives about transport needs and costs to achieve perceived sufficient living standards for those living in rural areas in the UK. 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.

Following transit, pedestrian travel (“Walk”) is the second most studied object of justice. Pedestrians represent a unique convergence of “what” and “who,” utilizing their own bodies

for mobility. Papers focusing solely on walking often use walkability scores to assess neighbourhood quality (Evans 2015) pedestrian mobility in different demographics (Towne et al. 2016; H. Kim et al. 2016), or urban peripheral regions (Blecic et al. 2021), measuring equity distribution. Some use walkability to gauge public health and urban vitality (Sung and Lee 2015; McCormack et al. 2012). Furthermore, pedestrian-focused papers often discuss walking as a bridge to connect multiple modes as part of active transportation systems: linking walking, with cycling (“Bicycle”), and “Transit”. Topics include how active transport impacts children’s physical activity (Mammen et al. 2014), walkability as a car alternative (Bertrand, Therien, and Cloutier 2008), and tensions between modes leading to unsafe walking conditions (Siu 2019; Ferencak and Marshall 2019).

Papers with a pedestrian focus also often see walking as a bridge to connect multiple modes: they discuss ‘walkability’ as part of active transportation, which focuses on both walking, bicycle and/or transit. Concepts discussed include how active transport contributes to children’s physical activity levels (Mammen et al. 2014), walkability as an alternative to car predominance (Bertrand, Therien, and Cloutier 2008) or tension that exists between modes, creating unsafe conditions for walking (Siu 2019; Ferencak and Marshall 2019).

The third most studied category is “Car”. Unlike transit and walking, cars are rarely the sole focus. When studied in the corpus, they’re critically compared with transit or considered in areas with inadequate transit (Kimmel et al. 2018; Aljoufie 2016). Upon the rise of automobility, walking and cycling were in the way; Transit came to be seen as a social service and sometimes as a hindrance to the full realization of automobility. We surmise that the corpus’ focus on non-car modes is a reckoning with automobility’s legacy and ongoing requirements of disproportionate amounts of space, public subsidies and government support that underestimates its true cost (Gössling et al. 2019; Timperley 2021) including externalities like air pollution or safety (Feng and Timmermans 2014; Houston et al. 2006). Other than “Car” being compared to walk, cycle or transit, some papers reflect the existing ways of travel and alongside “Car” including “Other” (Figure 1) options namely wheelchair accessible taxi and/or paratransit (Marquez, Poveda, and Vega 2019; Wilkinson-Meyers et al. 2015), travel on waterways (Vadrevu and Kanjilal 2016; Cao and Stanley 2017; Parry et al. 2018), motorcycles or other micro-mobility (Berry et al. 2016; Schmitz et al. 2019; Tiwari and Phillip 2021), or by emergency vehicle (Pedigo and Odoi 2010; Patel, Waters, and Ghali 2007).

Papers that pay no particular attention to any mode are “Unspecified”: as examples, a focus on road infrastructure or road network distances (Wismadi et al. 2014; Mishra et al. 2014), travel needs generally (Titheridge, Solomon, and Accessibility and User Needs in Transport for Sustainable Urban Environments Consortium (AUNT-SUE) 2008; Benevenuto and Caulfield 2020), realized travel (Abasolo, Manning, and Jones 2001), or externalities of realized travel (Iungman et al. 2021).

“What” are the objects of transportation justice

From the corpus reviewed, we infer that one of the most fundamental benefits of transportation systems are mobility (enabling or impeding movement) and accessibility (the ease of reaching destinations). These benefits are sometimes valued by themselves but are often seen by the corpus as instrumental to achieve an ulterior goal (e.g., activity participation and associated wellbeing benefits). For example, although vehicle kilometers traveled (VKT) is sometimes seen as a useful policy instrument (Pengjun Zhao and Li 2021), travelling more is not necessarily a sign of advantage when accessibility is low (A. Paez et al. 2010), and short trips may be a sign of advantage (K. 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 destinations.

Impartial to destination interaction

Most papers take a broad approach, with 47% focusing on “Unspecified” destinations (Figure 1). They examine various equity dimensions across different transportation modes. Some papers focus on factors that impact the trip itself like infrastructure quality, safety, and service level (Zhe et al. 2008; Prasertsapakij and Nitivattananon 2012; Fürst and Vogelauer 2013 ; Lattman, Friman, and Olsson 2016). Others analyze trips tailored for 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 while also shaping user experiences.

