Public Transit Innovations, Equity, and Blind Spots: Examining the Benefits and Unintended Consequences of Investments in Public Transport Projects in Three Global South Cities

by

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Abstract

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Cities in the global South are often characterized as being grossly unequal. A historical lack of efficient public transit is often cited as a barrier to urban opportunities for the poor. Decision-makers now address the adverse effects of decades of disinvestment in transport infrastructure by pouring vast public resources into public transport innovations such as bus rapid transit (BRT) systems and urban gondolas, which are intended to replace or displace privately-provided, sometimes informal transit services. These public transport innovations have been contextualized as pro-poor in scholarly circles and planning discourses because they are expected to improve the quality of life of economically disadvantaged population groups.

To what extent and under which conditions do such investments accomplish what they promise? Despite increasing interest in transport equity and justice in contemporary urban transport scholarship and the steady growth of investments in public transport, there is surprisingly little empirical evidence detailing how the benefits of recent public transport infrastructure investments are distributed. Moreover, in terms of urban and regional planning, scholarship seldom links questions of moral philosophy with land development patterns and issues with data representation that may bias outcomes from transport policies. Finally, few studies investigate whether and how these public transport investments disrupt the pre-existing private and often informal transport services upon which the urban poor in the global South often depend. What is the role of local actors, social networks, and the state in enabling such adaptation?

Following a three-paper format that employs multi- and interdisciplinary research approaches, this dissertation links public transport provision in the global South with questions of equity and justice. The two first papers address questions of distributive

justice from investments in public transport. The first paper draws from a retrospective intercept survey administered after BRT deployments in Barranquilla, Colombia, and Cape Town, South Africa. Our findings suggest that while BRT deployment did not narrow the gap in commute times between low and high socio-economic strata groups in Barranquilla, BRT did narrow the gap in commute times between different races in Cape Town. A critical lesson from this chapter is that BRT route configuration and urban form influence the degree to which BRT can benefit economically disadvantaged populations.

The second uses Bogotá's urban gondola as a case study. It uses urban data analytic methods to understand how public transport innovation enables changes in the geography of regional job accessibility in the city that benefit additional groups than those conceived as beneficiaries during the project promotion. I show that extending the reach of Bogotá's transit network to a marginalized area with available jobs enabled gains in job accessibility far away from where the project was built. I find that the positive accessibility effects of TransMiCable go well beyond its station areas, spilling over to low- and middle-class neighborhoods in other parts of the Bogotá urban region. I also show how methodological choices made when measuring how public transport investment affects accessibility can influence findings; those can, in turn, can be linked to different, often contrasting principles of fairness.

The third and last paper draws from ethnographic methods, remotely-sensed data, and social media to untangle the market and non-market forces that drive the informal transport sector in the district where the gondola was built. I find that, contrary to my expectations, most pre-existing informal transport services remained unchanged more than a year after TransMiCable opened to the public, while two new informal routes emerged. I explain these findings by considering the socially embedded character of informal transport and the peripheral urbanization process characteristic of many cities in the global South. I find that informal routes in this peripheral district emerged in tandem with the ongoing peripheral urbanization process. Findings also indicate that community-based organizations collaborate with informal transport actors to plan and promote informal transport routes during the early stages of neighborhood development.

Together these papers critically reflect on the importance of investing in public transit projects sensitive to land development patterns, pre-existing transport services, and the economic and non-economic forces that enable transport networks to deliver more equitable outcomes. I adopt distinct and novel methodological approaches in each study. When combined, these approaches offer a more comprehensive method for understanding the complex relationships between transport, land development, and social networks and their effects on accessibility. By investigating the subject of transport justice in three different papers and cities in the global South, this dissertation offers new insights that contribute to transport scholarship, planning, and policymaking.

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Chapter 1 Introduction

Transport policies and planning decisions can have significant consequences on the populations they intend to serve. For instance, investing in effectively planned and executed expansions and improvements to public transport networks can improve mobility and accessibility of economically disadvantaged population groups, thus reducing economic gaps endemic to many cities in the global South. As more cities in this part of the globe invest scarce resources in capital-intensive public transport projects, often positioned as pro-poor, it is crucial to take a few steps back and ask: Are such investments delivering what they promise? To what extent do novel public transport infrastructures and services benefit those who need them the most?

This dissertation is guided by recent scholarship attempting to connect transport planning and policy decisions with principles of moral philosophy. Although the number of empirical works concerned with justice and equity in the transport policy and planning discipline has exponentially increased in recent decades, there is little conceptual clarity on what the terms mean in the transport context (Pereira et al., 2017; Taylor & Norton, 2009). Nevertheless, there is a growing consensus among transport scholars interested in moral philosophy, arguing that investments in transport ought to benefit the least advantaged groups in society.

Most scholarly work equity in transport relies on cross-sectional analyses to assess how the benefits from transport, primarily access to urban opportunities and amenities, are distributed across space and between different population groups. This growing body of literature is concerned with existing inequalities, providing valuable information during the early stages of any planning process that may help steer public transport investment to areas that need those interventions the most. While asking questions about how unequal benefits from transport are distributed helps transport planners define a moral compass and guide their decisions, investments in public transport may not always benefit the least advantaged members of society. Multiple reasons, including political ones, might prevent investments in public transport reach "transport equity" objectives. Therefore, it is imperative to assess also how benefits and burdens from investments in transport are distributed across space and between different population groups.

From a more theoretical standpoint, according to Karner and Pereira (2021), equity is not so much about the unequal distribution of resources across space; it is instead about how policy decisions shape the distribution of benefits and burdens from state interventions. In the realm of transport, their positive or proactive conceptualization of the term "equity," which they refer to as "transport equity," departs from previous work on cross-sectional inequalities to focus on one fundamental question: Do investments in transport benefit the least advantaged members of society? Their conceptualization of "transport equity" also draws from Rawls' maximin principle to suggest that transport policies ought to benefit the least advantaged members of society. Furthermore, Karner and Pereira (2021) contend that "[t]he concept of "transport justice" encompasses moral, political concerns, and diversity in the pursuit of more just cities and mobility systems." Diversity, in this context, involves the participation of different members of society, particularly historically underrepresented economically disadvantaged groups, in transport planning processes. This dissertation draws from both theoretical frameworks to examine Cape Town's and Barranquilla's BRT and Bogotá's urban gondola.

Contemporary conceptualizations of transport equity and justice have evolved in tandem with increasing state investment in innovative public transport projects, which are frequently positioned as pro-poor. During the past two decades, at least a hundred cities in the global South have poured significant shares of their thin budgets into sizable public transport infrastructure projects, including urban rail, bus rapid transit (BRT), and, more recently, urban gondolas (also referred to as aerial cable cars). These projects are often deployed in rapidly urbanizing cities characterized by vast inequalities in access to economic-generating opportunities, in which loosely regulated, or sometimes unregulated, privately provided transit has dominated the market for decades.

Bogotá opened the first phase of its celebrated BRT TransMilenio in 2000 to restructure its private transit sector; since then, several dozens of cities in the global South have invested in BRT. After Medellin, Colombia deployed its first urban gondola line in a historically marginalized district in 2004, many others followed. Some cities, including La Paz, Mexico City, Rio de Janeiro, Cali, and Caracas, have adopted the same technology to overcome topographical barriers many of these peripheries impose on other transit alternatives. Despite this increasing trend, planning agencies and transport scholars have published few studies on whether such investments deliver what they promise. Cities are left with limited guidance on how to conduct such assessments in contexts where data is limited.

By critically investigating some of the benefits of these transport interventions and their unintended consequences or blind spots, this dissertation contributes to transport equity and justice scholarship and planning praxis. The following questions motivate this doctoral research:

1. To which extent do public transport innovations, specifically BRT and urban gondolas, close mobility and accessibility gaps in cities in the global South?
2. What is the role of land development, or urban form, in enabling such interventions to deliver more equitable mobility and accessibility outcomes?
3. How do pre-existing private transit actors adapt to new investments in public transport?
4. What research methods can be employed in contexts with limited data availability?
5. How can data analyses inform and be informed by different moral philosophies of fair distribution of resources?

6. What are the barriers to data collection, and which issues of data representation should be considered when assessing benefits from improvements in public transport networks?

I answer these fundamental questions by examining three different cities in the global South following a three-paper dissertation format (Chapters 2, 4, and 6). Each paper contains an introduction, literature review, research design, and conclusion relevant to the transport mode and outcome of interest. Transitional chapters (3 and 5) connect these papers and expand on relevant contextual information. I conclude by summarizing how this doctoral research contributes to well-established scholarship, including transport planning scholarship, and providing policy recommendations (Chapter 7).

In the first paper (Chapter 2), published on June 18, 2021, in the *Journal of Transport and Land Use*, my colleague Lisa Rayle and I investigate the extent to which BRT can improve mobility outcomes for disadvantaged population groups. Previous studies have demonstrated that BRT can provide travel time advantages through a bundle of high-standard design elements that enable buses to increase speeds and provide passengers streamlined access to stations and vehicles. Perhaps the most relevant aspect is the segregated busways, or trunk corridors, which allow vehicles to reach significantly higher speed (Cervero, 2013; Munoz & Paget-Seekins, 2016). BRT mobility improvements have been recognized as a significant achievement, particularly in contexts with thin budgets that constrain BRT design goals to maximize ridership (Santana Palacios et al., 2020). Furthermore, BRT can enable commute time savings for economically disadvantaged population groups when feeder services reach peripheral areas. Although replacing direct-service private transit routes with trunk-feeder BRT systems may induce more transfers for those living in peripheral spaces, higher travel speeds on BRT trunk corridors should, in theory, compensate for the induced transferring times and possibly reduce travel time overall.

Despite the popularity of BRT, there is little evidence testing whether it contributes to diminishing transport-related inequalities. We filled this gap by first estimating and then comparing the distributional effects of BRT on commute times in Cape Town, South Africa, and Barranquilla, Colombia. We chose to compare Barranquilla and Cape Town's BRT systems for various reasons. BRT opened at about the same time in both cities (between 2010 and 2011), making them good candidates for our comparative analysis. Both cities adopted the same feeder-trunk route configuration following Bogotá's BRT success, with some variations, such as adding direct-route services to their route supply.

Cape Town's BRT system, MyCiti, opened in 2010 with regular trunk services and several feeder routes. As of 2015, MyCiti had a network consisting of approximately 31 kilometers of trunk corridors, 318 feeders, and 126 direct-routes services (buses with doors on both sides that enter and leave trunk corridors). Barranquilla's BRT, Transmetro, also opened to the public in 2010 and currently has approximately 14 kilometers of exclusive trunk corridors and 190 kilometers of feeder routes, and one direct-route service in 2015. Transmetro connects southern Barranquilla's neighborhoods and the municipality of Soledad, whose residents are predominantly low-income, with the city center and some neighborhoods in the city of Puerto Colombia to the north.

Drawing primarily on a retrospective intercept survey administered in Cape Town, South Africa, and Barranquilla, Colombia, approximately five years after new BRT systems were introduced in each city, we analyzed changes in commute times of different groups of residents and BRT users and compared our results. Our comparative and distributional analyses indicate that, while BRT narrowed the gap in commute times in Cape Town, it did not contribute to closing the gap in Barranquilla. We argue that this contradiction may partly be explained by the degree to which BRT route configuration responded to the urban form and pre-BRT transit conditions in each city. BRT route design is almost always a function of urban form and pre-existing services; however, equity impacts should be considered a crucial part of the design process.

In Chapter 4, I turn to Bogotá. This chapter questions the extent to which an extension of Bogotá's public transport system lifts the most disadvantaged groups' fortunes and reduces transport-related urban inequalities. I use Bogotá's first urban gondola line, TransMiCable, to understand how the project reshapes the geography of access to jobs for accessibility poor and economically disadvantaged populations living in the peripheral district of Ciudad Bolívar. Urban gondolas, like many BRT corridors and subway lines, have the advantage of bypassing traffic congestion, thus enabling significant reductions in commute times for those living in peripheral urban areas, similar to Cape Town's BRT. Substantial reductions in travel times, in turn, could enable significant increases in job accessibility, commonly defined as the potential to reach more economic-generating opportunities.

TransMiCable is a 3.4-kilometer cable-propelled line that opened to the public in December 2018 and constituted the newest addition to the city's public transport system. The investment is contextualized as an innovative alternative to traditional bus feeder services that also extend the geographical reach of the city's BRT to less dense, sprawling peripheral neighborhoods. Connecting BRT or other mass transit systems to bus lines may work relatively well if topographical conditions and road infrastructure thus allows it. However, the geographical conditions of many urban peripheries in the global South are not suitable for buses to efficiently and safely transport passengers. In this context, cable-propelled technology, adapted from ski resorts in Europe and North America to fit the needs of urban environments in the global South, has become a popular transport investment in Latin American urban areas.

To understand how Bogotá's new public transport investment reshapes the geography of access to economic-generating opportunities, I capitalized on openly available data on transport and land use. I combined these datasets with a quasi-counterfactual research design and urban data analytic tools to produce multiple spatial, descriptive, and comparative analyses. As expected, Bogotá's urban gondola enabled a notable increase in job accessibility for the residents near its three intermediate stations. My analysis also confirms that TransMiCable serves one of the most economically disadvantaged population groups with the lowest level of job accessibility in this urban area, which is aligned with transport equity principles.

I also demonstrate that the positive accessibility effects of TransMiCable go well beyond its station areas, spilling over to low- and middle-class neighborhoods in other parts of the Bogotá urban region. I contextualize this latter finding as one blind spot of many policy discourses that often focus on station areas or administrative districts. These discourses overlook the fact that peripheral transport interventions are part of extensive and complex urban systems encompassing multimodal transport networks and overlapping over multi-purpose land-use systems in urban peripheries.

In the case of Bogotá's urban gondola, the positive and far-reaching effects are enabled by the fact that the district of Ciudad Bolívar, where TransMiCable is located, is not an outlying area with only residential land uses; it is a center of economic activity with dozens of thousands of jobs. This finding challenges arguments against investing in small projects located in the urban fringe and positions regional accessibility impact analyses as a fundamental tool for transport planning and project assessments. I close Chapter 4 by quantifying how TransMiCable helped reduce job accessibility gaps in the city. Lastly, I discuss how methodological choices can influence the way findings are interpreted and linked to different and contrasting principles of fairness, some at odds with Rawlsian principles of distributive justice that suggest a more just society ought to generate the greatest benefit to the least-advantaged members.

For this dissertation's third and final paper (Chapter 6), I remain in Bogotá's periphery to investigate how the informal transport sector has adapted to TransMiCable. Urban gondolas, BRT systems, and other capital-intensive public transport investments are essential vehicles that improve mobility and accessibility for historically marginalized low-income residents. However, these interventions only represent a fraction of the services available to the urban poor in cities in the global South. Depending on the city, informal transport services are referred to as matatus, chanas, combis, piratas, or carritos. Non-sanctioned by the state and therefore considered illegal or informal, these vehicles often serve a large share of low-income urban dwellers, frequently located in the urban peripheries.

While both urban gondolas and informal transport play an important role in positively contributing to the travel needs of the urban poor, planners and urban scholars have yet to test the assumption that the former disrupts the latter or the degree to which informal transport providers adapt to state-funded interventions (or vice versa). To answer these two questions, I immersed myself in the field for nine months. I traced the operations of the informal transport sector of the peripheral district where TransMiCable sits before and after the project opened to the public. Information was obtained through multiple methods, including via smartphone remote sensors, satellite images, unobtrusive observations, and in-depth interviews with informal transport drivers, dispatchers, vehicle owners, community leaders, and transport planners.

Drawing from this empirical evidence and using a mixture of qualitative data analysis methods, I found little change in the operations of pre-existing informal transport services. Moreover, counter to assumptions grown in decades of scholarship on informal transport, a few new routes emerged at the urban fringe, feeding the latest station of TransMiCable. I make sense of the persistence and proliferation of informal transport services in Bogotá's periphery by triangulating these findings with the social embeddedness character of informal transport and land development patterns. Interviews also suggest that Community Action Board (CAB) members collaborate with informal transport actors to plan and promote informal transport routes. Interviews, observations, and satellite images indicate that informal transport emerged in tandem with the ongoing peripheral urbanization process. Interviews also suggest that CAB members participate in the planning for informal transport. The socially embedded character of informal transport in Ciudad Bolívar, particularly the role of community-based organizations like CABs in planning for transport services, contribute to new conceptualizations of "transport justice," in which not only the state plans for, and provides, transport services for those at the margins of society.

Read together, these three papers critically investigate some of the benefits of these transport interventions through the lenses of what some scholars refer to as "transport equity." This dissertation examines the forces and contexts that enable and or hinder transport investments in delivering more equitable distribution of benefits from such investments. It also surfaced some unintended consequences from the deployment of BRT and urban gondolas, using three case studies. In terms of methods, this dissertation offers new avenues for addressing equity questions in transport in contexts where little information is available.

Chapter 2 Shorter commutes, but for whom? Comparing the distributional effects of Bus Rapid Transit on commute times in Cape Town, South Africa, and Barranquilla, Colombia

Bus rapid transit (BRT) has become an increasingly popular investment worldwide. BRT systems can provide travel time advantages through a bundle of high-standard design elements that enable buses to increase speeds and provide passengers streamlined access to stations and vehicles. BRT buses operate on segregated busways, or trunk corridors, allowing them to reach significantly higher speeds (Cervero, 2013; Munoz & Paget-Seekins, 2016). The median-location of BRT corridors reduces conflicts with turning vehicles and on-street parking, reducing delay (Cervero, 2013). Furthermore, design elements, such as the use of smart-card-based off-board fare collection systems and platform-level boarding, offer passengers quicker access to public transport (Cervero, 2013). Thus, like rail systems, BRT can deliver significant travel time savings to commuters; however, BRT is faster to build at a fraction of the cost (Munoz & Paget-Seekins, 2016; Venter et al., 2017).

Because of these travel time and cost advantages, BRT is often positioned as an equitable public transport option in policy discourse, particularly in cities in the global South. Shaped in part by broader policy agendas and some road infrastructure attributes, most BRT systems are designed following Bogotá's BRT trunk-feeder system (Cervero, 2013; Montero, 2020; Silva Ardila, 2020). These BRT trunk-feeder systems consist of large-size buses operating on trunk-only bus corridors, often placed on pre-existing arterial road infrastructure, functioning as the system's backbone. BRT corridors are complemented by feeder services made up of mid-size buses circulating in mixed-traffic lanes. These feeder services extend the geographical reach of BRT to less dense and sprawling peripheral neighborhoods whose street networks are not suitable for trunk corridor construction. Examples of trunk-feeder BRT systems can be found in Seoul, Cape Town, Johannesburg, and many Latin American cities, including Barranquilla, Cali, Rio de Janeiro, and Lima.

BRT roll-out in these cities has often been promoted as a means for restructuring pre-existing, largely privately-run, loosely regulated, or unregulated, and inefficient shared "private transit" and "paratransit" services (Ardila-Gómez, 2008; Munoz & Paget-Seekins, 2016). Private transit services consist of mid-to large-size buses, often managed by private companies regulated by the state; paratransit is defined as a subset of private transit consisting of smaller vehicles that are typically more loosely regulated or illegal (Santana Palacios et al., 2020). Because private transit services operate in often-congested mixed-traffic lanes, the higher speeds enabled by BRT corridors may result in large travel time savings for commuters who switched to BRT services. Moreover, BRT has the potential to enable commute time savings for economically disadvantaged population groups in urban contexts where BRT reaches peripheral areas through feeder services through its seamless integration with trunk corridors. Although the replacement of direct-service private transit routes with trunk-feeder BRT systems may induce more transfers for those living in peripheral areas, higher travel speeds on BRT trunk corridors should, in theory, compensate for the induced transferring times, reducing travel time overall. Based on this information, planners and policymakers expect that investment in BRT will benefit economically disadvantaged groups (Venter et al., 2017), which is consistent with contemporary conceptualizations of 'transport equity' posited by Karner and Pereira (2021).

Investing in BRT to reduce economically disadvantaged groups' commute times is an important policy objective for multiple reasons. One main reason is that economically disadvantaged populations in global South cities often commute for considerably longer distances than their non-economically disadvantaged counterparts (Vasconcellos, 2014). Furthermore, the growing body of literature connecting transport and health outcomes suggests that longer commute times are associated with higher stress levels (Evans & Wener, 2006; Gottholmseder et al., 2009) and lesser life satisfaction (Chatterjee et al., 2020; Hilbrecht et al., 2014). Also, designing BRT systems that benefit disadvantaged populations may help reduce commute time and employment accessibility inequalities, consistent with moral principles of distributive justice (also referred to as equity in the literature) promoted by urban planners and transport scholars alike (Pereira et al., 2017; Venter et al., 2017).

Despite policymakers' interest and investment in BRT as a pro-poor public transport solution, few studies test whether BRT reduces commute time gaps between different socio-economic groups in urban areas or what factors, including urban form, pre-existing transit conditions, and BRT network configuration, may contribute to the distribution of the change in commute times across these groups. Drawing primarily on a retrospective intercept survey administered in Cape Town, South Africa, and Barranquilla, Colombia, five years after the introduction of new BRT systems in each city, we analyzed changes in commute times of different groups of residents and BRT users and compared our results.

Since we wanted to understand the first order (or direct) effects of BRT on commute times, our focus in this chapter is on residents who did not change home or work location (hereafter referred to as "non-movers"). By examining only non-movers, we are able to select respondents whose commute times are only affected by the BRT. We opted for not analyzing respondents who reported having relocated their home or work place during the period of analyses for a simple reason: it may be plausible that any change in travel times are not necessarily associated with the BRT but with their home or workplace relocation. If we had information on what motivated their moving decision, we might have included them in the analysis.

Our comparative analysis provides diverging results that, when triangulated with data on pre-BRT public transport and private transit conditions and urban form characteristics, contribute to policy debates and academic discussions surrounding BRT and transport justice in the global South. Furthermore, BRT has the potential to enable commute time savings for economically disadvantaged population groups in urban contexts where BRT reaches peripheral areas through feeder services through its seamless integration with trunk corridors. Although the replacement of direct-service private transit routes with trunk-feeder BRT systems may induce more transfers for those living in peripheral areas, higher travel speeds on BRT trunk corridors should, in theory, compensate for the induced transferring times, reducing travel time overall. Based on this information, planners and policymakers expect that investment in BRT will benefit economically disadvantaged groups (Venter et al., 2017).

Despite policymakers' interest and investment in BRT as a pro-poor public transport solution, few studies test whether BRT reduces commute time gaps between different socio-economic groups in urban areas or what factors, including urban form, pre-existing transit conditions, and BRT network configuration, may contribute to the distribution of the change in commute times across these groups. Drawing primarily on a retrospective intercept survey administered in Cape Town, South Africa, and Barranquilla, Colombia, five years after the introduction of new BRT systems in each city, we analyzed changes in commute times of different groups of residents and BRT users and compared our results. Since we wanted to understand the first order (or direct) effects of BRT on commute times, our focus in this paper is on residents who did not change home or work location (hereafter referred to as "non-movers"). Our comparative analysis provides diverging results that, when triangulated with data on pre-BRT transit conditions and urban form characteristics, contribute to policy debates and academic discussions surrounding BRT and transport justice in the global South.

2.1 Literature review

Empirical evidence indicates BRT delivers multiple benefits to its users, including reductions in air pollution (Bel & Holst, 2018; Hidalgo et al., 2013; Nugroho et al., 2011) and reductions in death and injury from traffic accidents (Duduta et al., 2012; Hidalgo et al., 2013). Other studies suggest that BRT deployment is associated with positive effects on land values and development patterns (Cervero & Kang, 2011; Rodriguez et al., 2016; Rodriguez & Targa, 2004). Despite the empirical evidence detailing these benefits, differential effects across user groups are underrepresented in academic literature (Venter et al., 2017). Moreover, studies that test whether BRT helps reduce inequalities in commute times between these groups are surprisingly limited.

The vast majority of empirical studies that focus on travel times suggest that the average travel time reductions enabled by BRT across populations are significant; however, the question of distributive justice (also referred to as equity in transport policy discussion) is rarely addressed. For example, Ernst's (2005) assessment of Jakarta's first BRT corridor suggests that users reduced their travel time by 59 minutes over the corridor's whole length at peak hour. Alpkokin and Ergun (2012) found that Istanbul's BRT corridor reduced travel times by about 50 minutes. This body of literature, which focuses solely on travel times, paints a reassuring picture. Nevertheless, studies based primarily on BRT corridors (or trunk services) fail to report whether they account for out-of-vehicle travel times and overlook the following fundamental questions: 1) How are travel time savings from trunk-feeder BRT systems distributed among different population groups? 2) Which socio-economic groups benefit most from investments in trunk-feeder BRT systems? and 3) How might some BRT route configurations privilege some groups over others?

