Is it fair? 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; a lively and rapidly growing literature has emerged on the topic (Karel Martens 2016; Karner, Pereira, and Farber 2024; 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. Transportation systems that are 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; Timothy F. Welch and Mishra 2013; Karel Martens, Bastiaanssen, and Lucas 2019; Pritchard, Zanchetta, and Martens 2022). Further, there are multiple works that discuss the conceptual and philosophical foundations of equity and fairness in transportation (Karel Martens 2016; R. H. M. Pereira, Schwanen, and Banister 2017; Vanoutrive and Cooper 2019). 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 this gap, we note how Oswald Beiler and Mohammed (2016) in their exploration of transport equity, cite the following strategies identified by the U.S. Department of Transportation 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 of 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 and by what criteria? What benefits should be distributed? How much of the benefits should minority and low-income residents receive for policymakers to declare that a project is sufficiently ‘equitable’? These questions touch on 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; Doran, El-Geneidy, and Manaugh 2021; Litman 2022)

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). In this spirit, our work seeks to make two significant contributions. First, it outlines a conceptual and flexible framework with supporting definitions for structuring transportation fairness and equity analysis. Second, it applies the framework to collate the existing academic knowledge that undertakes transportation equity analysis supported by equity standards and conceptualisations. We hope the findings and the presentation of academic knowledge will be useful in supporting the development and implementation of equity standards for transportation planners, policy, and decision makers. 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 to the literature and use them as a framework for presentation:

* **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 who is burdened by transportation systems? Along which lines of identity are transportation inequities examined?
* **Where and when** are equity standards applied in the literature? 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?

# Background

In the introductory section the terms “justice”, “equity”, and “fairness” are used relatively loosely. This was done purposefully. As noted, people often have strong intuitions of what is “just”, “equitable”, and “fair” which may or may not match those of the authorities who set the “standards” of fairness. But in democratic societies, the authority of all those charged with the business of governing should derive from the will of the people. It is therefore important to explicitly state what we mean by these terms. In the following, we describe justice as embracing moral motivation, equity as measurement tools, fairness as a yardstick of justice, and standards as statements of fairness.

**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 the needs and voices of victims to restore wrongdoers and the community according to moral values (Tyler 2006; Braithwaite et al. 2003). In planning and policy contexts, reparative justice is often conceived of as accountability mechanisms in which institutions that caused harm financially compensate victims (Safransky 2022).
* **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 studied form of justice (see Jaggar 2009, 2) as well in the transportation domain (R. H. M. Pereira, Schwanen, and Banister 2017). 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. To illustrate, retributive justice, is usually achieved 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.

From this perspective, we can then speak of the *purposes* of distributive justice: to mete out retribution *fairly*, to repair past harms, and to ensure that procedures offer *equitable* opportunities to influence outcomes. From this perspective, 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 tools to understand the distribution of benefits and burdens of things among a population, often emphasizing those with the least advantage and 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 e.g., (Tan et al. 2016; S.-X. Xu et al. 2018). From this standard, a policy could be considered fair as long it does no harm. A standard based on egalitarian theories such as proportional equity would weigh the benefits or burdens by population, and fairness is achieved when each group gives or receives in proportion to their size (Bills and Walker 2017; K. Martens, Golub, and Robinson 2012) In contrast, an affirmative action standard based in restorative justice is even stricter. 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 (Bierbaum, Karner, and Barajas 2021).

## A framework to analyze questions of justice

Give the discussed definitions of “justice”, “fairness”, “equity” and “standards”, we approach the literature with an analytical apparatus inspired by the framing of Jaggar (2009) for philosophical questions of justice.[[1]](#footnote-1). According to Jaggar (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. For example, we can distinguish literature from the global South and North, allowing us to examine how they approach, deal with, and position themselves in different spatial contexts in addressing transport inequalities.

Conventionally, the question of **“When?”** refers to the temporal circumstances within which the demands of justice have application. In the cause of transportation justice, one could 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 (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. In this literature review, given the amount of papers reviewed and the inconsistencies in how temporal aspects were addressed, we exclusively focus on the paper’s publication year.

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 such as 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 a person and their mobility tools.