Partial to destination interaction

Among studied destinations, “Healthcare” services (18%) and “Employment” (25%) receive the most attention (Figure 1). Papers on healthcare often highlight disparities in services, like Wang and Roisman (2011), who assess access to Mandarin-speaking family physicians for Chinese speakers in Toronto. Similarly, papers focusing on employment (e.g., Allen and Farber 2019) may do so since it is the most common trip purpose and is often correlated with other trip activities like shops, recreation, and other services, often identifying transportation-poor neighbourhoods. These studies typically use travel surveys, census data, and point-of-interest databases, and benefit from well-developed and institutional data that represents ‘typical trips,’ especially in the Global North where this data is more readily available.

Other activity types receive less focus but serve distinct purposes beyond typically studied travel patterns. “Shopping” destinations (19%) often aim to identify food deserts (Choi and Suzuki 2013; Jiao et al. 2012; McKey, Kim, and Seo 2020; D. Kim and Park 2020). “Education”-related papers (18%) explore children’s active transportation to school (Larkins, Dunning, and Ridout 2011) or universal design (Larkins, Dunning, and Ridout 2011). Places

of “Leisure” (18%) prompt accessibility questions like spatial distribution (Xu et al. 2017), accessibility (Mavoa et al. 2015), and explores of inequity (Mears et al. 2019). Fewer papers cover “Community” destinations (e.g., public service centres, places of community support or worship) (10%) or “Childcare” (5%), but they’re integral to study holistic activity participation (Alberts, Pfeffer, and Baud 2016; Smith, Hirsch, and Davis 2012). The lack of information about community destinations, especially for children, is notable in the literature broadly (Desjardins et al. 2022).

Dimensions of measurement

Defining the object of justice (the “What”), whether specific destinations or the trip itself, shapes measurements of inequality crucial for tracking progress towards transport justice. In the reviewed corpus, we characterize these dimensions as a focus on:

- accessibility and mobility;
- transport-related environmental externalities;
- centering human-health as related to transport systems;
- human safety related to vehicular-traffic; and
- cross-dimensional classifications.

As discussed next, these intersect with conceptualizations of fairness and applied standards, forming the philosophical foundations for assessing justice in transportation.

“How” is fairness determined

Conceptualisations of fairness

The philosophical foundations that are explicit or most often implicitly inferred from the corpus are broadly characterized as follows (Figure 2 details definitions). These categories emerged as we reviewed the corpus and are used to discuss trends, but are not an exhaustive list of conceptualizations.

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

A few slices of the literature and how they are characterized by their foundational conceptualisations of fairness are summarized. For example, a slice of the corpus is supported by broader “Rights” conceptualisations: 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, de Boer, and de Kloe 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 ADA regulations (Bharathy and D’Souza 2018) or the goal of *access for all* in land-use transportation master plans (Lim et al. 2021).

In another set of the corpus, 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, Ortega, and Lopez 2013) or population-groups (Sharma and Patil 2021). These papers may also address traffic-related air and noise pollution or urban temperatures. In these papers, equity is theoretically achieved if similar levels are attainable for all populations (horizontal equity) or spatial areas (spatial equity), discussions rarely explore both minimum and maximum levels contributing to inequities from a justice perspective.

Papers that center “Well-being” assess what constitutes a satisfactory life in relation to transportation; this set of literature uses mixed-methods and, in contrast to the last set often explicitly identifies objects of injustice. Some use physical activity guidelines and surveys to understand activity related to 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 (e.g., travel times for emergency treatment (Schmitz et al. 2019), or premature mortality (Awuor and Melles 2019)) lead to firmer justice identifications.

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

Standards and methods of measuring fairness

With the frequent way conceptualisations are applied within the corpus detailed, the following categories of standards that overlap with at least one conceptualisation are included (see Figure 2 for definitions):

- Opportunity standards (66%)

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

Papers suggesting “Opportunity” standards often employ quantitative methods to analyze disparities and assess distributional fairness. Many stem from travel impedance thresholds based on speed, distance, or cost (Z. 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, Munoz, and Hurtubia 2018). Further, methods tangential to travel impedance, like limiting transport expenditure to 10% of monthly income (Rivas, Serebrisky, and Suárez-Alemán 2018), or addressing spatial mismatch (Mulley et al. 2015), pinpointing areas of relative regional inequities are also used. Notably, many papers suggesting “Opportunity” standards include cross-dimensional considerations, employing similar methods but tailored to different focal points. For instance Peunghumsai et al. (2020) suggest service benchmarks of equal supply and demand of public transit, revealing “Horizontal equities” 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 e.g., (Fakhrmoosavi, Zockaie, and Abdelghany 2021; Zheng and Geroliminis 2020; Wismadi et al. 2014).

