Transportation in the Favelas of Rio de Janeiro

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Abstract

This paper presents findings on transportation patterns in the slums of Rio de Janeiro, based upon a survey of 2,000 residents in three favelas of diverse typology and geographic location. This study aims to fill a gap in the academic literature on transportation in informal or slum areas. Implications for policy are considered for how transportation investments can guide slum-upgrading programs and we highlight a knowledge gap in transportation planning for slum-upgrading programs. We analyze mobility index, vehicular ownership, non-motorized transportation, trip times and motives, and perceptions of road safety. We identify variations in travel both within and outside the favelas, and compare transportation use between residents of the formal city and the favelas.

Keywords: transportation, Rio de Janeiro, favelas, slum-upgrading, road safety

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Table of Contents

List of Figures, Tables, and Graphs

Transportation in the Favelas of Rio de Janeiro

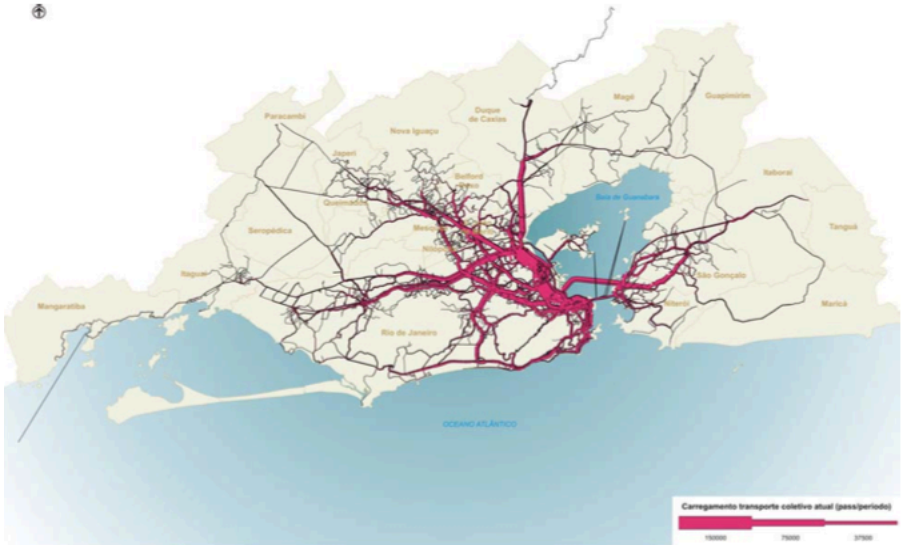
Introduction

Transportation in Rio de Janeiro

The city of Rio de Janeiro is undergoing a massive transformation. The specter of hosting the 2014 World Cup and 2016 Summer Olympic Games combined with an influx of federal funding for urban areas have brought the feeling that the city is one enormous construction zone. Investments in transportation infrastructure seek to effectively move massive numbers of international visitors during the mega-events and help unite a highly unequal metropolis after they have left.

The formal transportation network of Rio de Janeiro includes a large number of bus and van routes, a 35km two line Metro, five lines of an extensive yet degraded suburban rail network totaling 150kms, and commuter ferry boats that cross the Guanabara bay between Rio and nearby Niteroi. The city inaugurated a new cable car system in 2011 linking the suburban train network with the massive Complexo de Alemão favela. The informal, non-regulated transportation system comprises a variety of services ranging from moto-taxis[1] to vans.

Figure 1. Visualization of Public Transportation flows in Rio Metro Region[2]



The first of four projected Bus Rapid Transit (BRT) corridors was opened in early 2012 in the Barra de Tijuca region and will help carry passengers from the future extension of the Metro to

[1] "Moto-taxis" are motorcycle taxis, typically considered to be part of the informal transport sector, though some operate legally. The service is reported to be offered in 90% of Brazilian towns and 50% of major cities, see Vasconcellos 2012, p. 3.

[2] Image retrieved from PDTU 2003, p. 50.

the principal sites of the Olympic Games. There is a light-rail line projected to run between the Downtown and the revitalized Port area, also an Olympics legacy project. There is even talk of tearing down a hulking elevated highway which blights some formerly pleasant neighborhoods near the center of the city.

Figure 2. Visualization of Public Transportation Flows Rio City[3]

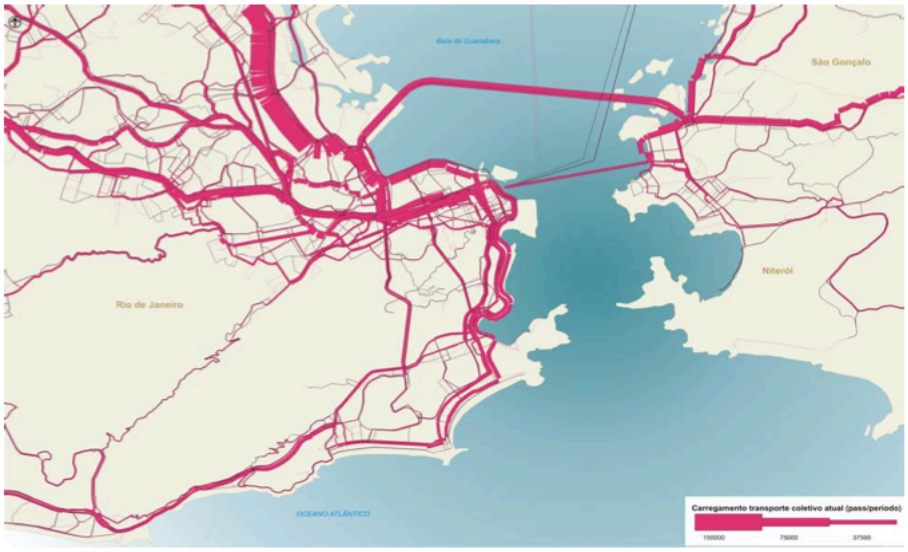


Figure 1 shows the flow of public transport trips in the Metro region while figure 2 depicts the flows in the urban core of Rio. These figures demonstrate the most trafficked corridors in the region and the city, and provide visual representation of the almost 9,000,000 daily public transport trips.[4]

There are serious questions of access and equity when it comes to the daily transportation reality of the poorest residents of the city. There remain large portions of the city that are informally settled and lack public services including public transportation. The problem of integrating the residents of favelas into the formal city and providing access to mass transport is stymied by a lack of data and research into their transportation habits and needs. The process of pacification of the favelas over the last few years offers the opportunity for inquiry and data gathering of the largely undocumented transportation habits and needs of a substantial portion of the city's population.

UPP and Favela Pacification

The 2010 census found the population of the city of Rio de Janeiro is just under 6 million and the population of the metropolitan region is 11.7 million. Residents of Rio's favelas make up almost 15 percent of the population, at around 1.7 million people.[5] The metropolitan region has the

[3] Image retrieved from PDTU 2003, p. 51.

[4] PDTU 2003, p. 10.

[5] IBGE 2010, Aglomerados subnormais: primeiros resultados, Tabela 3.

second highest favela population in Brazil, behind only São Paulo. The census identifies over 760 distinct favelas in the city. Despite the physical and social magnitude of the favelas, the transportation patterns in these areas are rarely studied and little understood.
Transportation is an integral part of the history and development of the favelas of Rio de Janeiro. The earliest favelas sprung up centrally in the city in part due to the lack of transportation access to more affordable yet peripherally located housing.[6] In recent years the favelas have been famous primarily for their spectacular violence as rival drug factions and milicia[7] fought for control of territories as bases for their lucrative business in illegal narcotics.

The pressure of hosting the international community in coming years and the ambitions of a small cadre of politicians has led to a dramatic change. Beginning in late 2008 the police began a new tactic and policy towards policing the favelas. Rather than quick operations that entered and then exited the areas, the police would now stay and occupy the favelas, replacing the parallel power of the drug gangs and milicia with the official hand of the state. The new police units receive special training, higher salaries, and aim to integrate themselves into the communities they are protecting.[8] The policing program, known as the UPP, which stands for units of pacifying police, already occupies wide swaths of territory in strategic parts of the city (see figure 3).

Figure 3. Map of Complexo da Penha UPP Installations[9]

[6] Cardoso, Elias, Pero, p. 1, and see also Secretaria Municipal de Habitação 2003, p. 15.

[7] Terms like *milicia* that have been left in their Portuguese form are explained in the Glossary of Terms on pages 6–7.

[8] See Romero 2011 and Barrionuevo 2010.

[9] The red lines delineate the limits of the favela territory and the blue outlines the limits of the UPP territory. Image retrieved from http://www.uppsocial.org/wp-content/uploads/2012/06/UPP-Chatuba-e-F%C3%A9-Sereno.jpg.

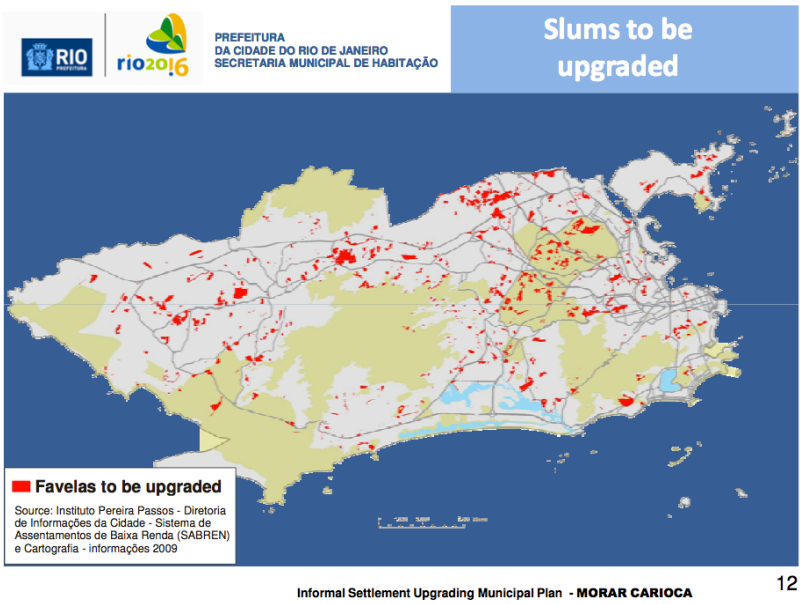
The success of the pacification so far has allowed public authorities to enter into formerly inaccessible terrain. Government officials, from across the full spectrum of public services can now focus efforts on providing benefits to the favelas and begin to try to patch together an integrated city. The informal settlement and growth patterns of the favelas have been a consistent and enduring challenge for city officials seeking to provide infrastructural upgrades and improve the quality of life for local residents.

Morar Carioca Favela Upgrading Program

Building upon the success of a public architecture competition held during the Favela-Bairro program of the 1990s, the Municipal Secretariat for Housing signed an agreement with the Brazilian Institute of Architects chapter in Rio de Janeiro (IAB) in 2010. The IAB would help organize a new architecture competition to solicit proposals for favela upgrading as well as organize seminars and trainings for the 40 architecture firms and interdisciplinary teams selected. The results of the competition, "Concurso Morar Carioca" were announced in late 2010. From the 86 submissions 40 interdisciplinary teams were selected.[10] Morar Carioca means roughly "to live Carioca (as the local residents of Rio are known);" the goal is extending citizenship and full social rights through the physical upgrading of the favelas, forging new linkages between the formal and informal cities, and the provision of public services.[11]

See figure 4 to see the scope and geographic distribution of the favelas to be upgraded by Morar Carioca.

Figure 4. Favelas To Be Upgraded by Morar Carioca[12]



[10] For contest information and winning submissions, see http://concursosdeprojeto.org/2010/12/18/premiados-concurso-morar-carioca/

[11] Secretaria Municipal de Habitação and Brazilian Institute of Architects, 2011.

[12] Morar Carioca Presentation, 2011, slide 12.

Investments in mobility are a central focus of Morar Carioca. It is telling that the first panel organized by the IAB was titled "Urban mobility, public transport and the city for all." The overall objective of the Morar Carioca program is to create an "Integrated City," and transportation investments, particularly alternative and innovative solutions, are the primary means towards achieving this long-sought goal. At the first panel, Secretary of Housing, Jorge Bittar said:

> "Both the first public works realized by the State-level government, with financing from the PAC, and those developed in the initial phase of Morar Carioca sought to ensure the right of mobility, through the implementation of alternative transportation investments—cable car, elevators, and funicular—and a roadway system that would allow all households access to public services such as garbage collection, hospital emergencies, and firefighting. The enormous diversity of types of occupations, however, prevents the use of static models to solve the problems of accessibility, demanding a combination of multiple means that offer the best cost-benefit ratio."[13]

This research project is motivated by the lack of data available on questions of transportation in the favelas. While there are significant barriers and issues with data collection, it is critical that the Morar Carioca program base its transportation investments on a detailed and accurate understanding of the local conditions and needs. This paper aims to fill a hole in the current academic literature as well as inform the Morar Carioca program.

Through a methodology targeted at pacified favelas, this paper's aim is to paint an initial picture of transportation patterns through original survey data collected in three favelas during early 2012. In the Literature Review, we will place our research effort in the context of previous work in the field and demonstrate the unprecedented nature of our study.

The Methodology section details the research process through sample selection, survey design, survey implementation, and the constraints of the study. We profile each of the case study communities and present socio-economic characteristics of the survey population, looking at income levels, employment and educational attainment. The Findings section of the paper presents an overview of our survey results, divided into sections on vehicular ownership, modal splits, mobility index, non-motorized transportation, trip times and motives, hourly distribution of travel, and perceptions of road safety. We then compare the formal and informal cities, analyzing our favela survey data against a secondary data source—the official 2002 citywide origin-destination travel study. Finally we outline the policy implications of our work, offering recommendations geared towards the policymakers shaping the favela upgrading efforts in Rio, and propose directions for future research.

Literature Review

[13] Bittar, 2011, p. 10.

This section presents an overview of the relevant current discourse relating to urban transportation and slum settlements. There is no comprehensive bibliography available of studies of transportation use in slum or informal areas. We have therefore compiled one, as a guide for this paper and for future researchers (see Appendix A). Within the preexisting scholarly work, a few principal areas of focus were identified: urban transportation and poverty, social/spatial exclusion and transportation, informal transportation, subsidies and transportation affordability, transportation and housing location, gender and transportation, and road safety. We also review the growing body of literature related to urbanization and slum upgrading programs. Brazil has a well-documented history of slum-upgrading programs, particularly in São Paulo and Rio de Janeiro. However the discussion of transportation within these programs is cursory. Medellin, Colombia is the most celebrated and studied recent case of urbanization in informal areas and mobility investments are a central component, most famously the cable-car system implemented in the early 2000s.

The relationship between poverty and transportation is a primary concern for much of the previous work.[14] Many of these studies held the same aim as ours, such as Renny's 2009 paper "Access to Transportation for the Urban Poor in Indonesia," which focused on understanding "mobility needs and access to transportation" in informal settlements in Indonesia. It utilized a broad methodology that aimed "to capture the travel system—formal and informal—in the settlements, typical destinations/trip purposes and key challenges."[15] Srinivasan and Rodgers' 2005 paper "Travel behavior of low-income residents in two contrasting locations in the city of Chennai, India" used central and peripheral case study locations to conclude that location of residence was "significant in travel behavior…it appears to affect all aspects of travel behavior: time spent, cost, frequency, and mode choice for the trip."[16] They also found that residents of the centrally located area make more non-motorized trips and women in the central location make more trips than those (women) in the periphery.

Similarly, Baker et al aimed in their 2005 study "Urban Poverty and Transport: The Case of Mumbai" (India) to "study the travel behavior of the poor and the non-poor as a function of residential location, employment location, the time and money costs of travel and the quality of transit service."[17] Their study found high reliance on walking for non-work trips, and public transport for work trips.

Much of the previous research found that the lack of affordable, accessible, or efficient transportation systems has led to walking as the main mode of transportation in slums.[18] In a study funded by the World Bank entitled "Poverty, Living Conditions, and Infrastructure Access: A Comparison of Slums in Dakar, Johannesburg, and Nairobi" Gulyani et al found that use of motorized public transport was low across all three cities, and walking was the primary

[14] See Gulyani et al. 2010, Renny 2009, Zhong-Ren et al 2008, Baker et al 2005, Srinivasan 2005, SITRASS 2004 (x2), Shuiying et al 2003, Urban Resource Center 2001, Howe and Bryceson 2000, Palmer et al 1997, Gannon and Liu 1997, and Booth et al 2000.

[15] Renny, 2009, p. 3.

[16] Srinivasan and Rogers, 2005, p. 273.

[17] Baker et al, 2005, p. 2.

[18] See Shuiying et al 2003, Howe and Bryceson 2000, Gulyani et al 2010, Baker et al 2005, and SITRASS 2004 (x2).

transportation mode for slum residents in Nairobi (Kenya) and Dakar (Senegal).[19] World Bank funded studies in Douala (Cameroon) similarly found that mobility was centered in a small neighborhood radius and most trips were made on foot.[20] A parallel World Bank study in Conakry (Guinea) found that mobility is severely constrained by an inadequate road network and an ineffective public transport system, and that walking accounts for around three-quarters of trips for both and poor and non-poor residents.[21]

Gender and transportation is another area of focus within the literature.[22] Most studies found that women face mobility restrictions compared to men, and frequently rely on walking as the primary transportation mode. Christoffel et al.'s 2007 study in Durban (South Africa) found that women travel less and walk more, and these differences were more pronounced for locations farther from the city center. They also found that women who lived in the urban core had very similar mobility patterns to men.[23] Anand and Tiwari found that women in Delhi (India) "lack mobility in the city due to gender-based restrictions, inferior access to transportation means, a high dependence on low-quality public transport, and a lack of availability of affordable modes of travel."[24] In Pune, India, Astrop found that women are more likely to walk or take public transport, and have less access to private vehicles.[25]

There is a growing literature on road safety in urban areas, but almost nothing written about road safety issues in slums.[26] Hoque has done work in Bangladesh focused on the road safety issues of vulnerable road users and found that they constitute the vast majority of traffic accident fatalities. Shuiying et al found anecdotal evidence from Wuhan, China that shows newly paved roads lead to an increase in vehicular speeds, which leads to more pedestrian accidents.[27] Golub et al highlighted the difficultly in analyzing road safety without proper data on accidents, "there was no satisfactory data or studies on accident rates."[28] The Urban Resource Center's 2001 study in Karachi (Pakistan) found death and injury from accidents are top concern for users, operators, and regulators.[29] In *Planet of Slums* Davis focuses on the impact of road safety in polemical language: "The result of this collision between urban poverty and traffic congestion is sheer carnage."[30]

The World Health Organization (WHO) has led the way in highlighting the significance of road deaths in the total worldwide mortality of vulnerable population groups including the young, women, and the elderly. The WHO reports that road deaths are the number one cause of death

[19] Gulyani et al, 2010, p. 14.

[20] SITRASS, 2004, p. 57.

[21] SITRASS, 2004, p. ii.