Most of the scholarship that examines BRT deployment in the context of transport equity in the global South focuses on accessibility benefits using cross-sectional analyses. Some scholars, however, have recently capitalized on data that captures employment spatial data and network changes over time to assess changes in job accessibility induced by travel time savings enabled by BRT. One influential study is conducted by Pereira et al. (2019), who found that Rio de Janeiro's BRT employment accessibility benefits are skewed towards middle- and high-income areas. Oviedo et al. (2019) report similar findings in their study of Lima's BRT. This research sheds some light on the distributional effects of benefits from BRT; however, questions about the influence of BRT design and urban form on the distribution of such benefits remain largely underexplored. These studies rely primarily on cross-sectional analyses to identify underserved areas -- see, for instance, Delmelle and Casas (2012) or Scholl et al., (2016). Although coverage issues are not unimportant distributive justice issues, these studies fail to address the questions above.

Moreover, research that relies primarily on multiple cross-sections where effects are confounded by multiple factors, such as home and workplace relocation patterns, has yielded inconclusive results about the effects of BRT on different population groups. Furthermore, most studies focus on a single intervention, which prevents researchers from making generalizations. For example, using survey data provided by Bogotá's BRT agency, Hidalgo and Yepes (2005) assessed travel time changes enabled by Bogotá's TransMilenio. The authors found that TransMilenio delivered greater travel time savings for low-income than middle-income passengers. However, in another study on Bogotá's TransMilenio, Lleras (2003) found that while those using only trunk services reduced their travel times, passengers who required one or more transfers experienced an increase in travel times.

A subsequent study conducted by Scholl et al. (2016) examined the effects of Cali's and Lima's BRT systems on travel times. Their research, which relied on GIS network analysis tools, also generated mixed results. Their analysis indicates that the lowest- and highest-income areas in Cali benefited with greater travel time savings than middle-income groups. In Lima, travel time savings associated with BRT deployment could be up to 34 minutes in some low-middle-income zones. In comparison, maximum savings in poor and very poor areas were 32 and 28 minutes, respectively, versus an average city-wide seven-minute decline. The authors noted that one possible explanation for their diverging results is the difference in BRT coverage, highlighting the challenges of reaching settlements in hilly and peripheral areas.

Gómez-Lobo (2020) provides some insights into the potential effects of restructuring private transit through trunk-feeder BRT systems on intra-urban travel in a more recent study. Using a multi-city and longitudinal data set, he found that cities that deployed BRT in Colombia experienced a more considerable decline in demand for public and private transit than similar cities that did not opt for such investment. By triangulating these primary findings with secondary data sources, the author posited that the BRT corridors in mid-sized cities tend to be relatively short and do not sufficiently reduce travel time to compensate for the more prolonged walking and waiting times induced by BRT. However, despite this significant contribution of his work, Gomez-Lobo's work does not provide empirical evidence on whether BRT helped reduce inequalities in commute times.

Gomez-Lobo's conjecture is expanded when placed in conversation with other recent scholarship. For example, drawing from in-depth interviews with Barranquilla residents after BRT deployment, Santana Palacios et al. (2020) noted that participants who used trunk lines for a large share of their trip reported that BRT provided travel time savings; however, BRT implementation may have increased travel duration for some residents, particularly for those who rely on feeder services. These users tend to live in peripheral neighborhoods and are often poor. Despite the insightful findings, their empirical evidence focuses on a limited number of respondents and only one city.

Our research draws from a large body of research on BRT and transport equity and departs from previous scholarship by employing a comparative research design. In this chapter, we first describe the changes in commute times experienced by residents in Cape Town and Barranquilla with BRT deployment, then draw from multiple sources to untangle the possible factors driving the distribution of commute time savings enabled by BRT between different population groups. Finally, by juxtaposing the results from each city, our research harnesses the benefits of comparison, which according to Collier (1993, p. 105), "is a fundamental tool of analysis [that] sharpens our power of description and plays a central role in concept-formation by bringing into focus suggestive similarities and contrasts among cases." Moreover, and as Goodrick (2019) noted, comparative analyses produce knowledge that is easier to generalize than when drawing inferences from a single case.

2.2 Research design

We used a comparative mixed-methods research design consisting of quantitative data analyses of original survey data collected in Cape Town and Barranquilla, followed by data triangulation with secondary sources to interpret the results from our survey analysis in both cities. Below we explain the rationale behind selecting Barranquilla and Cape Town for our comparative analysis and offer a summary of our sampling methodology, data collection instrument, recruitment strategy, and survey data analysis method. We close this section with some insights from our data triangulation exercise that then we expand in the conclusions and policy recommendations section.

Case selection rationale

We chose to compare Barranquilla and Cape Town's BRT systems for five reasons. First, BRT opened at about the same time in both cities (between 2010 and 2011), making them good candidates for our comparative analysis. Second, both cities invested in BRT as part of a broader policy intended to replace private transit routes gradually. Third, both cities adopted the same feeder-trunk route configuration following Bogotá's BRT success, with some variations, such as adding some direct-route services to their route supply. Fourth, both cities are entrenched in inequality and similar spatial segregation patterns—along racial lines in Cape Town and along economic lines in Barranquilla—allowing us to draw more congruent cross-case conclusions. Finally, data collection was feasible in both cities as we were able to identify local partners to aid with logistical issues in conducting fieldwork.

Despite the similarities between the two cases, they differ on at least three fronts, which we addressed during our triangulation process to help explain our survey results. First, Cape Town's urban extent is three times as large as Barranquilla's. Second, Cape Town's BRT trunk corridors and direct-route services are significantly longer than Barranquilla's. Third, the trunk-to-feeder length ratio is substantially greater in Cape Town than in Barranquilla. The following subsections summarize these characteristics and provide some background information on each BRT system.

Cape Town and its BRT, 'MyCiti'

With a population of 3.7 million inhabitants, Cape Town is characterized by relatively low density, with about 1,500 inhabitants per square kilometer and very high levels of racial and economic segregation (Christopher, 2001; Stats SA, 2011). As is the case with many cities in the global South, economically disadvantaged populations, primarily Black Africans, are concentrated in peripherally located areas (locally referred to as townships), far from the city business district and other employment clusters (Figure 2-1). Cape Town's transport system includes a mix of BRT (called MyCiti), commuter rail lines, loosely regulated minibus taxis, and regulated but privately-operated conventional buses (Golden Arrow).

The city's 2006 development plan called for transport interventions that would reduce average peak-period commute time for public transport users from a baseline of 45 minutes in 2007 to 35 minutes by 2012 (City of Cape Town, 2007). With this goal in mind, Cape Town's BRT plan included provisions such as "[providing] basic mobility for the economically disadvantaged but also a competitive alternative to the private vehicle with reference to convenience, comfort, network coverage, and geographical accessibility" (City of Cape Town, 2009, p. 15).

Cape Town's BRT network is shown in Figure 2-1. The first service opened in 2010 with a limited route for the FIFA World Cup. Regular trunk services began in 2011 along a corridor that connected the city center with the northern part of the city, along with several feeder routes. In 2015, the second phase of the project opened to the public, connecting the outlying townships of Mitchell's Plain and Khayelitsha with the city's business central district two direct-service (or express) routes. These express routes use the bus lane on the N2 highway to surpass traffic congestion on mixed traffic lanes during peak hours. As of 2015, MyCiti had a network consisting of approximately 133 kilometers of trunk routes, 318 feeders, and 126 direct-routes services (in which buses with doors on both sides enter and leave trunk corridors).

Barranquilla and its BRT, ‘Transmetro’

With a population of approximately 2.4 million in 2012, Barranquilla is considered a mid-sized metropolitan area. Barranquilla is characterized by relatively high density—on average, about 7,900 inhabitants per square kilometers—with very high levels of informality and socio-economic segregation (Figueroa, 2010; Mertins, 2007). Like many urban areas in the global South, economically disadvantaged populations reside in peripheral neighborhoods (Figure 2-2). As of 2015, Barranquilla's transit supply consisted of a mix of BRT trunk and feeder services and private transit services provided by loosely regulated private transit buses and unregulated paratransit services provided mostly in motorcycle-taxis and bicycle taxis.

Barranquilla's BRT, Transmetro, opened to the public in 2010 (the same year Cape Town's BRT opened to the public). With approximately 14 kilometers of exclusive trunk corridors and 190 kilometers of feeder routes, and one direct-route service, Transmetro connects the municipality of Soledad and southern Barranquilla's neighborhoods with the city center and some neighborhoods in the city of Puerto Colombia to the north (Figure 2-2). Soledad is the second biggest city in the Barranquilla metropolitan area. Hereafter, we refer to the three cities combined as "Barranquilla."

Barranquilla's BRT was designed to provide a safe, efficient, rapid, and convenient transport alternative to the existing inefficient and loosely regulated private transit services locally referred to as conventional transport or buses (DNP, 2004). As part of the BRT deployment plan, authorities removed some of the pre-existing conventional bus routes operating on areas Transmetro covers to reduce competition and excess supply along principal corridors. Private transit buses still operate in Barranquilla, covering origin and destination areas not covered by the BRT. Many use the same two major arterial roads where the two major BRT trunk corridors are placed.

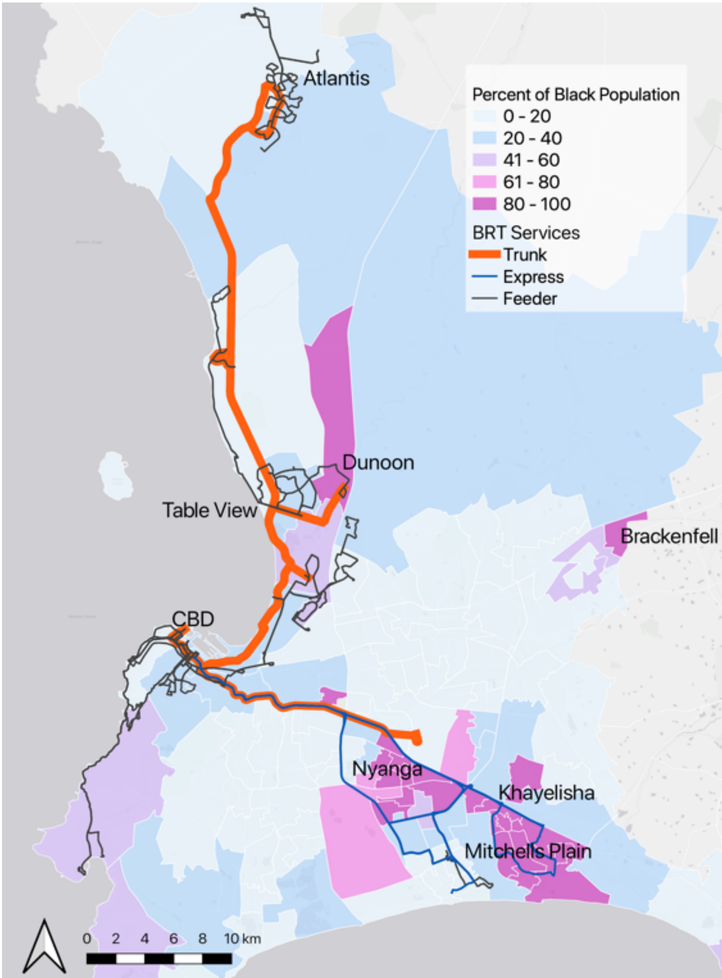

Figure 2-1 Population distribution by race in Cape Town and BRT network

Source: Own elaboration with data provided by MyCiti and the 2011 South African Census. Note: Phase 1 of the MyCiti network connects the Cape Town city center to neighborhoods and townships to the north. The MyCiti N2 Express (Phase 2) connects the city center to the eastern townships

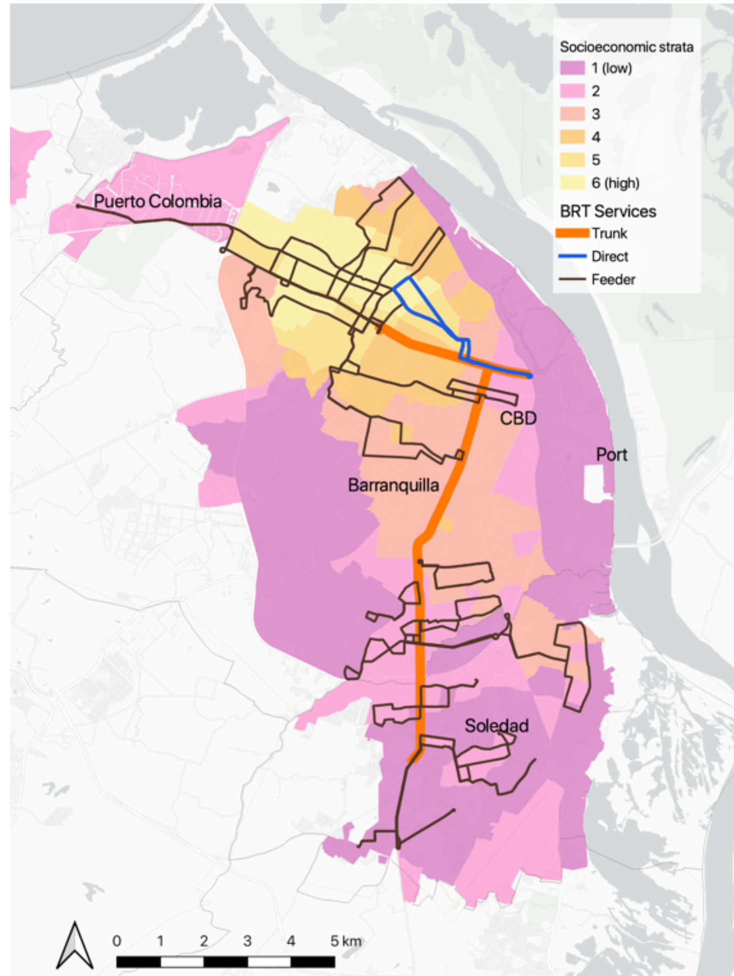

Figure 2-2 Population distribution by socio-economic strata in Barranquilla and BRT network

Source: Own elaboration with data provided by Universidad del Norte. Note: Phase 1 of the Transmetro network connects the Barranquilla city center to neighborhoods to the north and south of the city and with the municipality of Soledad

Sampling, data collection instrument, and recruitment strategy

Our sampling framework consisted of adults living in Cape Town and Barranquilla for at least five years. The five-year timeframe requirement guaranteed that we only included individuals who lived in each city before and after the introduction of BRT. We collected responses from a total of 1,165 respondents in Barranquilla and 1,115 in Cape Town. After excluding cases with no reported travel time in 2010 or 2015 or missing information regarding home or work address in 2010 or 2015, the number of cases was reduced to 1,059 in Barranquilla and 1,023 in Cape Town. Thus, the target population comprised those who lived in each city and traveled by any mode, with an emphasis on BRT users.

Our data collection instrument consisted of a retrospective intercept survey, administered in Cape Town during October and November 2015 and in Barranquilla during November 2015. We asked respondents to describe their usual trip to and from their place of work or study in 2010 (just before BRT opened to the public) and in 2015. The survey questionnaire also included questions regarding their pre- and post-BRT home and work locations (2010 and 2015, respectively) and their demographic and socio-economic characteristics. Our five-year sampling framework was appropriate for this retrospective survey since participants could reasonably remember their recurrent travel behavior patterns before BRT opened to the public.

We based our research design on a retrospective intercept survey for three reasons. First, and perhaps most importantly, on rare occasions, cities have available pre-BRT and post-BRT data that allows researchers to examine the effects of such investments on travel. In our case, we opted for a retrospective survey since in both cases BRT was already in place. Had we selected cities where BRT was about to be deployed to conduct a longitudinal analysis, it would have required not only significantly more financial resources, which can make research prohibitively expensive. It would also have extended our research time frame since planning and building these projects can take several years (if built at all). Additionally, researchers avoid panel attrition by conducting retrospective surveys, commonly found in longitudinal studies (Mayer, 2007). These are significant advantages for assessing potential outcomes from BRT implementation in the context of lack of secondary data and lengthy infrastructure planning and construction processes.

Once in the field, potential survey respondents were recruited following a non-probabilistic convenience sampling technique. Intercept sites in different areas of each city were carefully selected to elicit responses from respondents of diverse ages, occupations, and socio-economic and demographic backgrounds (Figures 2-3 and 2-4). Within these areas, we selected transit hubs that, based on our observations, have a high volume of travelers— particularly BRT and private transit users. We included shopping centers and markets to capture non-transit users. In Barranquilla, we also included public parks, small neighborhood stores, and universities.

Figure 2-3 Cape Town survey sites
Source: own elaboration with data provided by MyCiti and survey metadata

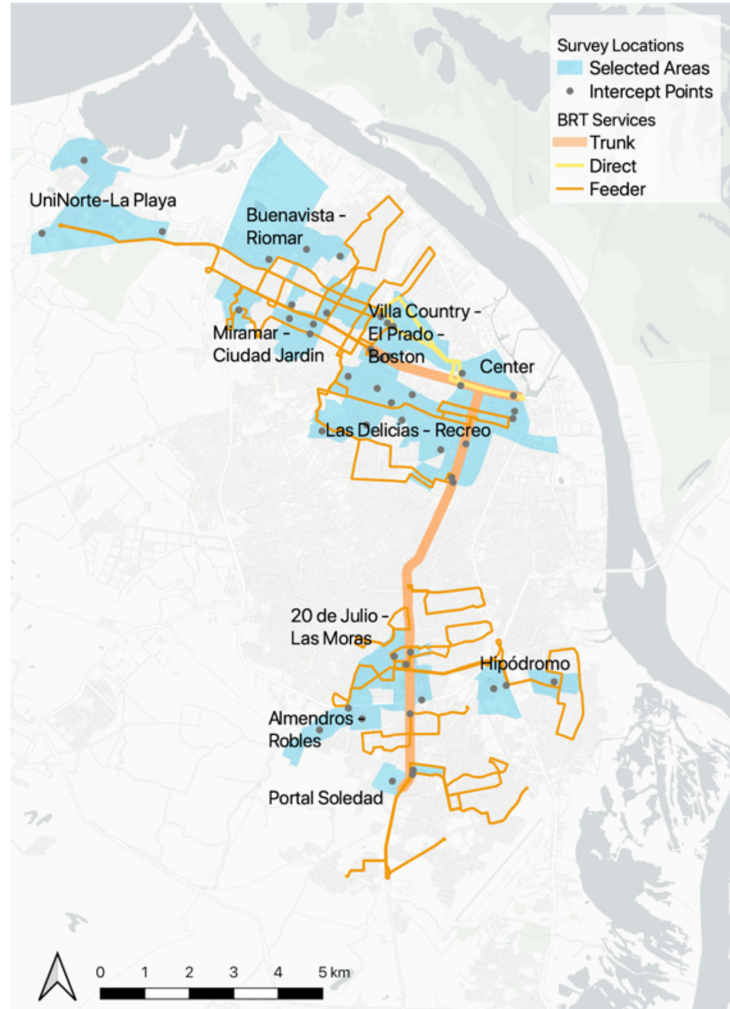

Figure 2-4 Barranquilla survey sites
Source: own elaboration with data provided by Transmetro S.A. and survey metadata

Data analysis method

Based on the belief that BRT delivers equitable outcomes in the global South, our research was guided by the following three hypotheses, which we tested independently: (1) on average, residents reduced their commute times after BRT was deployed in both cities—a trend that is primarily driven by residents switching from public (and private) transit to BRT; (2) BRT users reduced their commute time regardless of whether they had to transfer, although time savings are somewhat greater for BRT users who transfer since they are most likely to travel for longer distances on trunk corridors, and (3) disadvantaged BRT users experienced slightly greater commute time savings than non-disadvantaged BRT users.

To test these hypotheses, we estimated the differences in mean commute times for different groups of residents in each city. We compared the results following a multi-stage and decomposition process. We started by examining city-wide trends and trends for those who did not relocate their residence and workplace between 2010 and 2015 (whom we refer to as "non-movers"). We also classified participants by transport mode used in 2010, noting which individuals switched to BRT in 2015. In a subsequent step, we subclassified non-movers by (a) their need to transfer and (b) their socio-economic status in each city, and we compared commute time changes within those categories.

Because we compared the commute times of the same group of subjects (non-movers) before and after BRT deployment, and because no other significant changes in transport infrastructure occurred from 2010-2015, our research indicates that average commute time changes for that group are associated with BRT deployment. We opted not to analyze respondents who reported having relocated their home or workplace during the period of analyses for a simple reason: it may be plausible that any change in travel times is not necessarily associated with the BRT but with their home or workplace relocation. Had we had information on what motivated their moving decision, we had included them in the analysis. It is possible that other structural changes, for example, fare increases or economic downturn, may have affected non-movers travel behavior, impacting BRT demand expectations.

All of our comparisons are accompanied by tests of significance to assess whether the observed differences in means are not a result of random chance. We assumed non-equal variances for all the paired t-tests conducted and only refer to statistically significant changes at a 90 percent confidence level unless stated otherwise. We also assumed non-mover respondents selected the mode that minimized commute times. Therefore, for cases where respondents reported a change in commute time, we assumed residents chose the fastest mode they could afford.

We used different proxies for socio-economic status in each city. In Cape Town, we used as a proxy survey respondents' race, based on the fact that the racial stratification which was institutionalized during apartheid is, unfortunately, still in effect today

(Seekings & Nattrass, 2005). Within this socio-demographic structure, White residents are the most advantaged, followed by mixed-race groups and Black African residents. Respondents in Barranquilla were classified using the Colombian strata classification, which quantifies socio-economic status on a scale from one to six, with six being the highest (DANE, 2015). We grouped survey participants from Barranquilla into three categories: low (1 and 2), middle (3 and 4), and high strata (5 and 6). We considered using income for segmenting the population subject for our equity analyses; however, non-response rates for this question were unacceptably high (42 non-response in Cape Town and 23 percent in Barranquilla).

Limitations

Despite the merits of our research design, our paper may also have some limitations. First, the nature of intercept surveys means data may present some biases. To reduce self-selection and response biases, we recruited a large number and a wide variety of survey respondents by intercepting them in multiple locations and different times of the day during a period that extended for several weeks. Thus, locations and times of day were chosen to achieve a diverse sample of various economic and demographic backgrounds.

Notwithstanding these attempts to reduce potential biases, our sample is skewed towards BRT services areas, possibly underrepresenting some groups. We opted for this sampling strategy due to our limited resources and to guarantee we recruit a large enough and diverse sample of BRT users. However, our focus on BRT services areas may prevent us from making inferences about the impact of BRT on Barranquilla and Cape Town on residents, regardless of whether they switch to BRT. In Cape Town, White residents and car users seem to be underrepresented in our sample compared with 2010 census figures (Table 1). Our survey may also have underrepresented high-income residents and seniors in Barranquilla.

The question of representation, nonetheless, is difficult to assess due to a lack of reliable data. For example, the most recently available census in Colombia was conducted approximately a decade ago, which prevented us from comparing our sample with population figures. Moreover, researchers have consistently found difficulties in surveying certain population groups, for example, White residents in South Africa (Seekings & Nattrass, 2005). Underrepresentation, which in our sample to a few observations in a few population groups, deterred us from dividing the sample into smaller subgroups for additional comparisons. Our sample strategy is more consistent with our focus on BRT users.

Finally, it is possible that survey respondents perceived their travel times to be longer than they are, particularly for those who transfer from one route to another. The reason is that transit users tend to perceive walking and waiting times as more onerous than in-vehicle travel times (Iseki & Taylor, 2009; Wardman, 2004). Despite this limitation, using self-reported data may still provide valuable information not captured in other published work, such as those relying on network analyses. Standardized transit network data represent an invaluable resource that sheds some light on the potential changes in commute times and employment accessibility enabled by transit improvements when combined with spatial data analysis techniques. However, standardized transit data is seldom available in global South cities investing in BRT like Cape Town and Barranquilla.

2.3 Findings and discussions

Sample characteristics and descriptive statistics

Our data collection process resulted in a large and diverse sample in both cities and reflected population's demographics reasonably well (Table 1). The Barranquilla sample roughly matches the city's overall population distribution, although it skews younger than the general population estimates projected using the 2005 census. Similarly, Cape Town respondents are on average younger than the overall population. According to census figures, our sample in Cape Town comprises a larger proportion of Black residents and mixed-race respondents than the general population. Whether these differences may affect our results is discussed in the Research Design section.