“Population” standards are often founded on “Well-being” conceptualisations, assessing what constitutes a satisfactory life related to transportation from a variety of socio-demographic and spatial angles. Methods include establishing threshold based on questionnaires and comparisons to recommended physical activity levels e.g. (Auchincloss et al. 2020; McCormack et al. 2012; H. Kim et al. 2016; Timperio, Veitch, and Carver 2015), region-relative comparisons in health outcomes in a spatial unit e.g. (premature mortality rates Awuor and Melles 2019), spatial access benchmarks based on population-related characteristics e.g. (supermarket access Murphy et al. 2017; hospital access R. Pereira et al. 2021), summative per capita benchmarks e.g., (decent living energy consumption levels Rao and Baer 2012), and community-informed spatial boundaries e.g., (EJ defined communities Rowangould, Karner, and London 2016). While most of these papers use quantitative or mixed-methods approaches, some employ exclusively qualitative methods to explore themes (Berhe, Martinez, and Verplanke 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 mix-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 (W.-H. Chen 2010; Daniels and Mulley 2011; Sun and Thakuria 2021; Sharma and Patil 2021), linkages between transport disadvantages (A. Delbosc and Currie 2011b), areas experiencing transport poverty (Allen and Farber 2019; Churchill and Smyth 2019), food deserts (McKey, Kim, and Seo 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, Mortazavi, and Nassir 2021). Some exclusively use qualitative methods to analyze survey data on travel willingness/barriers or conduct interviews on unmet activity needs (W.-H. Chen 2010; Mehdizadeh, Mamdoohi, and Nordfjaern 2017; Nordbakke and Schwanen 2015).

“Infrastructure” standards offer another perspective on fairness, commonly grounded in “Rights” conceptualisations. Discussions of rights 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 mobility 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, Hagen, and Fearnley 2010; Larkins, Dunning, and Ridout 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, Poveda, and Vega 2019; Iderlina Mateo-Babiano, Kumar, and Mejia 2017; Fürst and Vogelauer 2013; Velho et al. 2016; J. Park et al. 2017; Lim et al. 2021; Stjernborg 2019; Desjardins et al. 2021) and assessment of standards under best-practice criteria (Daamen, de Boer, and de Kloe 2008; Velho et al. 2016; Bharathy and D’Souza 2018).

Additionally, “Infrastructure” standards papers sometimes encompass multiple dimensions, moving beyond rights (to the infrastructure) and suggest “Opportunity” and/or “Population” standards. These papers often employ “Vertical”, “Horizontal”, and “Spatial equity” lenses. These multi-dimensional 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, Ferrell, and Taecker 2017), and user-groups, especially disadvantaged ones with respect to vertical equity (Prasertsubpakij and Nitivattananon 2012) of multi-criteria indicators. Some focus explicitly on affordability and barriers, proposing infrastructure enhancements for better inclusivity, especially for the most disadvantaged (Basu and Alves 2019; Song, Kirschen, and Taylor 2019; T. Welch 2013), grounded in transport-related social exclusion (Kent and Karner 2019) or capabilities approaches (Smith, Hirsch, and Davis 2012).

Our corpus minimally focuses on “Environmental+” standards. These studies predominantly examine “inequitable externalities”, possibly because environmental burdens of transportation are addressed more broadly in other literature (e.g., environmental justice). However, these 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 externalities. Methods employed are primarily quantitative or mixed-methods, identifying inequalities through Gini coefficients (Feng and Timmermans 2014) and some develop composite indices (Agost-Felip, Rua, and Kouidmi 2021; Miranda and da Silva 2012; Corazza et al. 2020), occasionally incorporating

spatial analysis (Jephcote and Chen 2013; Carrier et al. 2014). Commonly, many use established thresholds or health guidelines e.g., WHO guidelines for Active Aging and targets included in the United Nations’ SDG (Agost-Felip, Rua, and Kouidmi 2021), OECD or WHO thresholds for traffic noise level, NO_2 levels, available green space and $PM_{2.5}$ level (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 communities, unlike accessibility measures, which vary in methods and assumptions.