[22] See Peters 2011, Salon and Gulyani 2010, Anand and Tiwari 2006, Astrop 1996, Christoffel et al 2007,

[23] Christffel et al, 2007, p. 674-75.

[24] Anand and Tiwari, 2006, p. 78.

[25] Astrop, 1996, p. 244-45.

[26] See Hoque et al 2008 and Bhattacharya et al 2007.

[27] Shuiying et al, 2003, p. 31.

[28] Golub et al, 2009, p. 607.

[29] Urban Resource Center, 2001, p. 232.

[30] Davis, 2007, p. 132.

for young people worldwide and is projected to become the fifth leading cause of death in the world. Furthermore, 90 percent of the deaths occur in developing countries.[31] Brazil has an annual road traffic mortality rate of 20 deaths per 100,000 people, according to research from the John Hopkins Bloomberg School of Public Health.[32] The growth in motorcycles sales and more widespread motorcycle use has dramatically changed the number of deaths related to motorcycles crashes in Brazil. Vasconcellos documents that from 1996 to 2006 motorcycle fatalities rose from 2.1 percent to 19.4 percent of all traffic deaths in Brazil.[33]

While most of the papers took quantitative approaches to the study of urban transportation and poverty, some have acknowledged the difficulty in accessing or generating this data. Peng and Zhu state that "The urban poor mainly rely on walking, bicycling, paratransit, and buses to get around." Yet they cite no specific studies, instead relying on "information derived from other data sources as well as field observations," and going on to note "it becomes difficult to analyze the travel modes and travel costs of the urban poor based on available transportation survey data."[34]

Our review of the literature found a geographic bias in slum transportation studies, which tend to be located in Africa and Asia with little focus on South America or Brazil. Only one other study known to the authors focuses solely on transportation and poverty in Rio, completed in 2003 by the Instituto de Desenvolvimento e Informação em Transporte. The study conducted 1,600 interviews in low-income households across Rio de Janeiro in addition to focus group interviews. The study found that the poor have generally low mobility indexes (as measured by trips/day). Public transport (bus) and walking were the primary modes of transportation, and work and education the primary trip motives.

The linkages between social exclusion and transportation in Rio have received some attention.[35] Silva Lemos et al believe the transportation system is tied to social exclusion but find it difficult to prove causality. Gomide looks at the relationships between poverty, social exclusion, and transportation and finds there are both direct and indirect links between them. Outside of Rio, Lucas has done extensive work looking at social exclusion and transportation.[36] While her work initially focused in the U.K., she has recently studied transportation and exclusion in South Africa.[37] She found that high travel costs and lack of accessibility to formal public transport are significant hardships added on top of other financial and physical hardships faced by the low-income population.[38]

Other research on transportation in Rio has tended to focus on specific aspects of travel such as access trips or informal transportation. Carvalho de Souza highlights the spatial disconnect

[31] Make Roads Safe, 2011, p. 4.

[32] Chandran et al, 2012, p. 11.

[33] Vasconcellos, 2012, p. 3.

[34] Peng. Z.R., 2010, p. 161.

[35] See Silva Lemos 2004 and Gomide 2003.

[36] See Lucas 2001 and 2010, and Lucas et al 2001.

[37] See Lucas 2011.

[38] Lucas, 2011, p. 1332.

between jobs and housing in the city. Her research focuses on access trips in two outlying neighborhoods utilizing a mixture of qualitative and quantitative survey methods. She found that walking, informal transportation, and bus were the main modes utilized in access trips to public transport. Interestingly, car and bicycles were not frequently used, representing less than 5 percent of the total access trips. She also found that walking is used for the shortest trips, while use of bus and informal transportation increases with access trip distance increase.[39] Cervero and Golub looked at the prevalence of informal transportation in Rio:

> "Total van ridership in the metropolitan region was about 150,000 trips per day in 2003, compared with 8 million trips by bus, and 350,000 each for suburban rail and metro. A large share of these trips by van, however, is concentrated in several important corridors linking downtown to the western suburbs and the Baixada Fluminense. In particularly affected corridors, vans might carry up to half of all trips."[40]

Cervero also has a chapter on informal transportation in Brazil from his 2000 book *Informal Transport in the Developing World*. He credits the rise in informal vans around the year 1995 to the declining quality of bus service. In 2009 Golub et al looked at proposed policies for the regulation of the informal transportation sector in Rio and analyzed their potential impacts on users. They conclude that "regulation of informality, eradication of monopoly in the formal sector, along with improvements in the service levels of the mass modes hold potential to bring substantial welfare gains."[41]

Fabricius notes that due to the small size of the vans they are able to penetrate the narrow street network of favelas "producing a broader, thinner, and more diverse transportation network. This network could be thought of as a diagram reflecting the true complexity of Rio's urban form."[42]

There is a rich history of social science research in the favelas of Rio; they have fascinated researchers since their inception in the late 19th century. We select a limited slice of this work in order to provide some context for our research objectives within a larger constellation of previous work centered in and on the favelas of Rio.

Valladares and Medeiros completed a comprehensive overview of research relating to Rio's favelas, indexing 668 papers, articles, books, and even university theses.[43] Within this exhaustive analytical bibliography of 668 sources, there is not a single one dedicated to transportation in the favelas.

Perlman conducted one of the most remarkable studies ever done in the favelas, focused on urban poverty and prevailing notions of "marginality."[44] After first venturing into Rio's favelas in 1968, she returned thirty years later and tracked down 1/3 of her original study participants.

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[39] de Souza et al, 2010, p. 7.

[40] Cervero and Golub, 2011, p. 511.

[41] Golub et al, 2009, p. 614.

[42] Fabricius, 2008, p. 14.

[43] Valladares and Medeiros, 2003.

[44] See Perlman 2004 and 2010.

This allowed her to conduct a multi-generational longitudinal panel study of social mobility and urban poverty. The work follows up on her *Myth of Marginality*, first published in 1976. She presented her preliminary findings in 2004 and then published *Favela: Four Decades of Living on the Edge in Rio de Janeiro* in 2010. She paints a complex picture of changes in favela life over the last 40 years and finds that new levels of violence and economic and social exclusion coexist tenuously with overall improved quality of life.

Magalhães and Xavier provide a good overview of the favelas' history and development, as part of the "Understanding slums—case studies for the Global Report on Human Settlements 2003." O'Hare and Barke show that Rio's favelas do not follow typical spatial patterns of informal settlements found in other Latin American cities and their growth and development is due to a complex and dynamic interplay of economic, political, and geographical factors.

Transportation is also understudied within the literature on urbanization and slum-upgrading programs. We will focus in primarily on the literature dealing with the country of Brazil, and the cities of São Paulo and Rio de Janeiro that have the best-documented citywide slum-upgrading or urbanization programs. Medellin Colombia has attracted a great deal of attention for its upgrading programs in the *comunas* or slums that crawl up the slopes of the Aburrá valley and the introduction of a cable-car system, adapting the European ski technology to the urban slum setting.

Barber has noted the challenge of integrating transportation and slum upgrading programs:

> "The trend in slum upgrading programs seems to be toward more integration. Across the different government agencies responsible for upgrading favelas, integration of transportation and environmental considerations is inconsistently executed or identified in the upgrade plans. There appears to be no formal, reliable or robust partnership between transport and slum upgrading agencies, despite the often systemic linkage."[45]

São Paulo has a well-documented and extensive recent history of innovative slum-upgrading programs.[46] Yet an explicit focus on transportation is largely absent from this body of work, with two exceptions. One, the collaboration with Urban Think Tank, who have recognized the importance of mobility in upgrading projects.[47] And the other, de Mello Franco, one of the architects responsible for upgrading projects in São Paulo, who described his designs for a new mobility corridor in Paraisópolis, the second largest favela in the city:

> "[There] will be a corridor of open spaces of varying widths for cyclists and pedestrians. This corridor sits on the site's gentlest slopes and will be the main mobility axis for the neighborhood. These intense human flows will foster the dynamics that activate and safeguard places."[48]

[45] Barber, 2009, p. 42.

[46] See http://www.habisp.inf.br/doc/ for the impressive trove of documents.

[47] See Brillembourg et al, 2010.

[48] de Mello Franco, 2011, p. 85.

In contrast to São Paulo, upgrading efforts in Medellin have employed alternative and innovative transportation projects as a central component of their slum upgrading programs, most notably the cable car system. There is already a large body of work investigating the impacts of these mobility investments. The Development Planning Unit at the University College London, together with partners at the Universidad Nacional de Colombia and the Universidad de los Andes created the Metrocables research project, titled "Local Governance, Urban Mobility and Poverty Reduction: Lessons from Medellin, Colombia."

Much of the research has concluded that the greatest benefits of the cable system are symbolic, relating to the change in perception of how the rest of the city views the *comuna* and how local residents view themselves and their neighborhood.[49] The transportation benefits of the system are mixed. Brand and Davila write that the mobility improvements have been largely limited to workers employed in the formal sector.[50] Davila and Daste reiterate this point and note that transportation improvements have been largely in travel cost reductions, while the cable-car system has done little to reduce travel times for these workers.[51] They conclude that the cable system had accessibility, social, and environmental benefits in the areas they were implemented. "The system has helped to improve the quality of life of the urban poor by making it easier for them to access the opportunities of the city, by enhancing the visibility of the socially stigmatized areas in which they live, and by improving air quality."[52]

The cable system was proposed as a stand-alone transportation project, but was later integrated into a comprehensive slum-upgrading strategy called "Integrated Urban Projects."[53] Gouverneur and Grauer note the focus on transportation investments in Medellin as part of a larger effort: "Value-creating interventions like building transportation, then public spaces at stations, then boulevards that lead to neighborhoods, plazas, parks, and retails are phased and overlapped."[54]

Research on Rio de Janeiro's history of slum-upgrading has focused predominantly on the Favela-Bairro program of the 1990s, the first coordinated and internationally financed major upgrading program in the city. Favela-Bairro attempted to intervene comprehensively in the favelas, addressing physical and infrastructural disparities as well as socio-economic exclusion and segregation. Investments in transportation were branded as "circulation" and resulted primarily in the paving of roads and improvement of stairways. These circulation routes, as Mossop notes, were "crucial to the movement of goods and people through the favelas…new circulation routes changes the urban structure of the favelas, providing hierarchy, making connections, and creating areas of concentration."[55] Though the category of "circulation" would seem to imply a broad conception of how people get around, in actuality it resulted in a relatively narrow range of built projects. The transportation or "circulation" interventions were one

[49] Brand and Davila, 2009, and Blanco and Kobayashi, 2007.

[50] Brand and Davila, 2009, pp. 644-655.

[51] Davila and Daste, 2011, p. 7.

[52] Davila and Daste, 2012, p. 4

[53] Davila and Daste, 2011, p. 5.

[54] Gouverneur and Grauer, 2008, p. 30.

[55] Mossop, p. 64.

component of a multifaceted design and engineering approach that attempted to take local conditions and knowledge into account, albeit in a fragmented way.

Segre identifies one of the objectives of the Favela-Bairro upgrading program: "to guarantee accessibility to all places in the city."[56] It is unclear from the language whether this is an explicit focus on transportation per se, or on a broader concept of accessibility—in which transportation plays a central role. Duarte and Magalhães write that the surveys of the favelas reached by Favela-Bairro:

> "Indicate that Favela-Bairro achieved one of its major goals: to correct the discontinuities in street grids, infrastructure, and public services by means of a qualitative improvement in the urban conditions of the favelas. The data also seem to indicate that the communities experienced significant improvements in sanitary conditions and in accessibility within the favela, to places of work outside, and to public facilities and urban services."[57]

Fiori and Brandão do the best job of describing the important links between transportation and community cohesion in Rio's favelas:

> "The great majority of dwellings in these consolidated areas are located along roads and better-defined pedestrian streets, in more recently developed areas houses are precariously built along narrow and sometimes dead-end footpaths. The lack of connection between areas within the same settlement—due to poor circulation systems for both cars and pedestrians—results in deficient internal social integration."[58]

They also highlight the particular difficulties faced by communities perched on the sides of hills and other areas with steep topographies:

> "The situation is even worse in the favelas settled on steep hillsides. These have precarious circulation systems formed mostly by narrow footpaths which occasionally represent 90 per cent of the circulation network, a situation that makes walking up and down the hills very hard for the dwellers that live at the top. In some cases, there is only one vehicular access route for the entire settlement."[59]

Rivera notes the series of transportation projects in favelas in Rio over the last few years: funicular in Dona Marta (2006), public elevator in Pavão-Pavãozinho (2010), and the cable car in Complexo do Alemão (2011).[60] He also highlights the pros and cons of these projects, emphasizing the fact that these efforts have led to mixed results in terms of improving mobility for local residents.[61]

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[56] Segre, 2010, p. 171.

[57] Duarte and Magalhães, 2009, p. 286.

[58] Fiori and Brandão, 2010, p. 195.

[59] Fiori and Brandão, 2010, p. 195.

[60] See Rivera 2011.

[61] The pros: mobility infrastructure brings visibility to the interventions, improvement in mobility and accessibility standards, new urban landmarks for the city, improvement in inhabitants self-esteem, and change in perceptions

Fabricius nicely sums of the situation of the favelas with the example of Morro de Providência, known as the first favela in Rio: "As an island floating within one of the oldest and most highly-planned sections of the city, Providência came to define what would be the qualities of the quintessential Rio favela—embedded yet isolated, close yet far, integrated yet segregated."[62]

It is clear from this review of the academic literature that there is a gap in knowledge about transportation in slum areas. Research on urban transportation has looked at the urban poor but has not tended to analyze the transportation patterns of certain settlement types or informal areas. There is much future work to be done in this area. It is also noted that transportation is largely absent from discussion and analysis of large-scale slum-upgrading programs, with the exception of the recent case of Medellin.

Research Methodology

It is evident from the Literature Review that there is no standard methodological approach to studying transportation in slum areas.[63] Especially given the lack of previous work focused in Brazil, there was little precedent on which to base our own methodology. Most of the relevant previous studies on urban transportation focused on the poor or low-income residents, and selected case study locations to achieve a representative sample of the urban poor. Our approach, however, was to target residents of a specific settlement type—favelas—rather than take a focus on the urban poor more generally. Our aim was to generate a wide range of empirical data on key transportation questions, with a look towards translating the research findings into policy guidelines and to highlight the importance of mobility in upgrading programs. Rather than focus on a single research question such as "transportation and poverty" or "road safety," we took a broad approach in order to produce initial findings on a spectrum of key transportation questions.

The development of a research methodology included: writing a survey tool, hiring a local research team, selecting sample sites, making contact with key stakeholders and local leaders in the sample sites, and conducting a pilot survey. A local research team with experience in favelas-based surveys was hired to complete the data collection and the data entry, working closely and collaboratively with the authors.

Survey Design[64]

Designing a research survey is an imperfect science. The aim is to create a tool that is easy to use on the part of the research team and easily understood by the interview participants.

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about the favelas. The cons: lack of planning and waste of resources, low community participation in the decisions, poor design standards, design subjected to political interference and non-technical decisions, non-transparent construction process, neglect of other infrastructure with low visibility, and stimulus to gentrification. See Rivera, 2011, pp. 102-103

[62] Fabricius, 2008, p. 11.

[63] See also Appendix 1 for more details on the methodologies of previous studies.

[64] Please see Appendix B for a copy of the Survey Questionnaire.

One of the tools available to guide our survey design was the Origin-Destination (OD) study completed in the city in 2002–2003. The OD study provides a useful picture of macro trends in transportation patterns for the metropolitan region of Rio de Janeiro. While the Rio OD study is useful for transportation planners and researchers looking at macro trends in transportation use patterns, the data does not detail trends at a favela level. For the purposes of our research, it is a critical secondary data source, allowing us the opportunity to compare data on the favelas versus the metro region. Our survey took into account the numbers available from the OD in order to make our data easier to compare. The constraints of this comparison, however, cannot be ignored, and are detailed later.

When addressing mobility in the favelas there are two main issues: travel within the favela and travel outside the favela in the formal city, both of which contribute to determining an overall picture of how people get around on a daily basis. We designed our survey in order to capture both trips within the favela and outside, giving us the ability to analyze differences in travel patterns and usage characteristics.

Sample Selection

As demonstrated in the Literature Review, most previous surveys of transportation in slums have focused on poor or low-income populations and not on a particular spatial typology. Our target population was not a demographic segment (low-income population, for example), but rather the residents of the specific slum typology—favelas.

There is no universally accepted definition of "favela." Perlman details a useful taxonomy of slum settlements in Brazilian cities (most notably Rio de Janeiro and São Paulo) that separates *favelas*, *cortiços*, and *habitação social*.[65] *Favelas* are self-built and self-organized informal housing settlements. *Cortiços* are buildings that have been subdivided into smaller dwelling units and typically are extremely densely occupied like a tenement house. *Habitação social* refers to social housing projects, similar to those built in the United States in the postwar era. They typically consist of large government built housing blocs, often in peripheral areas with a lack of surrounding services.

Selecting favelas to serve as representative is an inherently flawed process. Each favela contains unique characteristics, reflecting differing geography, history and age, topography, and level of consolidation and political power. Socio-economic indicators can vary from favela to favela dramatically, and may also vary house to house within a given favela. Our selection process therefore did not seek to represent all favelas. Rather, we selected three to correspond with the city's favela classification system and added geographic diversity due to the large geographic area of the city of Rio de Janeiro.

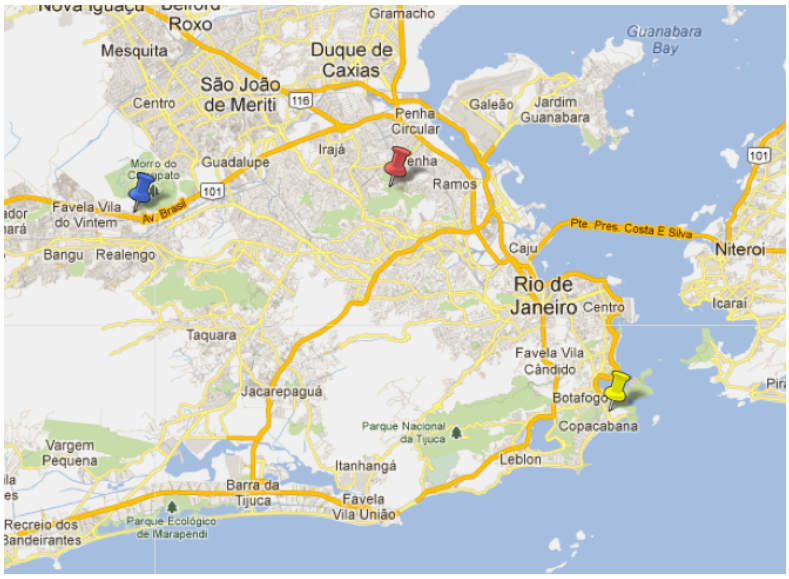
The SMH has established a three-type typology of favelas that they use in the Morar Carioca program. The typologies distinguish physical characteristics, grouping all favelas in the Rio de Janeiro into one of three typologies: isolated favela on a hillside, isolated favela in a flat area, and "complexo" or agglomeration of favelas. The complexo is a phenomenon that occurs when

[65] See Pearlman, 2011. See also Magalhães 2003.

small favelas expand, blurring individual community boundaries. Complexos are typically massive, covering large geographic areas and often encompassing dozens of smaller sub-communities. The most spectacular examples of complexos are the Complexo de Alemão in the Zona Norte, and Rocinha, both of which are estimated to be home to more than 100,000 people and are considered some of the largest slums in Latin America.

