Social Equity in Public Transit: A decision guide for practitioners and policymakers

International Energy and Environment Practicum Program, Johns Hopkins University School of Advanced International Studies

Lubna Anantakrishnan & Antonia-Sophie Gramsamer
TOYOTA MOBILITY FOUNDATION PRACTICUM TEAM
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Table of Contents

Table of Figures

Table of Tables

Executive Summary

Transport acts as a ‘gateway' service that can bolster or hinder various domains affecting the overall quality of life: income, employment, health and disability, education, geographical access to services, social environment, and housing (Wu and Hine 2003; Garrett and Taylor, 1999). Lack of access to public transport, therefore, creates significant barriers to accessing jobs, healthcare, education, social, and other opportunities (Kamruzzaman, Yigitcanlar, Yang and Mohamed, 2016). At the same time, private transportation is not always a feasible option due to cost restrictions, congestion or high volume of commuters. For this reason, the Leadership Conference on Civil and Human Rights (2011) has declared public transportation a civil and human rights priority (Leadership Conference Education Fund, 2011). Consequently, a robust equity analysis at the planning phase of public transit projects requires long-term thinking, which includes equity considerations. The central thesis of the paper is that equity is multi-dimensional and public transit should use a policy lever to bridge existing inequities. To put this into practice, this report answers the question: How can equity impacts be assessed at the project planning and appraisal stage to determine whether an intervention will improve equity?

This paper defines equity, argues for including equity considerations as a central feature of public transit project appraisal, and provides a snapshot of current practices in public transit project appraisal. Next, the multiple dimensions of equity are discussed with recommendations for how these considerations may be adapted at the decision-making and planning phase rather than at the impact evaluation phase. For each dimension, it explores the priorities for equity, why the given dimension is important, and how it can be applied at the project planning/appraisal stage. The dimensions of equity covered are Economic inclusion; Land use impacts; Gender and Safety; Environmental performance; and Accessibility. Finally, the key considerations from each category are filtered to provide a synthesized ‘equity checklist' based on the findings of the previous sections. The objective is to offer project planners and other stakeholders a detailed list of questions to ask during the planning phase of any public transit intervention. Therefore, the final section includes recommendations for handling trade-offs between the dimensions and project requirements without diminishing the focus on equity.

Introduction

Transport acts as a ‘gateway' service that can bolster or hinder various domains affecting the overall quality of life: income, employment, health and disability, education, geographical access to services, social environment, and housing (Wu and Hine 2003; Garrett and Taylor, 1999). Lack of access to public transport, therefore, creates significant barriers to accessing jobs, healthcare, education, social and other opportunities (Kamruzzaman, Yigitcanlar, Yang and Afzan, 2016). At the same time, private transportation is not always a feasible option due to cost restrictions, congestion, or high volume of commuters. For this reason, the Leadership Conference on Civil and Human Rights (2011) has declared public transportation a civil and human rights priority. Consequently, a robust equity analysis at the planning phase of public transit projects requires long-term thinking, which includes equity considerations. The central thesis of the paper is that equity is multi-dimensional and public transit should be used a policy lever to bridge existing inequities. To put this into practice, this report answers the question: How can equity impacts be assessed at the project planning and appraisal stage to determine whether an intervention will improve equity?

1. Equity in Public Transit

1.1 Equity and the Need for Disaggregation

The idea of equity comes from the political and philosophical idea of social justice, in particular distributive justice. While there is no consensus on a strict definition, transportation equity broadly refers to the fair or just distribution of transportation costs and benefits, among current (and future) members of society (Litman, 2002). Theories of equality are characterized by a focus on the welfare of the least advantaged groups (Konow, 2003) and can be broadly divided into two dimensions: horizontal equity and vertical equity.

Horizontal equity discusses the distribution of impacts between consumers regardless of individual ability and need. This means individuals and all groups are to be treated equally in the distribution of benefits and "get what they pay for and pay for what they get." [1] Consequently, maximizing horizontal equity is considered to be the ‘mass transit’ approach.

Vertical equity considers the distribution of costs and benefits between subgroups of differing ability and need and is therefore improved when the service to disadvantaged groups is improved. This means transportation policies are just if they prioritize socially and economically disadvantaged individual groups to make up for other inequities (Rawls, 1971). Consequently, maximizing vertical equity is the ‘social transit’ approach (Litman, 2017).

[1] This includes fees, taxes, and subsidies

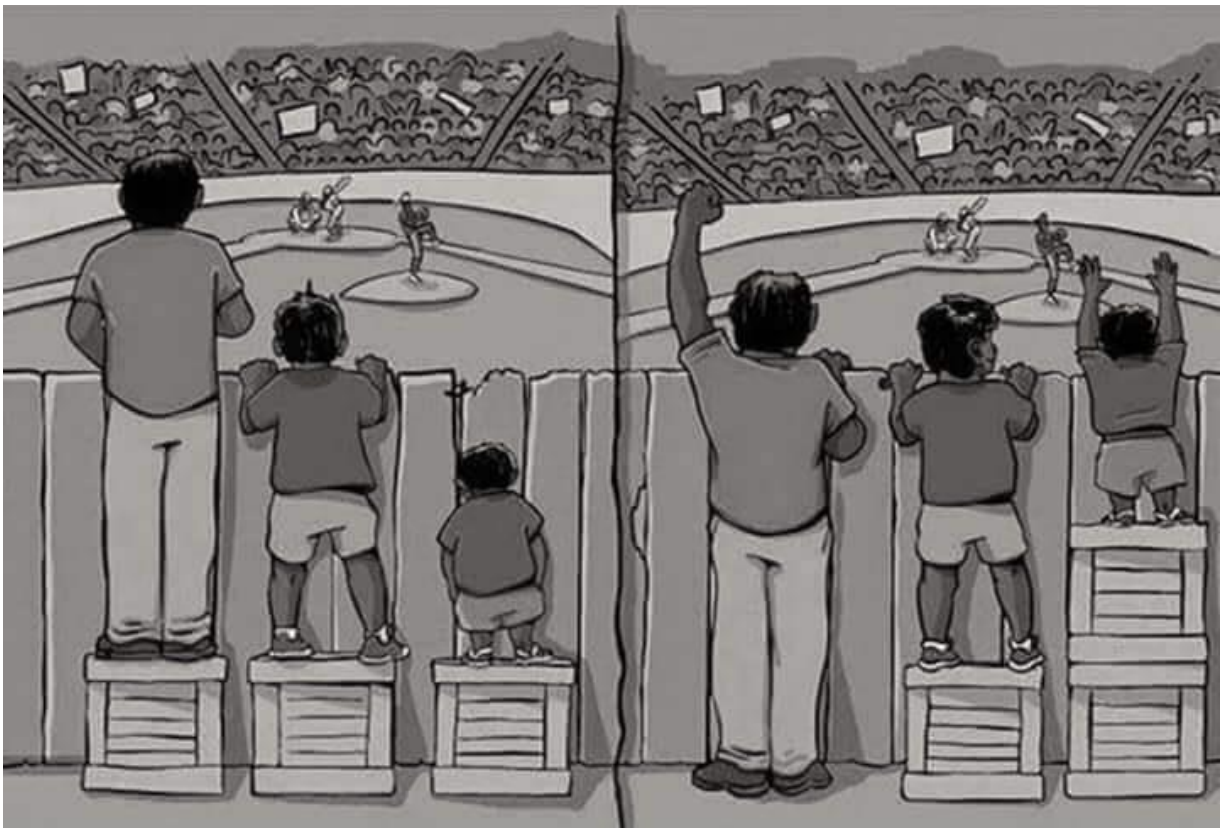

Figure 1: Illustrating Horizontal Equity (left) and Vertical Equity (right)

As highlighted by Figure 1, horizontal equity calls for equal treatment regardless of differences between groups, while vertical equity calls for unequal treatment to address the existing inequities. Thus, conflicts between the two different approaches to equity exist. For example, while horizontal equity necessitates passengers to equally pay for the costs of transportation, vertical equity demands subsidies for disadvantaged groups. This report considers transit as a crucial gateway service because it can be a tool to induce upward mobility for underprivileged groups by providing access to opportunities. Vertical equity is a framing that prioritizes systematically neglected groups by public transportation networks. Therefore, this framing emphasizes vertical equity.

It has been proven that transportation investments affected disadvantaged groups disproportionately in the past, given the deviation in transportation coverage and population distribution (Ward, 2005). To incorporate equity analysis into transportation planning, goals should include maximizing coverage and accessibility and minimizing discrepancies between different socio-economic groups (Golub & Martens, 2012). Currently, most equity analyses are conducted post-implementation – and inequities are discovered too late. Therefore, this report aims to use lessons from these analyses to prepare a framework to incorporate equity considerations explicitly into the project planning decision stage to ensure equity improving transit systems.

Aggregate measures of benefits overlook subgroup differences and can lead to inequitable distribution of transit accessibility (Bills and Walker, 2017). Identifying subgroups and measuring distributional effects, therefore, helps to target the most disadvantaged groups. The framing of transit as a gateway service is crucial because it can be a tool to induce upward mobility for underprivileged groups by providing access to opportunity. Therefore, this report emphasizes the disaggregated impacts of proposed public transit interventions.

1.2 Current Practice: Governance and Equity

A study of how transport equity considerations are prioritized, conceptualized and operationalized in multiple urban regions in North America concludes that equity targets and measures are included in various plans, but lack translation into concise objectives and measures for evaluation (Manaugh, Badami, and El-Geneidy, 2015). A study of 32 urban centers across the world reveals a similar story - despite identifying accessibility as a critical concept, only 55% of the 32 metropolitan cities studied used accessibility metrics to evaluate transport systems (Boisjoly, El-Geneidy, 2017). Even when used, the scope of accessibility was either limited or poorly defined, mostly being limited to access to a mode of transit, rather than access channels to a destination (Boisjoly, El-Geneidy, 2017). Importantly, this study found that current accessibility metrics tend to lump together all available transport (private and public) – although there is a need to distinguish accessibility for different income groups and demographics based on factors including income, geographic location, distance from place of work/public services, etc. (Boisjoly, El-Geneidy, 2017). Even when specified, not all dimensions of equity are given equal consideration – with environmental targets and traffic congestion improvements being typically prioritized over other social equity objectives (Manaugh, Badami, and El-Geneidy, 2017). So why is there a diminished focus on equity in public transit planning? This is due to two reasons: first, planning biases and distortions of decision-makers during the planning phase; and second, the differing objectives of the public and private sectors.

First, decision makers are often subject to planning biases and distortions during the planning phase which lead to inequitable transit design. For example, Beimborn and Puentes (2003), and Litman (2011; 2009) point out that decision makers tend to:

1. **Favor private motor transport over public transit:** Focus on mobility rather than accessibility, ultimately favors motorized modes of traveling over non-motorized modes (walking, biking) and underrate policies to increase accessibility. As a result, planning and funding are skewed towards motorized modes. This is an illustration of horizontal equity, where systems are built such that users can access what they can afford. This trend extends to bias in transportation planning in favor of private transport.

