ASSESSING TRANSPORTATION EQUITY: FROM CONCEPT TO EVALUATION[1]

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1. Introduction

The overall goal of this paper is to advance understanding of how to consider equity in transportation policy decisions.Recognition that an 'equitable' transportation system is a desirable end goal is growing in transportation policies and public statements by transportation authorities. Two key challenges to developing and evaluating policies related to equity are:

- **There is no clear definition, in practice or theory, of what constitutes an equitabletransportation policy.**
- **No standards, goals or performance measures exist, against which agencies can measure progress or success in achievingtransportation equity (Martens, Golub & Robinson, 2012).**

In this paper, weseek to clarify the concepts of equity with respect to transportation decision making and advance understanding of how to consider equity in transportation policy decisions.'Equity' with respect to the transportation system can be described generally as a concern with the *distribution* **of transportation-related** *benefits* **and** *costs*and whether that distribution is 'equitable' or 'inequitable'.

2. Distribution of What?

To advance the consideration of equity in transportation decision making, it is important to understand which transport-related distribution parameters are the most important to focus on. There are three types of transport-related distribution parameters whichhave a key influence on people's well-being:

- Transport-related resources (how much we have);
- Daily travel behaviour (how much we use); and,
- Transport accessibility (how easy is it to reach a given location).

Most of the focus to-date on transportation equity has been related to the unequal distribution of transport-related resources (how much we have), such as car ownership and proximity to transport services and infrastructure. This focus on resources can be misleading. People's needs, preferences, and abilities/skills are heterogeneous. As a result, this focus provides only a partial account of individuals' capacity to use such resources to move around cities and to reach desired activities. For example, proximity to transit services is of little use if they are not affordable, if the transport system is not adequately adapted to disabled people, or if that system does not connect the places between which individuals need to travel (Pereira, Schwanen & Banister, 2017).

A more appropriate approach than assessing transport-related resources (how much we have) and travel behaviour(how much we use) is to focus on inequalities in accessibility. There are two primary ways to define accessibility related to transportation (Bondemark, 2017):

- **Place-Based:** Place-based accessibility is an attribute of an (activity) location: a location is accessible (or inaccessible) for a certain set of people or from a certain set of other locations. For example, the number of people who can access a given supermarket or hospital within a specific geographical area.

- **Person-Based:** Person-based accessibility is an attribute of a person: a person has accessibility (or not) to a certain set of locations. For example, the number of supermarkets or hospitals accessible by an individual in a specific geographical area.

For the purposes of this paper we focus on person-based accessibility, or the ease with which persons can reach places and opportunities from a given location. It can be understood as the outcome of the interplay of characteristics of individuals, the transport system, and land use. Assessment of equity based on the distribution of accessibility rather than transport-related resources or travel behaviour is supported by the following principles:

- The primary purpose of transport policy is to improve access to the places, activities, and opportunities people have reason to value (Pereira, Schwanen & Banister, 2017);
- Some minimum level of accessibility to key destinations is a good necessary for people to satisfy their basic needs;
- The concept of accessibility draws out the spatial dimension concerns over equality of opportunities, which is a central consideration of distributive justice;
- Accessibility is a necessary, though not sufficient, condition for promoting equality of opportunity (Pereira, Schwanen & Banister, 2017); and,
- Transportation authorities and local governments have a direct influence on accessibility and how it is distributed (as opposed to transportation-related resources and behaviour which also depend significantly on individual preferences and circumstances).


3. Accessibility on a System-Wide Scale

Figure 1 provides a conceptual model or influence diagram of how accessibility interacts with public policy, individual choices/circumstances, and outcomes at an individual scale and system-wide scale. On the left-side of the diagram, there are the key policy levers that influence both the transportation system and land use patterns, both of which are also influenced by economic activity, geographic features and other factors.

The transportation system and land use patterns interact to make up what we can call an "Accessibility Map" – this map is always changing with time, but at any one point in time, it represents how easy it is to get around a given area (e.g. a city) from any given location. The transportation system and land use patterns can and will interact with each other in all directions, so that disadvantage in one dimension can potentially be compensated by creating advantage in another. For example, the disappearance of the last shops in a village (the land use dimension) can be compensated by better public transport options to travel to shopping areas in a nearby town (the transport dimension).