Moving forward: calls for action

Justice is a goal of social progress. To understand what that goal is, clearly defining standards of fairness is essential. Measuring context-specific evidence of transport inequities is necessary to build knowledge of injustices and inspire creative interventions that advance the cause of justice. Understanding and tracking transport inequities over time and space, specifically knowledge of “Where” (spatial context), “When” (temporal context), “Who” (the subject of justice, i.e., population groups and mobility tools they use), “What” (the object of justice, i.e., what benefit/burden is produced by the system and its distribution), “How” (the conceptualisation and standards used) and especially “Why” (the rationale and not included in the focus of this review) is essential. Armed with this knowledge, policy can be designed to address these inequities while remaining adaptable to evolving justice demands.

Flexible frameworks are important as transport is derived demand. What is (in)formally considered (in)essential today, could change during the next pandemic or technological revolution. Creating adaptable transport equity frameworks that lend themselves to change with the demands of justice is as important to ensure resiliency to backsliding. From the diverse corpus reviewed, we argue for the necessity of setting standards from a systems approach, considering both *positive* rights (a right to have access to sufficient quality of essential services, for example) and *negative* rights (mobility of cars must be limited to reduce their impact on air quality, health, safety, and positive rights).

This review synthesizes 165 academic articles that undertake standard- and conceptualisation-supported equity analysis; these studies use equity analysis as instruments to gauge proximity to their context’s just situation. We follow the flexible “Where”, “When”, “Who”, “What” and “How” framework and critically appraise the findings to answer:

- **What** are those benefits and burdens of transportation systems?
- **Who** benefits and is burdened by transportation systems? Along which lines of identity are transportation inequities examined?
- **Where and when** are equity standards applied?
- **How** are equity standards and inequities measured? From what’s reviewed, we set out the following calls for action.

Call 1: Underpin standards with rigorous concepts of justice

The conceptual grounding for standards is often left implicit within the literature: for example, Mueller et al. (2018) suggests the relative risk of mortality from transport-related air pollution should not be higher in deprived groups than the general population. While the conceptual justice foundations are not explicitly declared, we infer the standard conceptualizes *wellbeing* and could be in service of reparative justice. To move equity analysis outputs towards just transport futures, explicit inclusion of justice rationales (the “Why?”) should become more common place. We must be clear with our terms – what is equity and for whom?

Standards serve as benchmark for fairness, yet some standards are seemingly arbitrary in the reviewed literature. For example, Cao and Stanley (2017) proposes 20 ferries per day to avoid social exclusion for inter-island transport planning in the Philippines, though acknowledging the standard should be politically determined. It is unclear from the paper however, if selecting a different benchmark such as 10 or 30 ferries would make a difference in any specific object of justice (e.g., accessibility to particular destinations) or if that number is tied to funding or resource constraints. As another example, what is the conceptual underpinning of the 15-minute city, where 15 minutes is the standard for travel times. Is it sufficientarianism? Or is it egalitarianism? The standard can be interpreted in a multitude of ways. We argue that the framing used to conceptualize justice must guide the selection of the standard. As Karel Martens and Golub (2021) convincingly show, being explicit about “Why” is important.

For decision-makers, setting standards, measuring inequities and moving towards setting flexible guidelines for standards that are also compatible with community-informed calls for justice is the next step for transportation equity planning. If we assume that one function of the academic literature is to recommend standards, researchers must connect compatible equity conceptualisations and standards to justice frameworks. Currently, these fundamental connections are sorely needed.

Call 2: Develop creative methods for systems-thinking approaches to equity

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

While disparity analysis is frequently used in the reviewed literature, the standards suggested do not often align with practical application. For example, metrics of accessibility (usually measured with travel impedance cut-offs of between 15 to 60 minutes depending on the destination, population group and mode) are used to show descriptive differences among areas and groups but with scarce implications as to the experience of travelers. How low of an accessibility index is too low? Relatedly, given sufficient accessibility levels are reached, excessively high accessibility values will result in high inequalities. Are inequalities of a certain level an issue? This lack of discussion makes translating results from these equity analysis into policy practice that may move conditions towards justice challenging. Creative methods and discussion of metrics of quantitative accessibility with intention of practical intervention should be paired with results; they should yield interpretable results and the explicit discussion of minimum *and* maximum values in the distribution of the object of justice (the “What?”), as applicable, is critical.