For our study we selected three favelas: Complexo da Penha, Batam, and Babilônia/Chapéu Mangueira. The Complexo da Penha was selected to represent the Complexo typology, as well as the Zona Norte. It is marked by the red pin in figure 5. Batam, also known as Jardim Batam, was selected to represent the isolated favela in a flat area, as well as to represent the Zona Oeste. It is marked in figure 5 by the blue pin. Babilônia/Chapéu Mangueira was selected to represent the isolated favela on a hillside, as well as to represent the geographical region of the Zona Sul. It is marked in figure 5 by the yellow pin.

Figure 5. Map of Surveyed Favelas[66]



The other unifying selection characteristic was favelas that have already been pacified by the UPP. As explained in the Introduction, the police in Rio de Janeiro, with occasional assistance from the Brazilian armed forces, are systematically occupying the favelas in an effort to reassert public power and wrest control of the territories from the drug gangs and militia. We chose to focus our study on occupied favelas because they will be the first to receive infrastructural improvements and other interventions from the city government. The data from our survey will serve as a type of baseline for transportation indicators before the city's interventions. In order to measure impact and evaluate change it is necessary to understand what existed before.

We also chose to select favelas occupied by the Pacifying Police in order to avoid invoking fear of response amongst survey participants. In favela communities without the UPP local control is

[66] Map created with Google Maps. The survey favelas are marked with pins, Complexo da Penha – red pin, Batan - blue pin, and Babilônia/Chapéu Mangueira - yellow pin.

often exerted by drug factions or militia. These non-state actors control most local services, including informal transportation modes available in many favela communities. Would local residents be afraid to share information about their transportation use, given its control by local drug or militia? It was determined that this posed enough of a threat to data quality that we would focus our research in favelas already occupied by the pacifying police forces.

Selecting pacified favelas also gave the research team access to high-quality and up-to-date data on the communities, which can be difficult to come by for many favelas. Thanks to information published by the UPP Social[67] online, and through personal contact and communication with coordinators of the UPP Social and local UPP staff in the favelas, our research was guided by previously unavailable or out of date information.

Sample Size

Table 1 shows the projected survey sample size.[68] The representative sample was calculated based upon information from "Armazém de Dados—SABREN," the "sistema de assentamentos de baixa renda" or "data warehouse—system of low-income settlements," a publically accessible database maintained by the Instituto Pereira Passos, the municipal urban planning agency in Rio de Janeiro.[69]

Table 1. Survey Sample Size

Region	Favela	Interviews
Zona Norte	Complexo da Penha (sub-areas)	
	Centro Social Marcilio Dias	160
	Mandacaru II	8
	Morrinho	13
	Morro da Caixa de Agua	159
	Morro da Fe	179
	Morro do Caracol	175
	Morro do Sereno	65
	Parque Proletário do Grotão	223
	Rua de Batata	10
	Rua de Farinha	3
	Rua de Alho	2
	Rua de Alpiste	9
	Rua de Feijão	5
	Rua Frey Gaspar	22
	Rua Laudelino Freire	64
	Rua Nossa Senhora da Penha	4
	Vila Proletária da Penha	575
	Zona Norte Total	**1676**
Zona Oeste	Jardim Batam	146
	Zona Oeste Total	**146**
Zona Sul	Babilônia	98
	Chapéu Mangueira	80
	Zona Sul Total	**178**

[67] See Glossary of Terms for an explanation of the UPP Social.

[68] The sample calculation was projected for 2,000 interviews. The research team completed 2,068 interviews.

[69] Accessible at http://portalgeo.rio.rj.gov.br/sabren/index.html

	Total	2000

Table 2 shows the demographics of our survey sample, both gender and age. This was also calculated based upon data from SABREN, which relies upon data collected during the Brazilian Institute of Geography and Statistics (IBGE) census.[70]

Table 2. Survey Sample Demographics

	Gender		Age Range				
Favela	**Male**	**Female**	**18–19**	**20–29**	**30–39**	**40–49**	**50+**
Complexo da Panha	797	879	94	481	407	315	378
%	47.54	52.46	5.63	28.71	24.30	18.80	22.56
Batam	70	76	8	40	36	29	33
%	47.60	52.31	5.70	27.71	24.42	19.68	22.41
Babilônia/Chapéu Mangueira	82	96	9	50	48	32	38
%	45.97	54.03	5.10	28.36	26.69	18.25	21.60

Due to the numerous challenges in data collection in the favelas, we chose not to rely on random sampling methods and instead calculated the sample demographics presented in table 2. The research teams profiled potential respondents based upon gender and age, in order to fulfill the calculated survey sample.

Community Contact

It was important for the research team to establish contacts in each of the communities selected to survey. In Rio's favelas the first point of contact for anyone outside of the community seeking access is typically the local Resident's Association. The research team visited each of the Resident's Associations in order to explain the nature of the research project, distribute material with information on the research, and to obtain contact information from each of the Associations.

An informational sheet was distributed by the research team to the Resident's Associations. The research team asked the local representative to post the sheet in prominent public locations, and in some instances posted the information. The sheet provided contact information for the research team and explained the nature of the project.

Community contact was established differently in each of the three favelas surveyed. In Babilônia, the lead researcher lived in the community for a period of approximately three months and made contact with local leaders of the Resident's Association through personal contact and the building of relationships during this time. In Complexo da Penha, community contact was facilitated by the Municipal Housing Secretariat (SMH) "Equipe Social." Staff from SMH introduced the research team to the staff of the local social services center (CRAS), who in turn made personal introductions to the leaders of the seven distinct associations present in the

[70] At the time of the survey design, the 2010 census was still only partially available, so we had to rely on 2000 data to calculate our sample.

Complexo.[71] In Batam, the local staff of the UPP Social helped guide the researchers through the community and made introductions to the Resident's Association and other local social organizations and community leaders.

Pilot Survey

It is generally recommended that a pilot survey is a critical part of the survey design process.[72] The pilot survey allows the researchers to test out the survey instrument in field conditions, and to make any necessary changes before beginning the data collection.

One of the main difficulties faced during the pilot was the difficulty of reaching participants in their homes. This led us to change tactics from a home-based interview to identifying key areas of flux and stationing our interviewers in these hubs. This likely introduced an element of survey bias, leading us to under-survey the rate of immobility, or people who do not travel on a daily basis. Likewise, interviewing only those residents passing through points of flux may have resulted in over-stating the number of trips taken by favela residents. Unfortunately, these sample limitations were unavoidable due to the fieldwork constraints.

Based on the experience of the pilot survey we also developed a series of filter questions. We surveyed residents who had lived in the community for over one year,[73] were at least 18 years old, and had made at least one trip on the day prior to the interview.[74]

Community Profiles: Socio-Economic Characteristics of Survey Population

From the over 700 favelas perched on hillsides, blanketing the shorelines and riverbeds, and spread seemingly endlessly throughout the Cidade Maravilhosa, we selected three for our study—Complexo da Penha, Batam, and Babilônia/Chapéu Mangueira. In order to understand the context and unique characteristics of each community, this section will present brief overviews of the communities. For more detailed information on socio-demographic data collected in our survey on income, employment, and education (see Appendix C).

Complexo da Penha—Zona Norte

The Complexo da Penha stretches across hillsides and flatter areas in the northern zone of the city. Home to some 50,000 people and over 13,000 homes it covers an area of 1,189,028 m^2.[75] It is made up of a series of smaller favelas represented by seven different Residents Associations

[71] These associations, representing the differing neighborhoods and sub-communities within the larger Complexo, are: Morro de Caracol, Chatuba, Parque Proletario da Penha, Vila Cruzeiro, Cascatinha, Merendiba, and Quatro Bicas.

[72] Richardson, Ampt, Meyburg, 1995, pp. 213–221.

[73] This filter question was particularly focused on the "perception of road safety" section of the survey.

[74] It is important to acknowledge that immobility is a fact of life for some favela residents. The research team stopped 2,519 people and completed 2,068 interviews, or 451 people did not fit our respondent profile.

[75] "Complexo da Penha—Informações," retrieved from http://www.uppsocial.org/territorios/complexo-da-penha/?secao=inicio.

that gradually grew out of a planned workers community, the Vila Proletaria da Penha. It is punctuated visually by the Igreja da Penha, one of the oldest and most famous catholic churches in Rio, built on a site that has hosted shrines dedicated to Nossa Senhora da Penha de França since the 17th century. The Complexo was pacified in 2010, but the first UPP units were not inaugurated until June 2012.[76] Interventions are currently underway under the auspices of Morar Carioca, with a major focus on upgrading the roadway network (see figure 6).

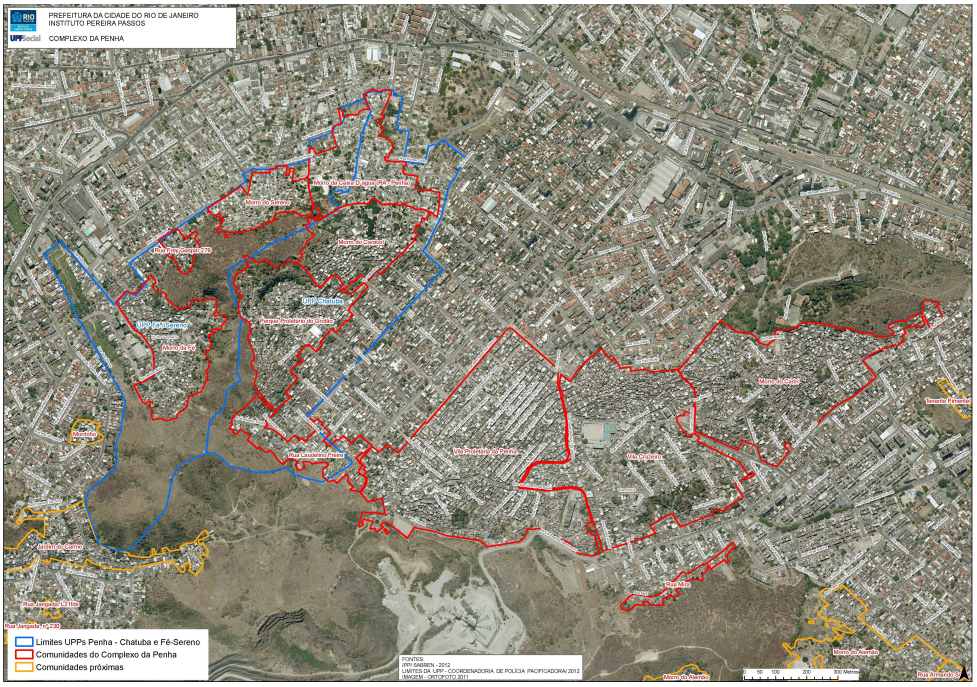
Figure 6. Morar Carioca Intervention Plan Complexo da Penha[77]

Thanks in part to its large territory, a number of formal bus and informal van lines serve the community. There is a nearby station on one of the suburban rail lines. Some of the hillier areas have mototaxis and more motorcycles visible on the streets.

[76] The first 2 units were installed on June 26, 2012, with the preview of 2 more units to be installed by the end of July 2012.

[77] Morar Carioca Presentation, 2011, p. 24.

Figure 7. Aerial Photo of Complexo da Penha[78]



Batam—Zona Oeste

The favela of Batam is located in the western region of Rio. It is largely flat and bordered on its southern edge by the Avenida Brasil, one of the busiest highways in the city that cuts east-west across the metropolitan region. The population is around 3,000 with just over 1,000 houses. The community was pacified in 2009 by the UPP but is bordered by some of the most violent areas of the city and large swaths of territory under control of the militia and drug gangs. Wide roads, mostly paved, serve the community and support a range of vehicle types from bicycles to large delivery trucks. Mothers on bicycles riding their young children to school are a common sight. Heavily trafficked van and bus stops on the edge of the favela are the closest transportation hubs but no official routes run through the community. The suburban train network and subway do not directly serve the community either but are accessible via a 15–30 minute access trip. The outlines of the community are shown in the aerial photograph below (figure 8), with Avenida Brasil cutting through the middle of the photo.

[78] The red lines mark the territory of the Complexo and the blue lines are the territories of the first two UPP installations. Image retrieved from http://www.uppsocial.org/wp-content/uploads/mapas_perimetro/perimetro_complexo-da-penha.jpg

Figure 8. Aerial Photo of Batam[79]

Babilônia/Chapéu Mangueira[80]**—Zona Sul**

Sitting on a hillside atop the neighborhood of Leme, Babilônia and Chapéu Mangueira have some of the most privileged views in all of Rio, overlooking Copacabana beach and Pão de Açucar, and with unobstructed views of the Christ the Redeemer statue. The population is just under 4,000 with just over 1,000 homes. The community was one of the first occupied by the UPP, in 2009. It is also one of the first favelas to receive interventions from the city under the Morar Carioca program and construction is currently underway throughout the area. A new service road (marked in red in figure 9) is planned to allow for trash collection and emergency vehicles to pass to the upper reaches of the community, and a variety of new housing and public spaces are scheduled to be completed in the next years. The upgrading efforts were showcased during the Rio+20 Conference in June 2012 and highlighted as an example of the "green" aspects—sustainable building practices and construction materials—of the Morar Carioca program.

[79] The blue line outlines the territory covered by the UPP, which includes both informal favelas, outlined in red, and formal neighborhoods. The favela of Batam is outlined in red and identified by the arrow. Image retrieved from http://www.uppsocial.org/wp-content/uploads/mapas_perimetro/perimetro_batan.jpg

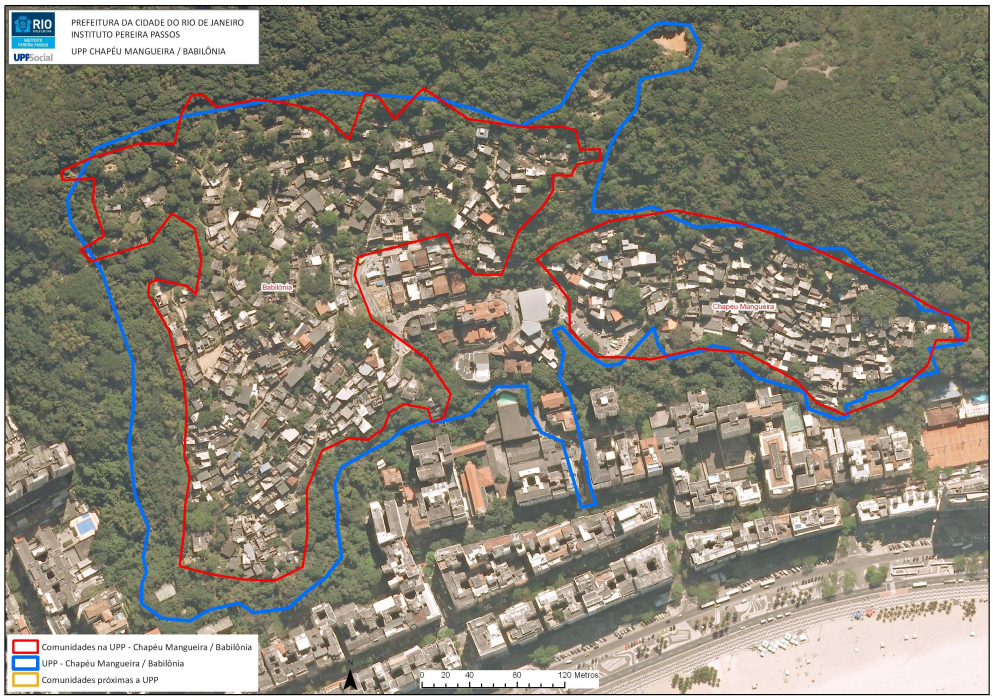
[80] It is important to note that Babilônia and Chapéu/Mangueira are actually two distinct communities located side by side on the same hillside, as seen clearly in the demarcated red areas in the aerial photograph. They each have their own Resident's Association, though they cooperate closely. The SMH recognizes that there are two communities but treats the area as a single favela intervention area. For the purposes of this study we followed the SMH and treated it as a single entity.

Figure 9. Morar Carioca Intervention Plan Babilônia/Chapéu Mangueira[81]

Due to its central location abutting Copacabana, one of the most popular tourist destinations in Rio, residents have access to a variety of transportation modes. The nearest subway stop is a 15-minute walk. Mototaxis are stationed at the bottom of the hill and can be seen ferrying passengers up and down the one access road to the community. Vans passing along Avenida Atlântica and up the hillside provide a variety of informal transportation options. An immense number of bus lines pass through the nearby tunnel connecting Copacabana to the rest of the Zona Sul and Centro, placing bus access to almost all parts of the city within a 5 minute walk. There is a collection of bicycles parked at the bottom of the hill and a steady stream of cars and motorcycles flowing up and down the hillside. The access road is a scene of constant flux and a mixture of people and vehicles sharing space.

[81] Morar Carioca Presentation, 2011, p. 26.

Figure 10. Aerial Photo of Babilônia/Chapéu Mangueira[82]



Findings and Analysis

Over the course of five weeks in April and May of 2012 we completed 2,068 interviews in three favelas in Rio de Janeiro. From these interviews we captured information on 4,336 unique trips, both within the favelas and throughout the streets of the formal city of Rio de Janeiro. The main findings of our study are presented in this section, together with analysis.[83] We present findings on vehicular ownership, vehicle types, and parking, modal split, mobility index, non-motorized transport, trip times and motives, the hourly distribution of travel, and perception of road safety.

Vehicle Ownership, Vehicle Types, and Parking

One of the key aspects in measuring personal mobility is access to private vehicles. In Rio the most commonly observed vehicles are cars, motorcycles and bicycles. One of the goals of our survey was to develop an initial understanding of vehicular ownership in the favelas, given the lack of existing data. This information is critical for policymakers overseeing the favela

[82] The red lines outline the two communities, with Babilônia on the left and Chapéu Mangueira on the right. Image retrieved from http://www.uppsocial.org/wp-content/uploads/mapas_perimetro/perimetro_Babilônia.jpg.

[83] Throughout this section we analyze data from each favela as well as totals from all three survey locations. When we present data as "total" it is always a weighted total, reflecting the number of interviews conducted in each location. For some points we look at difference between the three locations, and for others we simply look at the combined weighted "total" numbers.

upgrading program and the architects planning and designing upgrading efforts in these communities.