2. **Emphasize quantitative factors:** The *Cost-Benefit Analysis (CBA)* remains a widely used method for transportation project appraisal, despite drawbacks in capturing broader impacts. To address this, CBAs are now supported with a supplementary analysis of other effects. However, there is no standard practice for what information is included (significant variation exists in data availability) and how it should be incorporated into decision making (Mackie & Worsley, 2013). An alternative method for project appraisal is the *Multi-Criteria Analysis (MCA***)** which requires that the policymaker set targets for multiple categories and assign weights to each category of analysis. Importantly, this allows important but disregarded categories like environmental performance to be given higher weights and become more central to the decision. While the MCA has brought in factors that were traditionally left out of the analysis, it still suffers drawbacks including the endogenously determined policy objectives and need for quantification and data collection to conduct a meaningful assessment. This allows policymakers to ignore the range of direct equity impacts of public transit systems.
3. **Conduct incomplete evaluations:** Decision makers may undervalue indirect costs associated with public transit expansion and the advantages of alternative public transit modes. Moreover, planners and policy makers tend to be from very specific subgroups – often middle-to-high-income males- which means that the planning group does not represent the diverse needs of the population (Litman, 2017a).
4. **Underinvest in an equitable system:** The low political capital of vulnerable groups may allow policymakers to underinvest in transportation facilities for disadvantaged groups (Bullard & Johnson, 1997). Disadvantaged groups are often not consulted when new transit interventions are designed. Moreover, barriers to accessing public transit are not clearly understood before planning a new intervention.
5. **Make trade-offs between equity and other planning objectives:** Some common conflicts include striking a balance between maximizing ridership in high demand areas and coverage in low demand corridors (Bills and Walker, 2017); economic efficiency and social targets (Litman, 2017b). The former focuses on public transit services in larger municipal corridors, high-density areas or higher-income groups.
6. **Focus on funding:** Decisions are strongly driven by monetary considerations. Conducting an equity analysis upfront increases costs and may lead to design changes that

require higher investments (Litman, 2017a).

As a result, governance mechanisms and decision-making structures may lead, often inadvertently, to a diminished focus on equity.

Second, various factors have affected the ability of a country to invest such that transportation infrastructure is in equilibrium with the region's broader economic development goals. These factors include, but are not restricted to, economic conditions, bureaucratic struggles, and the ability to balance government spending and revenues.

In this context, Public Private Partnerships (PPPs) have become of greater interest to policymakers and viewed as a valuable alternative to bridge the gap between transportation infrastructure needs and financial resources (Tsamboulas, Verma & Moriaiti, 2013). PPPs are contractual agreements signed between public and private sector partners, covering a wide range of contracting, financing arrangements and project delivery (Tsamboulas, Verma & Moriaiti, 2013). According to the U.S. Department of Transportation, PPPs are defined as agreements that "usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and manage a facility or system. While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed (United States Department of Transportation, 2004).

As a result of the increasing popularity of PPPs, their proper use has led to a polarization of perspectives amongst different organizations and groups that include misinformation, misunderstanding, and delusive expectations (Tsamboulas, Verma & Moriaiti, 2013). Misinformation originates in the lack of appropriate fact-based information available to decision-makers. Misunderstanding and delusive expectations are grounded in the lack of understanding of the nature of public-private partnerships and how to construct and execute them. Even though the interests of the public and private sector sometimes align, they cannot be considered equal. As illustrated in Figure 1, the private sector tends to be focused on profitability, while the public-sector targets social welfare and the protection of public interest (Tsamboulas, Verma & Moriaiti, 2013). While none of these priorities are inherently bad or good, it matters how you plan and implement the projects. With this in mind, policymakers and governments should set guidelines for PPP contracts, procurements, and projects (Tsamboulas, Verma & Moriaiti, 2013) that explicitly ensure the P3 meets the government's financial, service, and equity needs.

Even though advances have been made by transportation regulations to identify equity principles for transportation projects, the difficulty of putting these into practice endures. For example, it has been proven that transportation investments have affected disadvantaged groups disproportionately in the past, given the deviation in transportation conditions and population size (Ward, 2005). While some groups in society gain from a

particular transportation investment/change, others are worse off (Bills and Walker, 2017). As broader public consultation is often left out, this report focuses on ways to include equity dimensions, and will not provide metrics for these well-measured aspects.

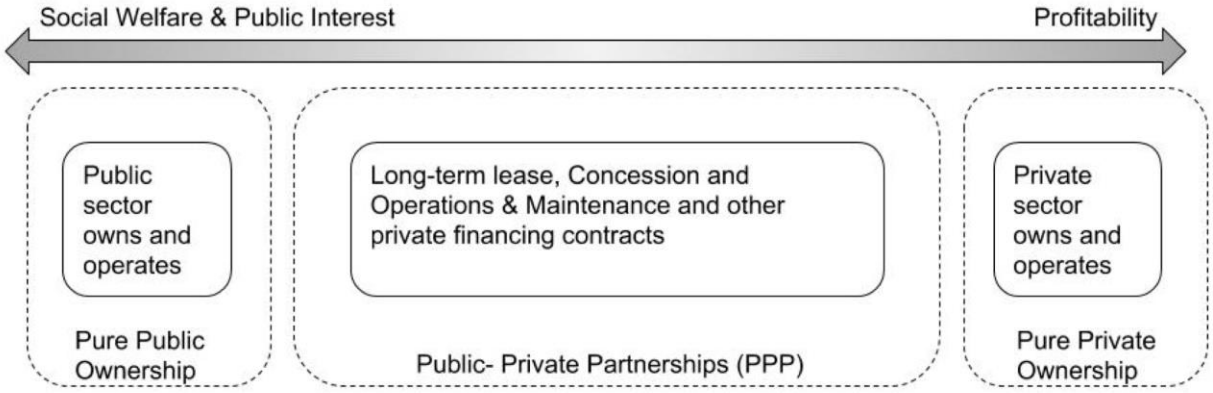

Figure 2: Project delivery models along a range of public and private sector ownership

2.1 Economic Inclusion

As argued in Chapter I, it is crucial to address social equity at the planning stage rather than through impact evaluations after the implementation of a project. This section uses project planning guidelines and well as lessons from impact evaluations to come up with a list of priorities for equity considerations in the planning of public transit interventions. Economic inclusion can be affected by the cost to users, the public transit routes and destinations, the frequency of operations, the design of the public transit vehicles and stations, and ancillary policy which ensures the durability of these benefits over time. However, the most overlooked aspect of public transit design in the planning phase is the identification of baseline inequities in the status quo and the design of public transit to address such inequities. The framing for economic inclusion is presented in *Table 1*.

Table 1: Economic Inclusion: Key Issues and recommendations

Key Issues and Recommendations	
User Fees Key Issues 1. High user fees can reduce or block access to transit 2. Key sub-group: Low-income 3. Setting user fees: a. No affordability benchmarks b. Suppressed demand Recommendations 1. Set an affordability benchmark 2. Conduct baseline affordability assessment a. By income group 3. Represent the needs of non-users a. Barriers to access **Employment** Key Issues 1. Access to jobs depends on public transit a. Affordability b. Routes/destinations 2. Jobs and people are unevenly distributed. 3. Sub-group characteristics: a. Transit-dependent b. Multiple jobs/ short-term jobs c. Intersection of vulnerabilities	**Land Value and Gentrification** Key Issues 1. Public transit increases land value 2. Land value changes depend on: a. Distance from transit station b. Preference for public transit c. System quality d. Micro-contexts 3. Land use is both endogenous and exogenous to public transit 4. Gentrification effects are varied 5. Integrated city planning matters Key Recommendations 1. Conduct spatial analysis to identify unsafe zones in existing system 2. Increase staff presence & training 3. Implement public awareness campaign to encourage users to join forces against perpetrators

4. Integrated city planning matters Recommendations 1. Spatial mapping of income groups and jobs by sector/skill 2. Routes should connect vulnerable groups to appropriate jobs 3. Integrated transit and city development	

2.1.1 Pre-Planning Considerations

Rapid Social Assessment

In the project conceptualization phase, a transport sector or macro-social analysis is required to identify the vulnerable sub-groups and the social inequities that are relevant in that context. The World Bank (2006) recommends that the following be the key areas of focus of the assessment:

1. "Identification of key social issues
2. Initial assessment of institutions, rules, behavior, policies
3. Stakeholder analysis
4. Participation framework
5. Initial risk assessment."

Baseline to Identify Transit-inequities

The San Francisco County Transportation Authority (Metropolitan Transportation Commission, 2017) conducted a two-step baseline analysis for the region on the existing transportation system to identify existing levels of performance and note inequities. The method involved identifying Communities of Concern (CoCs) based on the concentration of disadvantaged groups such as ethnic minorities, low-income groups, physically disabled individuals, cost-burdened rents, etc. and disaggregating all transit metrics to check for inequities between the mean and the CoCs. New projects are to be assessed against this baseline to determine whether to fund based on development priorities, i.e., on equity improvements to the existing transport system (Metropolitan Transportation Commission, 2017).

Profile of Planners

The consultation of members from disadvantaged groups has repeatedly been cited as an essential planning phase requirement for equity considerations (including women, non-users, low-income households, ethnic minorities, etc.) (Litman2002; Loukaitou-Sideris, 2016; Peters, 2001).

Plan for Impact Evaluation

Based on the identified inequities, the project concept must include indicators to monitor social benefits that propose to be addressed by the project (World Bank, 2006).

Recording User Complaints

For the present users of public transit, there should be a grievance mechanism to record complaints about traveler safety,
feedback on equipment, feedback on the transit system, etc. (Litman, 2002) which should be consulted when designing new interventions.

2.1.2 User Fees and Affordability

Setting a Benchmark for Affordability

In the case of other public services such as access to water and sanitation, the "affordability" benchmark is a maximum of 5% of monthly household expenditure (United Nations-WHO, 2010). However, no such standard is universally accepted for transportation. Estimates vary between countries and cities – from 6% in Belo Horizonte to 10% as per the South African Government (Serebrisky et al., 2009). A broader approach to identifying unaffordable transportation is when more than 10% of households spend more than 15% of income on work transit (Armstrong-Wright and Thiriez, 1987).

Table 2: Calculating the Affordability Index for a City (World Bank, 2005)

City-level Affordability Calculation
1. From the latest national census of household survey data, find the average per capita monthly income and the average for the bottom quintile of the income distribution, for the city. 2. Update these values to 2018-values using national per capita income growth rates. 3. Determine the minimum public transport fare to travel 10km using a daily ticket. 4. Calculate the cost of 60 trips at this fare. 5. Express this cost as a percent of the average and bottom quintile monthly incomes.