Other times, when analysis engages with metrics that may be tied to particular concepts of equity (like Gini coefficient or Theil index), they fall short in assessing whether the results are good or bad (e.g., Mijares, Suzuki, and Yai 2013). If a Gini coefficient of 0 means that all people have the same access to public transport stops, what does it mean if the result is 0.2, 0.3, or 0.4? Is this good or bad news? How should a decision-maker interpret this? Are new policies needed to reduce that number to a certain threshold, orienting future interventions? These questions usually remain unanswered in the literature despite its importance. These measurements can also bring some challenges and pitfalls (as recently summarized by Karner, Pereira, and Farber (2023)) but are necessary to move equity analysis into application and towards transport justice.

Call 3: Making data available is a matter of justice

In the review of the literature, we were left wondering specifically - what are the motivations for the use of some destination-types and the choice to not include other destinations types? For instance, papers including leisure destinations (e.g., green space, parks, recreation) are infrequently studied and some categories are missing all together. We suspect that since methods used are predominately quantitative, the reliance on commonly used point of interest databases is also high. These databases typically include education, health and occasionally include aggregated categories for leisure and community. They are quiet on types of ‘community’ and ‘leisure’ (are they a community organization, government services, a visit to a family or friend, a care-giving destination). Further, they may be missing categories all together like childcare, typically daycare or facilities – domestic work, mobilities of care, and mobility interdependence. These missing categories are unrepresented in the reviewed relative to the presence of work and healthcare destinations.

We can only track what we have collected and compiled; and we know that transport systems’ focus is more than just to work or as a source of economic development (though in underdeveloped regions, transport systems as a force of economic development is pronounced based on the

concentration of Global South transport-induce economic development studies e.g., high-speed rail (Z. Chen and Haynes 2017; Monzon, Ortega, and Lopez 2013; H. Kim and Sultana 2015)). As such, data availability matters, especially in the context of the Global South and rural geographies as fewer official data sources and public research resources exist relative to urban communities and areas in the Global North. As well as in the operationalization of emerging conceptual theories (i.e., sufficientarianism (van der Veen et al. 2020)) in equity analysis.

The calls for and relevant issues of data availability are not new, but they have at least three parts. What and who is the subject of justice? When/Where/How is it measured? And, who gets to consult and use the data? Deciding who is the subject of justice frames the data collection activity; if it's the mobility of those that do domestic work, the classification of who does this work and how it changes over time/space is fundamental. How we classify has implications for our understanding of just who is a subject of justice, as illustrated by the history of racial classifications in the US (see Lee 1993). What methods we're using, under what spatio-temporal boundaries we conduct data collection, and who has (and doesn't have) access to the collected data can all impact fulsome conceptualizations of 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).

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

Robust assessments of the implications of equity standards on the experience of the public is still lacking in the literature, but it is essential for equity analysis that translates into just practice. While the estimation of the benefits of increased mobility or accessibility, or reducing affordability burdens and transport externalities is commonplace in the literature, these estimations need to be associated with outcomes like life and neighbourhood satisfaction, subjective well-being, mental and physical health, social capital, among others.

Composite measures such as a transport-land-use index proposed by Appleyard, Ferrell, and Taecker (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 used demonstrate areas of relative high and low livability 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.

Call 5: Rigorously evaluate interventions and policies

We believe there is a need to evaluate equity interventions and policies: track their before, during, and after impacts. In this review, only approximately 10% 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, Lu, and Reddy 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.

Outcomes of interventions can be compared within and between communities, and cross community comparisons can be created that may expedite the adoption of effective policies that move towards just outcomes; the presence of these synthesis and comparative studies could support brave decision-makers in the application of research into practice.

Final remarks

To move the political needle and establish a common understanding of justice, it is critical that we have the concepts, the vocabulary, and the knowledge to express our intuitions. We argue that transportation, as an essential technology that can facilitate or hinder participation in society, is a very relevant sphere for matters of justice. The analysis of fairness and equity in transportation is vitally important for planning. Transportation systems and technologies converge space-time, and by definition they *always* leave certain populations, depending on the area and time scale, more or less burdened or benefited. The analysis and tracking of equity implications is fundamental in formulating standards that are flexible to the fluid demands of transport justice.

In this spirit, this work makes two significant contributions. It outlines a conceptual framework with supporting definitions for structuring fairness and equity analysis that may move us closer to transport justice. Then using this framework, we critically appraises findings from 165 relevant studies from the academic literature and recommend five calls to action.