The total rate of car ownership is 15.8 percent in Complexo da Penha, 31.5 percent in Batam, and 18.1 percent in Babilônia/Chapéu Mangueira. The total rates of bicycle ownership for the favelas are 19.6 percent in Complexo da Penha, 45.2 percent in Batam, and 33.2 percent in Babilônia/Chapéu Mangueira.[84] The total rate of motorcycle ownership is 9.2 percent in Complexo da Penha, 9 percent in Batam, and 9 percent in Babilônia/Chapéu Mangueira.

Table 3. Percentage of Vehicle Ownership by Favela

Vehicles	Complexo da Penha	Batam	Babilonia/ CM	Total
Bicycle	15.4	34.9	25.3	**17.6**
Motorcycle	5.8	4.8	5.6	**5.8**
Car	11.1	20.5	11.8	**11.8**
Bicycle / Motorcycle	1.1	1.4	2.2	**1.3**
Bicycle / Car	2.4	8.2	5.1	**3.0**
Motorcycle / Car	1.6	2.1	0.6	**1.5**
Bicycle / Motorcycle / Car	0.7	0.7	0.6	**0.7**

The car ownership rates from our survey are higher than some previous findings. In 2002, Pearlman found a 14 percent rate of car ownership amongst families in her longitudinal research study of three low-income communities in Rio de Janeiro.[85] A 2003 ITRANS study of low-income residents of the Rio metro region also found a very low rate of car ownership of 6 percent.[86] A study in Babilônia/Chapéu Mangueira in 2011 found 11 percent of people owned cars in Babilônia and 7 percent owned cars in Chapéu Mangueira.[87] The study contains no information about the rate of bicycle ownership.

Vehicle ownership is generally male-dominated (see table 4). Men are more likely to own a bicycle, motorcycle, car, or multiple vehicles. Bicycle ownership is the most equal between genders; 59 percent of bicycle owners are male and 41 percent are female. In Batam women are majority of bicycle owners at 51 percent, while in Babilônia/Chapéu Mangueira there is a 50 percent gender split in motorcycle ownerships. Babilônia/Chapéu Mangueira has the smallest gender gap in vehicle ownership, with women actually more likely to own multiple vehicles amongst our survey population.

[84] Total bicycle ownership rate includes respondents who just own a bicycle, as well as those who own a bicycle and another vehicle or more.

[85] Perlman, 2004, p. 133.

[86] The ITRANS report compares the Rio metro region at 6% ownership rate to the São Paulo metro region, with 15% vehicle ownership. ITRANS found that Rio had a lower rate of vehicular ownership amongst the poor as compared to other metropolitan regions in Brazil, see ITRANS 2003.

[87] CEBDS - Babilônia, 2011, p. 25, and CEBDS – Chapéu Mangueira, 2011, p. 25

Table 4. Percentage of Vehicle Ownership by Gender and by Favela

Vehicles	Complexo da Penha		Batam		Babilonia/ CM		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Bicycle	59.9	40.1	40.0	51.0	64.4	35.6	**58.9**	**41.1**
Motorcycle	76.5	23.5	85.7	14.3	50.0	50.0	**74.8**	**25.2**
Car	71.6	28.4	66.7	33.3	66.7	33.3	**70.6**	**29.4**
Bicycle / Motorcycle	70.0	30.0	100.0	0.0	25.0	75.0	**65.4**	**34.6**
Bicycle / Car	71.4	28.6	58.3	41.7	66.7	33.3	**68.3**	**31.7**
Motorcycle / Car	67.9	32.1	100.0	0.0	0.0	100.0	**68.8**	**31.3**
Bicycle / Motorcycle / Car	75.0	25.0	100.0	0.0	0.0	100.0	**71.4**	**28.6**

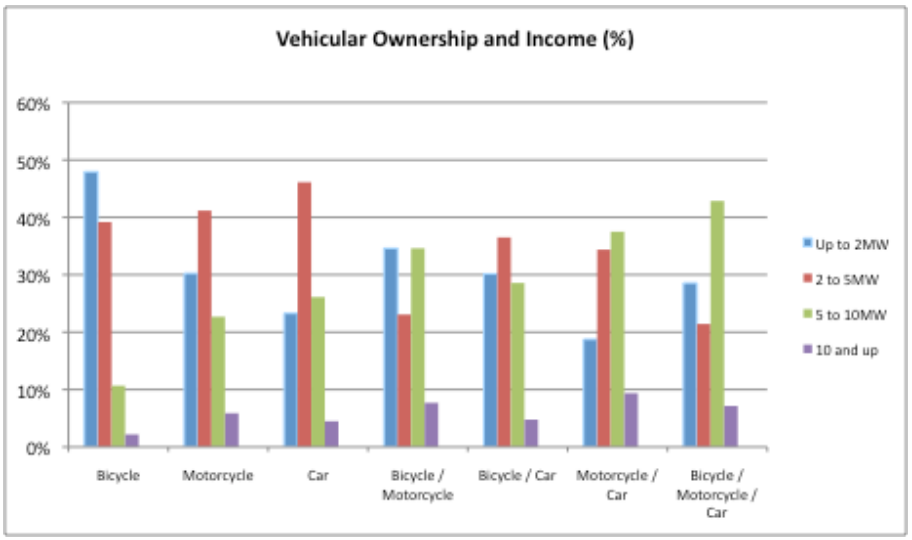
For vehicle ownership and age we found that motorcycles are most likely to be owned by young people, with 57 percent of motorcycle owners between the ages of 18 to 29 (see table 5). Car and bicycle ownership is more evenly spread amongst age ranges, as are those who own multiple vehicles.

Table 5. Percentages of Vehicle Ownership by Age Group

	18–19	20–29	30–39	40–49	50 +
Bicycle	7.1	25.5	27.9	21.6	17.8
Motorcycle	8.4	48.7	26.9	10.9	5.0
Car	3.3	21.2	32.7	22.9	20.0
Bicycle / Motorcycle	7.7	42.3	19.2	19.2	11.5
Bicycle / Car	6.3	19.0	30.2	33.3	11.1
Motorcycle / Car	6.3	34.4	40.6	12.5	6.3
Bicycle / Motorcycle / Car	14.3	28.6	28.6	14.3	14.3

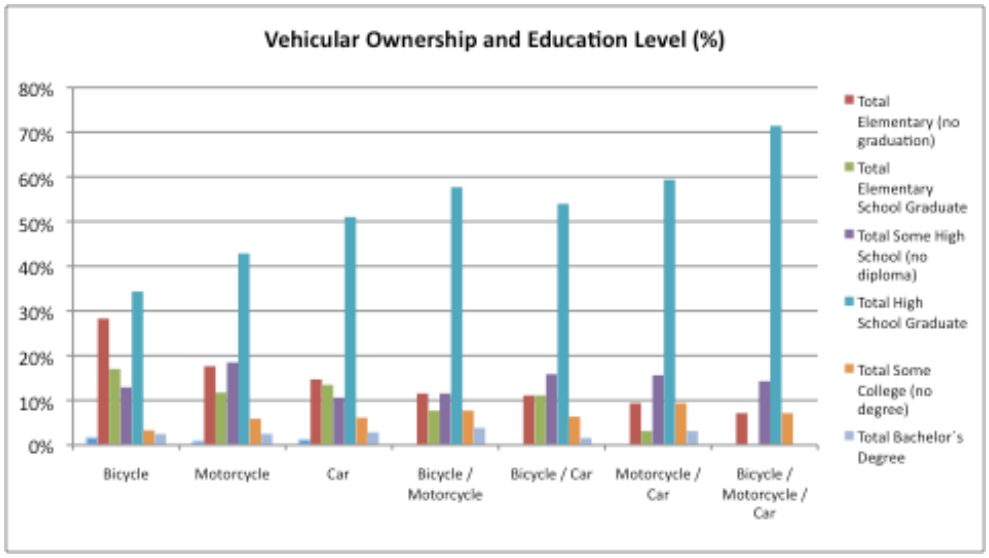
We also analyzed vehicle ownership by income and educational achievement (see graphs 1 and 2). We found that motorized vehicles are more attainable for those with higher incomes and bicycles are most common amongst the poorest segment of the survey population.

Graph 1. Vehicle Ownership and Income



There appears to be a strong correlation between graduating high school and owning a vehicle (see graph 2). Once again bicycles are most common for those with the least educational achievement, further reinforcing the notion that supporting safe bicycle usage may be a central ingredient in an equitable and sustainable transportation system in the favelas.

Graph 2. Vehicle Ownership and Education Level



In order to gain a better understand of the condition of the existing vehicle fleet, for those who owned vehicles we asked a series of questions about vehicle types and conditions. The average age of motorized vehicles is around 5 years old for motorcycles and 12 years old for cars (see table 6).

Table 6. Average Age (years) of Vehicle by Favela

Vehicle	Complexo da Penha	Batam	Babilônia /CM	Total
Motorcycle	5.0	5.1	7.8	**5.3**
Car	12.3	11.6	12.1	**12.2**

The car fleet is older than the motorcycle fleet, reflecting recent growth in the popularity and availability of motorcycles. Attractive financing plans that feature low initial costs and allow customers to pay back over an extended period have helped motorcycle sales soar in Brazil in recent years. The number of motorcycles sold annually in Brazil has grown twelvefold since 1992 compared to a fourfold increase in automobile sales.[88]

We found that vehicle conditions are generally considered good (see table 7). Cars are judged to be in slightly better condition by their owners than motorcycles, and a very low percentage, less than 2.5 percent of vehicle owners responded that their cars or motorcycles were in bad

[88] Vasconcellos, 2012, p. 1.

condition. At the moment, there is no vehicle inspection law requiring regular vehicle testing in Brazil.

Table 7. Average Vehicle Condition by Favela and by Favela in Percentages

	Complexo da Penha	Batam	Babilônia /CM	Total
Motorcycle				
Good Condition	73.5	85.7	80.0	**74.8**
Regular Condition	24.5	14.3	20.0	**23.5**
Bad Condition	2.0	0.0	0.0	**1.7**
Car				
Good Condition	75.8	80.0	90.5	**77.6**
Regular Condition	21.6	16.7	9.5	**20.0**
Bad Condition	2.6	3.3	0.0	**2.4**

Motorcycles are almost exclusively gasoline powered (see table 8). Batam is the only favela with a small proportion of flex fuel motorcycles, 14.3 percent, and has the highest percentage of motorcycles in "good condition" according to the owners.

Table 8. Percentage of Motorcycle by Fuel Type and by Favela

Fuel	Complexo da Penha	Batam	Babilônia /CM	Total
Gasoline	97.1	85.7	100.0	**96.6**
Flex Fuel (Gasoline/Ethanol)	2.9	14.3	0.0	**3.4**

Reflecting a greater diversity of automobile types in Brazil due to widespread availability of fuel hybrids and alternatives to gasoline, we found a wide range of vehicle types (see table 9).

Table 9. Percentage of Cars by Fuel Type and by Favela

Fuel	Complexo da Penha	Batam	Babilônia CM	Total
Gasoline	31.5	46.7	47.6	**37.6**
Ethanol	7.2	13.3	0.0	**7.3**
Diesel	1.0	0.0	4.8	**1.2**
Flex Fuel (Gasoline / Ethanol)	19.1	13.3	4.8	**17.1**
Gasoline / Compressed Natural Gas	29.4	16.7	42.9	**29.0**
Ethanol / Compressed Natural Gas	1.5	6.7	0.0	**2.0**
Flex Fuel / Compressed Natural Gas	6.7	3.3	0.0	**5.7**

We found a high rate of properly registered vehicles (see table 10). Brazilian law requires vehicle registration, and our data shows a high rate of compliance amongst vehicle owners in the favelas.[89] Motorcycles are more likely than cars to be unregistered, but only by a small percentage. Both vehicle types showed a registration rate of over 95 percent.

[89] This may be related to the favela pacification process. A regular police presence on the streets of the occupied favelas may lead vehicle owners to register their vehicles and/or respond to our survey that they are properly registered regardless of actual registration status. It remains unclear whether vehicle inspection checks and traffic regulation will be a part of the regular duties of the UPP police forces.

Table 10. Percentage of Vehicles by Registration Status by Favela

Vehicle Registration	Complexo da Penha	Batam	Babilônia/CM	Total
Motorcycles				
Registered	95.1	95.1	95.1	**95.1**
Not Registered	4.9	4.9	4.9	**4.9**
Cars				
Registered	99.0	100.0	95.2	**98.8**
Not Registered	1.0	0.0	4.8	**1.2**

While vehicle registrations show a high rate of legal compliance, the other numbers related to regulatory adherence are more mixed. The legality of vehicle ownership and operation is also demonstrated by the prevalence of "*carteiras de habilitação*" or driver's licenses, both for cars and motorcycles. We found a wider range in the percentage of people in the survey population who are properly registered to legally operate a vehicle (see table 11).

Table 11. Percentage of Respondents who have Driver's Licenses by Favela

License /Vehicle Type	Complexo da Penha	Batam	Babilônia/CM	Total
Car	11.3	11.0	15.3	11.6
Motorcycle	2.7	0.7	2.8	2.6
Car / Motorcycle	3.0	9.6	3.4	3.5
None	82.9	78.8	78.4	82.3

These numbers are similar to the findings of a study done in 2010 in the first favelas pacified by the UPP. The IETS study found 11.7 percent of residents of Batam had a driver's license, closely matching our findings.[90]

When we look just at vehicle owners, our findings show that not all vehicle owners have licenses (see table 12). There are also significant differences among the three favelas surveyed. In Batam only 50 percent of car owners responded that they also have driver's license, while in Babilônia/Chapéu Mangueira 90.6 percent of car owners have driver's licenses.

Table 12. Vehicle Owners with and without Driver's Licenses by Favela

Driver License Rates	Complexo da Penha	Batam	Babilônia/ CM	Total
Car Ownership (%)	15.8	31.5	18.0	17.1
No. of Car Owners	276	46	32	354
No. of Car Owners w/Driver's Licenses	192	23	29	244
Car Owners w/Driver's Licenses (%)	**69.6**	**50.0**	**90.6**	**68.9**
Motorcycle Ownership (%)	9.3	8.9	9.0	9.2
No. of Motorcycle Owners	162	13	16	191
No. Motorcycle Owners w/Driver's Licenses	80	11	12	103
Motorcycle Owners w/Driver's Licenses (%)	**49.4**	**84.6**	**75.0**	**53.9**

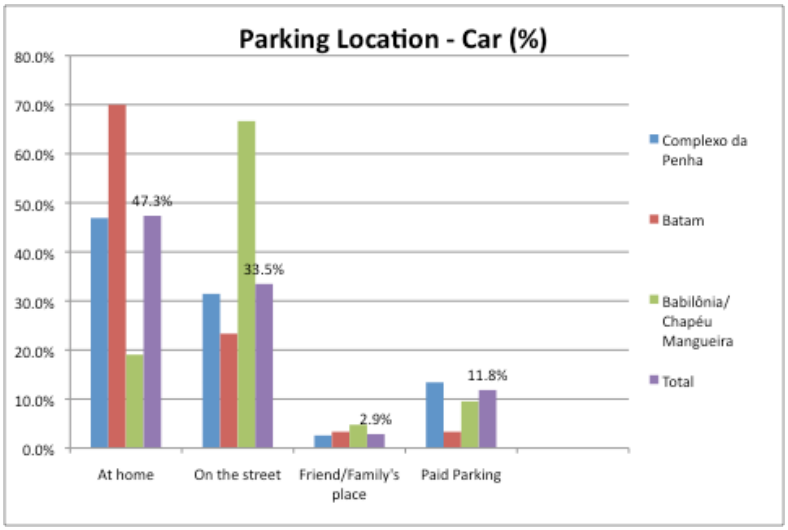
[90] IETS, 2010, p. 8, Batam was the only one of our favelas surveyed by IETS in the first batch of UPP-occupied favelas.

We found similar variations for motorcycle owners. Only 49.4 percent of motorcycle owners in Complexo da Penha have a motorcycle license, while in Batam 84.6 percent of motorcycle owners are properly licensed. Across our three surveyed favelas the average percentage of car owners who have a license was 68.9 percent and 53.9 percent for motorcycle owners. This shows a higher rate of legal compliance amongst car owners compared to motorcycle owners.

In addition to asking about the vehicles themselves, we sought to find out where people park their vehicles. The provision of parking is an important question in infrastructural upgrades in the favelas. The availability of parking closely reflects the topographical variations between favela typologies. To see photographs of the differing parking situations in each of the favelas surveyed, see Appendix D.

The favela with the most challenging topography, Babilônia/Chapéu Mangueira, has the highest percentage of vehicle owners who park on the street[91] (see graphs 3 and 4). This is true for both cars and motorcycles, though there is a slightly higher percentage of motorcycle owners that park on the street. Batam, the flattest favela, had the highest percentage of cars parked at home.

Graph 3. Parking Locations for Cars[92]



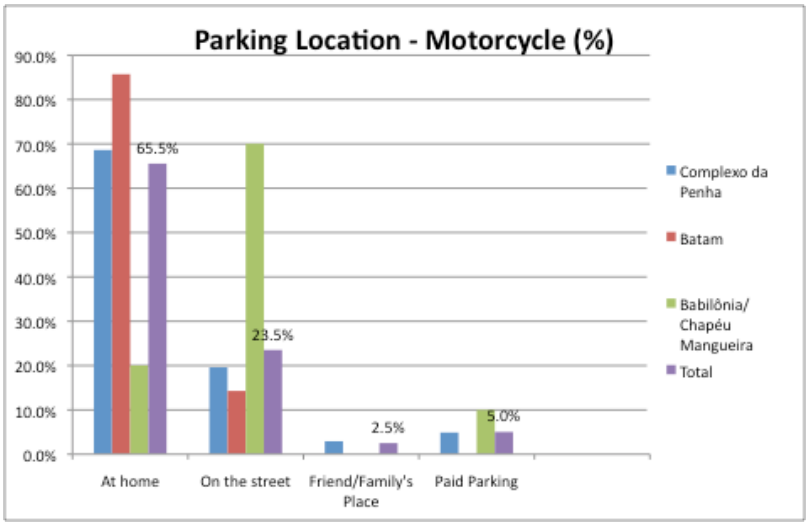
The greatest difference between car and motorcycle parking is seen in Complexo da Penha and Batam. In Complexo da Penha a higher percentage of people park motorcycles in their homes as compared to cars, at 68.6 percent versus 46.9 percent. In Batam the same is true, with 85.7 percent of motorcycles parked at home versus 70 percent of cars.

[91] Parking on the street, means on a public street, while parking at home means inside the home or close by it.

[92] A brief note about the response "At home" for this question: we did not specify whether this meant that the car/motorcycle was physically parked inside the home or on the sidewalk or driveway directly in front of the home. It is likely that some respondents park their vehicles directly in front of their homes and consider this to be "At home" rather than on the street. For an illustration of this issue, please see the photographs presented in Appendix D.