City-level Determination of Affordability

The World Bank (2005) calculated an affordability index for 27 cities to compare at the city-level the proportional expenditure on transportation of the bottom quintile to the average. This revealed the disproportionately high burden on the low-income groups and the importance of affordable transit. The following method (Table 2) was prescribed by the World Bank (2005) for calculating the relative weight on the bottom quintile as a baseline for assessing inequities.

However, affordability calculated by this index revealed consumption should not be the only indicator of affordability for the following reason:

Suppressed Demand and the Importance of Non-Users

Expenditure on transportation may conceal transit-based inequities if the cost-barrier prevents the use of public transit – for example if individuals resort to walking or fail to make the intended trips. Therefore, lower expenditure on transportation may not be an accurate indicator of welfare. Household surveys in Johannesburg (Behrens and Venter, 2005), Accra, Santiago de Chile, Ukraine all confirm that the bottom quintile spends proportionally less on transport then the second quintile (Figure 3).

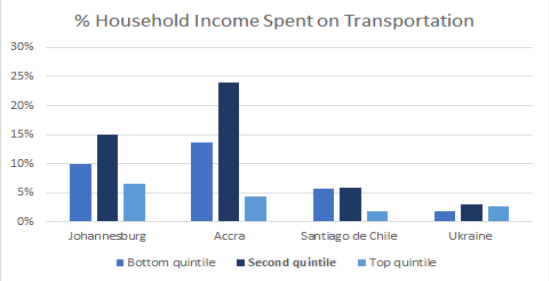

Figure 3 Illustrating the suppressed demand of low-income groups (Data Source: Venter and Behrens, 2005; Serebrisky et al., 2009)

This highlights the need to consult non-users of public transit to get the complete picture of existing inequities that need to be addressed by new interventions. Individuals facing barriers to accessing public transit are likely to be disadvantaged and are crucial to vertical equity.

2.1.3 Access to Employment and Services

Low-income households are less likely to own private means of transportation as compared to a middle-income or high-income household. Further, mobility is limited without access to private means of transport, making public transit central not only to acquiring goods and services, but also to having access to economic opportunity, i.e., jobs. For this reason, it has been argued that public transit is an essential factor that determines accessibility to employment, and therefore employment of vulnerable populations.

Spatial variation in the distribution of destinations and people

The Hiawatha light-rail line was found to generate job accessibility gains for workers of low, middle and high wages, yet the benefits varied across regions within the city depending on the spatial concentration of jobs (Fan, Guthrie & Levinson, 2012). A significant finding was that the most significant gains in accessibility came from areas where bus routes and light rail routes connected and functioned as an integrated transit system (Fan, Guthrie & Levinson, 2012). In Cali, Colombia the BRT was found to ensure that 80% was within a 15-minute walk from a station (Delmelle & Casas, 2012). This increased equitable access to healthcare centers, recreational spots, and libraries; however, accessibility to healthcare showed the smallest increases due to spatial concentration of hospitals within few areas of the city (Delmelle & Casas, 2012). A study that compared the cities of Boston and Los Angeles to Tokyo found that transit-disadvantage is higher in the American municipalities – with the accessibility value in Tokyo being six to ten times higher than those in Boston and LA (Kawabata & Shen, 2006). Public transit is only one aspect of how urban design can be affected, but it is important to note the inequities arising from auto-biased urban design in regions like the United States.

2.1.4 Land Use, Land Value, and Gentrification

In the context of distributional impacts of transit implementation, land use, land value, and gentrification impacts are extremely important to equity but remain difficult to study and predict. The review of existing literature on the subject has revealed that studies are predominantly conducted post-implementation, causation is difficult to prove due to the interplay of other relevant factors, and hedonic price models are the most commonly used methods for studying land value changes. Most studies here have not disaggregated for rented and non-rented

properties, or explicitly accounted for displacement due to land value appreciation, and therefore land appreciation is commonly reported as a positive economic effect. Further, most studies on the subject come from developed countries, indicating a research gap in the developing world on the issue. The overwhelming importance of local factors makes the findings from the developed country setting difficult to extrapolate to developing cities of much higher density, different demographic characteristics, large informal sectors (including housing and transportation), and more.

2.1.4.1 Transit Development and Land Value

A meta-analysis of 23 studies (102 observations) on rail projects and land values revealed that in general, land value increased based on proximity to public transit (Mohammad et al., 2013). However, the level of increase showed a significant degree of variance, ranging from small negative impacts to large positive impacts (Mohammad et al., 2013). Therefore, results from studies cannot be used to reliably infer that transit development will increase property values. The heterogeneity in impacts points to the importance of city-level conditions and micro-contexts.

Preference for Public Transit

To explain the variation in results, the meta-analysis suggests that preference for public transit may be an essential factor that determines land-value impacts, citing the United States as a context that has a relatively low transit dependence compared to Asian cities (Mohammad et al., 2013). A study in Bogota reaffirms this through the conclusion that property values appreciated in housing markets that cater to transit users (Munoz-Raskin, 2010).

System Quality

A study of the BRT system in Seoul demonstrated the importance of system quality, showing a more significant appreciation in land-values after the BRT system was upgraded as part of a larger city-planning effort (Cervero & Kang, 2011).

Distance from the transit station

The meta-analysis also reveals that in some studies there is a decrease in land-value for properties within 200m of the station due to a nuisance effect (increased noise, congestion, crime, etc.) (Mohammad et al., 2013). This effect has been cited in Seoul for properties within 100m of the stations (Cervero & Kang, 2011).

The meta-analysis also finds that the optimum distance away from stations for highest land-value appreciation is between 200m and 800m, beyond which values are unaffected (Mohammad et al., 2013). However, this cannot be extrapolated as a ‘rule' because land value changes in Seoul become insignificant beyond 150m (Cervero & Kang, 2011). A study in Bogota found that residential land appreciated only within walking distance (under ten minutes) of the transit station (Munoz-Raskin, 2010).

Micro-contexts and city development

While multiple studies have shown the divergent effects of transit development on land value within the same country setting (Grube-Cavers & Patterson, 2015; Baker &

Lee, 2017; Khan, 2007), the complexity is not solved by narrowing to the city level. For instance, a study of the land-development impacts around the BRT routes in Beijing found that the least developed district studied (Tongzhou) showed the least appreciation in value, which was attributed to low market demand, and the existence of inadequate infrastructure for transit-oriented development (Zhang & Wang, 2013). A similar study in San Diego noted that land value appreciation was more significant in the downtown area which had a higher market demand and greater presence of commercial establishments that contributed to the appreciation, as compared to residential areas away from the city-center (Cervero, 2010).

Most importantly for planners, land use changes and development were found to be most strongly related to coordinated city planning and well-executed transit-oriented development, rather than a single factor like proximity to public transit (Zhang & Wang, 2013; Zhao, Das, & Larson, 2012; Cervero & Kang, 2011; Cervero, 2010). This is further explored in the following sections.

2.1.4.2 Transit Development and Land Use

Land-use has been studied both as an exogenous and endogenous factor in relation to transit development. Some studies that disaggregated by land-use found that the value of appreciation differed based on the land-use type; while other research found changes in land use as an effect of transit implementation.

How land-value effects of transit implementation differ based on land use

A study in San Diego that disaggregated land-value impact by land use type found differing results based on both land use type and transit type. The land value appreciation for the commuter rail was highest in the commercial properties of the downtown region and for the high-income residential properties that catered to professional-class workers; the light rail system led to the highest land value appreciation for apartments housing middle-income residents, indicating the importance of land-use type (Cervero, 2010). The commercial land was found to have larger appreciation than residential areas in Seoul (Cervero & Kang, 2011).

How land use is affected by transit implementation

A study in Minneapolis concluded that land-use changes resulting from transit implementation were more likely in the residential land; while no effects were seen on land-use for commercial land, vacant land and multi-family properties (Hurst & West, 2014). In Seoul, land use changes were not likely in areas within 100m of the station (Cervero & Kang, 2011). In Beijing, it was concluded that land use changes depended on city planning and did not occur because of transit implementation alone (Zhang & Wang, 2013).

2.1.4.3 Transit Development and Gentrification

Similar to land-value effects, research investigating the link between transit development and gentrification has shown mixed results. None of the studies cited determined a definite trend. To illustrate, a

study on transit-related gentrification in Canada identified gentrification as an increase in property value, percentage of professionally employed persons, percentage of owner-occupied housing, average household income and educational attainment relative to the city average trends (Grube-Cavers & Patterson, 2015). The same study found gentrification effects in Toronto and Montreal, but *opposite* effects along the Skytrain in Vancouver (i.e. a decrease in property values, household income, etc.). A study in New Jersey found no conclusive evidence on transit-related gentrification (excect for an increase in the average level of education in transit-proximate areas), yet identified African-Americans, elderly persons, and individuals with low education levels as the most likely to be affected negatively due to gentrification (Deka, 2017). While it identified renters as most likely to be 'priced out' because of gentrification, actual evidence of gentrification was inconclusive (Deka, 2017).

A study of 14 cities in the United States showed heterogeneous impacts of transit introduction disaggregated by 'Walk and Ride' and 'Park and Ride' transit (Khan, 2007). The general finding was that 'Walk and Ride' stations lead to gentrification, while 'Park and Ride' stations increase poverty in the area – yet even this generalization has exceptions including Los Angeles and Portland (Khan, 2007). A more recent study of 14 cities within the United States which used socio-economic characteristics to measure gentrification, noted divergent gentrification effects (ranging from strong gentrification in San Francisco to negative-gentrification in Portland) (Baker & Lee, 2017). The main difference between the cities was in the successful implementation of transit-oriented development and coordination with city planning (Baker & Lee, 2017) – a finding that was supported by the conclusion in Deka (2017). This was the most substantial factor that influenced whether disadvantaged communities received the benefits or were priced out.

Mapping Equity Impacts

From the above evidence, it is clear that land-value/use and gentrification are almost impossible to predict but are heavily influenced by city planning. The distribution effects of the transit intervention depend on the quality of service, the nature of the opportunities on the transit-route, the needs of the transit-dependent population, the ownership/rental status of transit-dependent residents, and the preference of the users. Transit systems that increase connectivity to high-value jobs may allow the suburbanization of high-income households, thus increasing property value. If the jobs increase connectivity for the working class, property values and rent will rise in low-to-middle income residential areas.

These factors make land value and gentrification challenging to account for in the planning phase. However, the planning of a transit intervention should consider factors that are likely to affect the existing inequities as follows: Policymakers should understand whether the population (aggregate or disaggregated by relevant sub-group) is transit-dependent or prefers private vehicles, in general (this may be through experience, revealed preference or observation of the city

population). Based on this preference, and the nature of the transit destinations in the proposed intervention, policymakers can make a realistic estimate of which sub-groups are more likely to use the proposed transit system. Based on this estimation, and a mapping of proposed routes, a realistic assessment can be made of which areas (proximate to transit stations) are likely to see an appreciation in land-value, if at all. Moreover, this should be cross-checked against the macro-social inequities of the city to understand whether this would lead to positive or negative distributional impacts.