Individuals make key choices in part due to the "Accessibility Map" of their home city. For example, it influences whether to own a vehicle and it influences their choice of where to live. Other factors that influence these choices include: a person's resources and their preferences or needs. The choice of where to live and whether to own a vehicle are key factors influencing someone's own personal Accessibility Map – representing the ease by which they can get to where they want to go. This personalized Accessibility Map influences transportation behaviour (mode choice, destination choice, # of trips, distance travelled). This transportation behaviour, in turn, has a feedback effect on the characteristics of the system – both the transportation system and land use patterns. Transportation behaviour then influences key outcomes at the individual level and system level.

Figure 1

Influence Diagram for Accessibility
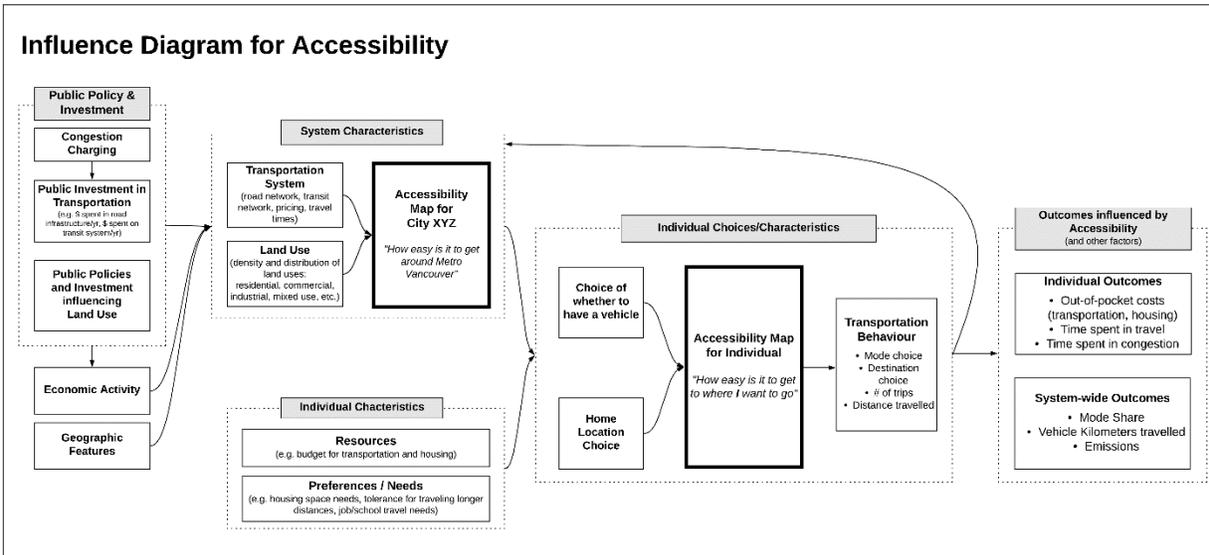
4. Perspectives on Equitable Distributions

We have identified five main perspectives on what an equitable distribution of accessibility could look like: (1) Egalitarianism, (2) Utilitarianism, (3) Libertarianism, (4) Sufficientarianism, (5) Maximax Criterion.

*Egalitarianism:*Egalitarianism is premised on the idea that society should treat all people equally. This concept of equity considers the perspective that the distribution of transportation, where everybody has the same amount, ie. an equal distribution, is the fairest. Using egalitarian theories to evaluate the equity of different transport policies justifies the case for moving away from journey-time savings as the primarily valuation method and towards improved accessibility to basic services. Egalitarianism encourages a policy focus on equalizing the relative level of accessibility between different social groups. From such a perspective, the benefits of providing a new bus service to improve the accessibility of unemployed young people to relevant employment opportunities would be valued more highly than the aggregate journey time savings of the whole population using that bus (Lucas, van Wee & Maat, 2016).

Does…	Does not…
• Focus on basic liberties and equal distribution of access. • Provide supporting justification for policies which aim to provide equality of accessibility or redistribution to provide equality of accessibility.	• Does not to make clear statements about acceptable levels of inequality, what an ideal distribution pattern looks like, or how far transport policies should go in reducing inequalities (Pereira, Schwanen & Banister, 2017).