Variable	Category	Our Survey		Census data
		All respondents	Non-movers	
Cape Town survey (n = 1,023)				
Sex	Female	58.8	61.5	51
	Male	39.9	37.4	49
	No response	1.3	1.1	-
Age (years)	20-34	50.4	39.3	44.3
	35-59	47.2	57.1	43.1
	60 or more	1.1	1.5	12.6
	No response	1.3	2.1	-
Race	Black	59.3	68.0	38.6
	Mixed Race	28.6	21.7	42.4
	Indian/Asian	1.2	0.5	1.4
	White	6.6	5.5	15.7
	No response	4.2	4.4	-
Barranquilla survey (n = 1,059)				
Sex	Female	49.8	46.6	51.2
	Male	49.3	52.8	48.8
	No response	0.9	0.6	-
Age (years)	17- 25	30.6	43.4	21.8
	26-54	61.6	51.7	56.7
	55 or more	6.8	4.5	21.5
	No response	1.0	0.3	-
Socio-economic Strata (1-6)	Low 1-2	57.5	56.7	66.4
	Medium 3-4	35.8	37.1	26.8
	High 5-6	6.4	5.7	6.8
	No response	0.3	0.5	-

Table 2-1 Demographics

Census data from Barranquilla correspond to our calculations based on population projections to 2015 published by DANE (2019) and socio-economic strata classification as of 2014 published by Camara de Comercio de Barranquilla (2015). Data for Cape Town come from the 2011 South African Census (Stats SA, 2011).

Groups	Year	Mean	Median	Std Dev	Min	Max
Cape Town						
	2010 (before BRT)	47.0	45	28.7	0	180
All (n=1,023)	2015 (after BRT)	45.5	45	22.1	4	150
	change	-1.5	0	27.8	-95	105
	2010 (before BRT)	52.3	45	29.1	10	180
Non-movers (n=618)	2015 (after BRT)	46.4	45	22.1	10	150
	change	-5.9	0	25.1	-95	105
Barranquilla						
	2010 (before BRT)	33.6	30	20.7	3	125
All (n=1,059) [b]	2015 (after BRT)	36.8	30	22.1	2	150
	change	3.2	0	23.6	-80	105
	2010 (before BRT)	34.5	30	20.7	3	125
Non-movers (n=479)	2015 (after BRT)	34.9	30	20.6	2	120
	change	0.4	0	15.7	-75	75

Table 2-2 Descriptive Statistics of Commute Time (in minutes)

How did commute time change city-wide after BRT implementation among non-movers?

As we expected, our analysis suggests that, as a group, those who shifted mode reduced their commute time in both cities (Table 3). In Cape Town, commute time savings were, to some extent, driven by a remarkable reduction in commute times from those who shifted from slow public transport buses (Golden Arrow) and commuter trains to BRT. These users saved an average of 18 and 11 minutes, respectively. Even more remarkable is the commute time reduction from those who shifted from train lines and public transport bus routes to minibus taxis, who saved an average of 35 and 21 minutes, respectively. It is worth noting that minibus taxis' services seem not to have improved, at least in terms of speed, after BRT deployment—a claim that is supported by the fact that those who used minibus taxis in 2010 and 2015 experienced, on average, a slight increase in travel time.

Nevertheless, and contrary to our expectations, we found no evidence suggesting that the group of non-movers who shifted to BRT in Barranquilla reduced their overall commute time (Table 3). Nor did we find evidence suggesting that those who shifted from private transit buses to BRT (which account for 96 percent of all who shifted mode) reduced their commute times as a group. Our Barranquilla analysis also suggests that commute time changes are driven by residents shifting from private transit to motorcycles. Since our sample only captures nine individuals that shifted from bus to motorcycle in Barranquilla, this finding is only indicative of a possible trend, consistent with empirical evidence presented by Rodríguez et al. (2015) and Hagen et al. (2016).

Main Mode in 2015 (after BRT)	Main Mode in 2010 (before BRT)	Freq	Mean commute time (min) 2010	2015	Mean change in commute time (min)
Cape Town					
Used BRT in 2015	Car as driver	33	44.2	49.5	5.3
	Bus (Golden Arrow)	117	73.6	55.6	-18.0**
	Minibus taxi	99	44.4	49.3	4.8*
	Train	31	74.7	63.7	-11.0*
Used minibus taxi in 2015	Bus (Golden Arrow)	56	64.5	43.5	-21.0***
	Minibus taxi	130	35.5	36.7	1.2**
	Train	34	74.3	38.8	-35.4***
Barranquilla					
BRT users in 2015	Bus	132	46.6	44.6	-2.1
Motorcycle users in 2015	Bus	9	40.6	19.4	-21.1**
	Motorcycle	21	24.8	24.1	-0.6

Table 2-3 Descriptive Commute time change by previous mode (non-movers)[1]
$^{*}\boldsymbol{p} \leq 0.10$, $^{**}\boldsymbol{p} \leq 0.05$, $^{***}\boldsymbol{p} \leq 0.01$

So far, our city-wide results are mixed, as with most findings from the body of literature examining BRT travel outcomes. However, our comparative research design and data collection instrument allowed us to uncover some notable trends that may help explain how and why BRT affects average commute times differently in these two cities. Additionally, although we found no evidence of commute time savings among non-mover BRT users in Barranquilla, it is still possible that some who rely on trunk services experienced gains, as previous studies suggest.

How did transfers affect commute times?

Because both cities modeled their BRT after Bogotá's trunk-feeder distributor model, it is essential to understand the extent to which the number of transfers increased and test whether an increase in transfers may have contributed to increases in overall commute times. In this context, we hypothesized that BRT users reduced their commute time regardless of whether they had to transfer, although savings may be greater for BRT users who do not transfer. Testing these two hypotheses in both cities was fundamental for determining under which conditions BRT may contribute to narrow commute time gaps in urban areas.

Our sample results indicate transfers increased considerably after BRT implementation in both cities. In Barranquilla in 2010, eight percent of all non-movers had to transfer between vehicles to access their final destination; this figure tripled in 2015, once BRT was in place. Similarly, the proportion of all non-movers who had to

[1] Following principles of visualization simplicity, only main transport modes with ten or more observations or which mean difference in commute times are statistically significant are reported. From those who shifted to BRT in Barranquilla, only one used car, one motorcycle, one walked, and three used taxi in 2010, representing less than four percent of all who shifted to BRT in our sample. No motorcycle users were intercepted in Cape Town, neither in our survey nor in the official 2014 Cape Town Household Travel Survey.

transfer in Cape Town increased from 18 percent in 2010 to 27 percent in 2015, representing a notable yet smaller increase than in Barranquilla.

Looking more closely at our data, we found that among those non-movers who used BRT in 2015 in Cape Town, 40 percent had to transfer, whereas, in 2010, only 23 percent of this subgroup did. Similarly, we found that among the same subset in Barranquilla, 64 percent had to transfer in 2015, whereas in 2010, only 16 percent did. The increase in transfers for the non-movers surveyed in both cities may be attributed to BRT since no other major change in the transit system was implemented within this time frame.

Despite evidence that BRT induced a notable increase in the proportion of transfers in both cities, whether such a surge was associated with longer commute times is another question. Our survey data from Cape Town suggests that, on average, non-mover BRT users reduced their overall commute time, regardless of whether they had to transfer (Table 4). In contrast, our survey data from Barranquilla suggests that only BRT users who do not transfer experienced commute time savings. This apparent contradiction raises two fundamental questions we answer in the following sections: (1) What are the potential causes of these divergences? (2) Do these diverging patterns also emerge when comparing commute time changes of different population groups?

Group	Freq.	Mean commute time		Mean change in commute time
		2010	2015	
Cape Town				
BRT users who transfer	119	62.9	58.0	-4.9*
BRT users who do not transfer	159	56.9	50.7	-6.2**
Barranquilla				
BRT users who transfer	89	49.6	50.4	0.8
BRT users who do not transfer	49	40.3	33.3	-7.0**

Table 2-4 Commute time change (in minutes) for BRT users who transfer and do not transfer (non-movers)
*$p \leq 0.10$, **$p \leq 0.05$, ***$p \leq 0.01$

How did changes in commute time differ between socio-economic population groups?

Since those who live in peripheral areas served by feeder services are most likely to transfer, one plausible outcome is that disadvantaged groups, who often locate in these areas, did not experience the same commute time savings as their non-disadvantaged counterparts. However, it is still possible that disadvantaged population groups experienced similar, if not more, commute time savings. First, not all economically disadvantaged BRT users reported a significant increase in the number of transfers, and some non-disadvantaged groups also experienced a rise in the number of transfers. Second, even if transfers increased more for disadvantaged groups, those whose significant amount of their commute rely on BRT trunk services may still experience large commute time reductions.[2]

As with the results of our comparative analysis on transfers, and in line with the mounting body of literature that examines BRT on equity grounds, our results measuring changes in commute times by socio-economic status are mixed (Table 5). Our results from Cape Town indicate that the gap in commute time between different socio-economic status groups narrowed after BRT was deployed; in Barranquilla, however, we found no evidence suggesting that average commute times changed at any socio-economic group level (Table 5). While non-mover Black residents who shifted to BRT in Cape Town saved seven minutes on average, we found no evidence that non-mover White residents who reported using BRT in the city reduced their commute time.[3]

Group	**Subgroup**	**Freq.**	**Mean commute time**		**Mean change in commute time**
			2010	**2015**	
Cape Town					
All respondents	Black African	607	49.9	45.1	-4.8***
	Mixed Race	293	44.7	48.5	3.9**
	White	68	34.5	41.8	7.4**
Non-movers, BRT-users	Black African	188	61.0	53.7	-7.4***
	Mixed Race	94	59.1	56.2	-2.9
	White	16	39.1	43.8	4.7
Barranquilla					
All respondents	Low (1-2)	609	36.0	40.3	4.4***
	Medium (3-4)	379	31.8	33.3	1.5
	High (5-6)	68	22.2	23.3	1.0
Non-movers, BRT users	Low (1-2)	93	50.7	48.5	-2.1
	Medium (3-4)	44	37.6	35.9	-1.7
	High (5-6)	1	25.0	25.0	0.0

Table 2-5 Commute time change by socio-economic status
*$p \leq 0.10$, **$p \leq 0.05$, ***$p \leq 0.01$

It is important to note that the small number of non-economically disadvantaged residents intercepted in each city does not compromise our conclusions. The 16 White non-mover BRT users in Cape Town represent 5 percent of all non-mover BRT users in our sample. If we assume the 0.3 percent of BRT commute trips in Cape Town are conducted by White residents, our 5 percent figure suggests our sample does not underrepresent White residents who used BRT vis-à-vis other users by race. Had we intercepted a significantly greater number of high-strata residents in Barranquilla, who, as a group, reported significantly large commute time changes, it would likewise not compromise our conclusions since we found no evidence that the large share of low-strata BRT users

[2] While our survey did not ask for the details of their commutes besides travel times and transfers, this information is still useful in providing an overall understanding of what socioeconomic status groups benefit the most from BRT deployment

[3] The difference in change in commute time between White and non-White residents was statistically significant (p-value=0.098).

reduced their commute time as a group. This would have still indicated that BRT did not contribute to closing the commute time gap in the city.

2.4 Conclusions and policy implications

How did commute time changes differ between socio-demographic status groups in Cape Town, South Africa, and Barranquilla, Colombia? Our survey data indicates that while BRT deployment did not narrow the gap in commute times between low and high socio-economic strata groups in Barranquilla, BRT did narrow the gap in commute times between different races in Cape Town. In other words, Cape Town's BRT fares well under the rubric of 'transport equity'; Barranquilla not so much. We argue that this apparent contradiction may be in part explained by the degree to which BRT design responded to urban form and pre-BRT transit conditions, two factors which are often overlooked in academic literature and policy discussions surrounding BRT and transport equity as Venter et al. (2017) also pointed out.

A critical lesson from this research is that BRT route configuration may dictate the degree to which BRT can benefit economically disadvantaged populations in cities with as much traffic congestion as Barranquilla and Cape Town. Although both cities exhibit similar urban segregation patterns, two evident characteristics in which these two metropolitan areas diverge is that they have drastically different urban extent and trunk-feeder routes' length ratios. Cape Town's urbanized area is about ten times as large as Barranquilla's and had longer arterial roads than Barranquilla before BRT started being considered. Accordingly, Cape Town's BRT exhibits considerably longer trunk corridors, with relatively shorter feeder services than Barranquilla's.

Therefore, it is entirely plausible that the commute time advantage provided by BRT trunk services in Barranquilla was not sufficient to compensate for the additional transfer times induced by BRT. Commute time savings in Cape Town seem to be enabled by a better-balanced feeder-trunk system and long direct (or express) routes that serve some outlying townships, where most Black residents reside. These findings also indicate that the popular feeder-trunk-distributor BRT model may not necessarily be the most appropriate alternative for mid-sized cities. Induced transfers are likely to have important impacts that differ across subgroups that require further attention from planners. For instance, women dislike transfers more than men, especially due to safety concerns (Fan et al., 2016).

Had we relied on a single case, this conclusion, which is consistent with conjectures posed by other scholars such as Gómez-Lobo (2020) and Salazar-Ferro and Behrens (2015), would not have been as compelling. Thus, our comparative research design and resulting evidence open a path for more studies that explores the apparent relationship between the distribution of commute time savings, BRT network design, and urban form. Based on this evidence, we recommend that future examinations of BRT and transport equity consider how user commute patterns, including distances traveled between home and workplace locations, influence the degree to which BRT can deliver more equitable travel time savings.

A second important lesson from this study is that when planning to restructure transit systems through BRT, planners must account for how efficient the pre-existing transport system is, paying particular attention to attributes such as travel time and convenience. In Cape Town, the decrease in commute times between 2010 and 2015 was driven by a remarkable drop in commute times from those who shifted from slow public transport buses and trains to BRT. In contrast, in Barranquilla, we found that those who switched to BRT from private transit buses, which account for the most BRT users, did not reduce their commute times. In other words, Cape Town's pre-existing transit conditions allowed BRT much room for improvement; however, in Barranquilla, the popular feeder-trunk BRT design seemed to have fewer chances to succeed.

Policymakers and planners who hope that BRT will reduce commute time gaps in global South cities must carefully consider the potential combined effects of BRT network design and urban form. Our research suggests that the BRT trunk-to-feeder length ratio plays a crucial role in determining the extent to which commute time benefits are distributed in space and points out the importance of considering other design alternatives. Striking an ideal trunk-to-feeder length balance seems to be of particular significance in cities where most economically disadvantaged populations reside in peripheral neighborhoods.

We recognize that many cities in the global South exhibit intricate street patterns in peripheral low-income areas of informal origins, making deploying BRT trunk corridors challenging. In the contexts of these cities, we recommend testing more feasible and less capital-intensive alternatives to overcome the physical limitations of extending BRT corridors to peripheral communities. One option is to implement bus-only lanes for feeder services to improve bus speeds and service reliability. Another complementary intervention is testing a few direct-service routes, as Cape Town did more extensively than Barranquilla. Able to serve both peripheral neighborhoods and trunk-corridor stations, direct-route services eliminate feeder-trunk transfers for those commuting from peripheral to more central locations.

Designing transit systems that are more sensitive to urban form, understood as the physical manifestation of land use planning (or lack of thereof), may result in better travel outcomes for economically disadvantaged populations and prevent residents from shifting from transit to private vehicles and increase overall transit ridership levels, as Gómez-Lobo (2020) suggests. Better public transit design choices may, in turn, increase the likelihood of cities becoming more equitable and environmentally sustainable.

Chapter 3 Transferring modes

Since Bogotá opened the first phase of its celebrated BRT TransMilenio in 2000, several dozens of cities in the global South have invested in BRT, many following the classic feeder-trunk route system design that proved successful in the Colombian capital. In the previous chapter, my colleague Lisa Rayle and I investigated the extent to which BRT can enable commute time reductions for disadvantaged population groups by comparing Barranquilla's and Cape Town's BRT systems. We based our research design on a retrospective intercept survey for a few reasons. First, it is rare that cities in the global South have available pre-BRT and post-BRT travel data that allows researchers to examine the effects of such investments on commute times. Second, we opted for a retrospective survey since in both cases BRT was already in place. Finally, we had no access to pre-BRT transit supply and land use data to estimate changes in access to key destinations.

Findings from the previous chapter suggest that while BRT deployment did not narrow the gap in commute times between low and high socio-economic strata groups in Barranquilla, BRT did narrow the gap in commute times between different races in Cape Town. The most critical lesson from that chapter is that BRT route configuration influences the degree to which BRT can benefit economically disadvantaged populations. Although the cities exhibit similar urban segregation patterns, two characteristics in which they diverge are that they have drastically different urban extent and trunk-feeder routes' length ratios. Cape Town's urbanized area is about ten times as large as Barranquilla's and had longer arterial roads than Barranquilla before BRT started being considered. Accordingly, Cape Town's BRT exhibits considerably longer trunk corridors, with relatively shorter feeder services than Barranquilla's.

As a point in case, feeder services extending BRT's geographical reach to less dense and sprawling peripheral neighborhoods can work relatively well in urban areas such as Cape Town, where topographical conditions and road infrastructure are conducive. However, the geographical conditions of urban peripheries in the global South, such as the neighborhoods surrounding Bogotá, are not suitable for buses to transport passengers efficiently and safely. These areas are often located on mountainous terrains, characterized by windy, narrow, and dangerously steep roads. These conditions constrain the circulation of buses and represent an additional burden to the urban poor, who are the vast majority of residents.

I continue my investigation of investments in innovative public transport in the global South and their contribution to 'transport equity' in urban areas by turning my attention from BRTs to urban gondolas. This cable-propelled technology, adapted from ski resorts in Europe and North America to urban environments in the global South, which has the advantage of bypassing traffic congestion and thus reducing travel times, has become a popular solution for overcoming the rough topography of many urban peripheries. I use Bogotá's first urban gondola, TransMiCable, the newest addition to

Bogotá's mass transit system, as a case of study to understand how the project enables changes in the geography of access to jobs for economically disadvantaged populations.

In the chapter that follows, I move from relying primarily on self-reported information collected through surveys and classical inferential statistical methods to using openly available and standardized data and analytical methods that fall at the intersection of urban data analytics (Chapple, 2020; Kaza, 2020) and geographical information science (Duckham et al., 2003). The methods use openly available data in the General Transit Feed Specification, imputation techniques to infer formal and informal job locations from travel behavior surveys, and novel data-wrangling algorithms to quickly generate regional accessibility indexes.

Chapter 4 Dilemmas of assessing equity in access to job: Lessons from Bogotá's urban gondola

Contemporary policy discourses in many cities in the global South have positioned new public transport projects as pro-poor investments. The rise in these investments coincides with a growing body of scholarship which critically examines how public transport investments reshape the geography of access to urban opportunities. Despite increased interest from urban planners, public officials, and funding institutions, little scholarship has examined the effects of urban gondolas on regional job accessibility and through the lenses of transport equity. In this chapter, I use Bogotá's urban gondola, TransMiCable, as a case study to address these voids in the literature.

Frequently interconnected with urban mass transit and built in geographically marginalized low-income areas, urban gondolas can make it easier for the poor to access regional job markets. The most significant advantage of these public transport innovations, like under- or above-ground urban rail systems, is that they can bypass traffic congestion, thus enabling significant reductions in travel times. Large reductions in travel times, in turn, enable potentially substantial increases in accessibility, defined as the potential to reach urban opportunities. This is consistent with the growing recognition of accessibility as the primary goal driving investments in public transport, and the growing interest in cable-propelled transit. More than two dozen urban gondolas have opened to serve economically disadvantaged and historically marginalized communities during the past two decades, including Caracas, Medellin, Cali, La Paz, and Rio de Janeiro. The most recent urban gondola opened in Colombia's capital, Bogotá, in December 2018, and more than six more are being added to the city's master plan.

Despite the growing popularity of urban gondolas, such investments have sometimes been promoted in ways that create confusion as to whom these projects are meant to serve: the poorest residents or the greatest number of people. In the case of Bogotá's TransMiCable, some planning documents characterize all residents of the district of Ciudad Bolívar, which has nearly 670,000 low-income inhabitants, as beneficiaries from the project (Alcaldía Mayor de Bogotá, 2017; TransMilenio, 2018). Other documents refer to potential users of the gondola, who are often described as marginalized residents who live near the project. According to the city's BRT agency, "TransMiCable is the system that improves the mobility in Ciudad Bolívar, and is the mobility option for about 80.000 inhabitants that live in the project surroundings." In a video highlighting the impacts of the project posted on YouTube in March 2020, the International Finance Corporation (2020) posits that "[TransMiCable] is a game-changer for nearly 20,000 residents who now rely on the system every day." These inconsistent views of who benefits from TransMiCable calls for an impact accessibility assessment that help transport planners gain a more holistic understanding of the geographical reach and magnitude of the impacts of the project.

Even though policy discourse often promotes urban gondolas as pro-poor investments, some have deemed these projects as not a fair use of scarce public resources because they cost a lot and benefit a few. For example, Brand and Davila (2011) question whether Medellin's first gondola was a good investment given its modest impact. Based on official survey data, the authors argue that journeys on Medellin's MetroCable represent only ten percent of all long-distance journeys in the project's direct area of influence. This view is consistent with some planners' opinions, who argued that investing in a project that moves only 20 thousand passengers daily like TransMiCable is not the fairest use of public resources, because buses can move a significantly larger number of low-income passengers at a lower cost. These criticisms are essential when contextualizing the measurable outcomes of these projects, since they inform assessments which gauge how equitable these types of investments are.

Moreover, when citing the quantifiable benefits of these transport investments, funding institutions and local planning agencies have frequently referred only to the advantages they provide to residents living in the most peripheral neighborhoods surrounding TransMiCable's El-Mirador Paraiso station. One year before the project started functioning, the city's administration indicated in a presentation that "travel times between Portal Tunal [the BRT-Gondola transfer terminal] and Mirador-Paraiso station will be reduced from one hour to 13 minutes (Alcaldía Mayor de Bogotá, 2017, p. 4). These same figures were also presented by funding agencies who stated that "[TransMiCable] helps about 20,000 passengers a day to cut their travel time from 1 hour to 13 minutes" (International Finance Corporation, 2020), and then become a popular discourse in planning and scholarly circles.

The confusion surrounding who benefits from TransMiCable, coupled with scant empirical evidence on accessibility benefits, may prevent planners from critically discussing the virtues of cable-propelled technologies. Furthermore, lack of consensus about how to judge the project may also bias transport data analysts when assessing who and to which extent these projects help reduce transport-related inequalities Accessibility impact evaluations have to the potential to help contextualize investments as part of a complex urban system, which may provide a more nuanced understanding of who benefits from investing in public transport and by how much.

Using Bogotá's TransMiCable investment as a case study, this chapter contributes to transport equity scholarship and policy discussions by examining how the project changed the geography of access to jobs within the project station areas, the district of Ciudad Bolívar, and beyond its official boundaries. This research contributes to the debate over who benefits from these transport investments and how to quantify their contribution to interpret outcomes from accessibility impact assessments by answering the following fundamental questions:

1. What was the level of accessibility for residents living near the TransMiCable station areas prior to TransMiCable? What are their socioeconomic characteristics?
1. How many people across socioeconomic groups benefit from increases in job accessibility due to TransMiCable?
2. How did changes in network connectivity affect employment accessibility near and far from station areas?

To answer these questions, I combined data on transport supply and travel behavior, a quasi-counterfactual research design, and urban data analytic tools to produce multiple spatial, descriptive, and comparative analyses. I show that while Bogotá's urban gondola enabled a notable increase in job accessibility for one of the most disadvantaged population groups in the city, who live near the project, the positive accessibility effect of the gondola go well beyond its station areas, spilling over to low- and middle-class neighborhoods in other parts of the Bogotá urban region. With this latter finding, I challenge utilitarian arguments against investment in small projects located in the urban fringe and invite a more nuanced interpretation of Rawls' Maximin principle in the context of understanding accessibility benefits from transport investments. I close by quantifying the extent to which TransMiCable helped reduce job accessibility gaps in the city and reflect on how methodological choices can influence the way findings are interpreted and linked to different principles of fairness.

4.1 Literature review

Critiques of urban gondolas can be tied to at least two economic principles. The first relates to the utilitarian school of thought, which suggests that public investments in urban areas should provide the greatest amount of benefits for the greatest number of residents (Fainstein, 2010, p. 39). Another related principle that may fuel anti-gondola sentiments is rooted in classic a transport finance discussion, focusing on project efficiency and effectiveness, in which the former is defined as the ratio of outputs (e.g., number of vehicle-kilometers) to inputs (e.g., capital costs) and the latter as the ratio of consumption (passengers), to outputs, (e.g., vehicle hours of service). These principles have persisted as building blocks guiding transport planning and policy evaluation because of their presumed simplicity, overlooking questions about social justice or fairness (Martens, 2016; Pereira et al., 2017).

Although traditional thinking on what is considered fair has influenced more than five decades of transport planning and policy evaluation, other scholars have long advocated for a moral principle that addresses pervasive inequalities in urban areas. Beginning with the publication of Hansen (1959) and Wachs & Kumagai's (1973) original work on accessibility, a large and growing number of scholars have advocated for planning processes that seek to identify vulnerable populations with low access to opportunities and policies which aim to improve access to economic-generating opportunities for economically disadvantaged groups.