**“What?”** asks which entities should be regarded as objects of inequities, meaning which categories of things should be distributed in a just manner. To understand the distributional implications of transportation systems, it is essential to understand what do they *produce*? Transportation systems are space-time convergence technologies, mobility 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 (Mokhtarian, Salomon, and Redmond 2001; Whalen, Paez, and Carrasco 2013; Redmond and Mokhtarian 2001; A. Paez and Whalen 2010). For this reason, we cannot stop at only considering mobility but must consider its ulterior goal– reaching destinations. Coupled with land use, mobility creates accessibility to needed or desired activities as well as varied burdens. 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 Sufficientarianism.

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. 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?”.

## 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 6.1](#sec-sect61) 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](#fig-figA2).

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.

# An appraisal of the lay of the land

This section threads together the trends identified in the corpus through the data extraction process ([Figure 4](#fig-figA2)). 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](#fig-fig1) visualises the prominence of each category under “When?”, “Where?”, “Who?”, and “What?”. The “How?” category, with its conceptualisations and standards, is visualised in the following [Figure 2](#fig-fig2).

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| 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. |

## “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 (Monzon, Ortega, and Lopez 2013), autonomous vehicle technology (Eppenberger and Richter 2021), or on the public consultation processes (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 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). These studies also incorporate the use of informal transportation options and tensions in developing road network infrastructure (which tends to support car dependency) over meeting the mobility/accessibility needs of citizens more equitably and sustainably (Thondoo et al. 2020). To address these challenges, researchers compile databases based on open and geo-referenced data, calculate objective and/or subjective measures (Berhe, Martinez, and Verplanke 2014), and focus on advancing transport justice for low to medium income countries by aligning their goals with external policy guidelines such as the Sustainability Development Goals (SDG), particularly those related to universal accessibility (Fried et al. 2020).

Of all the studies reviewed, 85% focus on urban and suburban settings and are highly varied in their research aims. To give an example, Cox and Bartle (2020) qualitatively examine cycling as a mode of travel for people with disabilities in a typical mid-size town in the 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 addressing and being situated at different points in the process of addressing transport inequities. 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., using the WHO noise and air pollution standard in Delhi case study (Apparicio et al. 2021). In contrast, these minimum standards may not be relevant in some areas of the Global North e.g., pollution near roadways in Montreal are consistently below the WHO standard though populations are disproportionately impacted (Carrier et al. 2014). In these ways, the Global South temporally lags Global North development. However, this lag presents opportunities for all: For the Global South, to adopt potentially successful enhancements from Global North formal equity planning processes (e.g., indicator creation for disadvantages groups (Cui et al. 2020)) and not repeat past mistakes (e.g., from entrenched car-centric development (Warren et al. 2015) to the disproportionate contribution to carbon-intense mobility (Chancel and Piketty 2015). For the Global North, there is an opportunity to reckon with their own 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](#fig-fig1), the majority focus on “Income”, especially the lowest-income groups who face lower mobility and accessibility and higher costs and exposure (Peungnumsai 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 (Peungnumsai 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; similar findings are uncovered in other spatial and temporal contexts (Foth, Manaugh, and El-Geneidy 2013; Allen and Farber 2019)

“Age” is the second most common population group category: 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 (Sharma and Patil 2022; 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 (Y. Chen et al. 2020), access to age-specific destinations (Cheng et al. 2019), and improved options to meet unmet travel needs (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 (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 implicit or explicit motivation is access (to necessities and desired destinations) for all.

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 (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 (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 (Rowangould, Karner, and London 2016; K. Park et al. 2021; Reddy, Chennadu, and Lu 2010).

Multi-dimensional considerations are so prevalent in the corpus that papers studying “Gender”, “Race/ethnicity”, “Education”, or “Employment” level characteristics 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 (Wang and Roisman 2011). Papers that focus *solely* on “Employment” status 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 maternity 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 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” such as the inequities in rural transit ‘mobility’ relative to cars (Giuffrida et al. 2021)).

Public transit characterises the majority of the corpus ([Figure 1](#fig-fig1)). 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; Timothy 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 (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](#fig-fig1). 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; Ferenchak 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; Ferenchak 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 congestion, air pollution or safety (Zheng and Geroliminis 2020; 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](#fig-fig1)) 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), motorcycle 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 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](#fig-fig1)). 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; Prasertsubpakij 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](#fig-fig1)). 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 are often aimed at identifying transportation-poor neighbourhoods (Allen and Farber 2019; Churchill and Smyth 2019). Employment is frequently used as a proxy for overall accessibility since it is the most common trip purpose and employment is usually collocated with other destinations like shops, recreation, and other services. These studies typically use travel surveys, census data and point-of-interest databases, and benefit from well-developed and institutional data. This especially holds 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 (M. 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 are integral in holistically studying 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).