Utilitarianism: Utilitarianism is based on three key assumptions, which structure its understanding of equity. Firstly, utilitarianism is based on the belief that human well-being, or "utility", is the only thing with intrinsic value and, therefore, is the core of equity concerns. Secondly, utilitarianism interprets the principle of equal respect as giving equal weight to everyone's welfare and interests, "regardless of the content of the preferences or the material situation of the person". Finally, utilitarianism holds a strictly

consequentialist view: the moral judgement of an action or policy should be based exclusively on its consequences, particularly on how it maximizes well-being, or "utility". As a result, the policy that best aggregates people's conflicting preferences becomes simply a matter of efficient administration, where the best alternative is the one which maximizes aggregate net welfare for the greatest number of people (Pereira, Schwanen & Banister, 2017). Utilitarians are not interested in accessibility in itself, but only in the value of actual trips for the promotion of those activities from which people derive utility. From this perspective, urban and transport policies should be designed to facilitate trips to those activities whichmaximize aggregate utility (Pereira, Schwanen & Banister, 2017).

Does…	Does not…
• Focus on welfare, well-being and utility– the distribution which maximizes overall benefits is considered the fairest (the greatest good for the greatest number). • Gives equal weight to everyone's welfare and interests, regardless of the situation of the person.	• Care about the distribution between individuals – even when the aggregate welfare comes at the expense of the least well-off. • Emphasize individual rights.

Libertarianism: The idea of self-ownership is at the heart of the libertarian concept of equity. It recognizes that all individuals equally share some fundamental rights (e.g. to one's own life and property) and the freedom to choose how to lead one's life according to one's values and goals, without interference by the state or others, provided the rights of others to do the same are respected. Libertarians claim free markets are inherently just and work as the best instrument to promote equity. State interventions such as regulation, taxes, and subsidies should be limited as they tend to distort market functioning. Libertarianism has no concern about how accessibility is distributed among members of society. According to libertarians, the fairest distribution of transport accessibility would be whatever distribution resulted from free market transactions between consenting adults (Pereira, Schwanen & Banister, 2017).

Does…	Does not…
• Focus on self-ownership. • Recognize that all individuals equally share some fundamental rights. • Consider a fair distribution as whatever results from free market transactions.	• Compromise individuals' liberties, even at the expense of human welfare. • Recognize that a person's preferences are never solely dependent on their individual choices. • See that government has a role in providing solutions to market failures such as transportation externalities. • Recognize power imbalances in market transactions.

Sufficientarianism: The concept underlying sufficientarianism is there are minimum levels of transport and accessibility to essential activities that should be available to everybody. Sufficientarianism assumes that everybody should be well-off up to a certain minimum threshold, which is 'sufficient'for fulfilling their basic needs and to guarantee their continued well-being. The concept of sufficientarianism provides a justification for developing policies which provide a minimum threshold level of accessibility to key destinations.

Does…	Does not…
• Focus on minimum levels of transport and accessibility. • Assume everybody should be well-off up to a certain minimum threshold to guarantee their continued well-being.	• Recognize that no minimum thresholds can be established without overarching assumptions about preferences and needs.

Maximax Criterion: Building on the concepts of egalitarianism and utilitarianism, the 'maximax' criterion for the distribution of accessibility has been defined. This criterion combines the goal of maximum average accessibility (utilitarianism concepts) with a limit on the maximum gap allowed between the worst-off and the best-off in terms of accessibility levels (egalitarianism concepts). The application of the maximax principle in transport planning and policy would assist decision-makers in the selection of transport projects that maximize average accessibility levels, while ensuring that the accessibility gaps between population groups remain within an acceptable range. Compared to the egalitarianism principle, the maximax criterion does not demand uniformity and is thus in line with the inevitable differences in accessibility created by space.

Does…	Does not…
• Focus on maximizing utility while minimizing the welfare gap. • Recognize the inevitable differences in accessibility created by space.	• Define the maximum welfare gap which should not be exceeded.

5. Equity and Transportation Decision Making

Transportation decision makersare not likely to subscribe purely to one of the equity perspectives described above. Rather, they will likely see some merit in many if not all of these perspectives and will seek a balance across them that they think is appropriate for a given decision. This balance will be different for different decision makers; it may also shift for any one decision maker depending on what's at stake. Broad public or political opinions about what's equitable may also vary over time.

Decision makers in the public realm are usually making decisions with the potential consequences for equity in mind. However, because they often consider equity implicitly rather than explicitly, those decisions are often not fully informed– the analysis and information provided to them about equity implications is often incomplete and is not necessarily focused on the types of information that would be most useful.