Furthermore, a second-level analysis may be necessary for some cities. For example, if transit is likely to connect low-income households to jobs, then "gentrification" within the city center may be an indication of a positive change – which allows households to move further away and pay lower rent while cutting down travel time and costs. There needs to be a thorough understanding of the transit route, the nature of the destinations, who is most likely to use the transit, which property is most likely to see a change in value and an understanding of the existing inequities. While accurate prediction is impossible, it does not free policymakers from considering these impacts in their planning.

2.2 Gender

The World Development Report documents that women perform a disproportionately higher amount of the unpaid care and housework (ranging from 59% in Sweden to 89% in India) than men; and this division holds true even when women are the sole earners of the family (evidence from Ghana and France) (World Bank, 2011). This gender-based division of labor within the household leads to the differential use of transit by men and women (Hamilton and Jenkins, 2000). On average, women make shorter, lower value trips related to the variety of household responsibilities they have, and often combine multiple short trips (trip-chaining); while men make single-purpose trips, which are often higher in monetary value (commuting to work, for example) (Turner and Grieco, 2000). Further, women are relatively 'time poor' given the more substantial number of tasks they complete in a day (in both, the developed and developing world) and therefore face a double-burden when there is unreliable or unsafe transit (Chatzitheochari & Arber, 2012; Jones et al.1983). Time poverty is worsened by lack of access to public transit and low-income, especially for transit-dependent households. Table 3 summarizes the recommendations for applying a 'gender lens' to the planning of public transit interventions.

Table 3: Gender: Summary of key issues and recommendations

Key Issues and Recommendations
Key Issues 1. Women have different transit needs a. Gender-based division of labor b. Safety concerns c. Suppressed demand 2. Ineffective redressal mechanisms 3. Women-only transit spaces can mitigate harassment and safety risks 4. No attention to other gender minorities Key Recommendations 1. Conduct spatial analysis to identify unsafe zones in existing system 2. Increase presence and training of staff 3. Implement public awareness campaign to encourage users to join forces against perpetrators

Pre-Planning Considerations

The design of the public transit system including transit-type, route, and destination can be made more gender-sensitive by understanding the needs of women and non-traditionally gendered individuals before the intervention is planned. Consequently, this helps to design a better intervention at the start.

Capturing latent demand

Transport inequities may exist between users and non-users that face barriers to accessing transit. This may be in the form of cost barriers, transit routes and destinations, frequency, perceived safety of transit, etc. (Peters, 2001; Loukaitou-Sideris, 2016). These inequities can only be targeted if non-users are consulted at the planning phase to detect latent demand.

Survey-type

It is well documented that narrow, quantitative research methods are unable to accurately capture all the aspects relevant to the safety-related and gendered factors that affect the use of public transit. Standardized survey questions cannot capture the perceptions of safety, inclusivity, social stressors, etc. and require open-ended interview questions (Peters, 2001) to ensure that the design accommodates all users. Therefore, surveys to assess demand, willingness to pay and potential ridership must include open-ended questions to reveal an accurate picture from all users.

Transit destinations

Women-only services to education and employment centers such as garment factories in Dhaka can increase safety and inclusivity (Peters, 2001).

Women-only spaces on transit vehicles and platforms:

Private areas for women in buses and light rail networks may increase safety and therefore encourage more transit-use by women. Ethnographic studies have shown that it is not only the presence of women-only compartments in metros but complementary station design and hiring of female staff that contributes to increasing the feeling of safety for female users (study of the metro system in New Delhi, India by Tara, 2011).

Gender sensitivity training:

Gender sensitivity training of transit staff and drivers may help to make the transit space safer for commuters, and make them more responsive to incidents of harassment, violence, and discrimination – which can include other gendered minorities (Lubitow, Carathers, Kelly & Abelson, 2017).

2.3 Security

Traveling by public transport should not only be comfortable and reliable but above all safe. Delbosc and Currie, 2012 found, that considerations about violent attacks, robbery, assaults or other crimes can have severe impacts on passengers and ridership. Moreover, safety levels are unevenly distributed. Various studies have concluded that disadvantaged groups and ethnic minorities have a higher tendency to be concerned about their personal safety (Larsson, 2009; Ross and Jang, 2000; Lynch andAtkins,1988). For example, Loukaitou-Sideris, Liggett and Iseki (2002), identified that low-income and high-density areas have higher crime rates than other neighborhoods. Moreover, a study of Delbosc and Currie, 2012 found that distance from the city center, gender, and age can have an impact on personal safety on public transport. Consequently, safety concerns can discourage use or negatively impact how public transit is used. Table 4 summarizes the recommendations for incorporating safety considerations at the planning stage.

Table 4: Security: Key issues and recommendations

Key Issues and Recommendations
Key Issues 1. Regular incidents: a. Violent attacks b. Robbery c. Assaults d. Other crimes 2. Safety levels are unevenly distributed 3. Safety concerns can discourage use Key Recommendations 1. Conduct spatial analysis to identify unsafe zones in existing system 2. Increase presence and training of staff 3. Implement public awareness campaign to encourage users to join forces against perpetrators

Pre-Planning Considerations

The security of the design of public transit systems can be enhanced by considering safety needs of users before the intervention is conducted. In doing so, maximum safety can be ensured.

Spatial analysis to identify unsafe zones in existing system

The safety of a public transit system can be measured by several tools. The appropriate tool depends on the level of data available. The main hurdle to estimating the safety level at the planning phase is that this aspect differs

depending on the location. For example, GIS can be used for post-implementation safety analysis (Yigitcanlar, Sipe, Evans & Pitot, 2007; Liu, & Zhu 2004). The evaluation of network accessibility performance of the current system can reveal spatial inequities, user demand, temporal inequities, and populations served by sub-group. This can be used to inform future public transit interventions.

Staff training and presence of staff

Passengers perception of safety is strongly influenced by trust in the people around them and feeling safe in the respective neighborhood (Delbosc and Currie, 2012). Therefore, active safeguarding by staff, avoidance of hazards and presence and visibility of supports need to be established (European Commission,1998). In doing so, regular staff and police presence should be ensured, accompanied by checks on the transit station and vehicle. Moreover, lighting, visible monitoring, and identified help points to report abnormalities need to be established. (European Commission,1998). Lastly, Joewono et al. (2005) concluded that the government is in a unique position to provide equipment for security features such as communication devices.

Public awareness campaigns to encourage users to join forces against perpetrators

According to a civil servant survey conducted by Joewono et al. (2005), passenger awareness and driver certification play the most crucial role when it comes to the security of public transit systems. Therefore, passengers' perception of security can be strengthened by conspicuousness of safety measures, and effective press relations (European Commission. 1998). These can include, but are not limited to passenger, ticket and luggage control; security clearance; presence of police, etc.

2.3 Environmental Performance

Public transit plays a critical role in the development of sustainable and active cities. Looking at the environmental performance of public transit, four environmental factor sets can be identified: energy use, pollution, land consumption, and greenhouse gas emissions (Miller et al. 2016). Energy use is concerned with the quantity of energy needed to operate the public transit system. Pollution refers to the environmental impact in the form of noise pollution and air quality deterioration caused by public transportation systems. Land consumption serves as an indicator for various environmental impacts such as ecosystem disruption or the use of urban environment to ensure transportation services. Lastly, greenhouse gas emissions are concerned with the transportation systems emission of CO2e.

To understand general transportation and urban sustainability, decision-making tools - like composite indices - have been developed. However, there are only a few decision-making tools with sustainability criteria to directly analyze public transportation systems (Miller et al. 2016). Moreover, studies tended to focus on comparing individual public transportation modes in the past (Rahman, 2009; Throne, Hubert, O'Donoghue and Santos, 2014) or focused on the environmental impact on a particular region (Kane (2010), but failed to "address the planning, development, and operations of a general transit system in a holistic sense" (Miller et al. 2016). Composite sustainability indices (CSI) are increasingly used to assess the environmental impacts of projects and associated policies. However, CSI frameworks have yet been implemented by public transit systems (Miller et al. 2016).

Table 5 summarizes the key recommendations for incorporating environmental considerations.

Table 5: Environmental considerations: Key issues and recommendations

Key Issues and Recommendations
Key Issues 1. Four environmental factor sets: a. Energy use b. Pollution c. Land consumption d. Greenhouse gas emissions 2. Few decision-making tools with sustainability criteria to directly analyze public transportation systems 3. Studies tend to focus on comparing individual public transportation modes Key Recommendations 1. Increase vehicle efficiency and reduce GHG emissions 2. Use spatial mapping to estimate emissions and overall environmental impacts 3. Implement innovative contracting, green procurement and environmental labelling as sustainable governance procedures

Pre-Planning Considerations

The environmental performance of public transit systems can be enhanced by considering energy use, pollution, land consumption and greenhouse gas emissions before the intervention is conducted. In doing so, a sustainable environmental performance can be ensured.

Energy: Sustainable public transit systems require low energy consumption (Banister, 2005). Thus, energy consumed per unit of transportation produced has been selected as a baseline for comparing transit systems on sustainability performance (Miller et al. 2016). In addition, energy consumption per passenger distance traveled should be included.

Pollution – emissions and noise: Pollution via transportation emissions is often directly related to the type of fuel used and energy consumed (Banister, 2005). Therefore, Potter (2003) created a guideline on emission analysis. He notes that transport emissions measurements depend on the legislation, but commonly include Nitrous Oxides, Carbon Monoxide, particulate matter, and hydrocarbons.
The transport emissions of a transit system can be calculated as follow:

Transport emissions per mode = (number of vehicles)*(distance traveled)*(emissions per vehicle distance travelled i.e. fuel efficiency) (Wright, 2004).

For the case of public transport, the "mode share" or the "number of vehicles" is affected by at least three component categories (Wright, 2004):

1. Customer utility*:* This factor includes system attributes such as comfort, cost, travel time, security, and cleanliness
2. Load factor*:* The number of occupants per vehicle as a percentage of the total maximum capacity; and,
3. Transit System capacity: "The total capacity of the system effectively acts as the ceiling to the amount of mode share that is possible to achieve."(Wright, 2004)

The "distance traveled" is affected by at least three component categories: (Wright, 2004)

1. Land use changes – "Transit-oriented-development (TOD) and complementary land-use policies can ultimately produce changes in travel distances by bringing destinations closer to trip origins and by allowing for a single trip to replace what was previously several separate journeys" (Wright, 2004).
2. System design: - The routing structure and the location of stations and terminals will directly affect the distance traveled;
3. System management*:* – Efficiently managing the number of vehicles operating at peak and non-peak times will produce savings.