## “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](#fig-fig2) 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 segments 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 subset 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), premature mortality (Awuor and Melles 2019)) leads 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 ways that conceptualisations are frequently applied within the corpus detailed, the following are categories of standards that overlap with at least one conceptualisation (see [Figure 2](#fig-fig2) 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 Peungnumsai 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 (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 thresholds based on questionnaires and comparisons to recommended physical activity levels (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 such as premature mortality rates (Awuor and Melles 2019), spatial access benchmarks based on population-related characteristics like supermarket access (Murphy et al. 2017) and hospital access R. Pereira et al. (2021)], summative per capita benchmarks such as decent living energy consumption levels (Rao and Baer 2012), and community-informed spatial boundaries like EJ defined communities (Rowangould, 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 mixed-methods, with questionnaires and qualitative approaches for “population” standards and quantitative methods like accessibility indices for “opportunity” standards. Census data and household estimates within specific travel distances or times to key destinations identify social exclusionary situations (W.-H. Chen 2010; Daniels and Mulley 2011; Sun and Thakuriah 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 (M. 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 of multi-criteria indicators (Prasertsubpakij and Nitivattananon 2012). Some focus explicitly on affordability and barriers, proposing infrastructure enhancements for better inclusivity, especially for the most disadvantaged (Basu and Alves 2019; Song, Kirschen, and Taylor 2019; Timothy F. 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) and OECD or WHO standards for traffic noise level, levels, available green space and levels (Kruize et al. 2007; Iungman et al. 2021; Apparicio et al. 2021; Khomenko et al. 2020; Mueller et al. 2018). These metrics are sometimes criticized for their general applicability. Nonetheless, their use provides interpretable values for tracking progress, offering comparability across 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.

As transport is a derived demand, flexible frameworks are crucial. 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 required 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).

In this spirit, this work makes two significant contributions. It outlines a conceptual and flexible “Where”, “When”, “Who”, “What” and “How” framework with supporting definitions for structuring transportation fairness and equity analysis. It also applies the framework in the synthesis and appraisal of 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. Following this framework and the reviewed literature it answers:

* **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 the outlined framework and the reviewed corpus, we recommend the following five calls to 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 benchmarks 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 sufficientarism? 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. Recent work by Karner, Pereira, and Farber (2024) provides several concrete examples for developing standards that follow directly from different justice conceptualizations.

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 discussions of quantitative accessibility metrics should be paired with results; they should yield interpretable results. 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 the Gini coefficient or Theil index), they fall short in assessing whether the results are good or bad (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 (2024)) 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 underrepresented in the reviewed corpus 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 in equity analysis, such as sufficientariansm (van der Veen et al. 2020).

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

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.

# 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

## Evidence search strategy

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| --- |
| 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](#fig-figA1). 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](#fig-figA1).

|  |
| --- |
| 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](#fig-figA2) 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](#fig-figA2) for the full list) and equity conceptualizations (e.g., “Justice” OR “equity” - see purple text in [Figure 4](#fig-figA2) 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](#fig-figA1) 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](#fig-figA2) 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

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| --- |
| 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](#fig-figA3)) 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](#fig-figA3)) 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](#fig-figA3)). 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. The following table contains the template that was input into *Covidence* and used throughout.