The task for analysts is to develop a robust analytical framework for considering equity in transportation decision making that can be used regardless of the particular views of any one decision maker at any one point in time. The building blocks of such an analytical framework include:

- **What matters:** Identification of the dimensions of equity that commonly matter to decision makers when it comes to equity and accessibility.

- **How to measure it (Metrics):** Developing methods fordescribing the implications of transportation decisions on equity and accessibility.

- **How to influence it (Modeling and Analysis):** Analysis that supports understanding the influence and relevance of different policy and investment levers on equity and accessibility.

Such an analytical framework would:

- Enable analysts to consistently and objectively describe the equity implications of different transportation policies using a small set of metrics,
- Allow decision makers to evaluate the relative importance of the metrics in the context of any given transportation decision,
- Help decision makers to balance equity considerations with other transportation policy objectives for any given transportation decision, and,
- Support informed deliberations among decision makers and ultimately an informed choice about which policy provides the best balance across multiple objectives.

The five equity perspectives described above suggest a range of things that are likely to be important to decision makers. These equity perspectives can be represented by different types of metrics, introduced in the table below. Once developed, these metrics can be used to describe changes in accessibility and the distribution of those changes for transportation policy and/or investments under consideration.

Table 1 Overview of metrics for equity in transportation decision-making

MetricType	Preferred Direction	Description
Average Accessibility	↑	Metrics in this category generally reflect a **utilitarianism** perspective of equity. Since increasing accessibility increases utility in society, then all else equal, a policy or investment that increases average accessibility would maximize aggregate net welfare for the greatest number of people.
Gap in Accessibility across Region	↓	Metrics in this category generally reflect the **egalitarianism** and **maximax criterion** perspectives on equity. Decreasing the gap in accessibility across people and regions is seen as desirable from both of these perspectives.
Minimum Accessibility	↑	Metrics in this category describe the accessibility level for the people or areas that have the lowest accessibility. These metrics generally reflect a **sufficientarianism** perspective on equity. Comparison of the accessibility level of this group with external benchmarks would be needed to help decision makers assess if this accessibility level is 'sufficient'.
Out-of-pocket costs in taxes and fees	↓	These metrics describe how much people have to spend in taxes and fees for access. Metrics in this category reflect a **libertarianism** perspective on equity – that is, that the levying of fees or taxes impedes individual spending decisions, and thus impacts individual freedom.

6. Example Equity Evaluation Approach

To illustrate how this equity analytical framework could be used for evaluating transportation alternatives, we offer a simple mock-up example of two alternative transit investment packages for a large metropolitan area of mixed densities that we call 'MadeupVille':

- **Transit package #1:** Transit capacity added across the city, but on balance, more capacity is added in denser, more urban areas than suburb areas.
- **Transit package #2:** Transit capacity added across the city, but on balance, more capacity is added to suburban areas than denser areas.

For the purposes of this mock-up example, we assume that the public and/or decision makers are trying to understand two main questions with respect to equity:

    (1) What is an equitable distribution of transit benefits across the municipalities in MadeupVille?
    (2) What is an equitable distribution of transit benefits across income groups?

The purpose of the analytical framework outlined in this paper is not to answer these questions directly, but rather, to provide the public and/or decision makers with useful information to make their own determinations on what they think is the best alternative in consideration of equity and any other factors that matter to them.

We also assume that the transit authority for MadeupVille has a transportation model that simulates changes in accessibility using the logsum method (Jong et al., 2006). Since accessibility metrics, such as logsums, are difficult to interpret for non-transportation experts, we envision that an "Accessibility Index" would be created with each index increment equal to a 1% change in accessibility – i.e. an increase in the index from 50 to 100 represents a 100% change in accessibility (Figure 2). The index value of 100 is anchored to a high logsum value but not the highest so that all transportation access zones (TAZs) in the region have an accessibility that falls somewhere between 0 and 200. Since 100 represents a high level of accessibility, it could be used as a benchmark to identify which TAZs to be most concerned about in relation to improving accessibility.
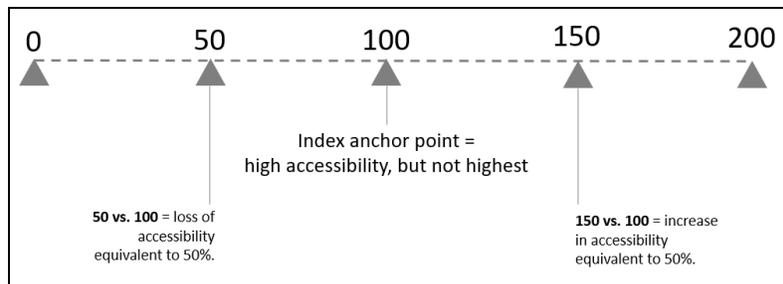
Figure 2Accessibility Index