"The "fuel efficiency" is affected by at least three component categories:

1. Operational efficiency: – The "smoothness" of the vehicle operations (number of stops, amount time idling, use of dedicated busways, etc.) will impact the fuel usage;

2. Fuel type: – The type of fuel utilized to propel the vehicle will have inherent characteristics that determine likely emissions; and,
3. Vehicle efficiency: – The type of propulsion technology, the materials and design of the vehicle, and the quality of the vehicle maintenance all directly impact the fuel usage rate" (Wright, 2004).

Table 6: Bogota TransMilenio as an Exemplar for Emissions Reduction

An Exemplar for Emissions Reduction
TransMilenio in Bogata is achieving emission reductions through the following mechanisms: ● Increasing the share of public transport ridership by dramatically improving the quality of service (regarding travel time, comfort, security, cleanliness, etc.); ● Replacing 4 to 5 smaller buses with a larger articulated vehicle; ● Requiring the destruction of 4 to 8 older buses for every new articulated vehicle introduced into the system; ● GPS controlled management of the fleet allowing the optimization of demand and supply during peak and non-peak periods; ● Encouraging transit-oriented development around stations and along corridors; and, ● Emission standards currently requiring a minimum of Euro II emission levels with a future schedule requiring eventual Euro III and Euro IV compliance. Source: (Wright, 2004)

Noise assessments are often difficult due to poor quality of data and the complex nature of analysis. In the USA, large transit projects normally require noise assessments as part of their environmental impact analysis (Hanson et al., 2006). As a result, there are methodologies to understand the noise impacts of transit projects that are well developed and nuanced (Hanson et al., 2006.). However, these methodologies are typically beyond the scope of high-level transit studies (Miller et al. 2016).

Land consumption and ecosystem degradation: "Land consumption is a proxy indicator for a variety of environmental impacts – ecosystem disruption, run off due to impermeable surface, and use of urban environment or limited land resources to provide mobility rather than environmental services. Typically, this land is consumed in the development of guide way (roads, tracks) and station or stop area. To measure this factor, an indicator is suggested by Dhingra et al. (2003), which utilizes right of way length and ecological impact weights to measure ecological impact of the system."(Miller et al. 2016).

Greenhouse gas emissions: "Transportation systems are major emitters of greenhouse gases, such as CO2 that contribute to climate change (Schipper and Fulton, 2003). Bongardt and Huizenga (2011) stated ''overall transportation is responsible for 13% of global GHG emissions and 23% of

energy-related CO2 emissions". GHG emissions represent the system's impact on global climate change via the greenhouse effect."(Miller et al. 2016).

Furthermore, Arts and Faith-Ell (2012) note, that a combination of LRT (Light Rail Transit) and RRT (Rapid Rail Transit) options score highest when it comes to environmental sustainability. This combination takes the benefits from an RRT and combines it with the low cost of an LRT. Despite its higher capital and operating costs, overall travel time is reduced which will ultimately influence economic performance (Miller et al. 2016).

Arts and Faith-Ell (2012) note that multiple decisions related to the environmental performance of transportation infrastructure are only made after the planning phase. Moreover, insufficient communication methods among stakeholders lead to the exclusion of information from the planning to the implementation phase. Therefore, increased cooperation between governmental, public and private stakeholders is required. For this reason, Arts and Faith-Ell (2012) recommend innovative contracting, green procurement and environmental labelling as sustainable transportation governance procedures. The former two are ecological policy instruments implemented with the goal to improve the environmental performance of public transit projects. The latter requires environmental standards and considerations to be integrated in policies, programs, and actions.

2.4 Accessibility

For this research, the goal of accessibility is to understand how the transit system performs for local populations based on their needs to travel. Two main issues are considered – network accessibility and user accessibility. Accessibility is commonly noted as a critical indicator in the literature on social aspects of transportation. While there is no strict definition of accessibility, the concept includes several aspects such as distribution of destinations, distribution of stations, quality of trip, frequency of service, type of activities served by transit, performance of system, characteristics of individuals, affordability, reliability of service, etc. (Silva & Pinho, 2006).

Not all groups served by a given transit network have the same levels of accessibility.

For example, a baseline equity analysis of the San Francisco region reveals that while network indicators do not show variation across sub-groups, system performance metrics such as transit speeds, reliability and crowding showed spatial variation that left disadvantaged communities with lower-quality service (Metropolitan Transportation Commission, 2017). Thus, accessibility is a concept that encompasses several essential aspects of equity such as differential system performance and network quality - and is a useful framing to assess the status quo of a given system. The key recommendations for incorporating accessibility are summarized in

Table , below.

Table 7: Accessibility: Key issues and recommendations

Key Issues and Recommendations
Key Issues 1. Problem: Differential levels of accessibility for different groups a. Network accessibility b. User accessibility 2. Depends on: a. System performance b. Network design 3. Despite identifying ‘accessibility’ as a key concept, only few cities use accessibility metrics to evaluate transport systems Key Recommendations 1. Identify groups with low access 2. Ensure that network and system design provide access to vulnerable groups 3. Use spatial mapping to estimate first and last mile improvements 4. Increase the range of destinations to suit all users 5. Define legal design requirements

Some critical metrics for accessibility can be incorporated into the planning phase as follows:

User accessibility:

A key measure of user accessibility is the first and last mile, i.e., travel time/mode from the origin to the transit stop and then from the transit stop to the destination (Murray, 2003). The first and last mile analysis can be used to assess the suitability of the transit in connecting individuals to destinations. A spatial first/last mile analysis can provide information on areas that require improved connections (by reducing the distance to stations, reducing the number of transfers, etc.).

Affordability is another important dimension of user accessibility (Dobransky- Niskota et al., 2007; Jeon et al., 2009; Litman, 2013). As stated in the economic inclusion section, affordability should be determined at the level of the intervention and disaggregated by income group. The burden on the low-income groups should be below a determined level of affordability.

Average user trip length is a measure of the distance each person must travel on the system to get to his or her destinations. Average trip lengths can be estimated based on system design and any improvements from the present modes can be noted as improvements.

The final indicator is a measure of accessibility for people with special needs related to physical disability. These considerations are part of the design of the intervention and can be mandated at the planning stage through the station and vehicle design. Project appraisal frameworks may require universal access to be a non-negotiable feature of public transit.

Network accessibility

Network accessibility can be measured by several tools. The tool used depends on the level of data available. The main hurdle to estimating network accessibility at the planning phase is that this aspect depends on system performance and is necessary post facto. GIS (Geographic Information System) is a conventional technique used for post-implementation spatial accessibility analysis, which cannot be efficiently captured at the planning phase (Yigitcanlar, Sipe, Evans & Pitot, 2007; Liu, & Zhu 2004). The evaluation of network accessibility performance of the current system can reveal spatial inequities, user demand, temporal inequities, and populations served by sub-group. This can be used to inform future public transit interventions.

One high-level indicator is the accessibility network index, which was used by Haghshenas and Vaziri (2012) to assess how overall transport systems provide mobility. According to that study, the accessibility can be calculated as passenger-km per capita/urban area. This indicator essentially represents the average amount of passenger-km traveled by each person per unit of metropolitan area – and can be estimated based on population densities along transit routes.

In situations where simulations of performance scenarios are possible, composite public transit equity indicators may be useful (Al Mamun and Lownes, 2011; Welch & Mishra, 2013). Accessibility is based on three components – trip coverage

(transit links travelers to their destinations), spatial coverage (transportation is closer to their home/destination), and temporal coverage (transit is available at the time of travel) (Al Mamun and Lownes, 2011). However, most measures of these aspects are post-implementation metrics, which will depend entirely on project estimates when adapted to the planning stage.

A significant trend in the literature is the emphasis on considering all potential users when planning, designing and implementing transit systems. Studies emphasize that transit systems should provide access to all users, regardless of their physical needs (Kane, 2010; Litman 2013). Overall, accessibility is a broad framing for a range of equity issues in transportation, and a useful tool to study sub-group inequities. This aspect of equity is linked to system performance and therefore may not be captured efficiently at the planning stage. Only elements which can be well accounted for at the planning phase should be included – such as spatial estimations of increased coverage (using a set radius to determine the catchment areas of each station), affordability, and improvements to the first and last mile of transit-disadvantaged groups.

3. Gaps in current approach

In sum, the following gaps were identified:

First, policymakers fail to conduct a needs assessment by sub-group. While transit systems are often planned with objectives like improving access to jobs, a disaggregated needs assessment is rarely part of the planning process. Often, transit is not planned based on an assessment of existing inequities.

Second, alternate transit options are rarely considered against each other. For example, studies have shown that BRT and light rail are rarely evaluated against each other at the time of planning in terms of cost effectiveness and estimation of successful implementation. BRTs are overwhelmingly cheaper (4 to 20 times cheaper) than light rails but are often judged based other factors such as experiences with bus transit, political preferences, etc. (Balbontina et al, 2017; Hensher, 2016). In Latin America, BRTs are often politically preferred due to success stories from the region without evaluation against LRT options (Rodriguez & Vergel, 2013).

Third, the distribution of costs and benefits between groups is not always explicitly considered.

Fourth, current planning does not recognize the entire range of equity impacts as direct costs and benefits of the project.

As a result, this leads to inequitable transit design. To address this, the following equity checklist should be part each public transit appraisal process.

4. Recommendations: An Equity Checklist

It is clear that public transit is a crucial service that affects the nature of urban life and interacts with socio-economic inequities. It has the power to be used for reducing social inequalities and empowering vulnerable groups. Through our study of equity in transportation and its various dimensions, it is clear that project design needs to be better directed to address existing inequities, or else the system may serve to reinforce inequities. So far, equity has been acknowledged as an essential part of the transit picture but is most often relegated to impact evaluations. We argue for a change in the method of project appraisal to make equity considerations the focus of transit design. The recommendations presented in this report (Table 8) provide a framework to assess the equity impacts of a project at the appraisal phase. The categories are provided only as a matter of simplicity. The foundation of the recommendation rests on the need for a disaggregated analysis. The entire equity checklist can be found in Table 8 on the following page.

Key recommendations are centered around what policymakers and planners can do as an assessment. A four-step process is recommended.

1. The first step is to conduct a baseline scenario. Where data do not exist, this can be done through an assessment and can be updated periodically. For private companies, which may not have regional expertise, it is recommended that the social inequities are studied on a regional level. The point of this is to identify what vulnerable groups exist in the region – this may be based on income, ethnicity, religion or more. There is likely to be regional variation, so it is recommended that this be done at the scale of the project as far as possible.
2. Second, all stakeholders should be identified to allow a balanced participation. This would include non-users of transit, the target group for which the intervention is planned, and the property owners or renters close to the transit station. Based on the analysis, potential impact channels should be identified.
3. Third, all transit options, like for example light rail and metro, should be considered.
4. Lastly, it is important to plan for impact evaluation at the start of the project appraisal phase to help set up data collection channels from the beginning and avoid high costs post-implementation.