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

|  |  |  |
| --- | --- | --- |
|  |  | *Our reference definition and/or action*  *\* = definition is unapplicable* |
| GENERAL PUBLICATION DETAILS | | |
|  | Author | (write-in) |
|  | Title | (write-in) |
|  | Publication year | (write-in) |
|  | Type of publication (academic paper or conference paper) | Multiple choice |
|  | Research goal/question | (write-in) |
| EQUITY DIMENSION AND CATEGORIES | | |
| Equity dimension (multiple choice + write in) | (Im)Mobility | Focus on people and their ability to freely move between activities (e.g., physical barriers). |
| Accessibility | Focus on people/infrastructure and the potential for interaction with activities. |
| Activity participation | The ability to freely participate in activities. |
| Quality of service | Related to user satisfaction with transportation service and/or objective measures (i.e., service frequency, road quality, congestion, crowding). |
| Affordability | Associated with socio-economic conditions of users and/or user-fees (e.g., housing affordability related to transportation, transport affordability, transport user fees) |
| Pollution - air, noise, visual | Pollution as a result of transportation systems or modes. |
| Energy | Related to transportation energy consumption and/or related concepts (e.g., fuel poverty). |
| Safety - Road safety/vision zero/sense of safety | Risk of physical injury related to transportation (e.g., car crashes, bike injuries, over-policing related risk, sense of safety using transportation systems such as harassment or over-policing.) |
| Health | Health aspects related to transportation systems (e.g., mode choice, health-related pollution, stress level ). |
| Community severance | A focus on the transport system & communities and how it limits people's mobility. |
| System resilience | Related to how transportation systems mitigate the severity and likelihood of failures/disruptions, to adapt to changing conditions, and to respond appropriately after the fact. |
| Other | (write-in) |
| Case study continent (multiple choice) | North America | \* |
| South America |
| Europe |
| Asia |
| Africa |
| Australia |
| Case study city and country (write in) | City, neighborhood, metropolitan area, county, state, or similar (separate multiple entries with a semi-colon) | (write in) |
| Country (separate multiple entries with a semi-colon) | (write in) |
| Case study urban form (multiple choice) | Urban | \* |
| Rural |
| Suburban |
| Other | (write in) |
| Service mode (multiple choice + write in) | Private | Privately owned vehicle, operating as owner’s/household’s transportation (i.e., transit, bike-share, publicly owned micro-mobility options) |
| Public | Publicly owned vehicle, operating as public transportation |
| Private-Shared | Privately owned vehicle, operating as shared transportation (i.e., carshare, ride-share) |
| Autonomous | Autonomous or semi-autonomous operation |
| Other | (write in) |
| Mode (multiple choice + write in) | Transit | Bus, subway, light-rail, BRT |
| Commuter rail | Heavy-rail train |
| Pedestrian | Any pedestrian travel, assisted or otherwise |
| Car | Any car, SUV, light truck, or van |
| Micromobility options | Bicycles, e-bikes, e-scooters, e-skateboards, shared bikes, scooters, skateboards |
| Other | (write in) |
| Network conditions (multiple choice + write in) | Peak | Peak traffic conditions (e.g., AM, PM) |
| Off-Peak | Off-peak conditions |
| Disrupted | e.g., COVID-19, emergency evaluation, planned service disruptions |
| Other | (write in) |
| Associated intervention (multiple choice + write in) | Pedestrian-related | Equitable improvements to facilities e.g., sidewalks, trails, lighting |
| Transit-related | Equitable improvements to facilities (e.g., stations, dedicated lanes, vehicles) or fare pricing schemes |
| Car-related | Equitable improvements to facilities (e.g., lanes, parking) or fare/toll pricing schemes |
| Micro-mobility-related | Equitable improvements to facilities (e.g., lanes, parking) or user pricing schemes |
| Population group (multiple choice + write in) | Age | (write in) |
| Gendered | (write in) |
| LGBTQ+ | (write in) |
| Income groups | (write in) |
| Unemployed status | (write in) |
| New-comer status | (write in) |
| (Dis)Abilities | (write in) |
| Race/Ethnicity | (write in) |
| Vulnerable groups (composite) | (write in) |
| Other | (write in) |
| Activities/Opportunities (multiple choice + write in) | Employment | Activities/opportunities viewed explicitly as employment within the record |
| Healthcare | e.g., Hospital, dentist, community health services |
| Educational facilities | e.g., primary/secondary schools, post-secondary institutions, apprentice training |
| Childcare facilities | e.g., home daycare, institutional daycares, child-minding services |
| Shops, markets or grocery stores | e.g., food stores, convenience stores, malls, electronic stores , stationary stores, pet shops, flower shops |
| Leisure (recreation or entertainment) | e.g., restaurants, theatre and cinema, museums, restaurants, beach |