This may be explained by two main factors relating to infrastructure and housing types in favelas. The first possibility is that there are simply more roads that can accommodate motorcycles and not cars, allowing more motorcycle owners to reach their homes on their bikes and park at home. The second possibility is that home sizes are small, and space is at a premium. The space needed to park the smaller motorcycle is easier to accommodate for favela residents while it may be harder to make space to park a car at home.

Graph 4. Parking Locations for Motorcycles



The other main issue with parking is security. There is a perceived risk involved in parking a motorcycle on a public street or location away from your home. There may also be a risk of car theft. There is no publically available data on vehicle theft in the favelas, making it difficult to quantify the real risk and prevalence of theft.

Main Findings—Vehicle Ownership, Vehicle Types, and Parking:

- Our data shows higher rates of car ownership than some previous studies.
- Bicycles are the most common vehicles in the favelas, but overall rates of ownership are still low. Batam had the highest bicycle ownership rate of 45.2 percent.
- Vehicle ownership is generally male-dominated, with the exception of Babilônia/Chapéu Mangueira, where women were more likely than men to own multiple vehicles.
- Bicycles ownership has the smallest gender gap. Men account for 59 percent of bicycle owners compared to 41 percent female owners.
- Motorcycle owners are the youngest vehicle owners overall. Bicycle and car ownership is more evenly distributed between age groups.
- Vehicle ownership is tied to income and educational level, but the highest correlation is between high school graduation and owning a car or multiple vehicles.
- Vehicles are generally perceived by their owners to be in good condition and the motorcycle fleet is newer than the car fleet.
- Almost all vehicles are properly registered, but we found wide variation among vehicle owners who are properly licensed to drive, ranging from 49.4 percent of motorcycle

owners in Complexo da Penha to 90.6 percent of car owners in Babilônia/Chapéu Mangueira.

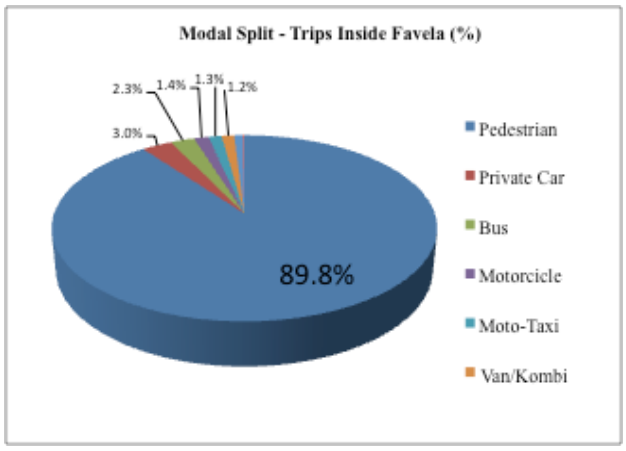
- Babilônia/Chapéu Mangueira, situated on a steep hillside, has the highest percentage of vehicle owners who park their vehicles on the street. Batam, the flattest favela, has the highest percentage of vehicles parked at home.
- In Complexo da Penha and Batam motorcycles are more likely to be parked at home than cars.

Modal Split

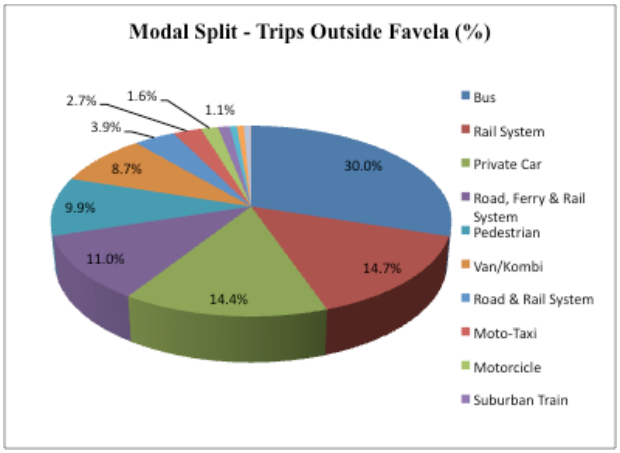
Modal split, or the distribution of travel by mode, is a key tool used to paint an overall picture of transportation

A vast majority of favela residents surveyed travel inside their community on foot (see graph 5). Pedestrian trips represent 89.9 percent of travel within the favela. Cars account for 3 percent, buses for 2.3 percent, and motorcycles 1.4 percent.

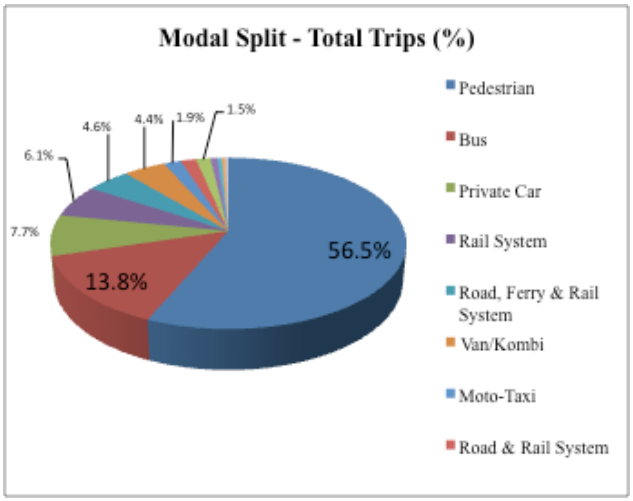
Graph 5. Modal Split—Trips Inside Favela



Graph 6. Modal Split—Trips Outside Favela



Graph 7. Modal Split—Total Trips



When we look at trip mode and gender, we find that women rely more on walking than men (see table 13). Men are more likely to make motorized trips, either in an individual vehicle or utilizing mass transport.[93] Men are also twice as likely to travel using individual vehicles as women, perhaps suggesting a gender disparity in access to individual transport.

Table 13. Percentage of Total Trips by Mode and by Gender

	Motorized		Non-Motorized	
Gender	Individual	Mass	Individual	Mass
Male	15	32	1	51
Female	8	27	0	65

Main Findings—Modal Split

- The vast majority of trips within the favelas are done on foot.
- For trips outside the favelas there are 6 modes with over 5 percent modal share. Bus is the largest share, at 30 percent of all trips outside the favelas.
- For total trips, both inside and outside the favelas, walking makes up the majority of trips (56.5 percent).
- Women are most likely to walk and men are more likely to use motorized forms of transport.
- Men are twice as likely to travel in an individual vehicle as women.

Mobility Index

The mobility index is a measurement of mobility, representing the number of daily trips per person. It is an important tool to analyze the mobility of a given population and allows for comparison between populations.

[93] Throughout the Findings and Analysis section we utilize the terms "mass transport" and "individual transport" to refer to public transportation modes and private transportation modes respectively.

Our data shows that people travelled outside the favelas slightly more than they travelled within the favelas. The mobility index across the three favelas surveyed was 1.69 inside the community and 1.76 outside the community. The highest single index was in Batam for travel outside the community, at 2.05. Overall Batam had the highest mobility index, followed by Complexo da Penha and then Babilônia/Chapéu Mangueira.

Table 14. Mobility Index by Type of Trip and by Favela

Trips Inside the Favela			
Favela	**No. Persons**	**No. Trips**	**Mobility Index**
Complexo da Penha	1,311	2.207	1.68
Batam	116	215	1.85
Babilônia/Chapéu Mangueira	66	108	1.64
Total	**1,493**	**2,530**	**1.69**
Trips Outside the Favela			
Favela	**No. Persons**	**No. Trips**	**Mobility Index**
Complexo da Penha	817	1,433	1.75
Batam	57	117	2.05
Babilônia/Chapéu Mangueira	154	256	1.67
Total	**1,026**	**1,806**	**1.76**
Total Trips			
Favela	**No. Persons**	**No. Trips**	**Mobility Index**
Complexo da Penha	2,128	3.640	1.71
Batam	173	332	1.92
Babilônia/Chapéu Mangueira	220	364	1.66
Total	**2,519**	**4,336**	**1.72**

The only significant mobility index within the favelas is for pedestrian trips. Mass transport, individual transport, and bicycle trips are all under 0.10, while the pedestrian mobility index is 1.52.

Table 15. Mobility Index for Motorized and Non-Motorized Trips Inside the Favela

Trips Inside the Favela	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	0.06	0.09	0.00	**0.06**
Individual Transport	0.11	0.04	0.05	**0.10**
Mobility Index Motorized Trips	**0.17**	**0.13**	**0.05**	**0.16**
Pedestrian	1.50	1.69	1.61	**1.53**
Bicycle	0.01	0.03	0.00	**0.01**
Mobility Index Non-Motorized Trips	**1.52**	**1.72**	**1.61**	**1.54**
Total	**1.68**	**1.85**	**1.64**	**1.69**

Outside the community mass transport has the highest mobility index, at 1.24, with the only other significant index being individual transport at 0.34. Non-motorized modes appear to make up a small portion of travel outside the favelas.

Table 16. Mobility Index for Motorized and Non-Motorized Trips Outside the Favela

Trips Outside the Favela	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	1.24	1.45	1.13	**1.24**
Individual Transport	0.35	0.51	0.25	**0.34**
Mobility Index Motorized Trips	**1.58**	**1.96**	**1.37**	**1.58**
Pedestrian	0.16	0.07	0.27	**0.17**
Bicycle	0.01	0.02	0.02	**0.01**
Mobility Index Non-Motorized Trips	**0.17**	**0.09**	**0.29**	**0.18**
Total	**1.75**	**2.05**	**1.67**	**1.76**

We found the total mobility indexes of men and women differed by a mere 0.01 daily trips/person. This is in contrast to much of the previous research done in other cities featured in the Literature Review. We did find, however, that women have a significantly higher mobility index for non-motorized trips, while male mobility indexes for motorized and non-motorized are more similar.

Table 17. Mobility Index by Gender for Motorized and Non-Motorized Trips

Trips	Male	Female
Motorized	0.81	0.67
Non-Motorized	0.90	1.06
Total	**1.72**	**1.73**

There are no clear patterns with regards to mobility index and age. The oldest age group has the highest index for motorized trips and the youngest age group has the highest index for non-motorized trips.

Table 18. Mobility Index by Age Group for Motorized and Non-Motorized Trips

Trips	18–19	20–29	30–39	40–49	50 +
Motorized	0.54	0.82	0.78	0.68	0.69
Non-Motorized	1.17	0.95	0.97	0.98	1.00
Total	1.71	1.76	1.75	1.66	1.69

The pattern is much clearer for mobility index and education. Motorized mobility index increases along with educational attainment while non-motorized index decreases. The largest incremental changes occur between high school graduates and those with some college, and between college graduates and those with some college experience.

Table 19. Mobility Index by Education Level for Motorized and Non-Motorized Trips

Trips	None	Incomplete Elementary	Graduate Elementary	Incomplete High school	Graduate High school	Incomplete College	Graduate College
Motorized	0.51	0.62	0.66	0.76	0.84	1.06	1.27
Non-Motorized	1.14	1.11	1.00	0.96	0.90	0.71	0.48
Total	**1.65**	**1.73**	**1.66**	**1.72**	**1.74**	**1.77**	**1.75**

Income closely mirrors education in its impact on mobility index. Motorized mobility index steadily increases with income and non-motorized mobility index decreases with increased income.

Table 20. Mobility Index by Income Level for Motorized and Non-Motorized Trips

	No. Minimum Monthly Salaries			
Trips	**0–2**	**2.5**	**5–10**	**10 +**
Motorized	0.68	0.83	0.98	1.21
Non-Motorized	1.05	0.89	0.73	0.51
Total	**1.73**	**1.71**	**1.72**	**1.72**

Main findings—Mobility Index

- Mobility index is higher for travel outside the community compared with travel inside the community.
- Batam had the highest mobility index of our surveyed favelas.
- The gap between motorized and non-motorized mobility index is more profound for women than men.
- Motorized mobility index clearly increases along with educational attainment and income level.
- Non-motorized mobility is highest for those with the least education.

Non-motorized Transportation

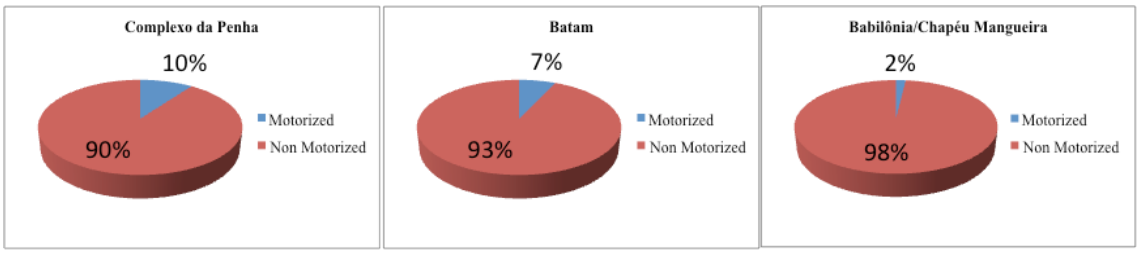
Non-motorized transportation is vitally important in the favelas. A majority of trips made in the three surveyed favelas were non-motorized. 57 percent of the total trips were made either on foot or on bicycle, compared with 43 percent motorized trips.

Table 21. Percentage of Motorized and Non-Motorized Trips by Favela

Trips	**Complexo da Penha**	**Batam**	**Babilônia/CM**
Motorized	42	38	59
Non-Motorized	58	62	41

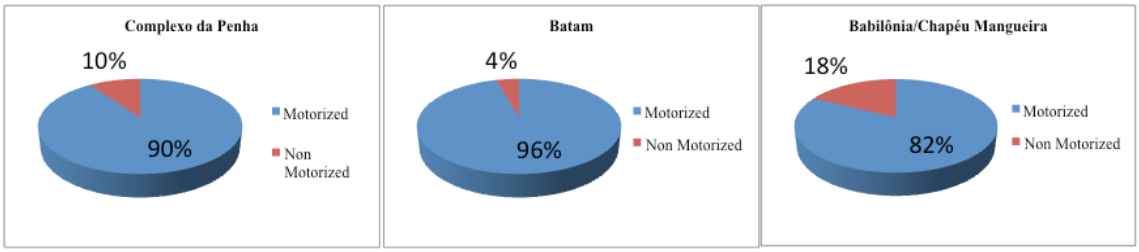
Within the favelas, the vast majority of trips were non-motorized (see graph 8). We found an almost complete reliance on walking and biking for trips within the favela. 91 percent of total tips within the favelas were completed utilizing non-motorized transportation.

Graph 8. Division of Motorized and Non-motorized Trips Inside the Favela



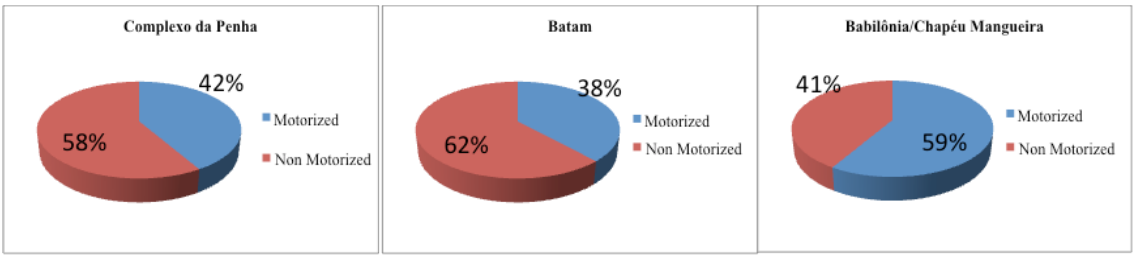
For trips outside of the favelas, our survey population relies on motorized means of transportation (see graph 9). The only location where motorized trips accounted for less than 90 percent of total travel outside the community was Babilônia/Chapéu Mangueira, with 18 percent of trips outside the favela non-motorized, the highest across our three favelas. This may be due to its central location in the Zona Sul directly above Copacabana, in close proximity to a variety of essential services.

Graph 9. Division of Motorized and Non-motorized Trips Outside the Favela



When we look at total trips, Babilônia/Chapéu Mangueira was the only community that had a majority of trips via motorized transportations (see graph 10). In both Complexo da Penha and Batam a majority of total trips were made utilizing non-motorized transportation.

Graph 10. Division of Motorized and Non-motorized trips—Total



The mobility index for non-motorized trips is 0.99, compared to 0.74 for motorized trips (see table 22).

Table 22. Mobility Index for Motorized and Non-Motorized Trips by Favela

Trips	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	0.51	0.54	0.79	**0.54**
Individual Transport	0.20	0.20	0.18	**0.20**
Mobility Index Motorized Trips	**0.71**	**0.73**	**0.97**	**0.74**
Pedestrian	0.99	1.15	0.67	**0.97**
Bicycle	0.01	0.03	0.01	**0.01**
Mobility Index Non-Motorized Trips	**1.00**	**1.18**	**0.69**	**0.99**
Total	**1.71**	**1.92**	**1.66**	**1.72**

Another measurement of non-motorized transportation is the percentage of walking trips lasting over 30 minutes. In Babilônia/Chapéu Mangueira 9.2 percent of walking trips were over 30 minutes, the highest percentage of the three favelas surveyed. This is consistent with the finding

that Babilônia/Chapéu Mangueira has the highest percentage of non-motorized trips outside the community, and with the finding that average trip times for pedestrian trips outside the favelas are higher than those within the favelas.

Table 23. Walking Trips Over 30 minutes by Favela

Trips	Complexo da Penha	Batam	Babilônia/ CM	Total
Total No. Walking Trips	7,280	650	728	**8,664**
No. Walking Trips > 30 m.	399	17	67	**483**
Percentage Walking Trips > 30 m	**5.5**	**2.6**	**9.2**	**5.6**

The average trip time for all trips was 15 minutes for non-motorized travel and 37 minutes for motorized travel. Bicycle trips, at 14 minutes, were slightly shorter than walking trips, at 17 minutes. For further discussion of travel times, see next section—Trip Times and Motives.

Table 24. Average Travel Time for Motorized and Non-Motorized Trips by Favela (minutes)

Trips	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	45	52	53	**44**
Individual Transport	22	17	35	**22**
All Motorized Trips	**38**	**40**	**46**	**37**
Pedestrian	**17**	**12**	**18**	**17**
Bicycle	**16**	**21**	**17**	**14**
All Non-Motorized Trips	**25**	**36**	**41**	**26**

We asked survey respondents whether they know how to ride a bicycle (see table 25). Almost a quarter of respondents in Complexo da Penha and Babilônia/Chapéu Mangueira, the two areas with steep topography, responded that they did not know how to ride a bicycle. In the flattest area, Batam, only 13 percent responded that they did not know how to ride a bicycle. This may support a conclusion that bicycles are a more important part of the transportation mix in Batam than the other surveyed communities.