Notably, during the past two decades, access to opportunities has been widely argued to be the most crucial benefit from transport systems and proposed as the primary goal of transport investments—see, for instance, Boisjoly and El-Geneidy, (2017); Geurs and van Wee (2004). Better access to jobs via public transport has been recently linked to better economic outcomes, for instance, higher employment rates in the formal job market in Sao Paulo (Boisjoly et al., 2017) and health-related outcomes, including subjective well-being in Johannesburg (Lionjanga & Venter, 2018).

Many studies interested in questions about distribution of benefits from transport have highlighted the gross inequalities in access to urban opportunities in cities in the global North and South. Examples of contemporary studies include, for example, Guzman et al. (2017), Peralta Quiroz and Mehndiratta (2015), and Grengs (2012). However, one commonality in the growing body of research is that scholars seldom discuss how their analyses are informed by or aligned with normative ideals about distributional justice (Martens, 2016; Martens et al., 2012; Pereira et al., 2017; Pereira & Karner, 2021), leaving the reader to interpret what philosophical principle guides their analyses and recommendations.

From a theoretical standpoint, according to Karner and Pereira (2021), equity is not so much about the unequal distribution of resources across space; it is instead about how policy decisions shape the distribution of benefits and burdens from state interventions. In the realm of transport, their positive or proactive conceptualization of the term "equity," which they refer to as "transport equity," departs from previous work on cross-sectional inequalities to focus on one fundamental question: Do investments in transport benefit the least advantaged members of society? Their proposition is grounded in John Rawls' maximin principle (1999, 2001) that seeks to maximize the welfare of the least advantaged members of society. Investing in public transport projects in marginal areas that benefit the poorest of the poor, may also contribute to closing gaps in access to opportunities between economically and non-economically disadvantaged groups in urban areas (Martens et al., 2012).

The few studies that examine the extent to which urban gondolas built in low-income peripheries often limit beneficiaries to those who live close to stations. Public transport projects' station areas are commonly demarcated by a buffer surrounding stations' centroids or pre-defined administrative areas of polygons that fall within such buffers. Such methodological approaches neglect potential spillovers occurring in complex land-use and transport systems that could be captured through city-wide accessibility impact assessments, preventing scholars from having a more nuanced understanding of who benefits from these investments.

For instance, Bocarejo et al. (2014) assess the impact of Medellin's aerial cable-car K-line on regional employment accessibility using travel data collected before and after the gondola opened to the public. Using 800-meter station area buffers, the authors conclude that employment accessibility for low-income residents living near the project almost doubled compared to the impact on employment accessibility for residents in control areas scattered through the city's periphery with similar characteristics but without intervention. Other scholars following a similar spatially constrained approach have examined the effects of urban gondolas on travel time reductions (Garsous et al., 2019; Heinrichs & Bernet, 2014); reductions in violence and crime (Bea, 2016; Cerdá et al., 2012); and self-reported quality of life (Fernandez Milan & Creutzig, 2017). Although these studies focus on the benefits of historically for underserved populations, their methods and sources may paint an incomplete picture of who else may benefit from public transport investments, since no 'network effects' are considered.

The previous peer-reviewed publications on urban gondolas are part of a growing body of literature that has investigated the equity impacts of recently built public transport projects. Some of these studies focus on cross-sectional accessibility analyses and suggest that low levels of access to urban opportunities are partly attributed to the limited physical coverage of investments. These studies also focus on 'what is physically close' and, therefore, on the more evident accessibility benefits, including the work of Delmelle and Casas (2012) and Scholl et al. (2016), who assessed the employment accessibility in the context of the deployment of Cali's and Lima's Bus Rapid Transit systems. Although discussions about distributional issues with coverage are not unimportant, these cross-sectional studies fail to address three central questions:

1. How did access to jobs change for residents who were impacted by these new investments?
2. What contributing factors (particularly infrastructure placement, network connectivity, and the spatial distribution of employment) enabled these changes?
3. To what extent did these investments help reduce inequalities in access to opportunities?

By studying multiple cross-sections of travel survey data, some scholars address change using geographic information techniques. For example, Oviedo et al. (2019) estimated the marginal effects of Lima's BRT corridor, which cuts across the city, on regional employment accessibility. The authors selected treatment and control areas using a concentric-rings approach and found that the increase in access to jobs enabled by the BRT was skewed towards higher socioeconomic status (SES) population groups, who reported smaller increases in commute times than their low SES counterparts. Like previous studies briefly described above, Oviedo et al. (2019) highlight the importance of infrastructure placement to advance towards more just cities.

Another group of scholars has utilized standardized data from public transport networks and efficient algorithms for spatial analysis of transport and land-use systems to examine how investments in public transport reshape socio-spatial inequalities in urban areas. For example, Pereira et al. (2019) used a quasi-counterfactual analysis to examine how the bundle of investments in public transport that occurred in the context of Rio's 2016 Olympic Games affected regional employment accessibility for different income groups. Investments included the construction of two BRT corridors and a light-rail line, and the extension of a subway line that together stretch approximately 108 kilometers across the city.

Findings presented by Pereira et al. (2019) indicate that the investments generated larger regional accessibility gains for higher-income groups. They noted that such results are in part explained by the proximity of new subway stations in higher-income areas, echoing previous arguments about infrastructure placement made by Delmelle and Casas (2012) and Scholl et al. (2016). Furthermore, Pereira et al. (2019) also observed that "a few clusters of both high- and low-income people have gained access due to one of the new BRT corridors and its connection to the subway line" (pg. 758).

A similar finding was highlighted by Fan et al. (2012), who assessed the distributional impacts on regional job accessibility of a new light-rail line that opened in the Twin Cities in Minnesota. The authors stated that "major low-wage employment accessibility gains occurred along the LRT corridor, as well as along bus routes offering LRT connections—broadening accessibility gains well beyond the LRT corridor" (Fan et al., 2012, p. 32). The authors attribute these 'spillovers' to the new infrastructure's connectivity with the bus network.

Although they offer important insights, these studies also leave several gaps. First, most transport equity academic studies are bounded by data availability and methodological choices. Second, discussions on how normative principles of distributive justice drive their methods and conclusions are seldom addressed. Third, little attention has been given to the ways in which spatial distribution of jobs may enable changes in accessibility in different areas connected by the public transport network. Finally, there is little empirical evidence which tests whether investments in public transport contribute to reducing unequal access to jobs. Using Bogotá's TransMiCable investment as a case study, this chapter addresses these gaps in the academic literature. In the section that follows I describe the TransMiCable project and its surroundings.

4.2 Study area: Bogotá's TransMiCable and its surroundings

After more than ten years of planning and more than two years of construction, TransMiCable opened to the public in December of 2018 in the district of Ciudad Bolívar (Figure 4-1). Located in the south-eastern periphery of Bogotá, Ciudad Bolívar is one of the largest and most diverse of the city's 19 districts. With an area of 13,000 hectares—of which only 3,400 are urban—this administrative area of Bogotá has 252 neighborhoods. Most of these neighborhoods emerged informally, in a process where newcomers invaded large haciendas located in the municipality of Bosa, now part of Bogotá. The occupation process of Ciudad Bolívar started in the 1950s, giving birth to the first informal settlements located at the bottom of the mountain that now bounds Bogotá's to the south-east (Alcaldía Mayor de Bogotá, n.d.). As more people arrived, Ciudad Bolívar's urban footprint extended towards the hills. By the end of the 1970s, Ciudad Bolívar had some 50,000 inhabitants; today, this district has 360 neighborhoods that house approximately 762,000 inhabitants – representing roughly nine percent of the population of Bogotá (Bogotá Cómo Vamos, n.d.).

Ciudad Bolívar houses a significant number of low-income residents. The city classifies residential neighborhoods by assigning a socioeconomic stratum based on physical housing characteristics. Ranging from one to six, one being the least affluent, this classification was created in the 1990s to assist in the creation of cross-class subsidies to assist households with the cost of public utilities (DANE, 2015). More than half of Stratum one dwellings in Bogotá are in Ciudad Bolívar. About 55 percent of Ciudad Bolívar's dwellings are classified as Stratum one, 40 as Stratum two, and 5 as Stratum three (Alcaldía Mayor de Bogotá, 2019). More than one-quarter of the population barely makes the monthly minimum wage, equivalent to approximately 260 U.S. Dollars, and half of the population makes less than twice that figure.

Figure 4-1 Arriving by TransMiCable to Manitas Station, in Ciudad Bolívar

TransMiCable comprises a single 3.4-kilometer line with three stations: El Mirador-Paraiso, Manitas, Juan Pablo II, and one terminal to transfer to the city's BRT called Portal Tunal (Figure 4-2). At Portal Tunal, TransMiCable passengers can transfer to more than a dozen trunk corridor services using the same smartcard, and with no additional charges (Sarmiento et al., 2020). The gondola has 163 eight-seater cabins that can carry up to 3,600 passengers per hour per direction, bypassing congestion at a constant 10-second headway at a speed of approximately 15 kilometers per hour. This investment was conceived as an 'extension' of Bogotá's BRT system, which reaches many employment hubs in other important districts in the city and the municipality of Soacha as shown in Figure 4-3.

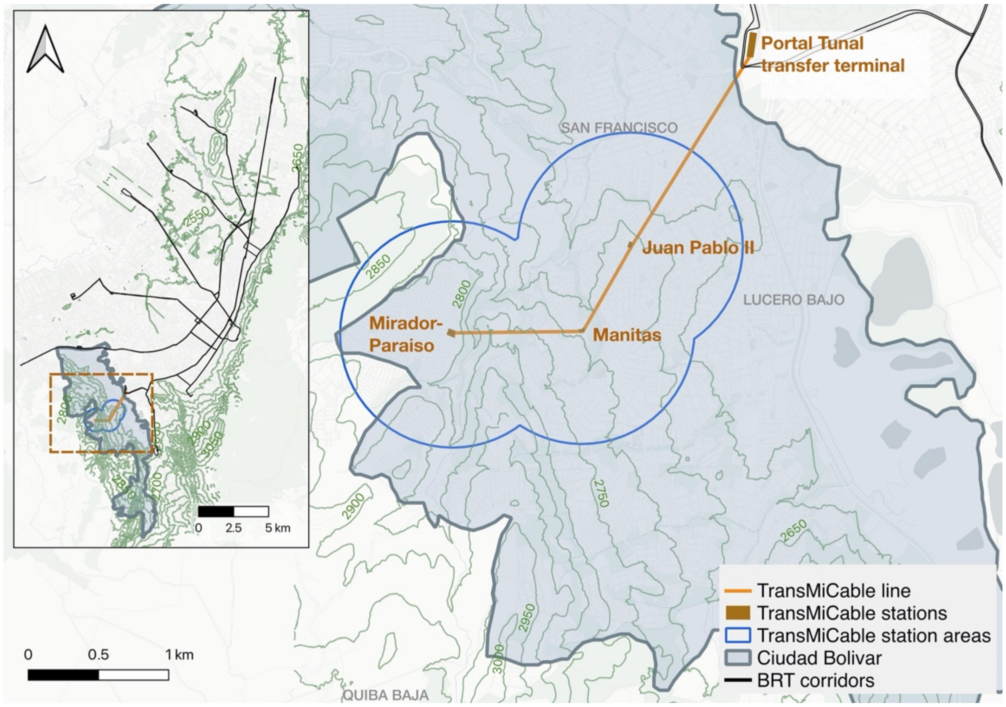

Figure 4-2 Project location and details
Source: Own elaboration with data available at https://datosabiertos.Bogotá.gov.co/

The seamless integration of TransMiCable with Bogotá's BRT allows a large percentage of economically disadvantaged residents to access multiple employment hubs in the city. This integration with Bogotá's extensive bus network, paired with TransMiCable's anticipated commute time savings, has been expected to significantly increase job accessibility for the economically and geographically disadvantaged population it serves. Likewise, since the district is also home to more than 51,000 jobs, it has also expected that residents from other areas of the Bogotá-Soacha region would benefit from this transport investment (Figure 4-3).

4.3 Methods and data

Public transport and walking network data

To represent the integrated transport network for the analysis, I first obtained geolocated information on TransMiCable routes, stops, and timetables for September 2018 from TransMiCable S.A. in the standardized and General Transit Feed Specification (GTFS) open data format; this information is also available at the OpenMobilityData website. Bogotá's GTFS includes the city's Integrated Public Transport System (SITP), comprising six bus rapid transit (BRT) lines, including the corridor reaching the municipality of Soacha, 55 feeder routes, 120 complimentary bus services, and approximately 12,000 stops.

Next, I used Conveyal's web-based Analysis Tool to combine the TransMiCable data with Bogotá's official bus transit network data using the daily operations available on the TransMiCable's official website. I then obtained data for the walking network, which connects the bus network with origin and destination points in the city from OpenStreetMaps. Finally, using Conveyal's Analysis Speed Editor and real-time speeds provided by Bogotá's public transport agency, TransMilenio S.A., calibrated route speeds to better represent reality.

Jobs data

One of the biggest challenges when assessing job accessibility for economically disadvantaged groups is that little data on the spatial distribution of informal jobs is available. This is a major limitation in the case of Bogotá, where nearly half of workers are part of the informal economy (DANE, 2021). To overcome this limitation, I imputed the spatial distribution of employment from the 2019 Household Travel Survey (HTS), available on the city's Open Data website. The 2019 HTS used a probabilistic sampling approach to randomly select households distributed across Bogotá's metropolitan region, reporting rich information on worker's travel behavior, including their SES, geolocated origins and destinations of their commutes, trip purposes, and start and end times for each trip. Workers reported this information regardless of the formal status of their job. The survey also reports survey weights, which I employed to estimate the number of jobs in each of the nearly 800 transport analysis zones in which the data is reported.

Using the HTS travel data, I imputed the number of jobs for each cell in the grid as follows. First, I categorized survey respondents into three groups: low-socioeconomic status (Strata 1 and 2), middle-SES (3 and 4), and high-SES (5 and 6). Then, for each commuter in the survey, I use this SES classification, the transport analysis zone where their commute ends, and their respective survey weights to proxy the quality and quantity of jobs in each zone. To counter the effects of the modifiable areal unit problem, I resampled the jobs dataset into a 300-by-300-meter standardized grid using Conveyal's areal interpolation online processing tool. This method allocates the number of jobs in each TAZ proportionately to grid cells based on the area of their intersection. For instance, if a traffic analysis zone has five thousand low-SES jobs, those five thousand jobs are dispersed throughout the grid cells intersecting that zone, according to the areal proportion of the intersection of each cell with the zone. This process was replicated for each grid cell and SES group, generating three different datasets, with jobs allocated to the regular standardized grid representing Bogotá.

Although using the most recent travel survey to infer job locations may be a better alternative than using official records of formal jobs, the use of the former also has some limitations. For instance, the dataset I am using was collected a few months after the gondola opened to the public, representing a potential threat to internal validity. Nevertheless, changes in land uses, including conversion from residential to commercial or industrial uses, could take several months if not years. In that sense, the use of the 2019 travel survey may not significantly influence the results.

Population and socioeconomic status data

I obtained population data from the 2018 Colombian Census. This open-to-the-public dataset contains population counts and socioeconomic statuses, aggregated by "*sector urbano*," roughly equivalent to census tracts. I filtered only data from the working-age population in census-designated polygons within the administrative boundaries of Bogotá and the municipality of Soacha, which I refer to as Bogotá from now on (unless stated otherwise). To make this dataset consistent with the spatial granularity employed for the analysis, I resampled population data to the same regular grid of 300-by-300 meters that I used to allocate jobs by SES. This imputation was performed using the Area Weighted Interpolation method that uses the area of overlapping geometries to apportion variables under the assumption that the population is evenly distributed within each source polygon.

To perform the distributional analysis of the impact of TransMiCable on access to jobs, I categorize residents in each 300-by-300-meters grid cell according to the predominant socioeconomic status (SES) designation. I grouped residents into three categories: low-socioeconomic status groups (1 and 2), middle-SES (3 and 4), and high-SES (5 and 6), a classification I employ to match jobs with residents.

Computing employment accessibility and matching residents with jobs

I estimated employment accessibility using a cumulative opportunities measure. In the context of this research, cumulative opportunities accessibility estimates determine how many jobs can be reached via the public transport network and within a predetermined travel time threshold (Equation 4-1).

$$A_{o,i,T} = median\left(\sum_{o=1}^{n} P_d \; f_{(t_{odr})}\right) \qquad \textbf{Equation 4-1}$$

$$f_{(t_{odr})} = \begin{cases} 1 \;\; if \;\; t_{odr} & \leq 1 \\ 0 \;\; if \;\; t_{odr} & > 1 \end{cases}$$

Where:

- $A_{o,i,T}$ is the accessibility level at origin o for population of income i within commute threshold T
- P_d is the number of opportunities (e.g., jobs) in location d
- t_{odr} is the commute time in minutes between origin o and destination d at departure time r
- $f_{(t_{odr})}$ is a binary function of commute time threshold and takes values of 1 or 0, depending on whether commute time t_{odr} is larger or smaller than commute threshold T

Employment accessibility was estimated based on a proxy match between the socioeconomic status group of residents and the associated status of the job imputed from the most recent travel survey. For working-age residents (between 16 and 65 years old) classified as low SES (Strata 1 and 2), accessibility estimates consider jobs associated with SES 1, 2, and 3 in the travel survey; for residents classified as middle class (Strata 3 and 4), accessibility estimates only considered jobs associated with SES 3, 4, and 5; and for residents belonging to the privileged group (Strata 5 and 6), accessibility estimates only considered jobs associated with SES 5, and 6. According to this matching criteria, each group is assumed to have access to jobs of the same or one higher socioeconomic status group level. This matching criteria recognizes aspirations for upward social mobility.

Rationales for a cumulative opportunities approach

I opted for a cumulative opportunities (or isochrones) approach to estimate employment accessibility levels because it is a more democratic construct as it may foster more public participation (Stewart, 2017; Stewart & Zegras, 2016). For instance, cumulative opportunities measures are easier to describe and understand by transport and non-transport scholars (Handy & Niemeier, 1997).

Other alternatives such as gravity-based or utility-based measures, which account for observed travel patterns and their determinants, require significantly larger amounts of data, are less transparent and more difficult to communicate to planners, policymakers, and communities that may benefit from investments in public transport. As Conway et al. (2018, p. 543) simply put it:

> "*It is far easier to grasp the idea of n opportunities being within a certain travel time, rather than a weighted average metric of many opportunities which do not count equally.*"

Selecting time thresholds and windows

Using different normative time thresholds may lead to different outcomes and therefore conclusions, as Pereira et al. (2019) argue. I opted for a 60-minute commute time threshold as the maximum reasonable time a person should travel for work within an urban area as large as Bogotá, regardless of her socioeconomic status or transport mode used. Normative travel time thresholds of this magnitude have been employed by other scholars (Páez et al., 2012) and planning agencies (Boisjoly & El-Geneidy, 2017), following similar normative rationales.

Furthermore, empirical data on travel times in Bogotá also support this normative choice. I analyzed data from the most recent household travel survey and found that the median commute time in the Bogotá-Soacha region is approximately 59 minutes. This figure is consistent with crowdsourced data collected by the mobile application MOVIT, a trip planning tool widely used in Bogotá, in which the average public transport commute trip takes approximately 64 minutes.

I focus on the 5:30 to 9:30 am peak morning time, using the median employment accessibility value for each cell as a proxy for its accessibility level. I selected the 5:30-to-9:30 time window for four? reasons. First, this range is within the gondola service hours, from 5:00 am to 11:30 am. Other scholars have suggested that access measured during late nighttime hours offers different results than at other times of the day—see for instance Kaza (2015) however, examining times out of TransMiCable services hours is out of the scope of this paper. Second, according to the most recent household travel survey, almost one-third of residents living in Ciudad Bolívar, where TransMiCable was built, leave their homes between 5:30 and 9:30 am. Third, some scholars suggest that results from regional accessibility analyses during the peak morning time are strikingly similar to those using larger time windows, which extend to off-peak periods and other peaks of the day (Boisjoly & El-Geneidy, 2016). Fourth, my analysis of the most recent travel survey indicates that the majority of commuters in the Bogotá-Soacha region start their commutes within that time window. Therefore, focusing on this two-hour time window should provide a good representation of the overall level of, and heterogeneity in, employment accessibility in the area of study and beyond.

Estimating the distribution of job accessibility benefits enabled by TransMiCable

The analysis is divided into three parts. In the first part, I map and discuss the spatial distribution of job accessibility in Bogotá, using public transit supply and SES data to estimate accessibility gaps with no gondola by comparing access levels between different SES groups across the city. I also compute descriptive statistics that summarize the results by area and SES group of interest. For each grid cell in which I subdivided the Bogotá-Soacha region, each SES group, and their respective employment market, I estimated the number of jobs accessible by public transport within a 60-minute commute. To account for uncertainty and variation in public transport schedules, I estimate accessibility over many departure times within the 5:30 to 9:30 am peak morning time and report the median value. This is consistent with recent work by (Conway et al., 2018), who contributed to developing the computational tools I use in this chapter.

The second part consists of estimating the gains in employment accessibility enabled by TransMiCable. Marginal effects are obtained by comparing the scenario with and without the gondola, accounting for population distribution by socioeconomic status. I compare with and without project scenarios, also referred to as a quasi-counterfactual research design—see, for instance, Pereira et al., (2019). To isolate the effects of TransMiCable on employment accessibility, I intentionally ignored a few changes in transport supply, including an increase in the frequency of one feeder bus that directly competes with TransMiCable and the emergence of two short informal transport routes close to the project. For the same reasons, I did not update data on the spatial distribution of jobs and population. Any potential second-order effects induced by TransMiCable, including the ripple effects on land uses which likely take several years to materialize, are out of the scope of this chapter.

A third and final step consists of a data aggregation process that explains how investing in TransMiCable helped bridge the employment accessibility gap in the city. As in the baseline gap analysis, I weigh accessibility indices for each cell by population counts. Once weighted by population, I estimate the average change in employment accessibility for each SES group that benefited from the intervention.

4.4 Findings and discussion

Baseline data: How unequal is access to jobs in Bogotá?

The Bogotá-Soacha region exhibited a notably unequal spatial distribution of job accessibility before TransMiCable opened to the public when compared with the perfect equality ideal. For example, most high- and middle-SES groups, who live near the city center, can access a considerably higher proportion of the city's job market than their low-SES counterparts located on the margins (Figure 4-4 and Figure 4-5). This spatial pattern is explained by the peripheral location of many low-SES groups (Figure 4-4) and the concentration of employment in more central areas (Figure 4-3). This finding is also consistent with multiple publications focusing on studies looking at inequalities in access in other cities in the global South (Boisjoly et al., 2017; Guzman et al., 2017).

In fact, the 800-meter buffers that constitute TransMiCable's direct area of influence contain low-SES households predominantly. This area of influence exhibits very low levels of accessibility, particularly surrounding the most peripheral station area, compared to many low-SES locations, and even lower than non-low-SES groups, as Figures 4-4 and 4-5 and Table 1 show. For these reasons, one could argue that residents within the project's direct area of influence are among the most deprived of access to jobs compared to other low-SES population groups located in the region.