| Places for exercise, outdoor activities, or sports | e.g., physical fitness facilities, parks (in different scales), sports stadiums |
| Community support , cultural or worship | e.g., governmental organization & social group, religious organizations, cultural facilities |
| Other | (write in) |
| EQUITY DIMENSION AND CATEGORIES | Additional details | (write in) |
| EQUITY STANDARDS | | |
| Type (multiple choice + write in) | Max./min. travel distance | (write in) |
| Max./min. travel time |
| Opportunity availability |
| Max. benefit and/or min. Cost |
| Accessibility score min/max. |
| Other | (write in) |
| How the type is mentioned | Explicit | Explicitly sated in the paper |
| Implicit | Inferred based on measurement |
| Measure (multiple choice + write in) | Gini/Lorenz | (write in) |
| De Palma index |
| Poverty measures (FGT or other) |
| Maximum gap approach |
| Needs-based approach |
| Capability approach |
| Composite mobility index |
| Composite vulnerability index |
| Accessibility index |
| Level of service |
| Other | (write in) |
| EQUITY STANDARDS | Additional details | (write in) |
| EQUITY CONCEPTUALIZTION | | |
| Type (multiple choice + write in) | Utilitarian | Concerned with the aggregate distribution of transportation benefits/burdens (not individual). Net benefit is maximized and/or net burden is minimized (Pereira et al., 2017). |
| Libertarianism | Distribution of transportation benefits/burdens as a result of free-market transactions (Pereira et al., 2017). |
| Rawl's Egalitarianism – Different Principle | Interventions (i.e., infrastructure investments, subsidies, service provision) can only be considered fair if they improve the accessibility levels of the least advantaged groups (Pereira et al., 2017). |
| Sufficientarism / Capabilities approach | Minimum and/or thresholds for interventions and/or outcomes related to key activities (accessibility/mobility, etc.) and quality of life/capability. (Pereira et al., 2017). |
| Horizontal equity | Equal interventions for all groups; this means treating individuals equally in equal circumstances and opposing unjustifiable preferences of one individual or group over another. e.g., a planner would distribute transit burdens and benefits evenly throughout the community (Camporeale et al., 2019; van Wee, 2011) . |
| Vertical equity | Equal outcomes for all groups; this means groups with greater ability should contribute more to groups with less ability (i.e., considers existing social inequities and/or different mobility or accessibility). E.g., a planner would prioritize transit benefits and the reduction of burdens for socio-economic disadvantages groups and/or mobility/accessibility disadvantages groups (Camporeale et al., 2019; van Wee, 2011). |
| Rights | Concerned with fundamental rights- i.e., right to the city/right to mobility/universal design principles |
| Transport disadvantage | Interrelation between inadequate transport, dispersed services and/or lack residential location choices. The focus could be disadvantaged groups who experience these problems, or transport/urban form characteristics |
| Transport poverty | An individual is transport poor if at least one of the following conditions apply:   * There is no transport option available that is suited to the individual’s physical condition and capabilities (Mobility poverty) * The existing transport options do not reach destinations where the individual can fulfil his/her daily activity needs, in order to maintain a reasonable quality of life. (Accessibility poverty) * The necessary weekly amount spent on transport leaves the household with a residual income below the official poverty line. (Affordability) * The individual needs to spend an excessive amount of time travelling, leading to time poverty or social isolation (Time poverty) * The prevailing travel conditions are dangerous, unsafe or unhealthy for the individual (Exposure to externalities) |
| Time poverty | Lucas et al (2016) transport-related definition: “The individual needs to spend an excessive amount of time travelling, leading to time poverty or social isolation”. Could relate to income-status but does not necessarily have to. |
| Transport-related social exclusion | Kenyon et al. (2002) have defined transport related social exclusion as “the process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility” |
| Wellbeing/satisfaction | Focus on subjective wellbeing or user satisfaction |
| Spatial or modal equity/equality | Focused on spatial differences in intervenions, outcomes, and/or socio-demographic composition of transportation users. |
| Community engagement and recognition –bottom-up transport planning | Focus on public participation and procedural justice as it concerns transportation planning. |
| Restorative justice | Focus on repairing harm for those harmed in any transportation dimension |
| Other | (write in) |
| How the type is mentioned | Explicit | The paper mentions the conceptualization by name |
| Implicit | The concept is inferred |
| EQUITY CONCEPTUALIZTION | Additional details | (write in) |