Table 1 Illustrative Results

Metric	Units	Pref Dir	Baseline	Commute Trips	
				Alternative 1 Transit Package #1	Alternative 2 Transit Package #2
Average Accessibility					
per household (w/ car)*	Access Index	↑	77	**80**	78
per household (w/o car)**	Access Index	↑	57	**67**	60
Average Accessibility by income group					
low income group (w/ car)	Access Index	↑	62	63	**64**
middle income group (w/ car)	Access Index	↑	77	79	**80**
high income group (w/car)	Access Index	↑	87	**88**	87
low income group (w/o car)	Access Index	↑	54	59	**62**
middle income group (w/o car)	Access Index	↑	62	67	**74**
high income group (w/o car)	Access Index	↑	67	**72**	71
Accessibility Gap - Income					
b/w high and low income (w/car)	Access Index	↓	25	25	**23**
b/w high and low income (w/o car)	Access Index	↓	13	13	**9**
b/w high income (w/car) and low income (w/o car)	Access Index	↓	33	29	**25**
Accessibility Gap - Municipalities					
across Municipalities (w/car)	Access Index	↓	45	46	**43**
across Municipalities (w/o car)	Access Index	↓	55	60	**50**
Minimum Accessibilty					
low income households (w/o car)	Access Index	↑	18	19	**20**
lowest municipality (w/o car)	Access Index	↑	30	32	**40**
Household Charges - Increase in taxes to pay for transit package					
Average per household	$/yr/household	↓	0	100	100
Average for low income household	$/yr/household	↓	0	40	40

*"w/car" means with access to car, transit, cycling and walking.
**"w/o car" means household does not have access to car beyond a minimal level (e.g. taxis) and has access to transit, cycling and walking.

Illustrative results for this example are shown in Table 1. Accessibility metrics are unique to trip purposes, so for this example, we only show results for commute trips. Results corresponding to the equity perspectives described in Section 4 are shown for the baseline and the two transit package alternatives. We purposely report the access index values for the baseline and do not just report the relative changes of an alternative to the baseline. We include the baseline as a separate column because for many of these metrics, it matters if accessibility is low or high in the baseline when evaluating the value of a change in accessibility. Note that for the metrics of average accessibility and minimum accessibility, the preferred direction of change is up. For the accessibility gap and the household charges, the preferred direction of change is down. The accessibility gap metric is calculated simply as the access index value for the first group (e.g. high income) minus the access index value for the second group (e.g. low income). For each row of the table, the alternative with the best value is bolded to enable the identification of trade-offs in choosing between the alternatives.

The types of conclusions that could be made from this illustrative example include:

- Both alternatives improve average accessibility, but **Alternative 1 improvesaverage accessibility more than Alternative 2**, indicating that at an aggregate level, Alternative 1 achieves higher gains in total accessibility across the population than Alternative 2.
    - Alternative 1 and 2 improve average accessibility for households without access to a car by **10** and **3** index points respectively relative to the baseline.
- **Alternative 2 is better than Alternative 1 in decreasing the accessibility gap and increasing minimum accessibility**.
    - For the gap metric that is arguably the most representative of the gap between the most advantaged group (high income with access to car(s)) and the least advantaged group (low income with no access to a car)), the accessibility gap is reduced relative to the baseline by **8**and **4**index points respectively for Alternative 2 and 1.

Providing this type of information to the public and/or decision makers allowsfor informed dialogue on the consequences of these two transit alternatives. Quantifying the changes for these different equity

perspectives allows the public and/or decision makers to weigh the trade-offs of this choice and form opinions on what's more important – the higher gains in average accessibility offered by Transit Package #1 or the higher gains in decreasing the accessibility gap and increasing minimum accessibility offered by Transit Package #2. These metrics also provide the public and/or decision makers with the information to weigh the gains in accessibility with the additional taxation costs to households for the increased transit services.

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