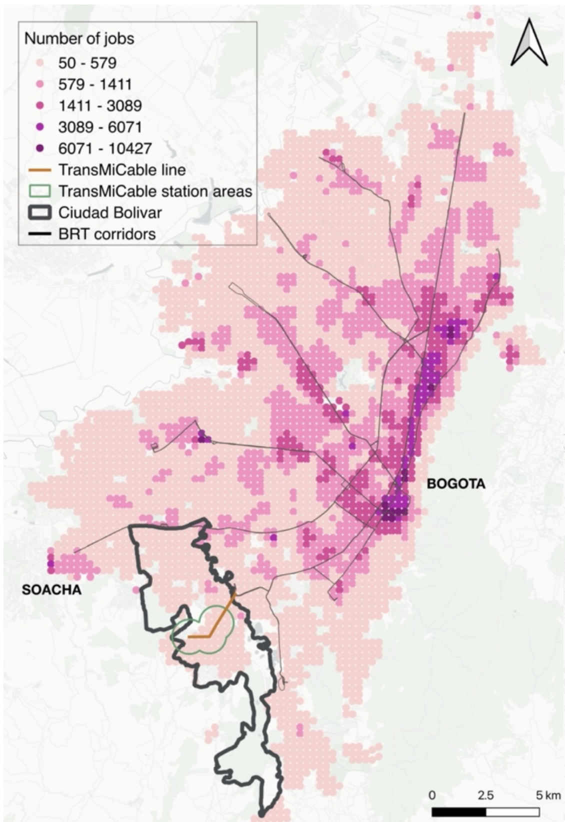

Figure 4-3 Spatial distribution of jobs and the mass transit network in Bogotá, including TransMiCable
Source: Own elaboration with data available at https://datosabiertos.Bogotá.gov.co/

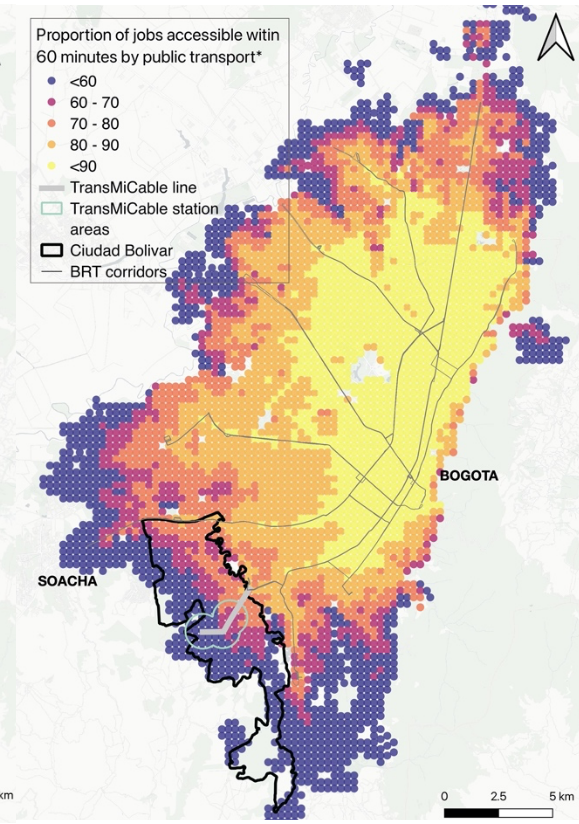

Figure 4-4 Proportion of Jobs Accessible with no project
Source: Own elaboration with data available at https://datosabiertos.Bogotá.gov.co/

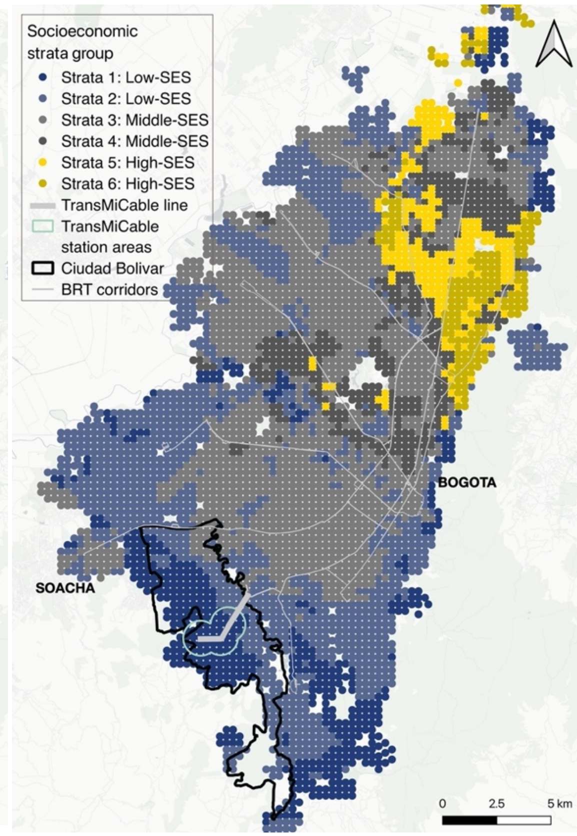

Figure 4-5 Spatial distribution of population by socioeconomic status
Source: Own elaboration with data available at the Departamento Nacional de Planeación (DANE) official website

Population group	**Mean accessibility level** as proportion of employment market size by SES
All three station areas	58.8%
Low-SES*	65.8%
Middle-SES	81.2%
High-SES	92.4%

Table 4-1 Mean access to job as a proportion of the employment market size by SES group: Baseline data.

Spatial distribution of change in job accessibility

Who benefits from the investment in TransMiCable? Figure 4-6 shows the geographical extent and magnitude of the effects of TransMiCable on job accessibility. One notable observation from this map is the positive effects far from Ciudad Bolívar. The regional spatial analysis depicted in Figure 4-6 captures increases in employment accessibility in low-SES areas located not only within the project station areas, but also outside of El Mirador- Paraiso station area and in south-western and south-eastern areas of the city, reaching the municipality of Soacha. In contrast to some critiques of investing in urban gondolas, approximately 1.9 and 1.7 million working-age residents from low- and middle-SES groups that live outside of TransMiCable's station areas seem to experience gains in job accessibility enabled by TransMiCable. Interestingly, this geographical interpretation is aligned with principles of efficiency of the use of public resources.

Station area effects, or "origin-based accessibility effects," are facilitated by the integration of TransMiCable with Bogotá's BRT network that reaches the most important employment hubs in the Bogotá-Soacha metropolitan area. Effects spilling over other areas far from TransMiCable, which I call "destination-based accessibility effects," are enabled by two factors. First, Ciudad Bolívar is also home to more than 51,000 low- and middle-income jobs. Second, jobs adjacent to TransMiCable are now more accessible to other parts of the city thanks to the reduced travel times enabled by the expansion of the public transport network and the gondola's seamless connectivity to the city's BRT.

A completely different question is how such benefits are distributed between different groups. For instance, and as expected, the project enabled significantly larger increases in access to jobs for neighborhoods close to the project. For those located within TransMiCable station areas, who are predominantly low-income, the project added on average approximately 94,000 additional jobs reachable by public transport within a 60-minute commute. This average is estimated over all grid cells whose centroid falls within the project stations areas. This figure represents an increase of 4.1 percent from their baseline mean accessibility level (approximately 891,000 jobs).

If the focus is, however, only those most accessibility deprived—that is the working-age population living by El Mirador-Paraiso station—their increase in accessibility of approximately 280.000 represents a 100 percent increase relative to the baseline job accessibility of this same grid cell. While both figures are consistent with Rawls' principle of generating the greatest benefit to the least-advantaged members of society, the latter figure paints a significantly more optimistic picture than when one focuses on the project's area of influence.

Nevertheless, if the objective is more aligned with utilitarian principles that seek to maximize the number of people benefiting from the project, focusing on the geographical reach to which benefits extend would make more sense, as it benefits approximately 375,000 working-age residents. Nonetheless, the magnitude of the accessibility benefits spilling over locations outside the project station areas is relatively small if one looks at each grid cell independently (Figure 4-6). As a matter of fact, the average gain is only 2,290 additional jobs, representing an increase of a mere 0.2 percent relative to the baseline.

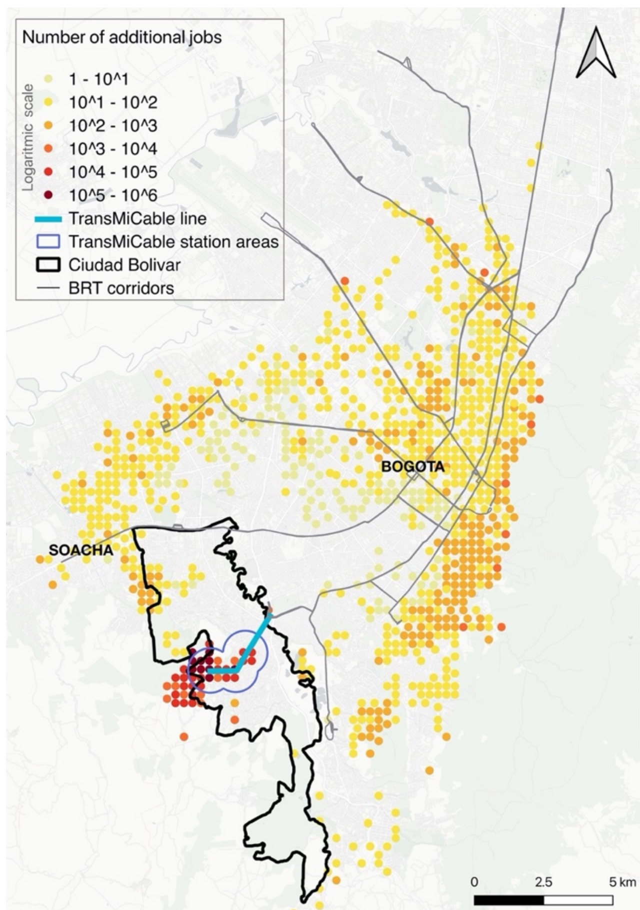

Figure 4-6 Change in number of jobs accessible enabled by TransMiCable
Source: Own elaboration with data available at https://datosabiertos.Bogotá.gov.co/

How did TransMiCable contribute to closing job accessibility gaps?

The spatial and regional job accessibility analyses convey essential information that can help discuss fairness in distributing accessibility benefits from transport investments. Nevertheless, in complex decision-making processes relying on transport policy assessments, maps showcasing changes in regional accessibility should be complemented with simplified abstractions that summarize outcomes or indexes in single aggregate metrics by neighborhoods or population groups (Martens et al., 2012; Pereira et al., 2019). Data aggregation by disadvantaged and non-disadvantaged groups is helpful for quantifying the extent to which TransMiCable contributed to narrowing accessibility gaps in the city between different groups.

Table 3 shows multiple job accessibility gaps that existed in the baseline and TransMiCable scenarios and quantification of the degree to which the project contributed to narrowing such gaps. Accessibility gaps for each scenario (baseline and with TransMiCable) are estimated as the change in the mean proportion of jobs accessible within 60 minutes by transit, measured in percentage points. The degree to which TransMiCable contributed to closing such gaps is calculated as the percent difference. If the policy objective is to reduce the gap between low-SES within TransMiCable direct area of influence and high-SES residents, the project reduced the gap in accessibility by approximately six percent. The number increases by 1.5 times when comparing low- with middle-SES residents, and by approximately five times when the goal is to compare or equivalent to a narrowing the gap in accessibility in approximately 28 percent, which is consistent with Rawls' principles of distributive justice.

Nevertheless, suppose the objective is to reduce the gap between the groups representing all low-SES residents, including those who presumably benefit from the far-way effects captured in the regional spatial accessibility analysis above. In that case, the results paint a cruder picture. This picture may be open to criticisms from those aligned with utilitarianism principles of fairness and efficiency in using public resources. Therefore, a critical lesson from this aggregative excerpt is that projects may seem more or less socially just depending on the groups compared and the level of aggregation employed to define who belongs to the disadvantaged population group in question.

Base	**Comparison Group**	**Baseline scenario gap** (in percentage points)	**TransMiCable scenario gap** (in percentage points)	**Percent change**
Station area	Low-SES	7.04	5.05	28.22%
	Middle-SES	22.39	20.40	8.89%
	High-SES	33.64	31.65	5.92%
Low-SES	Middle-SES	15.53	15.47	0.35%
	High-SES	26.78	26.72	0.21%

Table 4-2 Gap in the share of the job market accessible

4.5 Conclusions and policy implications

This paper positions the trend of investments in urban gondolas placed on marginalized urban areas within broader debates about transport equity. For instance, in this chapter I demonstrate that extending the reach of Bogotá's public transport network to a historically marginalized peripheral area with available jobs enabled gains in job accessibility close to the project and far away from its stations. Station area effects, or origin-based accessibility effects, are facilitated by the seamless connectivity of TransMiCable with Bogotá's BRT network that reaches the most important employment hubs in the Bogotá-Soacha metropolitan area.

Effects spilling over other areas far from TransMiCable, or destination-based accessibility effects, are enabled by two factors. First, TransMiCable is surrounded by a few hundred low- and middle-income jobs. Second, jobs adjacent to TransMiCable are now more accessible to other parts of the city thanks to the reduced travel times enabled by the expansion of the public transport network and the gondola's seamless connectivity to the city's BRT. These "destination-based accessibility effects" challenge common-held beliefs that investing in short and peripheral transit lines, in the case of this research, an urban gondola, only benefits those few living within the project station areas.

Interestingly, while accounting for these network effects, quantifying the number of residents who benefit from transport investments is more in line with guiding principles of efficiency in using public resources, consistent with utilitarian principles of benefiting as many as possible. However, if both the size of the impacts and the network effects are considered in spatial analyses, the interpretation of the results is more in line with Rawlsian principles of distributive justice. Following this methodological approach to understanding investment in public transport under the lenses of distributive justice, TransMiCable provided significantly larger benefits for low-SES residents with very low accessibility than their middle- and high-SES counterparts. In other words, TransMiCable provided the greatest benefit to the most disadvantaged.

Furthermore, data aggregations which summarize accessibility in a single metric may also provide results that align with different principles of fairness. For instance, aggregating the results by all station areas, and looking into the average number of jobs gained, gives the impression that the project benefits a large number of residents; however, this aggregation gives the impression that TransMiCable had little on the average number of jobs gained. Aggregating the results by the Mirador-Paraiso station area, the one at the end of the line, gives the impression the project only benefits a few, and yet their average gain in accessibility positions the project as very effective and progressive, at least in terms of the magnitude of the impact and the characteristics of the population it benefited the most. Recognizing methodological issues in data representation in the context of assessing the distributional impacts of investments in public transport on accessibility has policy implications. I envision this case study can help deepen the understanding of the nuances behind the operationalization of the Transport Equity concept in a discipline where what is considered fair is still debatable.

Chapter 5 Deepening the links between Bogotá's urban gondola and its surrounding informal and peripheral urban system

As I have pointed out in previous chapters, many cities in the global South have poured large shares of scarce resources into public transport infrastructures such as BRT and urban gondolas during the past two decades. In many cases, these investments reach the fast-growing urban peripheries where informal transport thrives. Informal transport routes frequently serve many low-income urban dwellers in many cities in the global South, covering neighborhoods not well served by public transport. However, the state is transforming some of these neighborhoods by deploying urban gondolas as part of large neighborhood upgrade programs.

The following chapter represents the last iteration of empirically-based research in this dissertation, in which I continue my investigation of transport innovations in the global South through the lenses of 'transport equity.' While cable-propelled transit, and in some cases Bus Rapid Transit, are important vehicles to enable historically marginalized low-income residents to improve mobility and accessibility conditions, and for cities to reduce transport-related inequalities in cities in the global South, these interventions only represent a fraction of the services available to the urban poor in many urban areas. Another essential mode often cited in transport studies corresponds to informal transport.

Often referred to as entrepreneurs in academic debates, these informal transport actors provide services via smaller, dated vehicles that sometimes offer the only transport alternative for the urban poor in some sprawling urban peripheries in the global South. Instead of focusing on TransMiCable as an object of study, as in the previous chapter, I use this physical infrastructure as an anchor to the site and as an entry point to the informal transport sector to understand how these services evolve. I pay particular attention to linkages among land development, investments in transport infrastructure, and the role of local actors, networks, and the state in enabling such evolution. The next chapter contributes to scholarship on transport studies and informal, peripheral, and marginal urbanization in the context of the global South.

During approximately three months of pre-dissertation work in 2017, I uncovered almost a dozen informal transport services that connect at least 30 low-income neighborhoods. Many of these services also cover the project's station areas that serve the poorest of the poor in the city (Figure 5-1). This spatial overlap and the timing of this dissertation allowed me to conduct fieldwork during the construction of TransMiCable and the months following its inauguration. These conditions opened a window of opportunity to study whether and how informal transport entrepreneurs adapt to the new transport infrastructure and the implications for such processes for concepts such as "transport justice."

Figure 5-1 Aboard of an informal transport route passing by one of TransMiCable stations in Ciudad Bolívar, Bogotá

Chapter 6 How did the informal transport sector adapt to Bogotá's urban gondola?

Taxi-like shared-transport services have operated with no state sanction for decades in cities in the global South. Often referred to as matatus, chanas, combis, piratas, or carritos, these informal transport modes frequently serve a large proportion of low-income urban dwellers in this part of the globe. One of the most influential as well as most contended studies on urban informality was conducted in 1989 by De Soto, who posited that the existence and proliferation of informal transport services have to do with the inability of the state to [a] cope with rapid urban expansion and [b] incapacity to provide appropriate public transport services to economically disadvantaged populations. The latter, in particular, has been widely recognized in transport policy discussions and scholarship, reinforcing the dominant assumption that informal transport emerges to fill gaps in the public transport network in a context of disinvestment in public transport and in the absence of state regulation.

Communities located on the peripheries of cities in the global South are especially affected by a lack of investment in high-quality public transport. The combination of rapid urbanization patterns, rising land costs, and limited affordable housing options often relegate low-income households to difficult-to-access peripheral zones far away from urban centers. Deficient provision of public transport services often results in long commute times, in part due to the distance between these communities and the urban centers where many jobs cluster, and in part to topographical challenges. Most scholarship suggests that the self-organized and self-regulated informal transport sector emerged in this context of rapidly populating peripheries and a lack of state-sponsored transport infrastructure to provide access to transport for the urban poor.

The complications posed by a lack of public transport and the proliferation of rapid land development are met with the ingenuity of urban entrepreneurs who organize and provide informal transport services in these fast-growing cities. Informal transport is frequently described as being a profit-driven business, run by rational actors that easily adapt to changes in travel demand (Cervero, 2000; Cervero & Golub, 2007; Kumar et al., 2016). Moreover, the informal transport market has been also positioned in scholarship as being remarkably flexible and adaptable to rapidly adjusting to changes in urban conditions such as the deployment of a new public public transport service or the emergence of new neighborhoods.

In this chapter, using the district of Ciudad Bolívar as a case study, I investigate how informal transport actors adapt to state-led transport interventions. Because of its rugged terrain and in part due to its informal origins, Ciudad Bolívar, one of the poorest and largest peripheral districts of Bogotá, has a complex road network made up of narrow, steep, and windy roads which impose a challenge for the public transport buses which serve many neighborhoods of this sprawling district. These geographical characteristics are also consistent with what Soto (1989) and Cervero (2000) consider a fertile ground for small entrepreneurs to enter and informally fill the gaps in the public transport network, usually without the state having complete knowledge about their operations and market size (Williams et al., 2015). Due to this predominant presence of informal transport,[4] Ciudad Bolívar offers a unique opportunity to test the dominant assumption that informal transport exists to fill gaps in the transport network.

Ciudad Bolívar also presents a timely [here give the second reason CB is a good case study], which can be seen as an exogenous shock to the informal transport system. To meet the mobility needs of the economically disadvantaged population of Ciudad Bolívar, the city deployed a 3.34-kilometer cable-propelled transit line in December 2018, locally known as TransMiCable (Figure 6-1). Capitalizing on Bogotá's deployment of TransMiCable in Ciudad Bolívar, I hypothesize that informal transport services would likely dwindle because the gondola now provides a new and potentially better way to access the periphery, and also due to more policing to deter competition at TransMiCable stations.

Figure 6-1 TransMiCable urban gondola arriving at Manitas station in Ciudad Bolívar, Bogotá

[4] Although a 2005 official report from the Secretaria de Movilidad reported there were three informal transit routes documented, and Carlos Brand reported in the local news outlet RCN in 2018 that only two routes had been identified in the district by transport planning authorities, the same news article cites the mayor of Ciudad Bolívar stating that in his district "there may be approximately 20 informal transport routes."

Despite a recent surge of investment in urban gondolas in cities in the global South and growing scholarly recognition of the social role informal transport has played in these areas (Dávila, 2013; Fernandez Milan & Creutzig, 2017), there is little empirical evidence documenting how informal transport adapts to urban gondolas, often deployed in fast-growing urban peripheries. Using Bogotá's first urban gondola as an example, this chapter examines and expands the dominant assumption that the informal transport economy exists to fill gaps in the public transport network. To that end, I ask the following fundamental questions:

1. How did informal transport providers adapt to TransMiCable and the changes that came with it?
2. Does informal transport fill gaps in the public transport network in the TransMiCable area?
3. How do informal transport actors respond to land development in Ciudad Bolívar?
4. What is the role of non-market forces—like social networks, local political leaders, and the state—in affecting the growth or decline of informal transport services?

I answer these questions using multiple data sources and a mixed-methods approach. I conducted and analyzed in-depth semi-structured interviews with key stakeholders including community leaders, informal transport drivers, and planners. I also collected spatial data on informal transport using smartphone sensors, and analyzed changes in land development using satellite images obtained from secondary sources. My analysis focuses on two themes: the link between land development and transport, and the actors and processes involved in responding to state-led transport interventions.

As detailed below, the empirical evidence I collected suggests, contrary to my expectations, that the vast majority of pre-existing informal transport services remained unchanged more than a year after TransMiCable opened to the public, while two new informal routes emerged. I explain the persistence and proliferation of informal transit services in Bogotá's periphery by contextualizing them within a broader discussion about urban informality while also examining the role of multiple actors, as well as their social connections and practices. This chapter concludes by reflecting on how this analytical framework and methods could be applied to other cases in which investments in public transport infrastructure clash with the informal transport sector, and makes an argument for an expanded conceptualization of transport justice.

6.1 Literature Review

Informal transport is often characterized by scholars as being remarkably flexible and adaptable to local conditions. The virtues of the flexibility of informal transport are sometimes described in relationship with how land development unfolds in the margins of many cities in the global South. For example, Gamble and Puga (2019) assert that informal routes in Quito, Equator are oriented towards the faster-growing and low-income edges of Quito. Likewise, Soto (1989) describes informal transport in an often-evolving spatial context that resembles the self-help housing building process described by many other scholars concerned with key actors involved in the urbanization and informality in the global South.

On the other hand, deprivation of public transport has also been contextualized in how the low-income urban periphery evolves. Abramo (2007) categorizes these urban peripheries according to two submarkets: one of land subdivisions and another of consolidated neighborhoods. On Abramo's account, the informal submarket of land subdivisions produces a spatial expansion of the urban periphery, where the poor can access affordable land, often outside the state regulatory system. As these marginal areas slowly develop, they become denser and more consolidated places. This submarket of consolidated neighborhoods typically involves a combination of self-help techniques of incremental housing improvements and regularization programs promoted by the state which provide land titles and essential public services and infrastructures like water supply, sewage, and electricity. The provision of public transport, however, is seldom part of such regularization processes, according to Gamble and Puga (2019).

Caldeira (2017) contributed to scholarship on urban informality by using the notion of "peripheral urbanization" to analyze the processes in which low-income residents engage to build their houses and neighborhoods. For the author, what makes the "peripheral urbanization" process peripheral is not its physical location, but rather the essential role of locals in the production of neighborhoods, who interact with the state and its institutions during an urbanization process that slowly unfolds.

The urbanization process that Caldeira describes (2017), which characterizes the production of marginal spaces in many cities in the global South, also highlights the temporalities in which neighborhoods evolve, expanding the market-drive description provided by Abramo (2007). For Caldeira, as peripheries develop, or in the words of Abramo "consolidate," they may become less affordable to the poorest residents, which in turn results in the reproduction of the peripheral urbanization process where still more peripheral land is cheaper, but usually still more difficult to access.

Land development, however, is not the only factor that may help explain how informal transport adapts to urban change. Scholars have also suggested that non-market forces, namely grassroots organizations and social networks and norms may enable or constrain informal transport actors from taking action. For instance, Gilbert and Ward

(1984) describe how the production of urban peripheries in some Latin American cities are mediated by community-based organizations. Community Action Boards (CABs) which were designed as a participatory planning mechanism in Colombia are actively involved in petitioning city agencies, district mayors, and politicians for public services and infrastructures. CABs also organize residents to informally upgrade neighborhoods during early stages of the peripheral urbanization process (Gilbert and Ward, 1984), and possibly to advocate for transport services before the state. Community-based organizations like CABs, therefore, are central actors in peripheral urbanization processes and can offer insight into the emergence and proliferation of informal transport in Ciudad Bolívar.

Another factor gaining some popularity among social scientists is how informal activities are socially embedded. The concept of embeddedness, initially proposed by (Polanyi & Károly, 1957) and later expanded by American sociologist (Granovetter, 1985), refers to the idea that economic activities are often bounded or constrained by non-economic actors. Granovetter was one scholar who pointed out that economic exchanges do not exist in an abstract, idealized market economy but are embedded in social networks. Similarly Simon (1978) argues that so-called “rational actors” are also bounded by social networks, politics, and informal arrangements. Since then, scholars from multiple disciplines have used the concept of embeddedness in understanding markets.

Sociologists also challenge the utilitarian neoclassical position and have long recognized that economic decisions and behavior of individuals and organizations are profoundly shaped by the social network in which they are embedded (Hess et al., 2011). Portes and Sensenbrenner (1993) suggest that social embeddedness at times facilitates and at other times constrains action, expanding the concept’s usefulness to guide analyses attempting to understand social dynamics in urban areas.

The concept of social embeddedness has been used in research on entrepreneurship and informal transport. For instance, drawing on the concept of embeddedness, Rekhviashvili and Sgibnev (2020) studied the social character of marshrutkas in the countries of Kyrgyzstan and Georgia. Providing paratransit-like services in minibuses, privately-owned marshrutkas proliferated in post-Soviet cities in early 1990s as a result of the collapse of public transport systems at that time (Sgibnev & Vozyanov, 2016). Using this case study, Rekhviashvili, and Sgibnev (2020) contend that relationships at differing scales and between diverse actors, including passengers, drivers, operating companies, and the state, are negotiated informally and are influenced by a range of socio-political considerations that defy the profit-seeking principle attributed to informal transport in the academic literature.