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

| **Dimension** | **Continent** | **Conceptualization** | **Standard** |
| --- | --- | --- | --- |
| What?: **mobility and accessibility** | Where? (Rivas, Serebrisky, and Suárez-Alemán 2018) - South America (select cities) | Analyses how affordable urban public transportation is in select Latin American and Caribbean countries. They look at the estimated average monthly cost of transit trips and average monthly household income and conceptualize **transportation-related** **affordability**, especially for the most economically vulnerable (**vertical equity**). | How?: The financial burden of a basket of urban public transportation trips (60 trip fares, representing 30 round-trips per month) should not exceed 10% of household monthly income. |
| Where?: (Bharathy and D’Souza 2018) - North America (USA - National) | This study designed a web-based tool and took a representative sample of wheeled mobility device (WhMD) users anthropometry measurements to determine if the minimum standard suggested by the ADA is sufficient. We understand this conceptualization as a type of **Rights** conceptualization that WhMD should have minimum clear floor space (as described the guidelines in line with the American Disabilities Act) to access bus shelters, bus stop pads, and transit terminals. | How?: The clear floor area for wheelchairs: 760 mm (30 in.) wide by 1220 mm (48 in.) in length as described by the ADA standards. Of note, this minimum clear floor area is insufficient for a variety of the WhMD users. |
| (Ryan and Pereira 2021) - Europe (Stockholm, Gothenburg and Malmo cities in Sweden) | Investigates what the literature and planning process is missing when we measure accessibility by comparing objective and self-reported accounts of accessibility among older people. This paper conceptualizes accessibility as from the position of the **capabilities approach** and **vertical equity** (particularly acknowledging that older people have capabilities that differ from the general population). | How?: Specifically for older populations (aged 65+), the following travel distances are suggested as equitable trip lengths to grocery stores per mode: Walking: less than or equal to 1500m, Combined public transit and walking (less than or equal to 1000m (walking element)), Combined car and walking: less than or equal to 1000m less than or equal to 1000m (walking element)), Bicycle: less than or equal to 3000m in addition to travel time threshold of less than 15 mins. |
| Where?: (Wismadi et al. 2014) - Asia (Yogyakarta, Indonesia) | Explores the equitable provision of transport infrastructure provision: an application of Sen’s **capability approach**. Conceptualizes equity through Sen’s capability approach and spatial equity. | How?: Areas below the relative poverty line (of its neighbours) can only be located transport resources (i.e., measure in person\*kms that can be travelled at car speed, i.e., mobility) based on the following 2 benchmarks (they can be considered, together as the floor/minmum access): 1) Global: standard deviation (SD) distance to mean should be minimized. 2) Local: priority to minimise the differences with its neighbourhood |
| Where?: (Zheng and Geroliminis 2020) - North America | This paper conceptualizies equity in the multimodal network (transit, car) being fair toll-pricing across differences in populatins value of time (VOT). VOT is determined based on household income, with lower income households having lower VOT and thus deserving of lower tolls (vertical equity). From this perspective, a utilitarian perspective that seeks to minimize multimodal traffic congestion through introducing toll-pricing based on VOT is implemented. | How?: suggest that a toll-pricing scheme based on individuals travel value-of-time (lower income people have a lower VOT) is equitable. |
| What?: **environmental pollution** | Where?: (Carrier et al. 2014) - North America (Montreal, Canada) | This work examines the statistical association between different social groups and the concentration of air pollutants. They frame their work from the perspective of environmental equity. We interpret the conceptualizations to be along the lines of **inequitable externalities**, **spatial** and **vertical equity** - transport-related air pollution is a product of road transport and it impacts the air of residents in unequal spatial ways. The paper then frames this impact as unfair, particularly from the perspective of disproportionately disadvantaged residents | How?: The literature suggests that the health implications from the transport-related air pollution from major roadways is most acute at residential distance locations of 200 m or less. Residential locations should not be located within this distance threshold from the perspective of human health. **Environmental+** and **Population standards**: Uses the WHO NO² threshold as a point of comparison (annual concentrations of NO² should not exceed 40 μg/m-3). They argue that even through no neighbourhood, even those disproportionately low income, exceed the WHO limit in this case study, they still suggest that air pollution should not be disproportionately impacting disadvantaged neighbourhoods. It can be interpreted that they use the WHO threshold as a minimum threshold and suggest that air pollution levels should not be impacting disadvantaged populations disproportionately ( a relative population standard) |