Defining *fairness* is complex, but complexity is no excuse to shirk from the task. We hope this work contributes to the promotion of the idea that all are deserving of “access to the opportunities they need to lead a meaningful and dignified life” (Karner et al. 2020, 440). This idea should guide our justice conceptualisation. Likewise, we hope that in reviewing the literature, this work will contribute to advance the development and implementation of equity standards that help bend the arc of history towards more just transportation systems, and ultimately better societies.

Declarations:

During the preparation of this work the authors used ChatGPT exclusively for copyediting: aiming to reduce word count, keep original style and correct typos. After using this tool, the

authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Appendix

Why? as part of the framework to analyse questions of justice

To give an example drawing from the Canadian Charter of Rights and Freedoms, a number of rights and fundamental freedoms [including the liberty to move freely; see Department of Justice (2023)] are recognized to exist in Canada “without discrimination by reason of race, national origin, colour, religion or sex”. Notice that this declaration includes several individual traits that define the subjects of justice, but does not consider age as one aspect of the person. Does this mean that they apply universally irrespective of age? Surely not, since no reasonable person would consider a toddler’s demands for freedom of association as absolute. So, when do these rights fully apply in the life of a person? In 2017, Adrian Crook of Vancouver, B.C., was warned by the province’s Ministry of Children and Family Development that his kids could not be out of home in the community, alone or with other kids the same age, without supervision. The Ministry’s argument was that children riding the bus unsupervised compromised the parent’s ability to provide care and placed them at risk (Brend 2017). Crook argued that the goal of teaching his kids (then aged 7, 8, 9 and 11) to ride transit to school was to raise self-reliant children (Stueck 2017). While both sides discovered to everyone’s surprise that no clear rules existed regarding children’s independent transit use (Brend 2017), statistically there is evidence that travel by car is riskier than travel by bus (Morency et al. 2018). If the public good is to reduce risk, shouldn’t children be banned from riding in cars? The Canadian legal system concerns itself with fundamental freedoms and rights, one of which is the liberty to move freely. This provides an answer (of many) as to “why” we would even

consider children as subjects of justice. But the devil is in the details, and answering the other questions discussed above is essential to pin the devil by the tail. Are children under the age of 10 subjects of justice (i.e., are they a “who”) and who decides if they are (i.e., the courts or the parents in this case)? If so, is the ability to use transit unsupervised an object of justice that should be justly distributed (i.e., the “what”) and under what circumstances (e.g., to school, to a social event; during the day, or late at night?). “When” (e.g., for all children going forward, for only 5 years) and “where” (e.g., only in the suburbs, across the country) do these questions apply? Eventually, in 2020, a court of appeals ruled in Crook’s favor, allowing his children to continue to ride the bus, thus providing much needed clarity with respect to the use of transit by children who desire and are encouraged to exercise independent mobility (Stueck 2020). In actuality, the courts *created* a standard of equity: starting at a certain age, children are objects of justice from the perspective of freedom of movement, and they are due the benefits of independent mobility by transit.

Another perspective on the answer to “Why?” are cultural *norms* that provide a rationale. In this case, the liberty of movement for all—including children—reigns supreme. But a competing concern is that the outside is dangerous, and it is so in part due to vehicular traffic (Morency et al. 2018), and in part because of potential violence from others. Parents may have over-pronounced ‘stranger danger’ based on neighbourhood and socio-economic characteristics of neighbourhoods (Francis et al. 2017) and children themselves may fear potential violence based on real threats of victimization (Pain 2006). Whose voice, what perception of fear, and actions we take to intervene define and reproduce cultural norms, all play into the rationale behind the question “Why?”.

Evidence search strategy

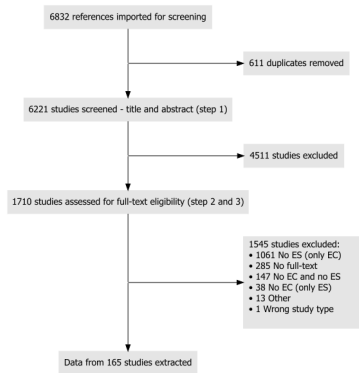


Figure 3: PRISMA flow diagram for the evidence selection process. ES signifies equity standard and EC signifies equity conceptualization.