6.2 Research design

The brief literature review above indicates that multiple market and non-market forces interact during the evolution of the urban periphery. These include informal land markets, neighborhood-based organizations, and social networks and norms. Given the complex environment in which peripheral areas like Ciudad Bolívar evolve, this chapter's research design draws on qualitative methods that allow for inductive and deductive reasoning. I combine primary data collected through in-depth semi-structured interviews with 33 key stakeholders—including community leaders, informal transport drivers, and route association leaders, and transport planners—and spatial data from smartphone sensors, with satellite images, and information on land development patterns and transit services in Ciudad Bolívar obtained from secondary sources such as Google Earth, Facebook, and Bogotá's open data portal. I analyze these sources of information using multiple methods, including interview coding and geographical information mapping techniques, which, in combination, provide valuable insights to answer the four research questions I posit in this chapter.

Since no official information on informal transport services in the area existed by the time this research began, it was necessary to depart from TransMiCable station areas to begin tracing informal transport services before the project opened to the public. During the two months that preceded the opening of TransMiCable and drawing from scholarship that mixes traditional and new technologies to characterize the informal transport market (Williams et al., 2015), I traced informal transport services in Ciudad Bolívar using unobtrusive observation methods aided with smartphone sensors to track routes. I started by identifying the informal transport stops within an 800-meter radius around the three TransMiCable stations and rode dozens of jeeps, vans, and sedans from routes' starting to ending points. I took copious notes to characterize their operations, from fare structures and schedules to vehicle typologies. I cleaned and processed the smartphone data using the free and open-source Quantum GIS desktop application. I also created a cartographic representation of private and public transport supply of an area that extends about three kilometers meters beyond TransMiCable, which was still in construction at the time.

Once I had a vivid characterization of the informal transport supply and my research site, I returned to the field five months after TransMiCable opened to the public to collect more information, hoping to understand whether informal transport services had changed and, if so, how and why. Table 1 shows the number of interviews I conducted classified by type of participant. I contacted informal transport providers through CAB leaders (community leaders for short) around the time the project began operations. I started by interviewing community leaders in each of the dozen neighborhoods served by TransMiCable about their views on the gondola and their history in the neighborhoods. Pursuing these two interview topics elicited insights about transport and, in many cases, led to fruitful discussions about informal transport. When possible, I asked them to refer me to informal transport providers, from drivers to dispatchers to administrative staff.

I interviewed 13 informal transport providers, primarily vehicle owners, who were, in most cases, also drivers, and some route organization leaders and dispatchers. In some cases, interviews of drivers were conducted while they were covering their routes, which elicited responses linked to the built environment we were traversing or other moving vehicles or actors. Many interviewees confirmed and expanded my pre-and post-opening observations, thus providing me with a more nuanced understanding of whether and how their activities were connected to the deployment of TransMiCable.

Group	No.
Transport planners	6
Community leaders	14
Informal transport providers	13

Table 6-1 Interviews classified by type of participant

All of the 33 semi-structured interviews were recorded and then transcribed and coded. I followed a flexible coding process to allow for a combination of deduction and induction using the qualitative data analysis software MaxQDA (Deterding & Waters, 2018). I started with a coding scheme consisting of keywords from my interview protocols. I then added codes that consistently emerged as I engaged with more data and new literature on informality. I used this coding process as a method of organization and retrieval of information that helped me identify linkages between physical objects, processes, and actors who were directly and indirectly involved in the planning process and everyday provision of informal transport services. I use pseudonyms and omit as many other personal characteristics and neighborhood names as possible to protect interviewees' identities.

6.3 Findings and discussion

Before examining what changed (or didn't) with the arrival of TransMiCable, it is necessary to start with a thorough description of how informal transport operated in the area of study from its beginning until the few months that followed the inauguration of the project. I traced the 11 routes that cut across the 800-meter buffers around stations often conceptualized in planning documents as the project's areas of influence (Figure 6-2). Some of these informal services emerged in Ciudad Bolívar three decades ago and now cut across several neighborhoods, ranging from consolidated areas to scattered communities which are still in early stages of the peripheral urbanization process.

Six months after TransMiCable's inauguration, contrary to what I had expected, I found little change in the routes that overlapped with TransMiCable's area of influence. The 11 routes remain serving the same areas, following the same operational characteristics, despite the fact that the gondola attracts more than 20,000 passengers per day. One exception was an intermittent detour one of the routes now takes to reach Manitas Station at passengers’ request (Figure 6-2). Nevertheless, two new routes emerged at El Mirador-Paraiso Station (Figure 6-2).

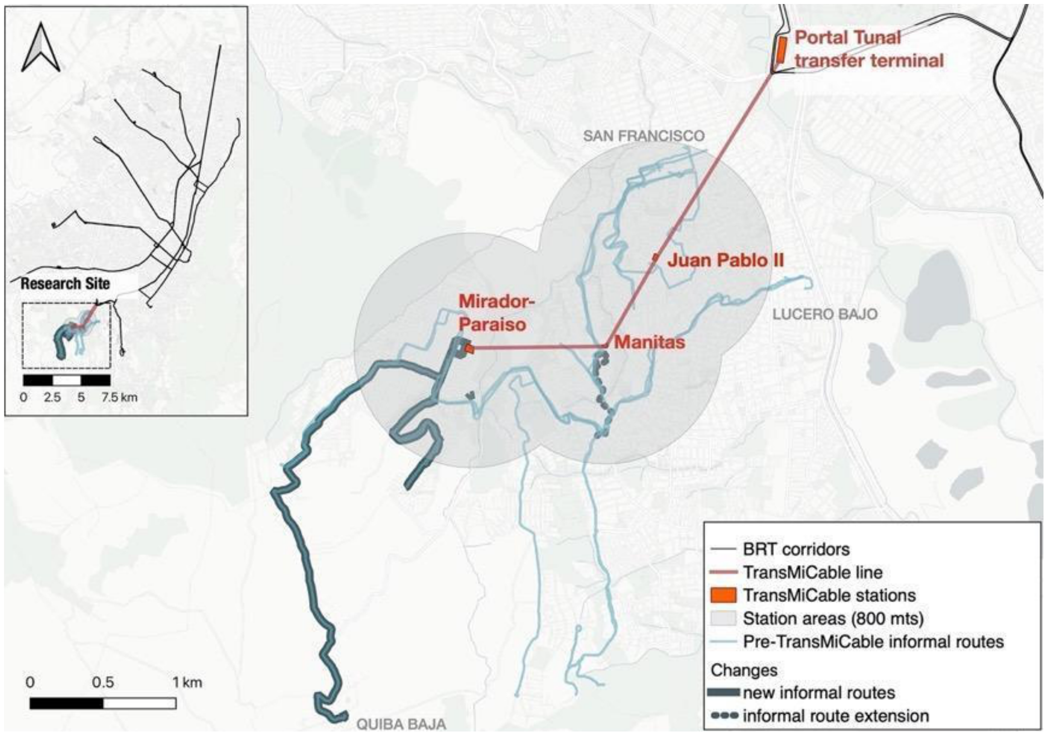

Figure 6-2 Stasis and growth of the informal transport network around TransMiCable
Source: Author with collected data

In the sections that follow, I start by characterizing informal transport services operations and discuss the multiple and interconnected factors that help to understand the stasis and proliferation of this transport market in response to the shock TransMiCable may have induced to the pre-existing system.

Informal transport routes and gaps in the public network in Ciudad Bolívar: Dissecting the surface

Each informal transport vehicle and its corresponding owner, driver, and dispatcher belongs to a route association. Despite being dated and made of a bricolage of parts, vehicles operating under the oldest and more organized associations try to present some visual homogeneity to increase brand recognition. These route associations provide services with fixed headways and scheduled routes, and are not demand responsive. For instance, one of the 11 routes is provided by old 4-wheel-drive 8-seater vehicles which depart from a terminal located in the San Francisco area every five minutes during peak hours and every 10 minutes during off-peak hours. Similarly, the two new routes I uncovered at El Mirador-Paraiso Station to Quiba, a rural-designated area, depart every seven minutes regardless of how many passengers are in line waiting. Vehicles range from small sedans to four-wheel-drive Cherokees and Fords (Figure 6-3); all were working under the umbrella of a cooperative called Cootransmicable and clearly advertise that they serve the gondola stations.

Figure 6-3 Small automobile affiliated to one of new informal routes feeding TransMiCable at El Mirador-Paraiso station

In other cases, demand for some informal transport services is enough to justify their existence but not sufficient to provide a fixed schedule with frequent services. These services operate under a fill-and-go departure pattern; depending on the day and hour, waiting times can vary from 5 to 60 minutes. One example is the route that connects the economic activity hub located in the neighborhood of Villa Gloria with the neighborhoods of Santa Marta, Naciones Unidas, and Canadá. Each neighborhood has informal origins, and some are in the early stages of development, a condition evidenced by non-paved roads and single-story houses, many still incomplete (Figure 6-4). Routes like this tend to be short and connect just a few neighborhoods.

Figure 6-4 Neighborhood of Santa Marta in its early stages of development in 2020.
Credits: Empresa de Acueducto de Bogotá (2020)

Another route that exhibits similar operational characteristics connects the already consolidated neighborhood of Lucero Bajo with Guaval, one area in the process of consolidating, using only 12-seater vans that operate under a cooperative whose name refers to the type of vans they use locally known as Páneles (Figure 6-5). They follow a fixed headway scheme, as do many of the oldest informal transport routes that cut across dozens of neighborhoods.

Figure 6-5 Van waiting for its turn to depart the terminal in Lucero, while a state-sanctioned bus serving the same destination passes by.

Even if public transit is available, according to some informal transport drivers, passengers prefer to use informal services over authorized buses because the latter are unreliable and infrequent. According to a community leader of one of these neighborhoods:

> The [Integrated Public Transport System] provides service, but a very, very poor one; the frequency is too low, one can sometimes wait up to one hour until one service passes. People who get up early from 4:00 am or 5:00 am stand to wait indefinitely for the service there [at the bus stop], and it never arrives ... the service for the peripheral neighborhoods is bad. There is no permanent service that serves the community.

Unreliable and infrequent bus services are more prevalent in places that are newer and more peripheral. For instance, one of the new informal routes I documented performs substantially better than the state-sanctioned bus route which has been covering the same route since 2015, thus filling a gap in the transit network. The lack of provision of decent-quality bus services by the state is at odds with the recent investment in a frequent and fast aerial cable-car line, and this contradiction in transport policies seems to play an enabling role in the growth of the informal transport sector.

These accounts are consistent with insights from interviews with planners who are aware of the competitive advantage informal transport has over state-sanctioned public transport buses in the area. This advantage is highlighted by one of the transport planners I interviewed, who noted that "[locals] have identified [things] like stops, links in the networks, whereas because of geographical or temporal gaps, or in terms of route headways, informal transport can compete. Let's say that this is why it has an important role." However, she also emphasized that "We [in the transport agency] have operational difficulties, then in those spots where we have issues, the informal arrives [enters the market]. Let's say, they do not have to follow schedules, or guarantee anything, then they simply provide a service, with all the perks and no responsibility." Here she refers to the fact that informal transport avoids regulations such as safety standards or requirements to provide insurance.

The substandard service that the public transport system provides is further exacerbated by the topographical and traffic conditions of the area. Large buses have difficulties navigating the narrow and dangerously steep roads. But smaller informal transport vehicles can easily deviate from their fixed routes to take narrower roads and avoid the traffic jams that are frequent in Ciudad Bolívar during peak hours, providing another competitive advantage. Informal transport also quickly responds to problems in the formal transport system by picking up passengers aboard buses stuck in traffic or which break down or crash (as I experienced during one of my trips to the area), and fills gaps in transport networks by feeding state-sanctioned routes.

Moreover, according to one interviewee, the difficult topographical conditions of the area have even prompted transport planning authorities to modify some routes to avoid traffic accidents, thus opening more gaps in the network for informal transport actors to expand their operations:

> “The bus route ended at the school over Centenario Road, but because the road was too steep and had many potholes, they [the planning authority] decided to suspend it. Because it [the bus] could suddenly go over the school and run over lots of children, so that's why they removed the route and sent it down the road, to Arabia [sector], it was the last year that the route was removed.”

In other cases, informal transport routes fill temporal gaps that remain open after state investments. For instance, one community leader said:

> “Those who depart from Paraiso, those are informal routes with service available in that location sometimes from 10:30, 11:30, 12:00 pm because at that time of the day TransMiCable does not operate, TransMilenio [Bogotá's BRT] is not open, and there aren't any of those [formal] services available. TransMiCable is operating only from 5:00 am until 10:00 pm, which [the city] promised to provide the service from 5:00 am to 11:00 pm, and they [city officials] lied to the community requesting the service.”

Gaps in the public transport network extend to other spatial and temporal dimensions, such as ease of fare payment. This was noted by another transport planner I interviewed, who stated, "There are enough charging points, for example, so not everyone has a charge, even though the system gives you credit, I no longer remember, like two tickets, I no longer remember how much one gives you, it is not very easy to reload [the transit payment card].” The state-sanctioned SITP system is cashless, which not only represents a barrier to low-income residents of peripheral areas that have to endure long commutes but also low access to places in which they can’t add money to their transit cards.

Going beyond transport gaps: Flexible adaptation and land development

Interviews and field observations suggest that informal routes in Ciudad Bolívar emerged in tandem with the ongoing peripheral urbanization process. Furthermore, my reading of the empirical evidence suggests that new land subdivisions and emerging neighborhoods are linked to the emergence of new informal transport services. This evidence extends the gap-filling theory often focused on transport provision, overlooking the role land development in the periphery has in facilitating the emergence of such gaps.

One example of the linkages between land development and the emergence of informal transport is provided by a community leader and former informal transport provider who I will refer to as Benjamin. He describes how fast his neighborhood is evolving while also highlighting the role of informal transport in tandem with neighborhood development. According to Benjamin, "several years ago, these were still pastures, they were very little built but it has already been growing more, and the more days there are more consolidated." He further adds:

> "Well, when I arrived [to the neighborhood], the [informal] routes began ... The first people that arrived up there; they [locals] made up another neighborhood, so there were several people at that time who said, from here up to there, let's put one car, two cars to work [as a shared transport service]. He [referring to one of his neighbors] started with two cars working, and then another friend arrived and started working ... until the business started growing up."

The new route that connects El Paraiso with Quiba Bajo emerged in part as a response to the peripheral urbanization process being replicated way beyond Bogotá's official urban boundary but not so far away from TransMiCable's Mirador-Paraiso station. A satellite image downloaded from Bogotá's open data website indicates that by the end of 2017, approximately one year before Bogotá's urban gondola opened to the public, a mosaic made from patches of land beyond the designated urban boundary was already built with houses (Figure 6-6). Using GIS tools, I estimate that these patches of urbanized land make up an area of approximately 60 hectares, intertwined with green pastures.

Approximately two years later, I took Charles' sedan, which was waiting for passengers at the Mirador-Paraiso station to take them to Quiba Bajo. Along the 20-minutes trip that took me to Quiba, I witnessed a few more houses being built and several dozens of small plots carefully divided by perfectly straight service roads. I triangulate these observations with a satellite image I obtained from Google Earth detailing the urban extent in the area by December 2019. Based on this satellite image, I estimate that the total area of the new land subdivision in 2019 encompasses approximately 25 hectares and is located less than two kilometers away from the latest gondola station (Figure 6-7).

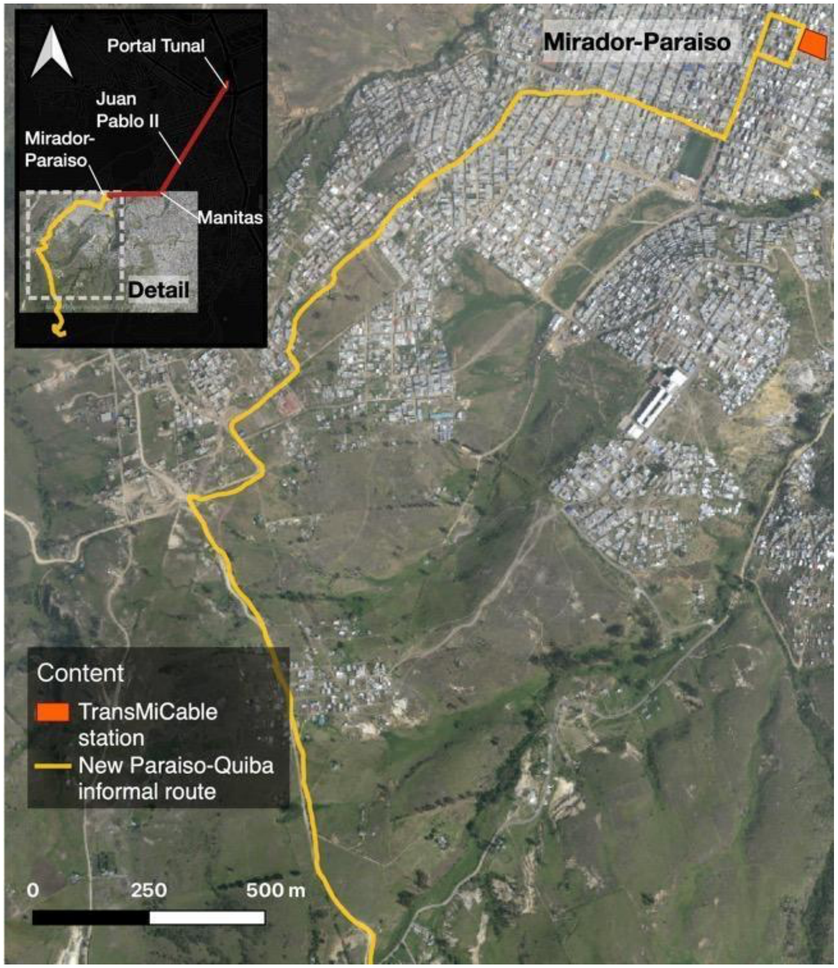

Figure 6-6 Urban footprint in 2017 beyond El-Mirador-Paraiso (pre-TransMiCable)
Source: Satellite images obtained from MapasBogotá.com

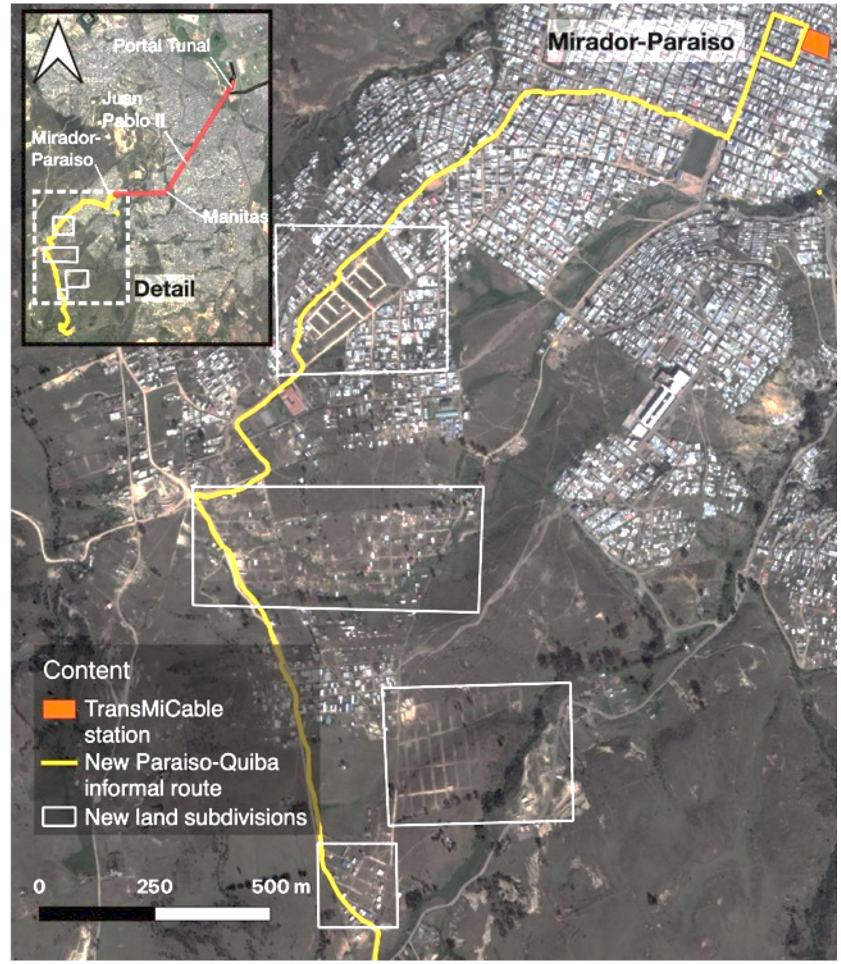

Figure 6-7 Urban footprint in 2019 beyond El-Mirador-Paraiso (post-TransMiCable)
Source: Satellite images obtained from Google Earth

The new markets of land subdivisions that I uncovered in 2019 are closely connected with both the deployment of TransMiCable and the emergence of the new informal transport routes that take passengers right from El Mirador-Paraiso to Quiba Baja. This route capitalizes on the growing demand for transport that will come because of the slow process of neighborhood consolidation and the reproduction of the peripheral urbanization process further out and where land is cheaper. According to Joe, an administrator of the new route, what motivated him to plan this route was the significant travel time savings TransMiCable would bring to communities far beyond the Mirador-Paraiso station and Bogotá's urban boundary. Joe believes that travel time savings of up to one hour would attract enough passengers to TransMiCable, and these patrons will need additional transport services.

> "Paraiso is the last one [on the edge of the urban footprint], but from here to there, there are rural villages, where the population is increasing a lot … each day, those farms are being subdivided to be transformed into neighborhoods."

Brokers of some of the new land subdivisions can be found on craigslist-like websites, highlighting as one advantage the proximity to TransMiCable (Figure 6-8). One such ad promotes “parcels in the Quiba Baja Sur in Bogotá at only five minutes [and approximately two kilometers away] from the latest station of TransMiCable.'' The ad further mentions that these parcels come with provisional water and energy services.

Figure 6-8 New land subdivisions in rural Quiba Baja
Source: Image obtained from OLX.com (2020)

This evidence is in some ways consistent with Gamble and Puga (2019). They contended that the degree to which informal transport adapts to urban change is closely linked to land market dynamics of the often-evolving periphery. At the same time, the evolution of Bogotá's contemporary urban periphery echoes the historical accounts of how land development and (private) transit evolved in tandem in the nineteen-century American city that created middle-class streetcar suburbs (Jackson, 1987; Muller, 2004).

However, the above description of the urbanization in Ciudad Bolívar diverges from historical accounts of cities in the global North in the sense that these spaces and modes are being (re)produced by and for the poor, who the most part have no access, affordable, decent-size and -quality, and well-located housing alternatives (Caldeira, 2017; Camargo Sierra & Hurtado Tarazona, 2013; Holston, 1989; Roy, 2005). Although examining the connection between peripheral urbanization, informal transport, and TransMiCable in Ciudad Bolívar paints a somewhat clear picture of how these elements of the urban systems are closely linked, it does not provide any plausible explanation of why most of the pre-existing informal routes have remained.

Digging deeper: The socially embedded character of informal transport and the role of community action boards

Two other crucial elements contribute to a better understanding of the dynamics of the informal sector in Ciudad Bolívar. One is the theoretical concept of social embeddedness. The other relates to the idea of insurgent planning. These concepts share a focus on the relationships among key local actors and the state. These elements help provide a deeper understanding of the dynamics of the informal transport economy in Ciudad Bolívar and further link their emergence and potential adaptation to peripheral development processes, gaps in the public transport network, and ultimately the investment in TransMiCable.

One recurring theme emerging from the interviews relates to the degree of proximity between the community and informal transport providers. For example, George, who drives one of the vehicles covering neighborhoods in their early stages of consolidation, also lives in the area where the terminal of his route is located. He explained how close he and his colleagues are to the community they serve.

> "We get along with the community … We help them, and they help us. It is as if we [he and his colleagues working on the same route] were part of their family. They even know my full name."

Proximity can contribute to building trust between actors with a common interest, in this case, lack of access to transport, and can also foster reciprocity. Proximity may help explain how informal routes emerged in the area and stayed despite the construction of TransMiCable. Most interviews with local leaders and informal transport actors suggest that CAB members often advocate for better transport infrastructure, among other demands. Their power stems from their legal status and close connections with the local mayoralty of the district and the local transport planning agency.

Grassroots planning processes in the city were mentioned by one interviewee working at one of Bogotá's transport planning agencies. This interview suggests that transport planning practices have migrated from the top-down radical planning approach to a process in which the community organizes and influences outcomes:

> "Something that we have been learning is that the community now organizes. A few years back, the [local] government was very dictatorial. They would come in, define something, and then that was what would be. In the last few years, by contrast, we have been met by a community with an opinion that would oppose and propose ideas. They are very active and proactive; they accomplish cool things, those that we can coordinate with. For example, we had problems with the bus parking lots, so they led the conciliation, and we found some land, and they helped us find an environmental group to assess the location."