Furthermore, each question is presented to determine whether the intervention is ‘equity improving.' A set of methods for assessment, possible metrics, and notes on methods are provided for each question. The questions are organized as an equity checklist to be used for evaluating any public transit project. This focuses on steps that are commonly missed during project appraisal. Finally, there is a discussion of how to address trade-offs in such an assessment. It is argued here that some increase in short-term costs is a necessary price to pay for inclusive and sustainable public systems.

Table 8: The Equity Checklist

Preliminary checklist	**Indicators / Methods**
Do the equity goals of the project match the wider social inequities of the region?	1. Identify vulnerable populations using a macro-social analysis, conducting a rapid analysis or conducting a baseline to measure inequities in the existing transit system. 2. Make sure that based on the existing inequities, the new intervention plans to address disparities. 3. Identify explicit equity goals, disaggregated by group. The project should be improving social equity by targeting vulnerable groups.
Have metrics for evaluating the equity outcomes been defined?	1. Based on the equity goals, plan metrics for an equity impact evaluation. 2. Determine mechanism to collect data on defined metrics.
Have all stakeholders been consulted/represented?	1. Create a profile of decision makers and determine an adequate representation of each group. 2. Implement a mechanism to actively involve civil society organizations that represent the needs of identified vulnerable subgroups
Has latent demand of non-users been measured?	1. Outreach with non-users to determine barriers to access is essential. - Represent subgroups like non-traditional genders, elderly individuals, etc. - Qualitative surveys are recommended (include questions about barriers to access) - If cost barriers are identified, plan to set user fees accordingly. - Address design related changes in tandem with the other considerations in the checklis.
Is the proposed transit intervention supported by broader city development targets?	1. Ensure that land value changes are in line with the general city development plans 2. Determine who is likely to experience advantages and disadvantages from land value changes and whether this can be addressed by a related policy.
Setting user fees	
Are the user fees affordable?	1. Set a benchmark for affordability such that no income group should be paying more than a certain percentage of their income to use public transit to make a fixed number of trips per day.

	2. Test the proposed user fee against this benchmark.
Planning transit destinations and routes	
Does the proposed project increase access to employment for vulnerable groups?	1. Conduct a sub-group analysis of the job centers for different income groups. 2. Determine which groups the proposed transit system will target.
Does the proposed project increase access to essential goods and services for vulnerable groups?	1. Pay attention to healthcare centers, educational institutions, libraries, marketplaces and recreational spaces like gardens.
Do transit destinations serve women's and other gender minorities' transit needs?	1. Identify current and future location of industries that mostly employ women and other gender minorities 2. Determine current and future location services accessed by women and other gender minorities (school, healthcare service) 3. Examine if men and women use transportation differently and analyze the socio-economic, political and ecological effects of this usage pattern. 4. Check if transit design (routes, fees, etc.) can be aligned with trip chaining.
Who is likely to benefit from the change in property values and is this equity improving?	1. Determine the areas likely to see land value appreciation based on the distance from transit station, preference for public transit, nature of destinations. 2. Implement measures to ensure that an increase in property values will not displace groups 3. Identify conflicts with other city development plans and prepare for trade-offs
Is gentrification likely to price out vulnerable populations?	1. Determine the demographic characteristics of individuals residing within walking distance of stations. 2. Check for the proportion of residents living in rented accommodation. 3. Safeguard the interest of vulnerable groups by enforcing rent controls. Prevent real estate developers from bidding up housing prices, etc. if the predicted land value changes are likely to have a negative impact on vulnerable communities.

Designing vehicles and stations	
Are there safe spaces for all genders?	1. Design safe spaces for vulnerable groups 2. Plan for gender safety training for public transit staff. 3. Set up a mechanism to report complaints/incidents. 4. Position staff/security personnel visibly at transit stops.
Are safety standards complied with?	1. Conduct a safety data analysis to identify trends and areas of highest safety risk 2. Invest in infrastructure, security cameras, security personnel, response mechanisms in areas marked as unsafe zones.
Is public transit accessible for physically disabled individuals?	1. Create a set of design requirements for stations and transit vehicles to accommodate the needs of physically disabled individuals. 2. Standardize the results across various modes.
Does the public transit project consider all relevant externalities as part of project evaluation?	1. Adhere to environmental regulations and use sustainable fuels where possible. 2. Include emissions, noise pollution, traffic congestion effects, and land use.
Is gentrification likely to price out vulnerable populations?	1. Determine the demographic characteristics of individuals residing within walking distance of stations. 2. Check for the proportion of residents living in rented accommodation. 3. Safeguard the interest of vulnerable groups by enforcing rent controls, preventing real estate developers from bidding up housing prices, etc.

4.1 Managing Trade-offs

Any project is likely to have some conflicts between various equity objects and between equity and other considerations like funding mechanisms or system quality, performance, and coverage. We argue that while there may be higher costs incurred in the short run, the proper consideration of transit equity will create long-run benefits to the individuals and the region as a whole. However, where trade-offs must be made, it is recommended that one of the following approaches be taken to incorporate equity as a non-negotiable lens of project appraisal. In New Zealand, projects with worse (Cost Benefit Analysis) CBAs are being accepted due to considerations against a larger set of targets (Mackie, & Worsley, 2013). Thus, the change in appraisal methods was successful in shifting the focus of appraisal to critical non-quantifiable factors, indicating the potential for take-up of the proposed method. Assessments for each category can be done with an understanding of stakeholders and the impact channels, project design[2], and in some cases, estimation using regional data. As far as possible, the metrics are designed such that they can be assessed before implementation and in a relatively short time-frame.

Minimum requirements for any project / Red Flag Approach

As part of the project appraisal method as a matter of policy or private company policy, a 'minimum requirements' approach can be taken such that any project evaluated would have to be considered 'equity improving' in a minimum number of sub-categories to be approved (see the blue line in Figure 4). This prevents some categories from being overlooked in a multi-criteria analysis that employs low weights to certain categories. Each category would have a binary indicator - whether the project can be deemed equity improving in that category or not. Since each project would be required to be 'equity improving' for a broad range of categories, this would lead to more sustainable and equitable transit design.

Alternatively, a 'red flag' approach can be used - In Germany, while there are no specified weights given to non-quantifiable impacts, a 'red flag' procedure is used to highlight violations of environmental standards (Mackie, & Worsley, 2013). To apply it to this set of factors, a maximum number of red flags can be set for each, thus allowing the project some flexibility in which factors they choose to address and ignore (see red line in Figure 4). In cases where there is a conflict between two equity dimensions, or where some categories of equity discussed are not relevant (or are currently well-addressed) the second system would allow for a trade-off between categories.

Figure 4 illustrates the differences between the two approaches to trade-offs described here.

[2] This may include changes to the network, i.e., expanding the network to a transit-poor neighborhood; modifications of the vehicle or station design including accessibility features, safety features, and gender safe spaces; agreements about user fees; etc.

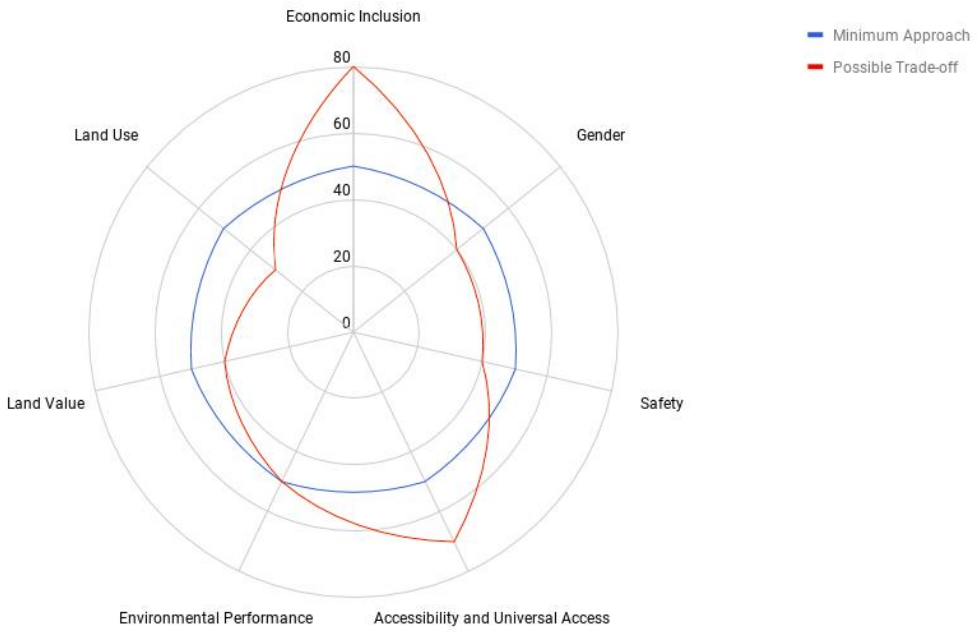

Figure 4: Illustration of two trade-off scenarios

Setting non-negotiable metrics

To create a sustainable public-transit system, the most significant inequities of the area should be positively addressed by any proposed public transit intervention. Specific sub-groups may face higher transit disadvantage due to characteristics like low wage, barriers to accessing private transport, gender, safety concerns, etc. To implement this method, the vulnerable communities identified should be ranked based on the level of disability or spatial concentration of the limitation. For example, geographic clusters of households with multiple layers of vulnerability (low income, low vehicle ownership, and no walkable access to public transit) should be prioritized when trade-offs are being made. A set of these factors can be made non-negotiable aspects of the project - which are required to pass the binary 'equity improving' test. The set of factors selected will depend on the regional characteristics.

Looking forward

This approach requires policymakers or private agencies to self-enforce a relatively complicated process of equity analysis. Further, implementing this strategy will involve an increase in costs that may be a hurdle to applying the framework. At the least, this document can be framed as a learning tool. Alternatively, it can be adopted by individual agencies like Departments of Transportation, or the Toyota Mobility Foundation and applied to all projects. This method of take-up would require a high willingness on the part of the decision maker. If this mechanism is not formally enforced, there will be no deterrence for inequitable design. We hope that these recommendations will be adopted, despite the initial high costs upfront, to improve the standard of transit planning and use transit as a tool to address social inequities.

5. Overall takeaways

In conclusion, the equity framework relative to traditional equity analysis methods is an upfront and relatively quick, low-cost method to inform the design process. It is not an absolute or precise equity analysis. Rather, the framework can help eliminate design options that fail to meet equity needs, and simultaneously help the planners to identify reasonable design parameters and justify those decisions. The individual equity priorities remain the responsibility of the planners.

The following points should be adhered to:

- First, an equity checklist should be created during the project appraisal phase. This checklist should include the dimensions: economic inclusion, land use, land value and gentrification, gender, safety, environmental performance and universal accessibility.
- Second, check if the interventions are equity improving. This may require more resources and time in the short-term but will pay-off in the long-run.
- Third, implement a set of mandated minimum equitable design requirements.
- Fourth, account for trade-offs. For example, this can be done in two ways: Either, by using minimum requirements for projects, which means that a minimum for each equity dimensions be met or, by using a maximum Red Flag Approach, which means that the project design should not exceed a maximum number of red flags.