Table 25. Percentage of Bicycle Riding Ability by Favela

	Complexo da Penha	Batam	Babilônia/ CM	Total
Can Ride a Bicycle	78	86	78	**79**
Cannot Ride a Bicycle	22	13	22	**21**

Main Findings—Non-motorized transportation

- 57 percent of all trips were non-motorized.
- The vast majority of trips within the favelas are non-motorized and a vast majority of trips outside the favelas are motorized.
- Mobility Index is higher for non-motorized transportation than for motorized transportation.

- The average trip time (for travel both inside and outside the favela) for non-motorized trips was 15 minutes.
- The average trip time for pedestrian trips is slightly longer than bicycle trips.
- Almost 80 percent of survey respondents said they knew how to ride a bicycle.

Trip Times and Motives

Trip times within the favelas are significantly shorter than those outside the community (see tables 26 and 27). The few motorized trips that do occur within the favelas are double the length of non-motorized trips. Complexo da Penha, the largest of the three surveyed favelas, has the longest average trip times within the favela for non-motorized modes.

Table 26. Average Travel Time for Trips Inside the Favela (minutes)

Trips	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	37	38		**38**
Individual Transport	15	10	12	**15**
Motorized Trips	**23**	**24**	**12**	**22**
Pedestrian	11	9	8	**11**
Bicycle	12	9		**11**
Non-Motorized Trips	**11**	**9**	**8**	**11**
Total	**12**	**10**	**10**	**11**

The average bicycle trip outside the favela of Batam was 45 minutes long. Batam is located in the much flatter Zona Oeste, and this number may point to the viability of bicycles for a wide range of trips outside the favela but within the region.

Table 27. Average Travel Time for Trips Outside the Favela (minutes)

Trips	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	46	56	53	**44**
Individual Transport	25	27	39	**26**
Motorized Trips	**39**	**48**	**47**	**38**
Pedestrian	27	26	39	**28**
Bicycle	33	45	17	**29**
Non-Motorized Trips	**30**	**35**	**28**	**29**
Total	**39**	**46**	**44**	**40**

Surprisingly, the centrally located Babilônia/Chapéu Mangueira had an average mass transport trip of 53 minutes, only 3 minutes less than the peripheral Batam. Babilônia/Chapéu Mangueira also had the highest average trip time for individual transport. Despite a seemingly favorable central location, residents of Babilônia/Chapéu Mangueira still make very long motorized trips.[94]

[94] This may be related to the economic growth of Rio de Janeiro over the course of the history of Babilônia/Chapéu Mangueira. Whereas many jobs may have been located within a short daily commute within the Zona Sul, due to the location of new jobs created during growth periods it appears that some residents commute long distances to work.

Table 28 presents average trip times by income level. A clear pattern emerges. Average trip time across the three favelas increases with income at an almost constant rate. This seems to confirm our findings that the wealthier make more motorized and fewer non-motorized trips.

Table 28. Average Travel Time by Income Level by Favela (minutes)

Monthly Minimum Salaries	Complexo da Penha	Batam	Babilônia/ CM	Total
0–2	22	30	29	**23**
2–5	27	26	31	**27**
5–10	33	27	20	**30**
10 +	30	49	40	**33**
Total	**25**	**29**	**30**	**26**

The highest average trip time (see table 29) for any mode was 78 minutes, on the multimodal rail system, or a trip that utilized both the suburban rail system and the subway. The multimodal trip mode "road and rail system" is a combination of rail modes (suburban train and subway) and public road based modes (bus, van/kombi, taxi, moto-taxi) and had a average trip time of 52 minutes, the 3rd highest. The third multimodal trip sequence "road, ferry, and rail system" was the fastest, at 27 minutes. This mode is a combination or road and rail together with the ferries that cross the Guanabara Bay between Rio and Niteroi.

Table 29. Average Travel Time by Mode by Favela (minutes)

Travel Mode	Complexo da Penha	Batam	Babilônia/ CM	Total
Van/Kinbi	38	47	56	**38**
Bus	52	61	76	**54**
Motorcycle-Taxi	20	5	40	**20**
Motorcycle	16	n/a	59	**17**
Private Car	25	31	27	**26**
Taxi	28	15	13	**27**
Ferry Boat	33	n/a	n/a	**33**
Suburban Train	26	n/a	n/a	**25**
Subway	45	54	20	**42**
Road & Rail System	64	47	57	**52**
Bicycle	16	21	17	**14**
Walking	17	12	18	**17**
Rail System	80	79	69	**78**
Road, Ferry & Rail System	25	27	38	**27**
Total	**25**	**36**	**41**	**26**

We also measured the time it took people to access their primary transportation mode (see table 30). This helps give an idea of the attractiveness of mass transport and overall transportation system efficiency in serving the favelas. Babilônia/Chapéu Mangueira had the highest average time to access both mass transport and individual transport, while Complexo da Penha had the shortest average trip time to access both transportation modes.

Table 30. Average Access Trip Time by Primary Transportation Mode by Favela (minutes)

Travel Mode	Complexo da Penha	Batam	Babilônia/ CM	Total
Mass Transport	10	12	17	**11**
Individual Transport	2	3	7	**2**
Total	**8**	**10**	**13**	**8**

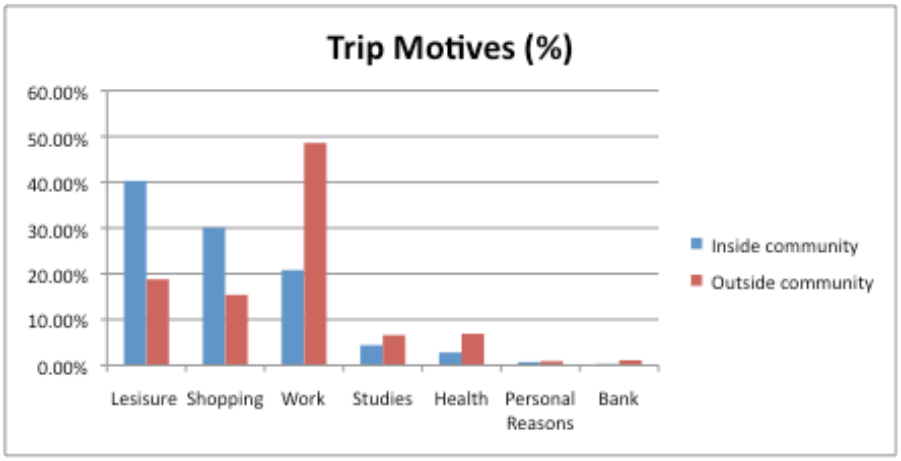
We also looked specifically at walking access trips (see table 31). Interestingly, the initial walking trips are about twice as long as the final walking trips. This suggests that favela residents walk farther to access their primary transport modes than they do to access their final destinations after they depart their primary transport mode. The transportation network provides better access to destinations like jobs and services for those who live in the formal city of Rio de Janeiro than it does to the residences in the favelas.

Table 31. Walking Access Trips Initial and Final by Favela (minutes)

Trips	Complexo da Penha		Batam		Babilônia/CM		Total	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Individual Transport	2.3	1.3	0.5	0.2	3.3	1.2	**2.4**	**1.3**
Mass Transport	9.4	4.2	6.7	3.7	7.2	3.8	**9.2**	**4.3**
Total Average	**5.9**	**2.8**	**3.6**	**2.0**	**5.3**	**2.5**	**5.8**	**2.8**

Leisure, shopping, and work were the three top motives for travel (see graph 11). For trips within the community, 40.3 percent were for leisure, 30.1 percent for shopping, and 20.8 percent for work. For trips outside the community, 48.6 percent were for work, 18.8 percent for leisure, and 15.4 percent for shopping. A much higher percentage of trips for work are made outside the community, while leisure and shopping trips are more common inside the community.

Graph 11. Trip Motives



We also looked at trip motives and mode (see table 32). The vast majority of leisure and shopping trips were via non-motorized transport, almost all on foot. Trips to work were more likely to be made via motorized transportation, in particular on mass transport. However 36

percent of trips to work were made on foot, highlighting the overall importance of pedestrian trips for diverse trip motives.

Table 32. Percentage of Trips by Motive and Mode

	Motorized Transport		Non-Motorized Transport	
Trip Motive	**Individual**	**Mass**	**Individual**	**Mass**
Work	12	51	1	**36**
Study	5	37	0	**57**
Health	17	49	0	**34**
Shopping	9	18	1	**73**
Leisure	14	16	1	69

Main Findings—Trip Times and Motives

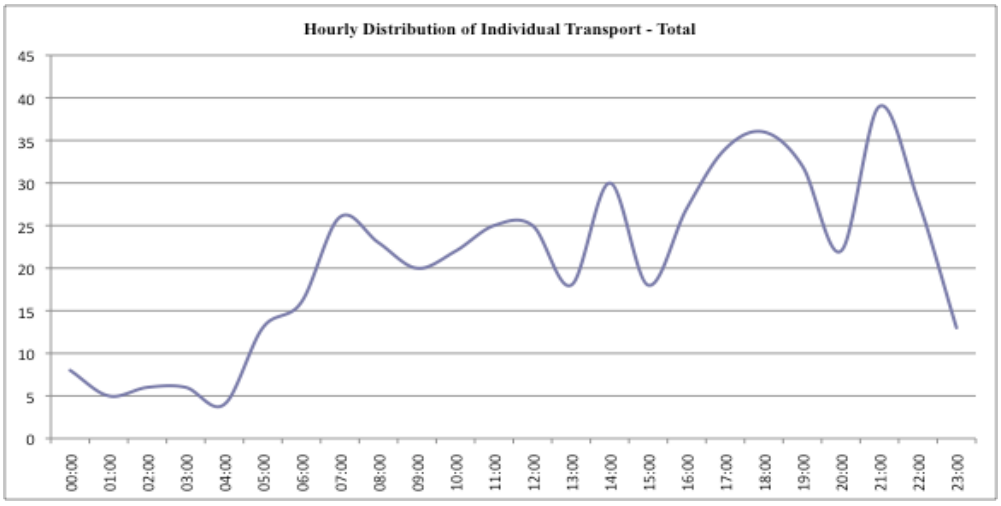
- Batam had the longest average bicycle trip time (45 minutes) outside the community, perhaps suggesting the viability of longer bicycle trips due to favorable topography and location of services.
- Despite a seemingly favorable central location, residents of Babilônia/Chapéu Mangueira still make very long motorized trips (47 minutes).
- Average trip time increases with income; the wealthiest travel the longest.
- The rail system has the highest average trip time of any mode surveyed.
- Multimodal trip sequences had high average trip times.
- Average time to access transport is higher for mass transport than for individual transport.
- Work is the main motive for trips outside the community.
- Shopping and leisure are the two most common motives for trips within the community.
- Over 70 percent of trips to shop or for leisure were made using non-motorized transport, while 63 percent of work trips were made via motorized transport.

Hourly Distribution of Travel

In order to understand the difference in transportation use at different times of day, we charted the hourly distribution of trips on individual transport, mass transport, and non-motorized transport.

Use of individual transport modes appears to peak after the end of the typical workday (see graph 12). The highest peaks of individual transport use are around 6:00 pm and 9:00 pm. There appear to be dips in individual transport use during lunchtimes and at the beginning of the afternoon commute or rush-hour.

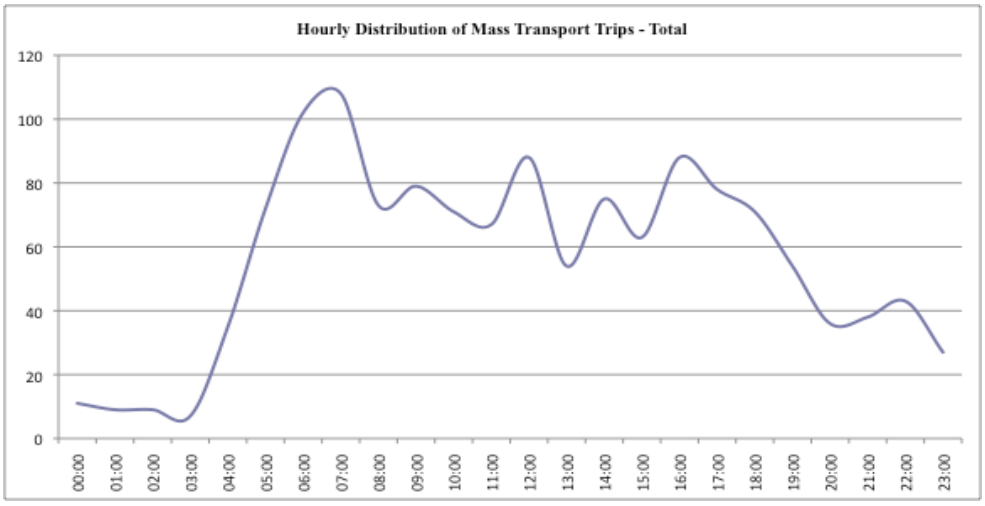
Graph 12. Hourly Distribution of Trips on Individual Transport—Total Trips



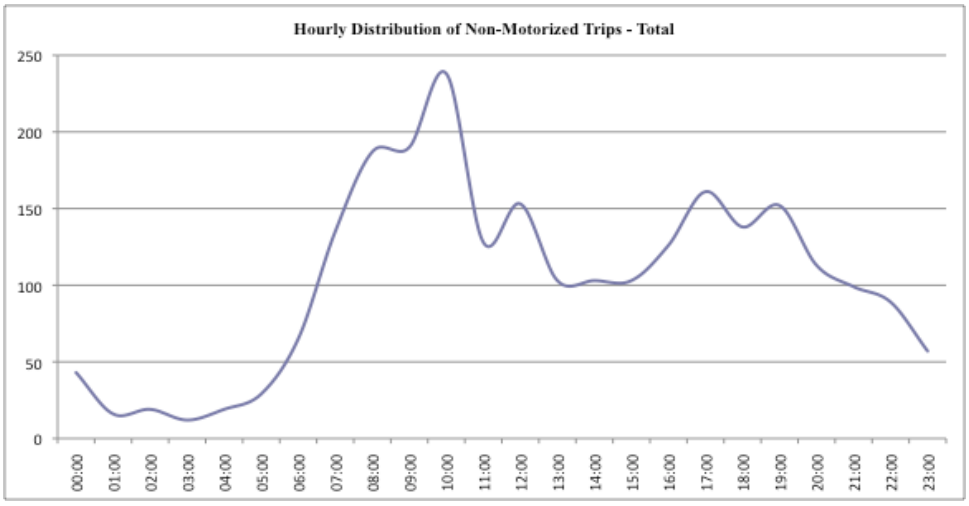
Mass transport use closely mirrors the rhythms of the workday (see graph 13). The highest peak appears during the morning rush-hour commute time between 6:00am and 7:00am. There are also peaks during lunchtime (noon) and the afternoon rush-hour (4:00pm to 5:00pm).

Non-motorized transport use rises throughout the morning hours, plateaus briefly at 8:00am, and reaches a peak around 9:30am (see graph 14). There is a brief early lunchtime peak and then peak levels from 4:30pm to 7:30pm.

Graph 13. Hourly Distribution of Trips on Mass Transport—Total



Graph 14. Hourly Distribution of Trips on Non-motorized Transport—Total



Main Findings—Hourly Distribution of Travel

- Individual transport use is highest at night, after the end of the typical workday.
- Mass transport peak usage closely matches the morning commute, lunchtime, and the afternoon commute.
- Non-motorized transport is highest in the late morning and the early evening.

Perception of Road Safety

As stated in the Literature Review, road deaths are a leading cause of death worldwide for young people and vulnerable populations and 90 percent of road deaths occur in developing countries like Brazil. Brazil has a traffic mortality rate of 20 deaths per 100,000 people, higher than neighboring Chile and Argentina.[95] Though there is data on road deaths at a national level, data on road deaths and traffic crashes at the favela level is difficult to find. Given this constraint, we approached the question of road safety from a qualitative side, surveying people's "perceptions" of road safety. Without being able to demonstrate quantitatively the differences between favela communities and the surrounding or formal city neighborhoods, we are able to show instead how safe people feel while traveling.

Favela residents feel safer as a pedestrian within their own communities.[96] 53.1 percent of favela residents feel unsafe as a pedestrian within their community, while 72 percent feel unsafe as a pedestrian outside of their community (see tables 33 and 34).

[95] Chandran et al, 2012, p. 11.

[96] We are including both those categories of "highly unsafe" and "unsafe" when we refer to those who felt unsafe.

Table 33. Pedestrian Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	11.1	11.0	9.0	**10.9**
Unsafe	43.8	28.8	37.1	**42.2**
Indifferent	8.5	10.3	10.7	**8.8**
Safe	34.9	47.9	40.4	**36.3**
Highly safe	1.7	2.1	2.8	**1.8**

The greatest variance for a single community was found in Batam, where 39.8 percent felt unsafe as a pedestrian within the community but 78.7 percent felt unsafe outside the community. This finding may be due to the community's proximity to Avenida Brasil, one of the busiest highways in Rio de Janeiro that effectively borders one side of the comunity. Many services are on the other side of the highway, and lacking sufficient pedestrian crossings of the busy thoroughfare, there are reportedly high numbers of pedestrian accidents.[97] It may also lead to the conclusion that flatter favelas have safer streets for pedestrian, or the infrastructure for pedestrians in flatter areas is of higher quality.

Table 34. Pedestrian Perceptions of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	15.5	17.1	10.1	**15.1**
Unsafe	57.7	61.6	44.4	**56.9**
Indifferent	8.4	6.2	13.5	**8.7**
Safe	17.1	13.7	30.9	**18.0**
Highly safe	1.3	1.4	1.1	**1.3**

Cyclists felt more in danger than pedestrians, both inside their communities and in the formal city. 63.6 percent of people felt unsafe as a cyclist within their communities, while 76.5 percent felt unsafe as a cyclist outside their communities (see tables 35 and 36).

Table 35. Cyclists' Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	10.3	14.8	5.1	**10.2**
Unsafe	54.2	37.3	58.8	**53.4**
Indifferent	6.2	9.2	8.5	**6.6**
Safe	28.6	38.7	27.1	**29.2**
Highly safe	0.7	0.0	0.6	**0.6**

Once again the largest disparity within a single community was Batam, with 52.1 percent of residents feeling unsafe as cyclists within the community and 86 percent feeling unsafe outside the community. This may point, once again, to the danger of nearby streets, including the major Avenida Brasil, and to a lack of bicycle infrastructure in the peripheral regions of the city.

[97] Based upon anecdotal evidence from conversations with local UPP Social staff.

Table 36. Cyclists' Perceptions of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	15.3	25.2	3.9	**15.0**
Unsafe	63.3	60.8	44.9	**61.5**
Indifferent	7.0	7.7	11.2	**7.4**
Safe	13.4	5.6	37.1	**14.9**
Highly safe	1.1	0.7	2.8	**1.2**

A high percentage of motorcycles drivers feel unsafe, both within the favelas and in the formal city. 65.5 percent of motorcycle drivers feel unsafe in the favelas and 76.2 percent feel unsafe in the streets of Rio de Janeiro outside their community (see tables 37 and 38).