Organized communities in peripheral areas, represented by their CABs, are also active in demanding better road infrastructure to benefit the operations of informal transport providers and their customers. These efforts are recognized by informal transport providers who benefit from political action taken by CABs. For instance, one driver commented that the informal route he and his colleagues operate "works thanks to the Community Action Board of his neighborhood." He then added:

> "They [CAB members] advocated before the local mayoralty that is now helping us fix the road up there ... The community helps us a lot in that regard. The community has no other transport alternatives."

CABs not only interact with the state, including district mayors, to provide better transport infrastructure; they also collaborate with informal transport providers at the early stages of route planning. Mr. Abraham, who has provided informal transport services in the area for more than a decade, commented that:

> "These routes emerged because, for example, you [residents] have a need, you see, that the person possibly needs that transport. Then one gets there and talks to the president of the [community action] board until we agree on the route. A meeting is held with the board leaders, and one concludes that a route will be established; with its inauguration party and everything. So, this type of transport is created through connections—with the board and the community."

Furthermore, and as in many other cities in the global South, informal transport routes in Ciudad Bolívar are territorially defined. Informal agreements between transport providers in the research site, often organized in route associations, delimit the geographical boundaries from which each route can profit. Thus, the existing social norms and informal agreements within this informal transport sector can also constrain the degree to which they can adapt to urban change. To my question about collaboration between route associations, one driver commented:

> "They are there, and we are here [referring to the areas they serve]. Everyone one in their place, each one respect the others' [territory] … those over there [referring to another route passing by], the routes that go down [to San Francisco] are the San Francisco route, and the other one is the Villa Gloria route [...] what happens is that we respect the work zone."

Besides being constrained by territorial agreements enforced by route associations, many neighborhoods served by pre-existing routes were already consolidated and, in many cases, formalized by the state several years ago. These neighborhoods are at the late stage of the peripheral urbanization process. Residents slowly improve their unfinished houses, where residents and community leaders may have already built strong and lasting relationships. Such relationships are based on trust and reciprocity with informal transport providers, making the latter even more embedded into the communities they serve. This conjecture is also consistent with the fact that new informal routes serve some neighborhoods that emerged more recently, and communities are just starting to organize.

Another emerging factor that helps explain why most routes remained unchanged while only two new routes emerged circles back to privileged connections and power. Those who built strong ties with powerful actors, including the local police, allowed them to quickly enter the market and even compete with pre-existing informal routes. For instance, Joe, one of the new route association leaders, capitalized on a relationship one of its members had with a local police officer to not only enter the market but to secure a privileged yet informal terminal location right by the latest TransMiCable station on top of the hill.

> "From the beginning, when I thought about the route, that route will be based on ten cars; we will work on ten vehicles. I talked with a friend who is a policeman and told him that there would be only ten cars we will use to work"

This new cooperative or route association entered the market to compete with another route from El Paraiso to Quiba for over a decade. Bill, a vehicle owner of one of the 1970s old vans operating long before the gondola opened in 2018, shared with me how TransMiCable had affected his business. He suggests that "TransMiCable, did affect us a little because they opened other [pirate] routes, there is already competition ... There are some, there are even others that leave TransMiCable with small cars, they go down here and reach the same place that we are." Bill further commented that, in order to avoid conflicts with other providers, informal agreements are established to delineate which roads can be used as pick-up and drop-off locations:

> "Even when they were going to start in December [2018], they came down to talk to us. [They told us:] "Look, we are going to start this route from that to that part, so we are going to respect your stop, [meaning not picking or dropping passengers nearby] .... We are going to stop there [by the Paraiso-Mirador station] so that you also respect it."

Another driver from a route that adapted to TransMiCable by providing on-demand feeder services confirmed how the powerful members of the state apparatus can enable and disable adaptation. He commented: "If people ask us, they don't have to walk all the way to the station. We help them get there … We take them to Manitas [the closest station to their route] … and then [they] take TransMiCable." But when I asked him about why his route association has not permanently extended their service to reach the station, he responded that it was "to avoid problems with the traffic police."

The above examples indicate that some route associations seem to have less collective power than the new route association that entered the market right after TransMiCable opened to the public. For instance, when I asked one driver who operates another pre-TransMiCable route connecting the area of Paraiso with Quiba why they did not move their terminal closer to the Paraiso-Mirador gondola station, he told me that the main reason was their lack of a true leader that helped them organize and obtain enough funds to pay local authorities to secure a privileged location by TransMiCable.

Insights from these interviews and my own observations paints a portrait of the socially embedded character of informal transport in Ciudad Bolívar. Furthermore, it provides an additional and yet interconnected layer that helps explain why some informal transport services adapted to the gondola and why others did not.

6.4 Concluding thoughts

How did informal transport providers adapt to TransMiCable? Contrary to my expectations, most pre-existing informal transport services remained unchanged more than a year after TransMiCable opened to the public and two new routes emerged. Many of the pre- and post-TransMiCable informal transport services appeared to complement the public transport network in a context where actors who were part of the state apparatus either turned a blind eye to this underground economy or sometimes facilitated its existence. This finding is partially consistent with the dominant assumption in the literature that informal transport emerges to fill gaps in the transit network in a context of disinvestment in public transport and the absence of state regulation.

Although this assumption is supported by the existence of gaps in the transport network, disinvestment in public transport is not the only factor that enables informal transport to thrive in the urban periphery. Ciudad Bolívar, home of more than a dozen informal transport routes, now enjoys a highly visible and efficient public transport investment: TransMiCable. And yet, informal transport did not decline but increased. I draw from the three bodies of scholarship summarized in my review of the literature to untangle this apparent contradiction that provides a more nuanced understanding of the dynamics of the informal transport sector.

Consistent with the literature on informal land development, insights from interviews and field observations indicate that, on one hand, informal routes in Ciudad Bolívar emerged in tandem with the ongoing peripheral urbanization process. The new markets of land subdivisions that I observed in 2019 are linked with both TransMiCable and the new informal transport route that takes passengers right from El Mirador-Paraiso to Quiba Baja. Actors involved in creating this route capitalized on the growing demand for transport that may come as a consequence of the fast land-subdivision process, often followed by a process of neighborhood consolidation where residents and the state actively work.

On the other hand, land developers anticipated the deployment of TransMiCable by subdividing large plots of rural land, where houses are then self-built by residents. The historical and ongoing urban expansion I describe is consistent with observations made by Caldeira (2017) in Istanbul, Santiago, São Paulo, or (Holston, 2008) in Brasilia. In all of these cities the peripheral urbanization process is reproduced further out, where land is cheaper. This dynamic land development system moves faster than the state in providing adequate infrastructure and transport services. Informal transit actors are able to complement less-reliable and infrequent state-sanctioned buses and connect residents from the sprawling periphery to the city center via TransMiCable. The evidence is highly indicative that state responses to the mobility needs of disadvantaged communities are reactive, while informal transport is proactive and anticipates the new modes of urbanization that constantly redefine the urban fringe.

Second, investigating the socially embedded character of informal transport and the role of community-based organizations in the co-production of the urban periphery sheds light on how informal transport adapts to urban change. For instance, insights from interviews with local leaders and informal transport actors suggest that CAB members' actions go well beyond the state's conception to promote participatory planning. Despite playing a role in shaping some state-led projects and advocating for public infrastructure, CABs also engage in insurgent citizenship practices by collaborating with informal transport actors to plan and promote informal transport routes. These actions foster trust between CABs and informal transport route associations that serve their communities. In turn, this evidence suggests that trust fosters reciprocity between informal transport providers and community leaders. Those strong bonds may act as a galvanizing force that attaches the former with the latter even more.

Third, other forces that may also enable informal transport providers or prevent them from adapting to local conditions include territorial agreements, privileged connections with state actors, and power imbalances. Informal agreements between transport route associations define the geographical boundaries from which each route can profit, making it more difficult to react to changes that extend beyond their turf. Those with strong ties with powerful actors, including the local police, allowed them to quickly enter the market and compete with pre-existing informal routes. For example, the new route association capitalized on a relationship one of its members had with a local police officer to enter the market and secure a privileged location by one more peripheral station of TransMiCable and compete with two pre-existing routes with a lack of strong leadership and less collective power to defend their turf. These routes intersect with a market economy by creating competition under these informal circumstances, which appear to materialize through clientelism and the trafficking of power and money.

Nevertheless, while trust, reciprocity, and informal agreements within the underground transport economy may constrain the degree to which they can adapt to urban change, power and connections with the state can facilitate market entry. This evidence is consistent with Portes and Sensenbrenner (1993), who contend, based on their work with immigrant communities in Miami, San Francisco, and New York City, that social embeddedness at times facilitates and at others constraints action. Furthermore, this chapter also demonstrates how the gap-filling thesis falls short of comprehensively explaining the complex dynamics that govern informal transport in peripheral areas where the state, despite investing large amounts of public resources in enhancing transport infrastructure, still left some gaps open. Some of these gaps are better understood when examining how transport, both formal and informal, are connected to peripheral urbanization processes, characteristic of many cities in the global South (Caldeira, 2017).

What elements from this research can be transferred to other geographies? The mixed data collection and analysis methods I used can be adopted by other transport scholars and practitioners looking at how informal transport adapts to the complex environments where these services often emerge. My experience gathering information on informal transport before and after the city opened TransMiCable through remote sensors and semi-structured interviews with key actors has proven successful in at least three ways. First, insights gained from this empirical evidence provided a more nuanced understanding of how and why informal transport providers adapt to urban change. Second, these methods and data helped identify many of the same issues found elsewhere in scholarship from other disciplines, making the findings more compelling. Finally, qualitative mixed research methods helped uncover many interconnected systems, actors, and networks frequently overlooked in the informal transport academic literature.

This chapter also contributes to transport scholarship. The particular focus on social embeddedness and community-led organizations provides evidence that not only questions the dominant assumption but also challenges contemporary conceptualizations of justice in transport planning. The most recent theoretical advances on defining transport justice privilege the role of the state in providing transport infrastructure services --see, for instance, Martens,(2017), or Karner and Pereira,(2021), while marginalizing non-state actors like community-based organizations. By providing better public transport in urban peripheries, the state may indeed play an essential role in reducing transport-related inequalities. However, as I demonstrate, grassroots organizations like CABs also play an essential role in improving transport supply. CABs help in planning and deploying informal transport routes that serve their community at early stages of neighborhood development. These actors are fundamental in facilitating the improvement of the supply of transport services in their neighborhoods, particularly when the state does not have the capacity to intervene.

These findings underscore the need for ongoing attention to the unintended consequences that emerge from investing in public transport infrastructure. Transport planning institutions—even in a city that has been celebrated for its proactive role in promoting better ways to provide public transport—may be slow to react to land development patterns and emerging mobility needs. In contrast, grassroots organizations, many of which were created to facilitate participatory planning processes, proactively support the provision of transport services, even when not sanctioned by the state.

Planners should incorporate observations and recommendations from locals in order to anticipate the ways in which state-funded projects can provide better transport services for the poor. Future research should explore how small cooperatives of informal transport can reduce their adverse effects on society and be more accountable for the needs of customers by integrating informal transport services into the whole public transport network.

Chapter 7 Concluding remarks

7.1 Summary of findings

During the past two decades, at least a hundred cities in the global South have poured significant shares of their thin budgets into public transport projects, including urban rail, BRT, and, more recently, urban gondolas. These are often built in rapidly urbanizing cities characterized by vast inequalities in access to economic-generating opportunities, in which loosely regulated, or sometimes non-regulated, privately provided transit has dominated the transport market for decades. This dissertation critically investigates some of the benefits of these transport interventions through the lenses of what some scholars refer to as "transport equity," broadly understood as the degree to which investments in transport and policies benefit the least advantaged members of society more than any other population group. It also surfaced some unintended consequences from the deployment of these interventions. Divided into three papers that examined three different transport investments in three different cities in the global South, this dissertation also places the concept of equity within broader discussions about transport and land use planning.

In Chapter 2, my colleague Lisa Rayle and I investigate the extent to which BRT can contribute to reducing commute time inequalities in cities that invest in this technology, thus advancing "transport equity" goals in both cities. Using a retrospective survey, we estimate and compare the distributional effects of BRT deployment on commute times in Cape Town, South Africa, and Barranquilla, Colombia. Our findings suggest that while BRT deployment did not narrow the gap in commute times between low and high socio-economic strata groups in Barranquilla, BRT did narrow the gap in commute times between different races in Cape Town.

A critical lesson from this chapter is that BRT route configuration influences the degree to which BRT can benefit economically disadvantaged populations. Although the cities exhibit similar urban segregation patterns, two characteristics in which they diverge are that they have drastically different urban extent and trunk-feeder routes' length ratios. Cape Town's urbanized area is about ten times as large as Barranquilla's and had longer arterial roads than Barranquilla before BRT started being considered. Accordingly, Cape Town's BRT exhibits considerably longer trunk corridors, with relatively shorter feeder services than Barranquilla's. It is plausible that the commute time advantage provided by the BRT trunk corridor in Barranquilla was not sufficient to compensate for the additional transfer times induced by transfers and waiting times induced by BRT. Commute time savings in Cape Town seem to be enabled by a better-balanced feeder-trunk system and long direct (or express) routes that serve some outlying townships.

Feeder services that extend the geographical reach of BRT to less dense and sprawling peripheral neighborhoods can work relatively well in urban areas such as Cape Town, where topographical conditions and road infrastructure are conducive. However, the geographical conditions of urban peripheries in the global South, such as the neighborhoods surrounding Bogotá, are often not suitable for buses to transport passengers efficiently and safely, preventing planners from advancing towards a more equitable distribution of benefit from transport interventions. These urban peripheries, often of informal origins, are located on mountainous terrains, characterized by windy, narrow, and dangerously steep roads. Such geographical conditions constrain the circulation of buses and represent an additional burden to the urban poor, who represent the vast majority living in these urban peripheries. It is in these contexts that cable-propelled transit, adapted from ski resorts in Europe and North America to urban environments in the global South, has become a popular solution intended to meet the mobility needs of the economically disadvantaged populations living in these peripheral urban enclaves.

In Chapter 4, I use Bogotá's first urban gondola line, locally known as TransMiCable, as a case study to understand how this investment reshapes the geography of access to jobs for economically disadvantaged populations. With a single 3.4-kilometer line and three stations, and one terminal where passengers can transfer to the city's BRT, the project promises to increase access to urban opportunities for the low-income population living in Ciudad Bolívar – one of the poorest districts in the city, which is in line with the concept of "transport equity." Using openly available data on transport provision and travel behavior, a quasi-counterfactual research design, and urban data analytic tools, I demonstrate that extending the reach of Bogotá's public transport network to a historically marginalized peripheral area with available low-skilled jobs enabled gains in job accessibility both near and far from where the project was built, challenging the conventional wisdom that investing in a short gondola line, only benefits a few.

In this chapter I also demonstrate how different data aggregation approaches result in measurements that may produce contrasting interpretations. Aggregating the results by all station areas, and looking into the average number of jobs gained, gives the impression that the project benefits a large number of residents; however, this aggregation gives the impression that TransMiCable had little on the average number of jobs gained. Aggregating the results by the Mirador-Paraiso station area, the one at the end of the line, gives the impression the project only benefits a few, and yet their average gain in accessibility positions the project as very effective and progressive, at least in terms of the magnitude of the impact and the characteristics of the population it benefited the most. Bogotá's investment in TransMiCable is consistent with Rawls' principle of generating the greatest benefit to the least-advantaged members of society *if* analyst considers only those living near to the more peripheral station.

In Chapter 6, I capitalize on Bogotá's deployment of TransMiCable in Ciudad Bolívar, which can be seen as an exogenous shock to the informal transport system, to investigate how the latter adapts to the former. Often referred to as matatus, chanas, combis, piratas, or carritos, these informal transport modes frequently serve a large proportion of low-income urban dwellers in this part of the globe. Because most scholarship suggests that informal transport emerges in contexts of lack of state-sponsored transport infrastructure to fill gaps in the transport network, I hypothesize that informal transport services would likely dwindle because the gondola now provides a new and potentially better way to access the periphery. Using multiple data sources and a mixed-methods approach, including in-depth semi-structured interviews and remote-sensed data, I find that, contrary to my expectations, most pre-existing informal transport services remained unchanged more than a year after TransMiCable opened to the public, while two new informal routes emerged. Investing in TransMiCable, paradoxically, seems to have improved the supply of transport in the area.

Insights from interviews suggest many of the pre- and post-TransMiCable informal transport services complemented public transport by filling gaps in the network . However, the gap-filling hypothesis falls short in explaining why informal transport proliferated in Ciudad Bolívar after TransMiCable was built. On the one hand, informal routes in this peripheral district emerged in tandem with the ongoing peripheral urbanization process. Actors involved in creating new routes capitalized on the growing demand for transport, which may come as a consequence of the rapidly land subdivision process occurring in the urban fringe. Interviews also suggest that Community Action Board (CAB) members collaborate with informal transport actors to plan and promote informal transport routes, fostering trust and reciprocity. The socially embedded character of informal transport in Ciudad Bolívar, particularly the role of community-based organizations like CABs in planning for transport services, contribute to new conceptualizations of "transport justice," in which not only the state plans for, and provides, transport services for those at the margins of society.

7.2 Policy implications

Several policy implications come out of this dissertation. Findings from Chapter 2 suggests that BRT does not always reduce commute time gaps between economically disadvantaged and non-disadvantaged groups. Striking an ideal trunk-to-feeder length balance seems to be of particular significance in cities where most economically disadvantaged populations reside in peripheral neighborhoods. Planners should attend to local contexts when designing and investing in capital-intensive infrastructures. For instance, our findings suggest that the popular feeder-trunk-distributor BRT model may not be the most appropriate alternative for mid-sized cities. The commute time advantage provided by BRT trunk services in Barranquilla was not sufficient to compensate for the additional transfer times induced by BRT; however, in Cape Town, commute time savings seem to be enabled by a better-balanced feeder-trunk system and long direct (or express) routes that serve some outlying townships, where most Black residents reside. Policymakers and planners who hope that BRT will reduce commute time gaps in global South cities must carefully consider the potential combined effects of BRT network design and urban form.

Furthermore, because many cities in the global South have narrow, circuitous street patterns in peripheral low-income areas, making the implementation of BRT trunk corridors challenging, planners should test more feasible and less capital-intensive alternatives. One option is to implement bus-only lanes for feeder services to improve bus speeds and service reliability. Another complementary intervention is testing a few direct-service routes, as Cape Town did more extensively than Barranquilla. Able to serve both peripheral neighborhoods and trunk-corridor stations, direct-route services eliminate feeder-trunk transfers for those commuting from peripheral to more central locations.

In places where topographical conditions and road infrastructure are not conducive for buses to circulate efficiently and safely, investing in cable-propelled transit may be more beneficial for the population groups public transport intends to serve. The distributional effects from Bogotá's urban gondola on employment accessibility in Chapter 4 demonstrate that such investment can enable significant accessibility gains for those living in proximity stations. Large and localized effects in the case of TransMiCable are enabled by the project's physical integration with the city's BRT. Cities intending to invest in cable-propelled transit should consider these peripheral projects as part of a larger transport network, and their analysis should aim to understand regional accessibility impacts using quasi-counterfactual research designs, as done in Chapter 4. Such analyses may shed some light on the role of network connectivity, and land uses in enabling localized and regional impacts from future investments.

Moreover, recognizing methodological issues in data representation in the context of assessing the distributional impacts of investments in public transport on accessibility also has policy implications. At the very least, transport analysts and planners should produce regional accessibility analyses that provide insights from multiple angles. This may contribute to facilitating more inclusive and democratic planning processes.

Chapter 6 highlights one blind spot associated with the deployment of Bogotá's urban gondola: the emergence of new informal transport routes in the project's area of influence. This finding underscores the need for ongoing attention to the unintended consequences that emerge from investing in public transport infrastructure. Informal transport evolves in tandem with rapid and mostly informal land development in the peripheral district where TransMiCable was built. Transport planning institutions may be slow to react to land development patterns and emerging mobility needs. In contrast, as findings from this chapter suggests, in some cases grass-roots organizations proactively work to support the provision of transport services, even when not sanctioned by the state. Planners should incorporate observations and recommendations from locals to anticipate the ways in which state-funded projects can provide better transport services for the poor.

7.3 Contributions to scholarship

By investigating the subject of justice in transport in three different papers using a mixture of research methods, this dissertation offers new insights that contribute to transport scholarship. The multiple methods employed in this dissertation offer a significant contribution to study how transport investments fare under the rubric of 'transport equity' and their unintended consequences. Together these methods and empirical evidence presented in this dissertation contribute to filling multiple gaps in the academic literature.

In Chapter 2, my colleague Lisa Rayle and I harness the power of comparison using case studies to uncover how urban form and other local conditions dictate the extent to which BRT can deliver more equitable commute time savings in particular contexts. The comparative research design and resulting evidence provided in this chapter open a path for more studies that explores the apparent relationship between the distribution of commute time savings, network design, and urban form. Chapter 2 also helps fill a fundamental gap in the academic literature. To the best of our knowledge, this is one of the few studies that assess how benefits from BRT are distributed across different population groups and provide policy recommendations intended to improve the potential for BRT to achieve more equitable outcomes.

The research design and case study combination employed in Chapter 4 also represent a significant contribution to transport scholarship. While other scholars have employed GTFS and land use data to estimate the distributional effects of investing in public transport on access to opportunities, this would appear to be the first study adopting such methods to investigate how an investment in an urban gondola, placed on a low-income district, reshapes the geography of access to jobs. Focusing on Bogotá's periphery enabled this study to uncover how positive gains in accessibility enabled by TransMiCable spill over to other areas of Bogotá's metropolitan region - an effect seldom discussed in transport scholarship and practice. Research studying large transport infrastructure projects that cut across entire urban areas may fail to identify such spill-overs.

Likewise, the mixed data collection and analysis methods I used in Chapter 6 can be adopted by other transport scholars and practitioners looking at how informal transport adapts to the complex environments where these services often emerge. This approach provided a more nuanced understanding of how and why informal transport providers adapt to urban change, thus contributing to filling a large gap in the literature on informal transport.

This dissertation challenges the conventional wisdom that investments reaching low-income peripheral areas are always pro-poor. While Bogotá's urban gondola benefited and Cape Town's BRT benefited economically disadvantaged groups more than any other group, Barranquilla's BRT did not. The commute time advantage provided by BRT trunk services in Barranquilla was not sufficient to compensate for the additional transfer times induced by BRT. The opposite may be true in Cape Town's BRT. Bogotá's urban gondola benefits not only low-income residents but more economically privileged residents living far beyond Ciudad Bolívar.

7.4 Future research

This dissertation examined the distributional effects of investments in public transport and some of their unintended consequences in three cities in the global South. Chapters 2 and 4 focus on how investing in BRT and urban gondolas can reshape the distribution of commute times and job accessibility. Future research could focus not on these direct benefits from public transport innovations but treat them as predictors of personal outcomes such as physical and mental health in cities in the global South. Although there is growing interest in studying the relationships between health and transport, most of the work has been focused on cities in the global North where the largest share of the population relies on automobiles. These studies often use cross-sectional secondary data with no information on home and work location preferences, preventing scholars from controlling for residential self-section..

It would also be interesting to understand how increases in access to key destinations enabled by public transport projects promote more trip making. Understanding induced demand from an equity perspective is crucial to provide a more nuanced understanding of how investing in public transport promotes economically disadvantaged populations to engage in more out-of-home activities.

Future research could also examine longer timelines to capture longer-term effects from public transport investments. The empirical evidence presented in this dissertation does not consider changes in land uses and captures only short-term effects on commute time savings and access to employment. It would be helpful to investigate how BRT and urban gondolas investments contribute to changes in land uses, reshaping the geography of access to key destinations and, potentially, travel behavior.