| Where?: (Jephcote and Chen 2013) - Europe (Leicester, UK) | Geospatial analysis of naturally occurring boundaries in road-transport emissions and childrens respiratory health across a demographically diverse cityscape. Emperically identifies at what distance away from major roadways children are most impacted by transport-related pollution. This is framed in the perspective of children’s **well-being**. Children are at most risk for acute respiratory distress from elevated levels of air pollution, and as such planning should consider this point of public health. | How?: Finds that children (most vulnerable to air pollution - related to motoized traffic) are most impacted by air pollution within 283 m of a road way. This should be the distance threshold that schools and other childrens facilities are located. |
| What?: **health impacts** | Where? (Adlakha and Parra 2020) - Asia (Chennai, India) | From the perspective of disparity in gendered physical activity, this paper focuses on women’s cycling as both transport and exercise. They advocate for all people achieving physical activity thresholds (**horizontal equity**) but prioritize women and especially women in neighbourhoods with low-walkability and socio-economic status (**vertical equity**). | How?: All people should get 150 min of moderate activity a week or 75 min of vigorous physical activity per week. |
| Where? (Schmitz et al. 2019) - Africa (Select urban and rural regions in Uganda) | The **well-being** of mothers, this paper examines the timely access to emergency obsteric and newborn care for child-bearing aged women in Uganda. | How?: 2 hours to the nearest facility with surgical capacity with anesthesia services - this threshold is determined through the onset of bleeding to death if a women with obstetric hemorrhage does not receive adequate treatment). |
| Where?: (Iungman et al. 2021) - Europe (Madrid and Barcelona, Spain) | They use environmental pollution guidelines, but from the position of health. They investigate the impact of urban and transport planning on attributable mortality burden in Madrid and Barcelona and its distribution by socioeconomic status . Pre-mature mortality is linked to the exposure to pollution and motorized vehicles (**inequitable externalities**). These externalities should not be impacting people disproportionately (**vertical equity**) and should be even across space (**spatial equity**). | How?: All minimum thresholds, if exceeded this is inequitable: NO² concentration 40 μg/m³; PM 2.5 concentration 10 μg/m³; Noise 53dB for average 24 hours; Living with 300 m crow-flies distance from at least .5 hectares of greenspace; and a Change of air temperature of at least 1 ⁰C. |
| Where?: (Mehdizadeh, Mamdoohi, and Nordfjaern 2017) - Asia (Rasht, Iran) | From the perspective of children’s **well-being**, assesses the walking time to school. They frame walking to school as health-related. | How?: perceived walking time to school for students aged 7-9 yrs is 10 mins, and the longer the PWTS the less likely they were to use an active mode to travel to school. |
| Where? (Murphy et al. 2017) - Oceania (Melbourne, Australia) | Assesses the relationship between supermarket access and transport mode used, the body mass index (BMI) of the mode-user (**wellbeing**) and the equity in access distribution by income (**vertical equity**). | How?: all households should be sufficiently active (greater than 150 min and at least 5 sessions) and households should be within 1 km euclidean distance to supermarket (80-90% of the dwellings should meet this). Planners should prioritize socially disadvantaged areas to meeting these standards first. |
| What?: **transport-related safety** | Where?: (Ferenchak and Marshall 2019) - North America (Denver, USA) | Operationalizes and compares an equity analysis of proactively- and reactively-identified traffic safety issues from the perspective of **Spatial equity**, **Vertical equity** and **Inequitable exposure to externalities**. | How?: standards are suggested for both reactive and proactive analysis. First, the lower the number of collisions on the road with pedestrians/cyclists (i.e., reactive safety analysis), the better. No/minimal inequalities for general population vs. equity seeking groups (high proportion of POC and/or low income in tract). Second, the lower the perceived safety, the better (i.e., if travel to school by ped. or bike is unsafe due to traffic conditions). No/minimal inequalities for general population vs. equity seeking groups (high proportion of POC and/or low income in tract). |
| Where?: (Zhe et al. 2008) - Asia (Tokyo, Takamatsu, and Tokushima) | Evaluates the observed safety of shared use pedestrian and bicycle paths from the perspective of **well-being**. | How?: the study suggests that the safety threshold for bicycles and pedestrians to coexist on shared infrastructure is less than 0.5 pedestrians/minute per metre of sidewalk (width) and less than 3.0 cyclists/minute per metre of sidewalk (width). The standard for pedestrian/bicycle share use in terms of hourly traffic volume is less than 26 pedestrians / hour and 108 cyclists / hour for 2m wide sidewalks. |