Our hope is by including equity in public transit planning, the needs of disadvantaged groups can be met for a more prosperous future.

Bibliography

Al Mamun, Md and Nicholas E. Lownes. 2011. "A Composite Index of Public Transit Accessibility." *Journal of Public Transportation* 14 (2): 1-4. http://scholarcommons.usf.edu/jpt/vol14/iss2/4/.

Armstrong-Wright, Alan and Sebastien Thiriez. 1987. "Bus Services: Reducing Costs, Raising Standards." (TP-68): 1-783. http://documents.worldbank.org/curated/en/572491468764379405/Bus-services-reducing-costs-raising-standards.

Arts, Jos and Charlotta Faith-Ell. 2012. *New Governance Approaches for Sustainable Project Delivery*. Vol. 48. doi://doi.org/10.1016/j.sbspro.2012.06.1290. http://www.sciencedirect.com/science/article/pii/S1877042812030339.

Banister, David. 2005. *Unsustainable Transport: City Transport in the New Century* Taylor & Francis.

Behrens, Roger and Christoffel Jacobus Venter. 2005. "Transport Expenditures: Is the 10% Policy Benchmark Appropriate?" *Satc 2005*: 1-12. https://www.researchgate.net/profile/Christo_Venter2/publication/228470964_Transport_expenditure_Is_the_10_policy_benchmark_appropriate/links/54f95cc10cf2ccffe9e0d93e/Transport-expenditure-Is-the-10-policy-benchmark-appropriate.pdf.

Beimborn, Edward and Robert Puentes. 2003. "Highways and Transit: Leveling the Playing Field in Federal Transportation Policy." *Brookings Institute*: 1-20. https://www.brookings.edu/research/highways-and-transit-leveling-the-playing-field-in-federal-transportation-policy/.

Bills, Tierra S. and Joan L. Walker. 2017. "Looking Beyond the Mean for Equity Analysis: Examining Distributional Impacts of Transportation Improvements." *Transport Policy* 54: 61-69. doi:10.1016/j.tranpol.2016.08.003.

Bongardt, Daniel, Dominik Schmid, Cornie Huizenga, and Todd Litman. 2011. "Sustainable Transport Evaluation - Developing Practical Tools for Evaluation in the Context of the CSD Process."

Bullard, Robert D. and Glenn S. Johnson. 1997. "Just Transportation: Dismantling Race and Class Barriers to Mobility." : 193.

Carruthers, Robin, Malise Dick, and Anuja Saurkr. 2005. "Affordability of Public Transport in Developing Countries." *Transport.* http://hdl.handle.net/10986/17408.

Cervero, Robert. 2010. "Effects of Light and Commuter Rail Transit on Land Prices: Experiences in San Diego County."Journal of the Transportation Research Forum, .

Cervero, Robert and Chang Deok Kang. 2011. "Bus Rapid Transit Impacts on Land Uses and Land Values in Seoul, Korea." *Transport Policy* 18 (1): 102-116. doi://doi.org/10.1016/j.tranpol.2010.06.005. http://www.sciencedirect.com/science/article/pii/S0967070X1000082X.

Chatzitheochari, Stella and Sara Arber. 2012. "Class, Gender and Time Poverty: A Time-use Analysis of British Workers' Free Time Resources." *The British Journal of Sociology* 63 (3): 451-471. doi:10.1111/j.1468-4446.2012.01419.x. http://onlinelibrary.wiley.com/doi/10.1111/j.1468-4446.2012.01419.x/abstract.

Deka, Devajyoti. 2017. "Benchmarking Gentrification Near Commuter Rail Stations in New Jersey." *Urban Studies* 54 (13): 2955-2972. http://journals.sagepub.com/doi/abs/10.1177/0042098016664830.

Delbosc, Alexa and Graham Currie. 2012. *Modelling the Causes and Impacts of Personal Safety Perceptions on Public Transport Ridership*. Vol. 24. doi://doi-org.proxy1.library.jhu.edu/10.1016/j.tranpol.2012.09.009. http://www.sciencedirect.com.proxy1.library.jhu.edu/science/article/pii/S0967070X12001576.

Delmelle, Elizabeth Cahill and Irene Casas. 2012. "Evaluating the Spatial Equity of Bus Rapid Transit-Based Accessibility Patterns in a Developing Country: The Case of Cali, Colombia." *Transport Policy* 20: 36-46. doi:10.1016/j.tranpol.2011.12.001.

Dhingra, Sunder L., K. V. K. Rao, and V. M. Tom. 2003. "Environmental Impact Assessment for Sustainable Transport." In *Handbook of Transport and the Environment*. Vol. 4, 309-329: Emerald Group Publishing Limited. doi:10.1108/9781786359513-017. https://doi.org/10.1108/9781786359513-017.

Dobranskyte-Niskota, A., A. Perujo, and M. Pregl. 2007. "Indicators to Assess Sustainability of Transport Activities." *European Comission, Joint Research Centre*. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC54971/sust_transp_ind_report_final.pdf.

El-Geneidy, Ahmed, David Levinson, Ehab Diab, Genevieve Boisjoly, David Verbich, and Charis Loong. 2016. "The Cost of Equity: Assessing Transit Accessibility and Social Disparity using Total Travel Cost." *Transportation Research: Part A: Policy and Practice* 91: 302-316. doi:10.1016/j.tra.2016.07.003.

European Comission. 1998. *Final Report Synthesis and Recommendations*.

Ewing, Gordon. 1987. "Understanding Travel Behaviour: By P.M. Jones, M.C. Dix, M.I. Clarke, and I.G. Heggie. Gower Publishing Company (Old Post Road. Brookfield, VT 05036, USA). ISBN 0-566-00606-5, 1983, xviii+281 Pp. (Tables, Figures, Bibliography), $36.95(Cloth)." *Annals of Tourism Research* 14 (1): 163-166. doi://doi.org/10.1016/0160-7383(87)90061-2 ". http://www.sciencedirect.com/science/article/pii/0160738387900612.

Fan, Yingling, Andrew Guthrie, and David Levinson. 2010. *Impact of Light Rail Implementation on Labor Market Accessibility: A Transportation Equity Perspective*. https://www.jtlu.org/index.php/jtlu/article/view/240.

Garrett, Mark and Brian Taylor. 2015. "Reconsidering Social Equity in Public Transi." *Journal of Strength and Conditioning Research*: 1-22. doi:10.1519/JSC.0000000000001149. https://escholarship.org/uc/item/1mc9t108.

Golub, Aaron and Karel Martens. 2014. "Using Principles of Justice to Assess the Modal Equity of Regional Transportation Plans." *Journal of Transport Geography* 41: 10-20. doi://doi.org/10.1016/j.jtrangeo.2014.07.014. http://www.sciencedirect.com/science/article/pii/S0966692314001628.

Grube-Cavers, Annelise and Zachary Patterson. 2015. "Urban Rapid Rail Transit and Gentrification in Canadian Urban Centres: A Survival Analysis Approach." *Urban Studies* 52 (1): 178-194. doi:10.1177/0042098014524287. http://journals.sagepub.com/doi/full/10.1177/0042098014524287.

Haghshenas, Hossein and Manouchehr Vaziri. 2012. "Urban Sustainable Transportation Indicators for Global Comparison." *Ecological Indicators* 15 (1): 115-121. doi://doi.org/10.1016/j.ecolind.2011.09.010. http://www.sciencedirect.com/science/article/pii/S1470160X11002974.

Hamilton, Kerry and Linda Jenkins. 2000. "A Gender Audit for Public Transport: A New Policy Tool in the Tackling of Social Exclusion." *Urban Studies* 37 (10): 1793-1800. doi:10.1080/00420980020080411. http://www.jstor.org/stable/43196460.

Hanson, Carl, David Towers, and Lance D. Meister. 2006. "Transit Noise and Vibration Impact Assessment TPE16-30." *The National Academies of Sciences, Engineering, and Medicine*: 1. https://search.proquest.com/docview/193559973.

Hanson, Susan. 2010. "Gender and Mobility: New Approaches for Informing Sustainability." *Gender, Place & Culture* 17 (1): 5-23. doi:10.1080/09663690903498225. http://www.tandfonline.com/doi/abs/10.1080/09663690903498225.

Hurst, Needham B. and Sarah E. West. 2014. "Public Transit and Urban Redevelopment: The Effect of Light Rail Transit on Land use in Minneapolis, Minnesota." *Regional Science and Urban Economics* 46: 57-72. doi://doi.org/10.1016/j.regsciurbeco.2014.02.002. http://www.sciencedirect.com/science/article/pii/S016604621400026X.

Jeon, Christy Mihyeon, Adjo A. Amekudzi, and Randall L. Guensler. 2010. "Evaluating Plan Alternatives for Transportation System Sustainability: Atlanta Metropolitan Region." *International Journal of Sustainable Transportation* 4 (4): 227-247. doi:10.1080/15568310902940209. https://doi.org/10.1080/15568310902940209.

Joewono, Tri Basuki and Hisashi Kubota. 2006. "Safety and Security Improvement in Public Transportation Based on Public Perception in Developing Countries." *IATSS Research* 30 (1): 86-100. doi://doi.org/10.1016/S0386-1112(14)60159-X. http://www.sciencedirect.com/science/article/pii/S038611121460159X.

Kahn, Matthew E. 2007. "Gentrification Trends in New Transit-Oriented Communities." *Real Estate Economics* 35 (2): 155-182. http://www.econis.eu/PPNSET?PPN=548000514.

Kamruzzaman, Md, Tan Yigitcanlar, Jay Yang, and Mohd Mohamed. 2016. "Measures of Transport-Related Social Exclusion: A Critical Review of the Literature." *Sustainability* 8 (7): 696. doi:10.3390/su8070696. https://doaj.org/article/5bcd7fe70cf84e18b56405b0d6759e5b.

Kane, Lisa. 2010. "Sustainable Transport Indicators for Cape Town, South Africa: Advocacy, Negotiation and Partnership in Transport Planning Practice." *Natural Resources Forum* 34 (4): 289-302. doi:10.1111/j.1477-8947.2010.01313.x. https://doi.org/10.1111/j.1477-8947.2010.01313.x.

Kawabata, Mizuki and Qing Shen. 2006. "Job Accessibility as an Indicator of Auto-Oriented Urban Structure: A Comparison of Boston and Los Angeles with Tokyo." *Environment and Planning B: Planning and Design* 33 (1): 115-130. http://journals.sagepub.com/doi/abs/10.1068/b31144.

Konow, James. 2003. "Which is the Fairest One of all? A Positive Analysis of Justice Theories." *Journal of Economic Literature* 41 (4): 1188-1239. https://www.aeaweb.org/articles?id=10.1257/002205103771800013.