The evidence selection process is also represented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (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 "streetcar*" OR "subway*" OR "tram" OR "trams" OR "tramway" OR "public transport*" OR "rail*" OR "train" OR "trains" OR "bak*" 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 "motorist*"))) 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 "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 "dissonance" 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 "equ*" 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 "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 "dissonance" 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 "equ*" OR "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 equity 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 equity 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 3 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 equity standards and equity 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.

Evidence selection and data extraction

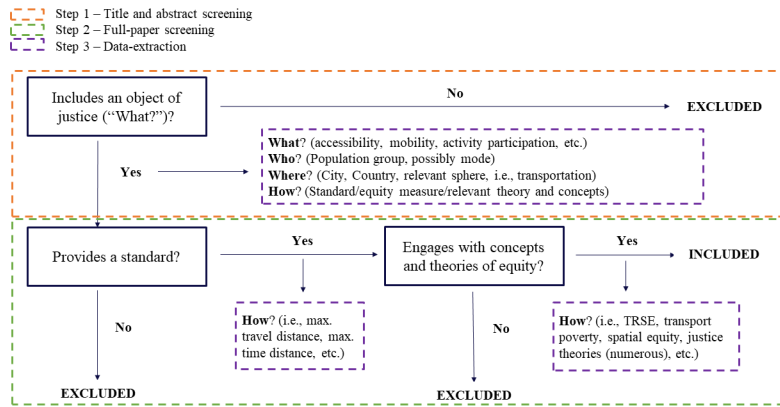


Figure 5: Evidence selection workflow. Step 1 (orange) is title and abstract screening, step 2 (green) is full-text review, and step 3 (purple) is data extraction.

The following steps summarize 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 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?” (equity standard(s) and concepts) was filled out for each study. Figure 6 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:

To provide further example of data extraction, a table of the resulting literature looked like:

Dimension	Continent	Conceptualization
What?: environmental pollution Where?: mobility and accessibility	Where? (Rivas, Serebrisky, and Suárez-Alemán 2018) - South America (select cities)	Analyses how affordable urban public
	Where?: (Bharathy and D’Souza 2018) - North America (USA - National)	This study designed a web-based too
	(Ryan and Pereira 2021) - Europe (Stockholm, Gothenburg and Malmo cities in Sweden)	Investigates what the literature and p
	Where?: (Wismadi et al. 2014) - Asia (Yogyakarta, Indonesia)	Explores the equitable provision of tr
	Where?: (Zheng and Geroliminis 2020) - North America	This paper conceptualizes equity in
	Where?: (Carrier et al. 2014) - North America (Montreal, Canada)	This work examines the statistical as
	Where?: (Jephcote and Chen 2013) - Europe (Leicester, UK)	Geospatial analysis of naturally occu
	Where? (Adlakha and Parra 2020) - Asia (Chennai, India)	From the perspective of disparity in

What?: Mobility/ accessibility and health impacts	Dimension	Continent	Conceptualization
	What?: health impacts	Where? (Schmitz et al. 2019) - Africa (Select urban and rural regions in Uganda)	The well-being of mothers, this paper
		Where?: (Iungman et al. 2021) - Europe (Madrid and Barcelona, Spain)	They use environmental pollution gu
		Where?: (Mehdizadeh, Mamdoohi, and Nordfjaern 2017) - Asia (Rasht, Iran)	From the perspective of children's w
		Where? (Murphy et al. 2017) - Oceania (Melbourne, Australia)	Assesses the relationship between sup
	What?: health impacts	Where?: (Ferenchak and Marshall 2019) - North America (Denver, USA)	Operationalizes and compares an equ
		Where?: (Zhe et al. 2008) - Asia (Tokyo, Takamatsu, and Tokushima)	Evaluates the observed safety of shar
	What?: Mobility/ accessibility	Where?: (Alderton et al. 2019) - Asia (Bangkok, Thailand) – Mobility/ accessibility and health	Establishes short-, medium-, and lon
		Where?: (Berhe, Martinez, and Verplanke 2014) - Africa (Mekelle, Ethiopia)	Examines adaption and dissonance in
	What?: Mobility/ accessibility		

Dimension	Continent	Conceptualization
What?: mobility/accessibility and safety	Where?: (Agost-Felip, Rua, and Kouidmi 2021) - Europe (Castellon, Spain)	Conceptualizes equity through age-fr
	Where?: (Mateo-Babiano 2016) - Asian (Manila, Philippine)	The perception of pedestrians' walkin

[illegible]

Figure 6: The data extraction template with associated definitions.