Chapter 8 Bibliography

Abramo, P. (2007). A cidade COM-FUSA: A mão inoxidável do mercado e a produção da estrutura urbana nas grandes metrópoles latino-americanas. *Revista Brasileira de Estudos Urbanos e Regionais*, *9*(2), 25. https://doi.org/10.22296/2317-1529.2007v9n2p25

Alcaldía Mayor de Bogotá. (n.d.). *Conociendo mi localidad*. Retrieved August 12, 2020, from http://www.ciudadbolivar.gov.co/mi-localidad/conociendo-mi-localidad/-historia

Alcaldía Mayor de Bogotá. (2017). *TransMiCable Un Sueno De Volar Hecho Realidad*. https://www.caf.com/media/8389/7-transmicable-un-sueno-de-volar-hecho-realidad-jerzon-carrillo.pdf

Alcaldía Mayor de Bogotá, O. de D. E. (2019). *Infografía Localidades 2019—Ciudad Bolívar*. https://observatorio.desarrolloeconomico.gov.co/sites/default/files/-files_articles/boletin_ciudad_bolivar.pdf

Alpkokin, P., & Ergun, M. (2012). Istanbul Metrobüs: First intercontinental bus rapid transit. *Journal of Transport Geography*, *24*, 58–66. https://doi.org/10.1016/j.jtrangeo.2012.05.009

Ardila-Gómez, A. (2008). Limitation of Competition in and for the Public Transportation Market in Developing Countries: Lessons from Latin American Cities. *Transportation Research Record: Journal of the Transportation Research Board*, *2048*, 8–15. https://doi.org/10.3141/2048-02

Bea, D. C. (2016). Transport Engineering and Reduction in Crime: The Medellín Case. *Transportation Research Procedia*, *18*, 88–92. https://doi.org/10.1016/j.trpro.2016.12.012

Bel, G., & Holst, M. (2018). Evaluation of the impact of Bus Rapid Transit on air pollution in Mexico City. *Transport Policy*, *63*, 209–220. https://doi.org/10.1016/j.tranpol.2018.01.001

Bocarejo, J. P., Portilla, I. J., Velásquez, J. M., Cruz, M. N., Peña, A., & Oviedo, D. R. (2014). An innovative transit system and its impact on low income users: The case of the Metrocable in Medellín. *Journal of Transport Geography*, *39*, 49–61. https://doi.org/10.1016/j.jtrangeo.2014.06.018

Bogotá Cómo Vamos. (n.d.). Ciudad Bolívar. *Bogotá Cómo Vamos*. Retrieved August 12, 2021, from https://bogotacomovamos.org/localidades/ciudad-bolivar/

Boisjoly, G., & El-Geneidy, A. (2016). Daily fluctuations in transit and job availability: A comparative assessment of time-sensitive accessibility measures. *Journal of Transport Geography*, *52*, 73–81. https://doi.org/10.1016/j.jtrangeo.2016.03.004

Boisjoly, G., & El-Geneidy, A. M. (2017). How to get there? A critical assessment of accessibility objectives and indicators in metropolitan transportation plans. *Transport Policy*, *55*, 38–50. https://doi.org/10.1016/j.tranpol.2016.12.011

Boisjoly, G., Moreno-Monroy, A. I., & El-Geneidy, A. (2017). Informality and accessibility to jobs by public transit: Evidence from the São Paulo Metropolitan Region. *Journal of Transport Geography*, *64*, 89–96. https://doi.org/10.1016/j.jtrangeo.2017.08.005

Brand, P., & Dávila, J. D. (2011). Mobility innovation at the urban margins. *City*, *15*(6), 647–661. https://doi.org/10.1080/13604813.2011.609007

Caldeira, T. P. (2017). Peripheral urbanization: Autoconstruction, transversal logics, and politics in cities of the global south. *Environment and Planning D: Society and Space*, *35*(1), 3–20. https://doi.org/10.1177/0263775816658479

Cámara de Comercio de Barranquilla. (2015). *Observatorio Urbano Local del Área Metropolitana de Barraquilla*. http://www.ambq.gov.co/wp-content/uploads/2017/07/Observatorio-metropolinato-2017.pdf

Camargo Sierra, A. P., & Hurtado Tarazona, A. (2013). Urbanización informal en Bogotá: Agentes y lógicas de producción del espacio urbano. *Revista INVI*, *28*(78), 77–107. https://doi.org/10.4067/S0718-83582013000200003

Cerdá, M., Morenoff, J. D., Hansen, B. B., Tessari Hicks, K. J., Duque, L. F., Restrepo, A., & Diez-Roux, A. V. (2012). Reducing Violence by Transforming Neighborhoods: A Natural Experiment in Medellín, Colombia. *American Journal of Epidemiology*, *175*(10), 1045–1053. https://doi.org/10.1093/aje/kwr428

Cervero, R. (2000). *Informal Transport in the Developing World*. UN-HABITAT.

Cervero, R. (2013). *Bus Rapid Transit (BRT): An Efficient and Competitive Mode of Public Transport* (Working Paper No. 2013–01). Institute of Urban and Regional Development; University of California, Berkeley.

Cervero, R., & Golub, A. (2007). Informal transport: A global perspective. *Transport Policy*, *14*(6), 445–457. https://doi.org/10.1016/j.tranpol.2007.04.011

Cervero, R., & Kang, C. D. (2011). Bus rapid transit impacts on land uses and land values in Seoul, Korea. *Transport Policy*, *18*(1), 102–116. https://doi.org/10.1016/j.tranpol.2010.06.005

Chapple, K. (2020, Spring). *CP 101—City and Regional Planning*. Department of City and Regional Planning at the University of California, Berkeley. http://www.cp101.org

Chatterjee, K., Chng, S., Clark, B., Davis, A., Vos, J. D., Ettema, D., Handy, S., Martin, A., & Reardon, L. (2020). Commuting and wellbeing: A critical overview of the literature with implications for policy and future research. *Transport Reviews*, *40*(1), 5–34. https://doi.org/10.1080/01441647.2019.1649317

Christopher, A. J. (2001). Urban Segregation in Post-apartheid South Africa. *Urban Studies*, *38*(3), 449–466. https://doi.org/10.1080/00420980120080031

City of Cape Town. (2007). *Five-Year Plan for Cape Town—Integrated Development Plan 2007/8-2011/12*. City of Cape Town.

City of Cape Town. (2009). *Integrated Transport Plan 2006-2011 Review 2009*. City of Cape Town.

Collier, D. (1993). The Comparative Method. In A. W. Finifter & American Political Science Association (Eds.), *Political science: The state of the discipline II*. American Political Science Association.

Conway, M. W., Byrd, A., & Van Eggermond, M. (2018). Accounting for uncertainty and variation in accessibility metrics for public transport sketch planning. *Journal of Transport and Land Use*, *11*(1). https://doi.org/10.5198/jtlu.2018.1074

DANE. (2015). *Estratificación socioeconómica para servicios públicos domiciliarios*. Departamento Administrativo Nacional de Estádistica. https://www.dane.gov.co/index.php/servicios-al-ciudadano/servicios-informacion/estratificacion-socioeconomica

DANE. (2019). *Proyecciones de población*. Departamento Administrativo Nacional de Estádistica. https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/proyecciones-de-poblacion

DANE. (2021). *Medición de empleo informal y seguridad social*. Departamento Nacional de Estadística. https://www.dane.gov.co/files/investigaciones/boletines/ech/ech_informalidad/bol_ech_informalidad_dic18_feb19.pdf

Dávila, J. D. (Ed.). (2013). *Urban mobility & poverty: Lessons from Medellín and Soacha, Colombia*. Development Planning Unit, UCL & Faculty of Architecture, Universidad Nacional de Colombia (Medellín campus). http://www.ucl.ac.uk/dpu/metrocables/book

Delmelle, E. C., & Casas, I. (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. https://doi.org/10.1016/j.tranpol.2011.12.001

Deterding, N. M., & Waters, M. C. (2018). Flexible Coding of In-depth Interviews: A Twenty-first-century Approach. *Sociological Methods & Research*, 004912411879937. https://doi.org/10.1177/0049124118799377

DNP. (2004). *Conpes 3306. Sistema Integrado del Servicio Público Urbando de Transprote Masivo de Pasajeros del Distrito de Barranquilla y su Área Metropolitana*. Departamento Nacional de Planeación.

Duckham, M., Goodchild, M. F., & Worboys, M. (2003). *Foundations of Geographic Information Science*.

Duduta, N., Adriazola, C., Hidalgo, D., Lindau, L. A., & Jaffe, R. (2012). Understanding Road Safety Impact of High-Performance Bus Rapid Transit and Busway Design Features. *Transportation Research Record: Journal of the Transportation Research Board*, *2317*(1), 8–14. https://doi.org/10.3141/2317-02

Empresa de Acueducto de Bogotá [@acueductobogota] (2020, Abril 28). Twitter. https://twitter.com/AcueductoBogota/status/1255278043536470016/photo/1

Ernst, J. (2005). Initiating Bus Rapid Transit in Jakarta, Indonesia. *Transportation Research Record: Journal of the Transportation Research Board*, *1903*, 20–26. https://doi.org/10.3141/1903-03

Evans, G. W., & Wener, R. E. (2006). Rail commuting duration and passenger stress. *Health Psychology*, *25*(3), 408–412. https://doi.org/10.1037/0278-6133.25.3.408

Fainstein, S. S. (2010). *The Just City*. Cornell University Press.

Fan, Y., Guthrie, A., & Levinson, D. (2016). Waiting time perceptions at transit stops and stations: Effects of basic amenities, gender, and security. *Transportation Research Part A: Policy and Practice*, *88*, 251–264. https://doi.org/10.1016/j.tra.2016.04.012

Fan, Y., Guthrie, A. E., & Levinson, D. M. (2012). Impact of light rail implementation on labor market accessibility: A transportation equity perspective. *Journal of Transport and Land Use*, *5*(3). https://doi.org/10.5198/jtlu.v5i3.240

Fernandez Milan, B., & Creutzig, F. (2017). Lifting peripheral fortunes: Upgrading transit improves spatial, income and gender equity in Medellin. *Cities*, *70*, 122–134. https://doi.org/10.1016/j.cities.2017.07.019

Figueroa, C. (2010). Determinantes de la informalidad laboral y el subempleo en las áreas metropolitanas de Barranquilla, Cartagena y Montería. *Documentos IEEC, Universidad Del Norte*.

Gamble, J., & Puga, E. (2019). *Is Informal Transit Land-Oriented? Investigating the Links Between Informal Transit and Land-Use Planning in Quito, Ecuador*. https://www.lincolninst.edu/es/publications/working-papers/informal-transit-land-oriented-investigating-links-between-informal

Garsous, G., Suárez-Alemán, A., & Serebrisky, T. (2019). Cable cars in urban transport: Travel time savings from La Paz-El Alto (Bolivia). *Transport Policy*, *75*, 171–182. https://doi.org/10.1016/j.tranpol.2017.05.005

Geurs, K. T., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography*, *12*(2), 127–140. https://doi.org/10.1016/j.jtrangeo.2003.10.005

Gilbert, A., & Ward, P. (1984). Community action by the urban poor: Democratic involvement, community self-help or a means of social control? *World Development*, *12*(8), 769–782. https://doi.org/10.1016/0305-750X(84)90073-1

Gómez-Lobo, A. (2020). Transit reforms in intermediate cities of Colombia: An ex-post evaluation. *Transportation Research Part A: Policy and Practice*, *132*, 349–364. https://doi.org/10.1016/j.tra.2019.11.014

Goodrick, D. (2019). Comparative Case Studies. In *SAGE Research Methods Foundations*. SAGE Publications Ltd. https://doi.org/10.4135/9781526421036849021

Gottholmseder, G., Nowotny, K., Pruckner, G. J., & Theurl, E. (2009). Stress perception and commuting. *Health Economics*, *18*(5), 559–576. https://doi.org/10.1002/hec.1389

Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology*, *91*(3), 481–510. https://doi.org/10.1086/228311

Grengs, J. (2012). Equity and the social distribution of job accessibility in Detroit. *Environment and Planning B: Planning and Design*, *39*(5), 785–800. https://doi.org/10.1068/b36097

Guzman, L. A., Oviedo, D., & Rivera, C. (2017). Assessing equity in transport accessibility to work and study: The Bogotá region. *Journal of Transport Geography*, *58*, 236–246. https://doi.org/10.1016/j.jtrangeo.2016.12.016

Hagen, J. X., Pardo, C., & Valente, J. B. (2016). Motivations for motorcycle use for Urban travel in Latin America: A qualitative study. *Transport Policy*, *49*, 93–104. https://doi.org/10.1016/j.tranpol.2016.04.010

Handy, S. L., & Niemeier, D. A. (1997). Measuring Accessibility: An Exploration of Issues and Alternatives. *Environment and Planning A: Economy and Space*, *29*(7), 1175–1194. https://doi.org/10.1068/a291175

Hansen, W. G. (1959). How Accessibility Shapes Land Use. *Journal of the American Institute of Planners*, *25*(2), 73–76. https://doi.org/10.1080/01944365908978307

Heinrichs, D., & Bernet, J. S. (2014). Public Transport and Accessibility in Informal Settlements: Aerial Cable Cars in Medellín, Colombia. *Transportation Research Procedia*, *4*, 55–67. https://doi.org/10.1016/j.trpro.2014.11.005

Hess, T., Lang, K. R., & Xu, S. X. (2011). Social embeddedness and online consumer behavior. *Electronic Markets*, *21*(3), 157–159. https://doi.org/10.1007/s12525-011-0071-1

Hidalgo, D., Pereira, L., Estupiñán, N., & Jiménez, P. L. (2013). TransMilenio BRT system in Bogotá, high performance and positive impact – Main results of an ex-post evaluation. *Research in Transportation Economics*, *39*(1), 133–138. https://doi.org/10.1016/j.retrec.2012.06.005

Hidalgo, D., & Yepes, T. (2005). *Are Bus Rapid Transit Systems Effective in Poverty Reduction? Experience of Bogotá's TransMilenio and Lessons For Other Cities*. Transportation Research Board Annual Meeting, Washington D.C.

Hilbrecht, M., Smale, B., & Mock, S. E. (2014). Highway to health? Commute time and well-being among Canadian adults. *World Leisure Journal*, *56*(2), 151–163. https://doi.org/10.1080/16078055.2014.903723

Holston, J. (1989). *The Modernist City: An Anthropological Critique of Brasilia*. University of Chicago Press.

Holston, J. (2008). *Insurgent Citizenship: Disjunctions of Democracy and Modernity in Brazil*. Princeton University Press.

International Finance Corporation. (2020, March). *TransMiCable es más que un proyecto de transporte, es un proyecto de inclusión social*. https://www.youtube.com/watch?v=f7WUxKYwm9U

Iseki, H., & Taylor, B. D. (2009). Not All Transfers Are Created Equal: Towards a Framework Relating Transfer Connectivity to Travel Behaviour. *Transport Reviews*, *29*(6), 777–800. https://doi.org/10.1080/01441640902811304

Jackson, K. T. (1987). *Crabgrass Frontier: The Suburbanization of the United States*. Oxford University Press, USA.

Kaza, N. (2015). Time dependent accessibility. *Journal of Urban Management*, *4*(1), 24–39. https://doi.org/10.1016/j.jum.2015.06.001

Kaza, N. (2020, Spring). *PLAN 672—Urban Data Analytics in R*. Department of City and Regional Planning, University of North Carolina at Chapel Hill. https://planning.unc.edu/wp-content/uploads/sites/399/2019/01/PLAN_672_KAZA.pdf

Kumar, M., Singh, S., Ghate, A. T., Pal, S., & Wilson, S. A. (2016). Informal public transport modes in India: A case study of five city regions. *IATSS Research*, *39*(2), 102–109. https://doi.org/10.1016/j.iatssr.2016.01.001

Lionjanga, N., & Venter, C. (2018). Does public transport accessibility enhance subjective well-being? A study of the City of Johannesburg. *Research in Transportation Economics*, *69*, 523–535. https://doi.org/10.1016/j.retrec.2018.07.011

Lleras, G. C. (2003). *Bus rapid transit: Impacts on travel behavior in Bogotá* [Thesis, Massachusetts Institute of Technology]. http://dspace.mit.edu/handle/1721.1/39777

Martens, K. (2016). *Transport Justice: Designing fair transportation systems* (1 edition). Routledge.

Martens, K. (2017). *Transport Justice: Designing Fair Transportation Systems*. Routledge.

Martens, K., Golub, A., & Robinson, G. (2012). A justice-theoretic approach to the distribution of transportation benefits: Implications for transportation planning practice in the United States. *Transportation Research Part A: Policy and Practice*, *46*(4), 684–695. https://doi.org/10.1016/j.tra.2012.01.004

Mayer, K. U. (2007). Retrospective longitudinal research: The German life history study. In *Handbook of Longitudinal Research: Design, Measurement, and Analysis*. Elsevier.

Mertins, G. (2007). Estudios Urbanos-Regionales desde el Caribe: El crecimiento moderno espacial-urbano en Barranquilla:?` Planeación pública-oficial o manejo del sector privado? *Memorias. Revista Digital de Historia y Arqueología Desde El Caribe*, *4*(7), 0.

Montero, S. (2020). Leveraging Bogotá: Sustainable development, global philanthropy and the rise of urban solutionism. *Urban Studies*, *57*(11), 2263–2281. https://doi.org/10.1177/0042098018798555

Muller, P. (2004). Transportation and Urban Form: Stages in the Spatial Evolution of the Amercian Metropolis. In *The Geography of Urban Transportation*. Guilford Press.

Munoz, J. C., & Paget-Seekins, L. (2016). *Restructuring Public Transport Through Bus Rapid Transit: An International and Interdisciplinary Perspective*. Policy Press.

Nugroho, S. B., Fujiwara, A., & Zhang, J. (2011). An empirical analysis of the impact of a bus rapid transit system on the concentration of secondary pollutants in the roadside areas of the TransJakarta corridors: A structural equation model and artificial neural network approach. *Stochastic Environmental Research and Risk Assessment*, *25*(5), 655–669. https://doi.org/10.1007/s00477-011-0472-x

OLX.com (2020, June 20). *Lotes—Venta en Quiba Bajo*. https://www.olx.com.co/quiba-bajo_g5304707/lotes-venta_c410?page=1

Oviedo, D., Scholl, L., Innao, M., & Pedraza, L. (2019). Do Bus Rapid Transit Systems Improve Accessibility to Job Opportunities for the Poor? The Case of Lima, Peru. *Sustainability*, *11*(10), 2795. https://doi.org/10.3390/su11102795

Páez, A., Scott, D. M., & Morency, C. (2012). Measuring accessibility: Positive and normative implementations of various accessibility indicators. *Journal of Transport Geography*, *25*, 141–153. https://doi.org/10.1016/j.jtrangeo.2012.03.016

Peralta Quirós, T., & Mehndiratta, S. R. (2015). Accessibility Analysis of Growth Patterns in Buenos Aires, Argentina: Density, Employment, and Spatial Form. *Transportation Research Record: Journal of the Transportation Research Board*, *2512*, 101–109. https://doi.org/10.3141/2512-12

Pereira, R. H. M., Banister, D., Schwanen, T., & Wessel, N. (2019). Distributional effects of transport policies on inequalities in access to opportunities in Rio de Janeiro. *Journal of Transport and Land Use*, *12*(1). https://doi.org/10.5198/jtlu.2019.1523

Pereira, R. H. M., & Karner, A. (2021). Transportation Equity. In *International Encyclopedia of Transportation* (pp. 271–277). Elsevier. https://doi.org/10.1016/B978-0-08-102671-7.10053-3

Pereira, R. H. M., Schwanen, T., & Banister, D. (2017). Distributive justice and equity in transportation. *Transport Reviews*, *37*(2), 170–191. https://doi.org/10.1080/01441647.2016.1257660

Polanyi, K., & Károly, P. (1957). *The Great Transformation*. Beacon Press.

Portes, A., & Sensenbrenner, J. (1993). Embeddedness and Immigration: Notes on the Social Determinants of Economic Action. *American Journal of Sociology*, *98*(6), 1320–1350.

Rawls, J. (1999). *A Theory of Justice*. Harvard University Press.

Rawls, J. (2001). *Justice as Fairness: A Restatement*. Harvard University Press.

Brand, C. (2018, July 9). El mapa del transporte informal en Bogotá. *RCN Radio*. https://www.rcnradio.com/recomendado-del-editor/el-mapa-del-transporte-informal-en-bogota

Rekhviashvili, L., & Sgibnev, W. (2020). Theorising informality and social embeddedness for the study of informal transport. Lessons from the marshrutka mobility phenomenon. *Journal of Transport Geography*, *88*, 102386. https://doi.org/10.1016/j.jtrangeo.2019.01.006

Rodríguez, D. A., Santana, M., & Pardo, C. F. (2015). *La motocicleta en América Latina: Caracterización de su uso e impactos en la movilidad en cinco ciudades de la región* (Despacio). CAF. http://scioteca.caf.com/handle/123456789/754

Rodriguez, D. A., & Targa, F. (2004). Value of accessibility to Bogotá's bus rapid transit system. *Transport Reviews*, *24*(5), 587–610. https://doi.org/10.1080/0144164042000195081

Rodriguez, D. A., Vergel-Tovar, E., & Camargo, W. F. (2016). Land development impacts of BRT in a sample of stops in Quito and Bogotá. *Transport Policy*, *51*, 4–14. https://doi.org/10.1016/j.tranpol.2015.10.002

Roy, A. (2005). Urban Informality: Toward an Epistemology of Planning. *Journal of the American Planning Association*, *71*(2), 147–158. https://doi.org/10.1080/01944360508976689

Salazar Ferro, P., & Behrens, R. (2015). From direct to trunk-and-feeder public transport services in the Urban South: Territorial implications. *Journal of Transport and Land Use*, *8*(1), 123. https://doi.org/10.5198/jtlu.2015.389

Santana Palacios, M., Cochran, A., Bell, C., Hernández Jiménez, U., Leshner, E., Trejo Morales, F., & Chatman, D. G. (2020). Bus rapid transit arrives in Barranquilla, Colombia: Understanding a changing landscape through residents' travel experiences. *Travel Behaviour and Society*, *21*, 131–139. https://doi.org/10.1016/j.tbs.2020.06.003

Sarmiento, O. L., Higuera-Mendieta, D., Wilches-Mogollon, M. A., Guzman, L. A., Rodríguez, D. A., Morales, R., Méndez, D., Bedoya, C., Linares-Vásquez, M., Arévalo, M. I., Martínez-Herrera, E., Montes, F., Meisel, J. D., Useche, A. F., García, E., Triana, C. A., Medaglia, A. L., Hessel, P., Arellana, J., … Diez Roux, A. V. (2020). Urban Transformations and Health: Methods for TrUST—a Natural Experiment Evaluating the Impacts of a Mass Transit Cable Car in Bogotá, Colombia. *Frontiers in Public Health*, *0*. https://doi.org/10.3389/fpubh.2020.00064

Scholl, L., Bouillon, C., Oviedo, D., Corsetto, L., Jansson, M., & Gray, C. (2016). *Urban Transport and Poverty: Mobility and Accessibility Effects of IDB-supported BRT Systems in Cali and Lima*.

Seekings, J., & Nattrass, N. (2005). *Class, Race, and Inequality in South Africa*. Yale University Press.

Sgibnev, W., & Vozyanov, A. (2016). Assemblages of mobility: The marshrutkas of Central Asia. *Central Asian Survey*, *35*(2), 276–291. https://doi.org/10.1080/02634937.2016.1145381

Silva Ardila, D. (2020). Global policies for moving cities: The role of think tanks in the proliferation of Bus Rapid Transit systems in Latin America and worldwide. *Policy and Society*, *39*(1), 70–90. https://doi.org/10.1080/14494035.2019.1699636

Simon, H. A. (1978). Rationality as Process and as Product of Thought. *The American Economic Review*, *68*(2), 1–16.

Soto, H. D. (1989). *The Other Path: The Economic Answer to Terrorism*. Basic Books.

Stats SA. (2011). *South Africa Census*.

Stewart, A. F. (2017). Mapping transit accessibility: Possibilities for public participation. *Transportation Research Part A: Policy and Practice*, *104*, 150–166. https://doi.org/10.1016/j.tra.2017.03.015

Stewart, A. F., & Zegras, P. C. (2016). CoAXs: A Collaborative Accessibility-based Stakeholder Engagement System for communicating transport impacts. *Research in Transportation Economics*, *59*, 423–433. https://doi.org/10.1016/j.retrec.2016.07.016

Taylor, B., & Norton, A. (2009). Paying for Transportation: What's a Fair Price? *Journal of Planning Literature*, *24*(1), 22–36. https://doi.org/10.1177/0885412209347156

TransMilenio. (2018, December 23). *Abecé de TransMiCable*. https://www.transmilenio.gov.co/publicaciones/151067/abece-de-transmicable/

Venter, C., Jennings, G., Hidalgo, D., & Valderrama Pineda, A. F. (2017). The equity impacts of bus rapid transit: A review of the evidence and implications for sustainable transport. *International Journal of Sustainable Transportation*, 1–13. https://doi.org/10.1080/15568318.2017.1340528

Wachs, M., & Kumagai, T. G. (1973). Physical accessibility as a social indicator. *Socio-Economic Planning Sciences*, *7*(5), 437–456. https://doi.org/10.1016/0038-0121(73)90041-4

Wardman, M. (2004). Public transport values of time. *Transport Policy*, *11*(4), 363–377. https://doi.org/10.1016/j.tranpol.2004.05.001

Williams, S., White, A., Waiganjo, P., Orwa, D., & Klopp, J. (2015). The digital matatu project: Using cell phones to create an open source data for Nairobi's semi-formal bus system. *Journal of Transport Geography*, *49*, 39–51. https://doi.org/10.1016/j.jtrangeo.2015.10.005