Larsson, Daniel. 2009. "Fear of Crime among the Poor in Britain and Sweden." *International Review of Victimology* 15 (3): 223-254. doi:10.1177/026975800901500302. https://doi.org/10.1177/026975800901500302.

Litman, Todd. 2013. "Comprehensive Evaluation of Energy Conservation and Emission Reduction Policies." *Transportation Research Part A: Policy and Practice* 47: 153-166. doi://doi-org.proxy1.library.jhu.edu/10.1016/j.tra.2012.10.022. http://www.sciencedirect.com.proxy1.library.jhu.edu/science/article/pii/S0965856412001619.

———. 2017a. "Evaluating Transportation Economic Development Impacts." . http://deslibris.ca/ID/10091870.

———. 2002. "Evaluating Transportation Equity." *World Transport Policy & Practice* 8 (2): 50-65. https://www.scopus.com/record/display.uri?eid=2-s2.0-34249305028&origin=inward&txGid=123b0a3879745566be252a4a0bccfbac.

———. 2017b. "Evaluating Transportation Equity." . http://deslibris.ca/ID/10091871.

———. 2011. "Measuring Transportation: Traffic, Mobility and Accessibility." *Institute of Transportation Engineers. ITE Journal* 73 (10): 28. https://search.proquest.com/docview/224891125.

———. 2009. "Transportation Cost and Benefit Analysis." *Victoria Transport Policy Institute* 31. http://www.vtpi.org/tca/tca00.pdf.

Loukaitou-Sideris, Anastasia. 2016. "A Gendered View of Mobility and Transport: Next Steps and Future Directions." *Town Planning Review*: 547-565. 10.3828/tpr.2016.38.

Loukaitou-Sideris, Anastasia, Robin Liggett, and Hiroyuki Iseki. 2002. "The Geography of Transit Crime." *Journal of Planning Education and Research* 22 (2): 135-151. doi:10.1177/0739456X02238443. http://journals.sagepub.com/doi/full/10.1177/0739456X02238443.

Lubitow, Amy, JaDee Carathers, Maura Kelly, and Miriam Abelson. 2017. "Transmobilities: Mobility, Harassment, and Violence Experienced by Transgender and Gender Nonconforming Public Transit Riders in Portland, Oregon." *Gender, Place & Culture* 24 (10): 1398. doi:10.1080/0966369X.2017.1382451. http://www.tandfonline.com/doi/abs/10.1080/0966369X.2017.1382451.

Lynch, G. and S. Atkins. 1988. "The Influence of Personal Security Fears on Women's Travel Patterns." *Transportation* 15 (3): 257-277. doi:10.1007/BF00837584. https://doi.org/10.1007/BF00837584.

Mackie, Peter and Tom Worsley. 2012. "International Comparisons of Transport Appraisal Practice - Overview Report." *Institute for Transport Studies*: 1-29. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/209530/final-overview-report.pdf.

Manaugh, Kevin, Madhav G. Badami, and Ahmed M. El-Geneidy. 2015. "Integrating Social Equity into Urban Transportation Planning: A Critical Evaluation of Equity Objectives and Measures in Transportation Plans in North America." *Transport Policy* 37: 167-176. doi://doi-org.proxy1.library.jhu.edu/10.1016/j.tranpol.2014.09.013. http://www.sciencedirect.com.proxy1.library.jhu.edu/science/article/pii/S0967070X14002145.

Metropolitan Transportation Commission. 2017. "Equity Analysis Report - Plan Bay Area 2040 Final Supplemental Report." : 1-133. http://2040.planbayarea.org/sites/default/files/2017-07/Equity_Report_PBA%202040%20_7-2017.pdf.

Miller, Patrick, Alexandre G. de Barros, Lina Kattan, and S. C. Wirasinghe. 2016. *Analyzing the Sustainability Performance of Public Transit*. Vol. 44. doi://doi.org/10.1016/j.trd.2016.02.012. http://www.sciencedirect.com/science/article/pii/S1361920916000213.

Mohammad, Sara I., Daniel J. Graham, Patricia C. Melo, and Richard J. Anderson. 2013. "A Meta-Analysis of the Impact of Rail Projects on Land and Property Values." *Transportation Research Part A: Policy and Practice* 50: 158-170. https://www.sciencedirect.com/science/article/pii/S0965856413000207.

Munoz-Raskin, Ramon. 2010. "Walking Accessibility to Bus Rapid Transit: Does it Affect Property Values? the Case of Bogotá, Colombia." *Transport Policy* 17 (2): 72-84. doi:10.1016/j.tranpol.2009.11.002. https://www.sciencedirect.com/science/article/pii/S0967070X09001334.

Murray, Alan. 2003. "A Coverage Model for Improving Public Transit System Accessibility and Expanding Access." *Annals of Operations Research* 123 (1): 143-156. doi:1026123329433. https://search.proquest.com/docview/214508670.

Peters, Dirk. 2001. "Gender and Transport in Less Developed Countries: A Background Paper in Preparation for CSD-9." *Journal of Public Transportation* 14: 1-19. https://www.geschundkunstgesch.tu-berlin.de/fileadmin/fg95/Hauptordner_Megaprojekte/Peters2001PaperGenderAndTransportSouth.pdf.

Potter, Stephen. 2003. "Transport Energy and Emissions: Urban Public Transport." In *Handbook of Transport and the Environment*, 247-262: Emerald Group Publishing Limited.

Rahman, A K M Mushfiqur. 2009. "Estimation of Direct and Indirect Energy Requirements for Bus Rapid Transit (BRT) and Light Rail Transit (LRT)." M.A.Sc., Carleton University (Canada). https://search.proquest.com/docview/238014490?accountid=11752.

Rawls, J. 2009. *A Theory of Justice* Harvard University Press. https://books.google.com/books?id=kvpby7HtAe0C.

Ross, Catherine E. and Sung Joon Jang. 2000. "Neighborhood Disorder, Fear, and Mistrust: The Buffering Role of Social Ties with Neighbors." *American Journal of Community Psychology* 28 (4): 401-420. doi:1005137713332. https://doi.org/10.1023/A:1005137713332.

Schipper, Lee J. and Lewis Fulton. 2003. "Carbon Dioxide Emissions from Transportation: Trends, Driving Factors, and Forces for Change[a]." In *Handbook of Transport and the Environment*. Vol. 4, 203-225: Emerald Group Publishing Limited. doi:10.1108/9781786359513-011. https://doi.org/10.1108/9781786359513-011.

Serebrisky, Tomás, Andrés Gómez-Lobo, Nicolás Estupiñán, and Ramón Muñoz-Raskin. 2009. "Affordability and Subsidies in Public Urban Transport: What do we Mean, what can be done?" *Transport Reviews* 29 (6): 715-739. https://openknowledge.worldbank.org/handle/10986/7562.

Silva, Cecilia and Paulo Pinho. 2006. "A Methodology to Assess the Contribution of the Land use and Transport Systems to Sustainable Urban Mobility." : 1-20. http://web.mit.edu/11.951/oldstuff/albacete/Other_Documents/Europe%20Transport%20Conference/planning_for_sustainab/a_methodology_to_a1565.pdf.

Tara, Shelly. 2011. "Private Space in Public Transport: Locating Gender in the Delhi Metro." *Economic and Political Weekly* 46 (51): 71-74. http://www.jstor.org/stable/23065551.

The Leadership Conference Education Fund. 2011. "Where we Need to Go: A Civil Rights Roadmap for Transportation Equity." *Annals of Neurology* 69 (3): A15. doi:10.1002/ana.22401. https://onlinelibrary.wiley.com/doi/abs/10.1002/ana.22401.

Throne, James H., Patrick R. Hubert, Elisabeth O'Donoghue, and Maria J. Santos. 2014. "The use of Regional Advance Mitigation Planning (RAMP) to Integrate Transportation Infrastructure Impacts with Sustainability; a Perspective from the USA." *Environmental Research Letters* 9 (6). http://iopscience.iop.org/article/10.1088/1748-9326/9/6/065001.

Tsamboulas, D., A. Verma, and P. Moraiti. 2013. "Transport Infrastructure Provision and Operations: Why should Governments Choose Private-Public Partnership?" *Research in Transportation Economics* 38 (1): 122-127. doi:10.1016/j.retrec.2012.05.004.

Turner, Jeff and Margaret Grieco. 2000. "Gender and Time Poverty: The Neglected Social Policy Implications of Gendered Time, Transport and Travel." *Time & Society* 9 (1): 129-136. doi:10.1177/0961463X00009001007. http://journals.sagepub.com/doi/full/10.1177/0961463X00009001007.

United States Department of Transportation. 2004. "Report to Congress on Public-Private Partnerships.".

Ward, Beverly G. 2005. "Case Studies in Environmental Justice and Public Transit Title Vl Reporting Final Report." *National Center for Transit Research*: 1-80. http://www.trb.org/Main/Blurbs/156215.aspx.

Welch, Timothy F. and Sabyasachee Mishra. 2013. "A Measure of Equity for Public Transit Connectivity." *Journal of Transport Geography* 33: 29-41. https://www.sciencedirect.com/science/article/pii/S0966692313001762.

World Bank. 2011. "World Development Report 2012: Gender Equality and Development." .

World bank and Social Development Department. 2006. "Social Analysis in Transport Proejcts: Guidelines for Incorporating Social Dimensions into Bank-Supported Projects." .

Wright, Lloyd. 2004. "The Limits of Technology: Achieving Transport Efficiency in Developing Nations." .

Wu, Belinda M. and Julian P. Hine. 2003. "A PTAL Approach to Measuring Changes in Bus Service Accessibility." *Transport Policy* 10 (4): 307-320. doi:10.1016/S0967-070X(03)00053-2. https://www.sciencedirect.com/science/article/pii/S0967070X03000532.

Yigitcanlar, Tan, Nell Sipe, Rick Evans, and Matt Pitot. 2007. "A GIS-based Land use and Public Transport Accessibility Indexing Model." *Australian Planner* 44 (3): 30-37. doi:10.1080/07293682.2007.9982586. https://doi.org/10.1080/07293682.2007.9982586.

Zhang, Ming and Lanlan Wang. 2013. "The Impacts of Mass Transit on Land Development in China: The Case of Beijing." *Research in Transportation Economics* 40 (1): 124-133. 10.1016/j.retrec.2012.06.039.

Zhao, Zhirong Jerry, Kirti Vardhan Das, and Kerstin Larson. 2012. "Joint Development as a Value Capture Strategy for Public Transit Finance." *Journal of Transport and Land Use* 5 (1): 5-17. http://www.jstor.org/stable/26201681.

Zhu, Xuan, Suxia Liu, and Mun-Ching Yeow. 2006. "Accessibility Analysis for Housing Development in Singapore with GIS and Multi-Criteria Analysis Methods." *Applied GIS* 2 (2): 13.12. doi:10.2104/ag060013. http://www.publishing.monash.edu.au/epress/ag/ag060013.pdf.