Table 37. Moto Drivers' Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo Da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	15.2	8.3	6.3	**13.9**
Unsafe	52.1	41.7	55.2	**51.76**
Indifferent	8.1	20.8	5.2	**8.7**
Safe	23.6	29.2	33.3	**24.8**
Highly safe	1.1	0.0	0.0	**0.9**

Batam is the outlier. Within the community, 50 percent of motorcycle drivers feel unsafe, and 50 percent feel either indifferent or safe. Batam showed the highest percentage of motorcycle drivers who felt indifferent, neither safe nor unsafe, both inside and outside the community. Batam also showed the highest variance, with 50 percent of drivers feeling unsafe within the community, and 75 percent feeling unsafe outside the community. Babilônia/Chapéu Mangueira was the only favela where motorcycle drivers felt safer within the community rather than on the roads of the city outside the community.[98]

Table 38. Moto Drivers' Perceptions of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	20.4	22.2	7.3	**19.4**
Unsafe	57.9	52.8	49.2	**56.8**
Indifferent	8.1	18.1	9.6	**9.0**
Safe	12.2	5.6	31.1	**13.4**
Highly safe	1.3	1.4	2.8	**1.5**

Passengers on motorcycles feel highly unsafe, within and outside of their communities. 65.7 percent of passengers feel unsafe within their community and 74.5 percent feel unsafe in the

[98] Based upon observations, motorcycles are more prominent and aggressive on the streets within favelas as compared to the streets of greater Rio de Janeiro. On the streets of the favelas motorcycles are frequently the biggest vehicles on the road, while on the streets of the formal city they have to compete for space with much larger vehicles. This may lead to the streets of the favelas, with their current mix of road users, being a relatively safer environment for motorcyclists than the formal streets outside the favelas.

streets of Rio outside their community (see tables 39 and 40). This is very consistent with motorcycle drivers, only about a 2 percent change between drivers and passengers.

Table 39. Moto Passengers' Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	17.9	13.8	9.6	**16.9**
Unsafe	49.9	37.9	47.8	**48.8**
Indifferent	9.7	23.4	9.0	**10.6**
Safe	21.1	24.1	33.1	**22.4**
Highly safe	1.4	0.7	0.6	**1.3**

Batam shows the highest variance among motorcycle passengers, with about 20 percent more respondents feeling unsafe outside the community. Batam also recorded the highest number of respondents feeling "indifferent," both on the streets inside and outside the community.

Table 40. Moto Passengers' Perception of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	21.1	21.4	9.1	**20.1**
Unsafe	54.9	49.0	54.0	**54.4**
Indifferent	8.9	20.7	8.5	**9.7**
Safe	13.4	6.9	25.6	**14.0**
Highly safe	1.7	2.1	2.8	**1.8**

Passengers on buses feel slightly safer inside their communities. 56.3 percent of people feel safe inside the community, while 47.5 percent feel safe in the streets of Rio outside their community (see tables 41 and 42).

Table 41. Bus Passengers' Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	6.6	3.4	5.1	**6.3**
Unsafe	29.9	16.4	27.4	**28.7**
Indifferent	8.3	10.3	12.0	**8.8**
Safe	53.3	69.2	54.3	**54.5**
Highly safe	1.9	0.7	1.1	**1.8**

Batam's outlier status holds true for passengers on buses. 69.9 percent of respondents feel safe on a bus within their community, with 50 percent feeling safe outside the community. The almost twenty percentage-point difference is similar to the range of other user groups surveyed.

Table 42. Bus Passengers' Perception of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	8.7	11.0	5.1	**8.1**
Unsafe	36.4	34.9	31.5	**35.9**
Indifferent	8.6	4.1	10.7	**8.5**
Safe	44.7	40.3	50.0	**45.5**
Highly safe	2.1	0.7	2.8	**2.0**

Van[99] passengers are relatively evenly split on their perceptions of safety (see tables 43 and 44). 50.6 percent feel unsafe within their communities, and 59.8 percent feel unsafe in the streets of Rio. Across the different favelas, residents of Batam feel the most safe, with 68.5 percent responding that they feel safe and 26.7 percent who feel unsafe. In Complexo da Penha, 53.6 percent feel unsafe, with 37.6 percent feeling safe. Residents of Babilônia/Chapéu Mangueira are even more split, with 47.5 percent who feel safe, and 40.5 percent who feel unsafe.

Table 43. Van Passengers' Perceptions of Road Safety within the Favela (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	10.8	13.0	5.1	**10.5**
Unsafe	42.8	13.7	35.4	**40.1**
Indifferent	8.8	4.8	12.0	**8.8**
Safe	36.3	67.8	46.9	**39.4**
Highly safe	1.3	0.7	0.6	**1.2**

Batam shows the highest variance, 68.5 percent feel safe within the community and 37.7 percent feel safe outside it. The thirty one percentage point spread is larger than for the previous categories of road users.

Table 44. Van Passengers' Perception of Road Safety in the Street of Rio de Janeiro (percentages)

Perception (%)	Complexo da Penha	Batam	Babilônia/ CM	Total
Highly unsafe	13.4	19.2	5.6	**13.1**
Unsafe	48.0	38.4	40.4	**46.7**
Indifferent	8.3	4.8	11.2	**8.3**
Safe	29.0	36.3	41.0	**30.6**
Highly safe	1.3	1.4	1.7	**1.4**

Main Findings—Perception of Road Safety:

- All of the 6 user groups surveyed felt safer on the roads within their communities than on the streets of Rio outside their communities.
- Bus passengers were the only user group that did not show a majority response of "unsafe."

[99] Van refers to both van and kombi, the popular terms for informal transport modes.

- Cyclists feel the most vulnerable of any user group surveyed. Almost exactly two-thirds of respondents felt unsafe or highly unsafe in the streets of Rio, this was the highest average percentage of respondents who feel unsafe in any category.
- Drivers of motorcycles are the second most vulnerable group. They are only slightly behind the total average of cyclists who feel unsafe outside the community (76.2 percent versus 76.5 percent). Moto drivers feel slightly more unsafe than cyclists inside their community (65.5 percent versus 63.6 percent).
- Batam had the most dramatic differences in perceptions of safety inside the community versus the streets outside the community. We found a consistent 20–30 percentage point difference in perceptions of people who felt more safe inside their community than outside.
- Residents of Batam were the most likely to feel "highly unsafe." In 8 out of 12 tables presented, Batam showed the highest percentage of respondents who felt highly unsafe, with the highest single category being 25.2 percent of cyclists in Batam who feel highly unsafe riding outside their community.

Comparing the Formal and Informal Cities

One of the objectives of this study was to identify the differences in transportation use between residents of Rio's favelas and the formal city. In order to complete this comparison, we analyze our survey data against a secondary dataset—the Rio Origin-Destination study completed in 2002 and 2003 (O/D). This is the most recent O/D survey to cover the whole metropolitan region of Rio de Janeiro, including the 20 municipalities that comprise the metropolitan region. The municipality of Rio de Janeiro is 487 square miles, while the metropolitan region encompasses 1,760 square miles (see figure 11).

Figure 11. Map of Rio de Janeiro Metropolitan Region[100]

It is critically important to understand how the favela population uses transportation compared to the rest of the population of Rio de Janeiro. While acknowledging the serious constraints in comparison, this section will present an analysis of the main differences in transportation use between the favelas and the formal city of metropolitan Rio de Janeiro.[101]

Data Comparison—Favela Survey and Metropolitan Rio de Janeiro O/D Survey

In the O/D survey, the modal split for metro Rio is very balanced, with an almost equal 1/3 split between pedestrian (33.9 percent), bus (33.1 percent), and a combination of other modes (33 percent). Comparatively, the favela population shows a much higher reliance on walking trips (56.5 percent), and lower utilization of buses and private vehicles. The favela numbers in table 45 do not present the multi-modal trips that we captured, slightly lowering the percentages for bus and rail modes.[102]

[100] Image retrieved from PDTU, 2003, p. 5.

[101] The most serious constraint is a matter of scale and data reliability. Our survey interviewed 2,068 people and captured 4,336 trips, while the Rio OD covered the whole metropolitan region, interviewed 99,310 people and captured 19.9 million daily trips. Clearly there was a significant difference in study scope.

[102] For the modal splits, we captured multi-modal trips. We did not ask the participants to identify a primary transportation mode, whereas the Rio OD shows primary mode. For graph 15 we excluded multi-modal trips in the overall modal split.

Table 45. Modal Split for Favela and Metro Rio (percentages)

Travel Mode	Favela	Metro Rio
Pedestrian	56.5	33.9
Bus	13.8	33.1
Private Car	7.7	15.1
Van / Kombi	4.4	8.2
Motorcycle	1.5	0.5
Bicycle	0.7	3.2
Suburban Train	0.7	1.5
Taxi	0.3	0.7
Subway	0.3	1.8
Ferry Boat	0.0	0.4

The balanced distribution of trips in metro Rio and the greater reliance on walking for the favelas is clearly illustrated in graph 15. Informal transport, as measured by the "Van/Kombi" transportation mode, shows a higher use rate in the formal city than in the favelas. This may be explained by the methodological constraints, or may show a higher reliance on informal transport in the greater metropolitan region than in the city of Rio. Our findings for the modal share of vans/kombis are similar to earlier estimates.[103]

Graph 15. Favela and Metro Rio Modal Split

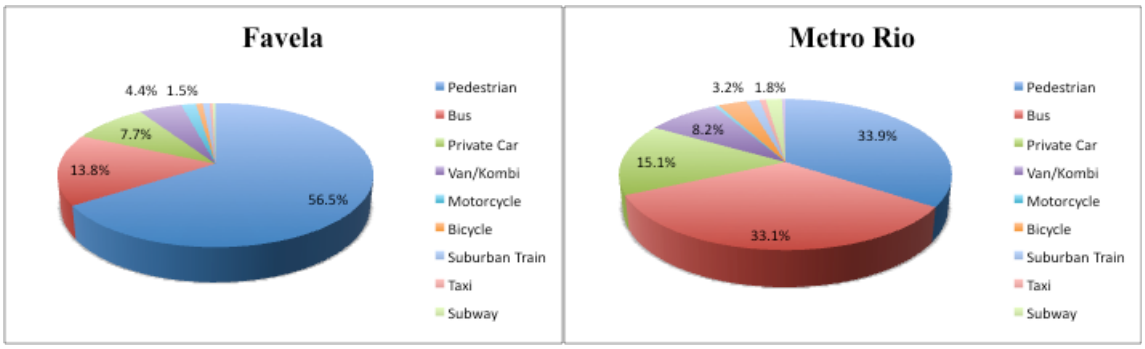


Table 46 shows the number of transfers, giving an idea of the prevalence of multi-modal trips. The transfer index is also a measure of transportation system efficiency. The comparison shows a higher transfer index for the favela population, at 1.60 transfers/trips in the favelas versus 1.18 for metro Rio.

Table 46. Transfer Index for Favela and Metro Rio

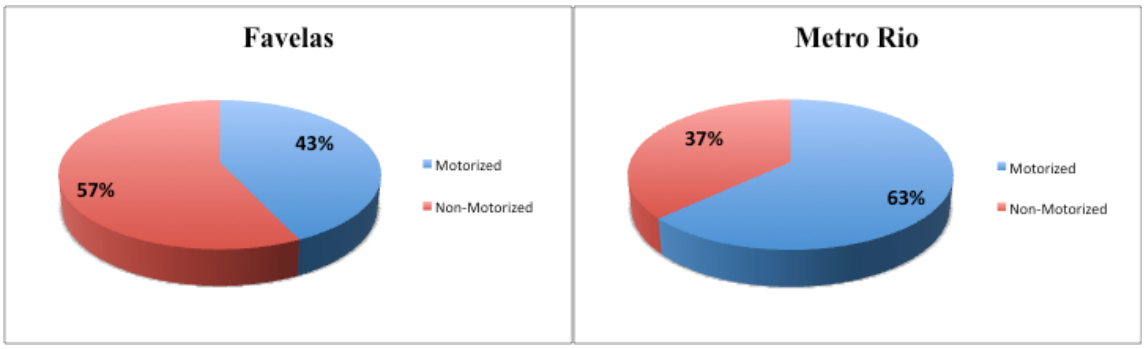
	Favela	Metro Rio
No. Trips	4,336	8,958,800
No. Transfers	6,923	10,574,156
Transfer Index	1.60	1.18

Residents of the favelas use non-motorized transportation modes, walking and bicycling, more frequently than residents in the formal city. We found an overall division of 57 percent non-

[103] See Balassiano and Braga, 1999, p. 14.

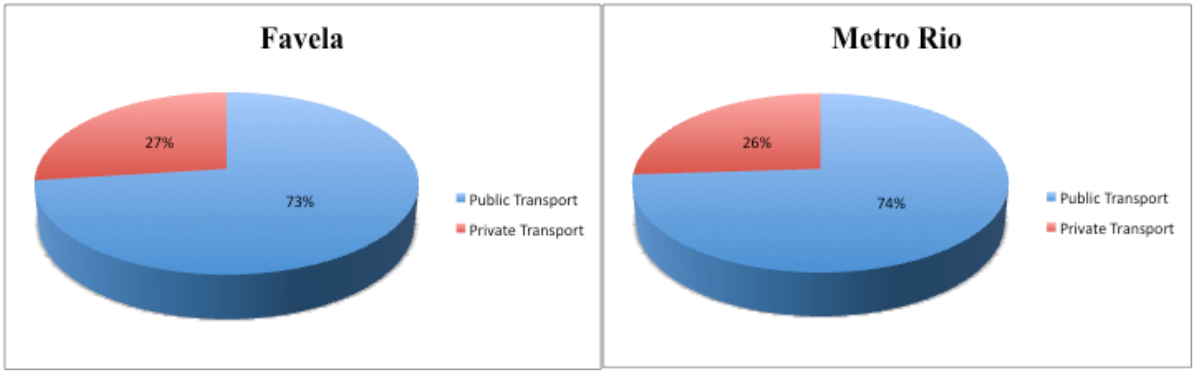
motorized and 43 percent motorized trips in the favelas, compared to 37 percent non-motorized and 63 percent motorized in metro Rio. The division is starker in the formal city.

Graph 16. Favela and Metro Rio Division of Trips Motorized/Non-motorized Transportation



Graph 17 shows the similarity in the division of motorized trips. Both populations show ¾ of motorized trips are on mass transport.

Graph 17. Favela and Metro Rio Division of Motorized Trips



Mobility index is a measurement of the number of daily trips for an individual, and a widely used barometer of personal mobility. We found that residents of metro Rio have a slightly higher mobility index than residents of the favelas (see table 47).

Table 47. Mobility Index for Favela and Metro Rio

	No. Trips	No. People	Mobility Index
Favela	4,336	2,519	1.72
Metro Rio	19,915,654	11,279,789	1.77

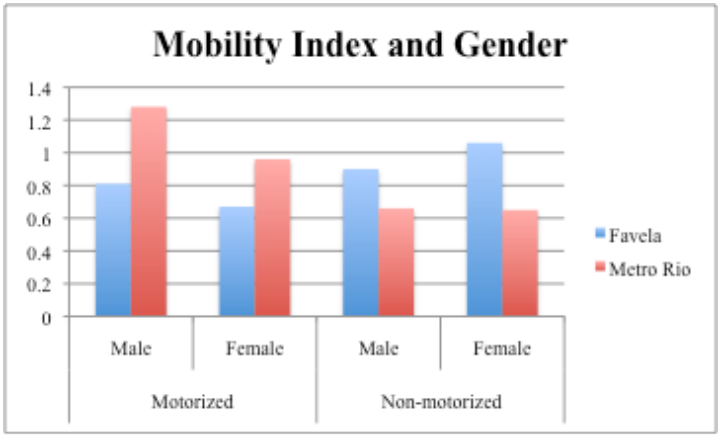
When the mobility index numbers are broken down into motorized and non-motorized trips, we see the greatest difference in mass transport and pedestrian trips. Metro Rio has a higher index of mass transport trips, and a lower index of walking trips. The index of individual transport trips is only slightly higher in the formal city, perhaps a surprise given the relatively low rates of vehicle ownership in the favelas.

Table 48. Mobility Index for Motorized and Non-Motorized Trip for Favela and Metro Rio

Type of Trip	Favela	Metro Rio
Motorized		
Mass Transport	0.54	0.82
Individual Transport	0.20	0.29
Non-Motorized		
Pedestrian	0.97	0.60
Bicycle	0.01	0.06
Total	**1.72**	**1.77**

Graph 18 reveals a clear pattern for mobility index tied to gender and motorization. Both men and women have higher motorized mobility in metro Rio, while both genders have higher non-motorized mobility in the favelas. This shows a fundamental difference in transportation usage between the two populations.

Graph 18. Favela and Metro Rio Mobility Index and Gender



When the mobility index numbers are broken down by age, we can see that the frequency of daily travel generally decreases with age (see table 49). The only outliers are those 50 years and older in the favelas, who have a slightly higher index than those in their 40s. The largest decrease in daily mobility is observed between those in their 40s and those over 50 in metro Rio. This may suggest a lack of adequate planning and system design for older users in the formal city. It is also clear that residents of metro Rio rely more on motorized modes than residents of the favelas.

Table 49. Mobility Index for Favela and Metro Rio by Age Group

Age Group	Favela			Metro Rio		
	Motorized	Non-Motorized	Total	Motorized	Non-Motorized	Total
20–29	0.82	0.95	1.77	1.32	0.71	2.05
30–39	0.78	0.97	1.75	1.44	0.52	1.96
40–49	0.68	0.98	1.66	1.44	0.40	1.84
50 +	0.69	1.00	1.69	1.22	0.43	1.55

Table 50 shows the correlations between mobility index and education. Metro Rio shows a clear pattern of more mobility for those with more educational attainment. The numbers are more unclear for the favela population. This may be due to our sample size, or may demonstrate less correlation between education and mobility in the favelas as compared to the formal city.

Table 50. Mobility Index for Favela and Metro Rio by Education Level

Education Level	Mobility Index	
	Favela	Metro Rio
Incomplete Elementary	1.73	1.60
Complete Elementary	1.66	1.68
High School Graduate	1.74	1.93
College	1.76	2.70

Once again for mobility index and income, the numbers are clearer for metro Rio (see table 51). The mobility index increases with income, as the wealthier make around 2 more trips per day than the poor. Within our surveyed favelas, the mobility index ranges only .02 between the different income groups.