| What?: **mobility/accessibility and health impacts** | Where?: (Alderton et al. 2019) - Asia (Bangkok, Thailand) – **Mobility/ accessibility** and **health** | Establishes short-, medium-, and long-term goals for the city in collaboration with technical leaders within the municipal government for the perspective of **well-being** (urban liveability): the standards included in this table relate directly to transportation systems. Indicators are inspired by the Sustainable Development Goals (SDGs) as well other global planning standards. | How?: 1) Green space: % of residents living < 400 m from public open space, a large park (> 1.5ha), and/or local park, 2) Public transit access: % of residents living < 400 m of a local bus stop and <800 m of train station, 3) Facilities: % of residents living < 400 m of a community centre. The following **Infrastructure standard** is suggested: Canal water quality - dissolved oxygen content of equal to or less than 2.0 mL/L |
| Where?: (Berhe, Martinez, and Verplanke 2014) - Africa (Mekelle, Ethiopia) | Examines adaption and dissonance in the quality of life (QoL) of residents. QoL is conceptualized along the lines of **well-being** and aspects of QoL directly tie into transport systems. They conduct a qualitative QoL survey of residents on the topic of three QoL domains: housing quality, access to important destinations, and affordability. They also measure quantitative indicators associated with these domains. We assume the equity goal for this paper is that subjective and objective QoL measures should not be mismatched: as discussed by the authors of this study, subjective QoL is higher than objective QoL the participant is experiencing adaption and in the reverse scenario the participant is experience dissonance. | How: 1 & 2) Access to primary or secondary education facility, percentage of households living within 1 km or 2km (walking distance), respectively from a primary school or secondary school. 3) Access to health facility, percentage of households within 40 min walking time from a health facility. 4) Access to public transport, percentage of households within a distance of 500 m from a mini-bus stop. **Population standards**: 1) Adequate family income, percentage of households earning more than the official poverty line. 2) Subjective QoL is constructed based on the households level of satisfaction for each of the eight indicators using a six point Likert-scale (1=very satisfied to 6=very dissatisfied). |
| What?: **mobility/accessibility, health impacts, and safety** | Where? (Agost-Felip, Rua, and Kouidmi 2021) - Europe (Castellon, Spain) | Conceptualizes equity through age-friendly urban spaces that reduce (and eliminate) conditions for **transportation-related social exclusion** for older populations and prioritize those who are economically vulnerable (**vertical equity**). These guidelines are inspired by the SDGs in addition to planning guidelines used national, regional, and local guidelines used in Spain. | How: 1) Access to facilities needed for old age health. Minimum distance thresholds from the geometric center of neighbourhood are suggested: at least: 1000 m from health facilities (600 m or less is preferred), elderly-specific care facilities and shops should be 600 m (300 m or less is preferred). **Population standards**: 1) Certain neighbourhoods should be prioritized above others. From this papers focus on age-friendly urban environment, they suggest that if the neighbourhood has an average old age indicator (i.e., greater than 64 years, and/or greater than 79 years, and/or aging ratio of persons aged greater than 64 relative to 15 to 64 age) should be prioritized. 2) Economic vulnerable and non-civically engaged neighbourhoods should also be prioritized. If the neighbourhood has a lower percentage of civic associations within the neighbourhood than average, and/or household income, and/or a higher than average interventions for dependency and/or social subsidies, they should be priorized. **Infrastructure standards** : 1) Green space: should be at least 10 m2 per inhabitant in the neighbourhood, greater than 15 m2 per inhab. is the goal. 2) As related to sidewalk infrastructure at least 50% of all sidewalks (preferably 75% or greater) should: have a width of 1.5m or larger, ramps should have a grade of 8% or less, be well maintained (free from deficiencies), be paved for pedestrian use, and cover public transit stops. 3) Lighting is critical for traffic-safety and a sense of safety overall. As such, at least 50% roads should: have a min. of 35 lux (road traffic) and 20 lux (pedestrian streets), and adapted traffic lights. 4) Buildings should be age-friendly. As a proxy for the quality of residential living space quality, at least 50% of residential buildings in a neighbourhood should be built within the last 50 years (preferably 75% or more). In terms of physical access into the buildings, at least 10% should have elevators and accessible entrances (preferably 25% or more). **Environment + standards** : 1) Noise at the street level should be less than 55 dB and 45 dB (but preferably less than 50 dB and 40 dB) in the daytime and nighttime, respectively. |
| What?: **mobility/accessibility and safety** | Where?: (Mateo-Babiano 2016) - Asia (Manila, Philippine) | The perception of pedestrians’ walking environments should be sufficient across 6 themes. Equity is conceptualized around **spatial equity** (equally fair walking environments for all locations) and **rights** (the right to mobility/accessibility for pedestrians) | How?: perceived pedestrian perception on protection, ease, equitable access, mobility, identity, and enjoyment must be met. |

1. Similar 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). [↑](#footnote-ref-1)