Table 51. Mobility Index for Favela and Metro Rio by Income Level

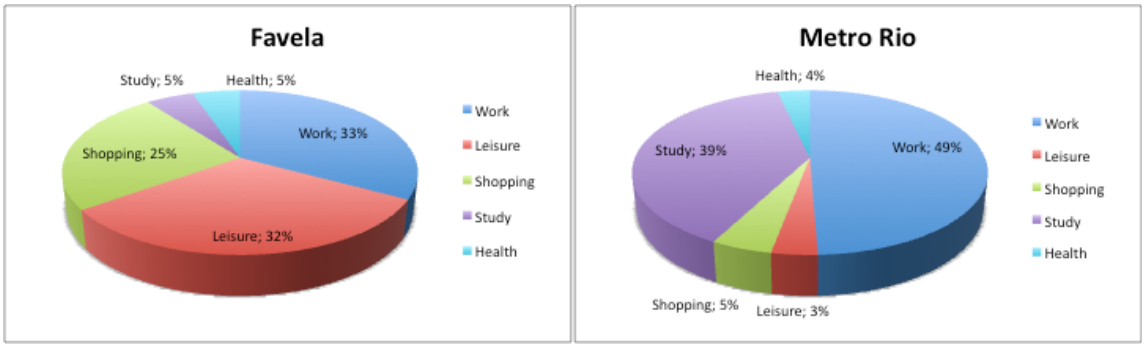
No. Minimum Monthly Salaries	Mobility Index	
	Favela	Metro Rio
0–2	1.73	1.46
2.5	1.71	1.69
5.10	1.72	2.04
10 +	1.72	2.40

We found a wide range in trip motives between the favelas and the formal city. The favela population travelled for purposes of leisure much more frequently than in the formal city. This may reflect our survey's focus on trips within the favelas, which captured many non-essential trips, including those for leisure. It may also reflect a fundamental difference in how the different populations access leisure, perhaps showing that residents of the formal city do not have to travel as frequently or as far in order to access leisure activities, which may be located close to their home.[104]

Travel to study represents almost 40 percent of the trips in metro Rio, and was the second most common trip motive. In the favelas only 5 percent of trips were for study. Our study only surveyed those over 18 years old, whereas the Rio OD captured trips for younger residents, who are more likely to be in school and travelling daily for study. Shopping represented a higher percentage of trips for the favelas, 25 percent, compared to only 5 percent for the formal city.

[104] It may also reflect a difference in understanding of "leisure" between the different populations.

Graph 19. Favela and Metro Rio Trip Motives



The average trip times for metro Rio are higher than for the favela population (see table 52). This is likely explained by the difference in scope of the two studies. The Rio OD captured travel across a massive metropolitan region, while our favela survey focused on the city of Rio. The average trip time for pedestrians was almost equal despite the differences.

Table 52. Average Trip Time (in minutes) for Favela and Metro Rio by Trip Mode

Trip Mode	Average Trip Time	
	Favela	Metro Rio
Mass Transport	44	54.8
Individual Transport	22	34.0
Pedestrian	17	17.4
Total	26	37.4

While trip times rise with increased income in the favelas, the lowest and highest income ranges have the shortest trip times in metro Rio (see table 53).

Table 53. Average Trip Time (in minutes) for Favela and Metro Rio by Income Level

No. Minimum Monthly Salaries	Average Trip Time	
	Favela	Metro Rio
0–2	23	34.5
2.5	27	40
5.10	30	41
10 +	33	36.5

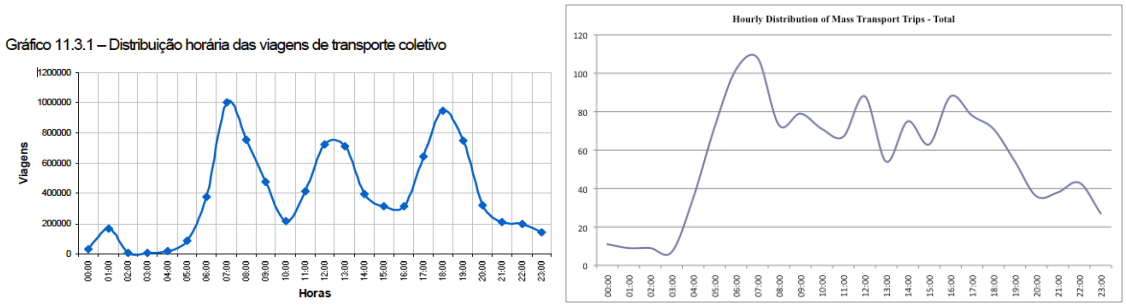
Table 54 presents the average time taken to access the primary transportation mode. Residents of the favelas take 11 minutes to access mass transport while in the formal city it takes a little over 5 minutes, or half as long. Table 52 also shows that it takes only 2 minutes to access individual transport modes in the favelas, versus just over 40 seconds for the formal city. This reflects the disparity in parking of private vehicles between the two populations. Residents of the favelas are less likely than residents of the formal city to be able to park their cars at or close to their homes.

Table 54. Average Access Trip Time (in minutes) for Favela and Metro Rio by Mode

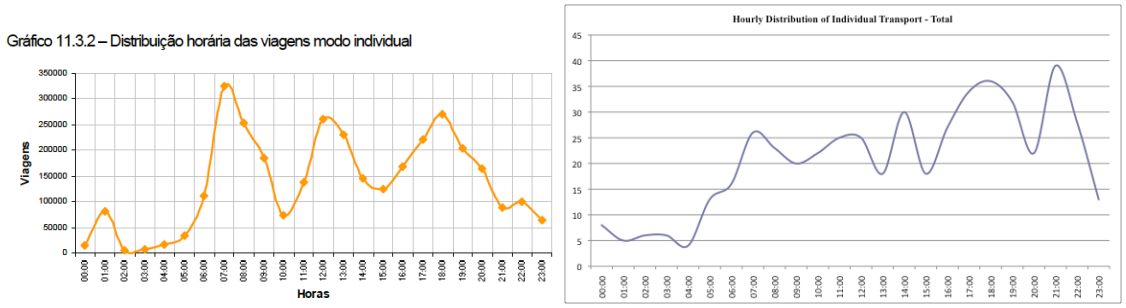
Trip Mode	Mean Access Time	
	Favela	Metro Rio
Mass Transport	11	5.1
Individual Transport	2	0.4

The graphs of hourly distribution of travel clearly show the benefit of capturing more data for indentifying clear patterns (see graphs 20–22). While the graphs for metro Rio have very well defined trends, our graphs for the favelas are more uneven, with smaller dips and peaks.

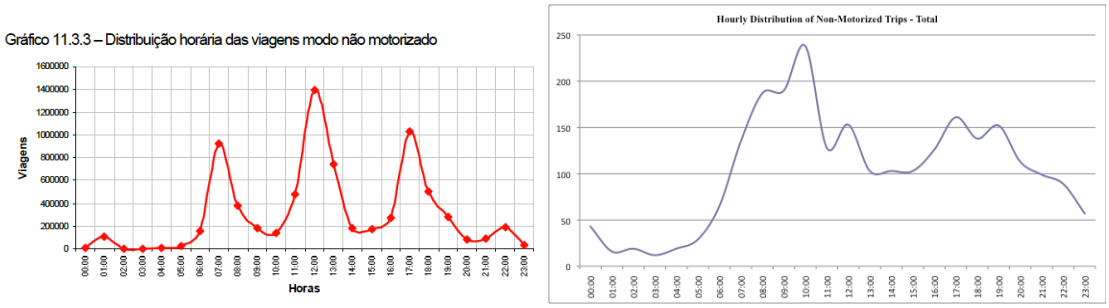
Graph 20. Favela and Metro Rio Hourly Distribution of Travel—Mass Transportation



Graph 21. Favela and Metro Rio Hourly Distribution of Travel—Individual Transportation



Graph 22. Favela and Metro Rio Hourly Distribution of Travel—Non-motorized Transportation



Main Findings—Comparison of Formal and Informal Cities

- Favela residents are more reliant on walking as a primary transportation mode.
- There is a higher reliance on non-motorized transportation in the favelas, but a smaller gap in the number of total motorized and non-motorized trips.
- Both men and women in metro Rio have a higher mobility index for motorized trips, while both men and women in the favelas have higher non-motorized mobility.
- ¾ of motorized trips are made on mass transport in both the favelas and metro Rio.
- Mobility index is more clearly correlated to education and income in metro Rio than the favelas.
- Access trips are longer for mass transport but shorter for individual transport in the favelas than in metro Rio.

Policy Implications

This research study was designed and conducted with the ultimate goal of influencing policy in the city of Rio de Janeiro. The city's housing department, SMH, aims to upgrade and redevelop *all* favelas in the city by 2020, which it hopes will be one of the main legacies of the 2016 Olympic Games.[105] One way in which researchers can contribute is to highlight a previously underappreciated area of interest to urban researchers and policymakers. We believe our research shows the need for a central focus on transportation within slum upgrading programs.

Investments in transportation are a central component of slum-upgrading programs, yet the base of knowledge about transportation use in Rio's favelas is woefully inadequate and the impacts of previous efforts to improve transportation remain little understood or analyzed. The research team relied upon the cooperation of the SMH staff throughout the formative stages of the research project. The next step is to continue this collaboration in the enumeration of policy recommendations for Morar Carioca based upon the research findings presented in this paper.

SMH created a yearlong design process for the Morar Carioca teams, demonstrating the high value placed on understanding the local conditions and including the voice of the community in the design process. The design teams are required to spend time developing an understanding of the local area where they will be working, including the local transportation needs and patterns. The design teams are also given technical guidelines by the SMH that they must follow in their proposals. Our research can help inform the methodology employed during the Morar Carioca design phase and provide concrete technical guidelines for the Morar Carioca projects.

The aim here is not to present a comprehensive and fully defined set of investigative mobility methodologies nor technical guidelines, but to offer a few initial guiding principles for both.

- *Transportation must be understood more broadly than "circulation networks"* (how it has traditionally been defined in previous analyses of slum upgrading projects).

[105] See Morar Carioca informational booklet, also see the website Cidade Olímpica, including http://www.cidadeolimpica.com/en/urbanization-that-integrates-the-slums-with-the-asphalt/

Upgrading projects have profound impact on how residents get around their community and how they access the formal city. Any definition of transportation should include vehicle ownership, modal split, and non-motorized transportation.

- *Interventions must focus on supporting non-motorized transportation*. Favelas are predominantly pedestrian communities, and physical infrastructure must enable safe environments for walking and bicycling. Infrastructure for non-motorized transportation should be prioritized ahead of motorized transportation. This is an especially important point for community development, as we found that many non-essential trips (non work, non study trips) were made via non-motorized transportation.

- *There is great potential to improve and expand bicycle infrastructures*, including bicycle paths and lanes and bicycle parking. This is especially true in flatter areas of the city, like the Zona Oeste. Bicycles can be an important access mode and must be considered an important part of a sustainable transportation system in the favelas. There are also opportunities for micro-enterprises related to bicycles strategically located near bicycle parking.

- *Vehicle speeds must remain low*. There is great worry that with improved pavement and street conditions, vehicle speeds will increase, leading to more accidents and road deaths. The connection between high vehicle speeds and injury and death is well documented by a growing body of literature. Vehicle speeds must be considered a central component of creating a safe transportation network for the favelas.

- *Vehicle parking is clearly a challenge for favela communities*. The current situation, with vehicles occupying space on streets and sidewalks, is untenable. Upgrading projects should develop creative ways to provide vehicle parking that meets local demand for parking while not incentivizing future motorization. Safe public parking should be provided in some form to get vehicles off the streets and sidewalks. Parking can also be an opportunity for local economic development and job creation. There could also be opportunities for micro-enterprises related to vehicle maintenance close to parking.

- *Slum-upgrading programs require integrated institutional frameworks* that bring all public agencies together. In Rio de Janeiro, this means that the SMH must foster connections with the Secretariat of Transport, and the Secretariat of the Environment (responsible for bicycles projects in Rio), in addition to other public agencies. Medellin has shown the importance of institutional frameworks that holistically address upgrading combined with the political leadership necessary foster effective cross-sector collaboration.

- *Favelas are sites of dynamic growth and near constant flux*. Upgrading strategies, particularly transportation, must recognize and plan for future growth. Transportation networks can impact the physical form of development, especially in areas that have grown organically, and often without the benefit of public infrastructures to guide development. Planners must recognize the complex interplay of public and private development interests and tailor their approaches to benefit the long-term public good.

Directions for Future Research

Our study is one of the first to broadly investigate a range of transportation issues in Latin American slums, and to take an empirical approach to generating data on key questions and indicators of transportation. It is important, therefore, to marshal our experience to help guide future work. This section presents a list of important points of attention that we hope will be addressed by future research.

- *Comparative research on transportation in slums*. It is costly and time-consuming to conduct research in a single slum in a single city, let alone multiple slums across multiples cities. Yet a comparative analysis of transportation in slums in different countries and regions is a critical area for future attention. We found that Asia and Africa are well represented in the existing literature, while South America remains understudied.

- *Inclusion of transportation indicators in other slum research studies*. Some of the previous research highlighted in this paper focused on cross-sectoral poverty analysis. Some papers looked at how transportation affected other services like health and education. Understanding the relationships between transportation and other services and their contribution to urban poverty should continue to garner attention.

- *Establishment of commonly accepted slum transportation indicators*. Comparative research would be greatly aided by a widely accepted set of transportation indicators. This would facilitate geographically disparate researchers and academics in the comparison of different case studies. It is also critical for the interface of academia and local policymakers. In Rio we observed that the SMH measures "mobility" and "accessibility" through one measurement, while the UPP Social uses a different one, and researchers take another approach. We believe the resulting dialogue around what are the most critical measurements of transportation in slums is of fundamental importance and we hope it will be taken up by our peers and partners.

- *Micro-scale study of road safety*. One of the greatest challenges faced in our survey was the key question of how to measure road safety. Given the increasing prominence of road safety in international discourse (see the UN 2011–2020 "Decade of Action on Road Safety"), it is important for researchers to tackle the problem on a micro as well as macro scale. Data availability on traffic accidents in the favelas is very poor. Lacking any official data sources, it is extremely difficult for researchers to survey quantitatively. There are no examples known to the authors of previous studies generating empirical data on traffic accidents in slum areas. Beyond quantitative measurements, there is no clear standard established for qualitative assessments of road safety. We believe that the favela environment poses unique conditions for researchers interested in road safety and hope that future researchers take more interest in this area.

- *Differences in transportation use between sub-areas in larger settlements*. Our survey was not able to highlight differences in transportation patterns between diverse sub-areas within our selected favelas. However, we believe this is an important area of interest and should be explored in greater depth. A case study of large Complexos would likely yield interesting results about the differences in travel behavior for residents of disparate locations within a single sprawling settlement, and help provide insight for upgrading efforts targeted to complex large settlements.

Conclusion

The next few years are a critical period in the history and development of Rio's favelas. The confluence of forces driving the upgrading and redevelopment—pacification, federal funding, political will, and mega-events—will shape a dramatic new reality for a child born in a favela in 2013.

Will he or she grow up in a neighborhood with all of the benefits of the formal city? Will he or she be able to access education, healthcare and employment opportunities on an efficient and equitable transportation system? Will the favelas maintain distinct cultural and social identities while guaranteeing a quality of life and the full slate of rights reflecting the economic and political reality of the globalized 21st century?

With all of the energy and resources dedicated to upgrading the biggest mistake that politicians and technical officials could make would be to implement universal solutions without regard to the specificities and power of local history and culture. The prevailing discourse within the disciplines of architecture, urban planning, and transportation engineering too often disregard the practical wisdom of local knowledge and the ingenuity of local transportation solutions.

How can we help the favelas maintain their distinct character while innovating and pushing the boundaries of urbanization and upgrading forward? How do we make sure that families who have lived in these communities for generations keep control of their destinies while working together with public officials to make sure that their neighborhoods provide the best possible future for all local children?

Perhaps the most important question of all is whether Rio de Janeiro can achieve its remarkable ambition to intervene in every favela in the city by developing strategies with large enough scope that they actually make a difference in the lives of favela residents citywide. Can the politicians, funders, and technical officials and designers successfully align their individual interests and sustain the momentum to create a program that is both scalable and respectful of local context?

Our research findings confirm the notion that it takes time to understand local conditions, especially for areas that have disconnected or disjointed for so long from mainstream and formal political, economic, and social processes. Each favela community faces unique constraints and has unique needs. We found both significant difference in travel behavior between the different favela typologies and geographic locations, and between the favelas and the formal city.

The provision of an efficient and equitable transportation network in Rio faces particular challenges in recognizing and addressing the unique needs of different parts of the city and different populations. The best approach is a detailed understanding of local conditions and a profound commitment on the part of public officials and publicly contracted architects and designers to develop open dialogues and engage favela communities in a participatory upgrading process.

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Glossary of Terms and Acronyms

Armazém de Dados: "Data warehouse" maintained by the municipal urban planning agency in Rio de Janeiro, known as Institute Pereira Passos. Within the Armazém is SABREN, the "sistema de assentamentos de baixa renda" or "system of low-income settlements," which collects public information on the favelas, including data and maps.

Cidade Maravilhosa:"Marvelous City," a colloquial name for Rio de Janeiro, thought to refer to both the physical beauty of the city and the lifestyle of its inhabitants.

Complexo: "Complex" in English, refers to a particular spatial typology of favelas in Rio de Janeiro. Typically it is a series of distinct settlements that have gradually grown and morphed into each other, blurring territorial boundaries and creating new spatial and social dynamics. One of the three study sites, Complexo da Penha, conforms to this type both in name and spatial configuration.

Cortiço: a tenement style housing building. A cortiço is typically defined by the subdividing of units and extreme population density.

CRAS: Centro Referencial de Assistiência Social, local social services center.

Favela: the most common Brazilian name for a slum or informal area. The definition is explored in the paper (pp. 21–22) at greater length.

Habitação social: social housing, or public housing developments built by the public sector for mostly low-income citizens.

IBGE: Instituto Brasileiro de Geografia e Estatística, the Brazilian Institute of Geography and Statistics, which is a federal agency responsible for carrying out the national census.

Kombi: popular term used for van, informal transportation, it is typically a 12 passenger van.

Milicia[106] (militia): a paramilitary group controlling a favela territory or territories, typically composed of current or former police, military, fire, and prison guards. They exact duties from the local residents in return for "protection," control most local services, including informal transportation in the form of vans and kombi's, and exact further fees from local residents in return for these services. They are extremely violent groups who often kill or kick out the local drug factions. They are typically connected to the local political and judicial structures and control vast portions of the Zona Oeste of Rio de Janeiro. It is estimated that they control as much as 45 percent of the city's favelas.

Morar Carioca: Citywide slum upgrading program, run by SMH. The goal is to intervene in *all* favelas in the city by 2020, with a projected investment of over $5bn USD and affecting the lives of over 1 million people.

[106] See also Romero and Barnes, 2012.

PAC: Programa de Aceleração do Crescimento, or Program to Accelerate Growth, is a program of Federal financing to the State-level government for large-scale public works projects, including those focused on urban mobility. The program was started by former President Luis Inacio Lula da Silva and has continued and expanded under President Dilma Rousseff. In 2009 the PAC provided US $6.6bn to host cities of the World Cup and Olympics, followed by a second round of US $12bn. The cable-car system (teleférico) in Complexo de Alemão was financed by PAC.

SMH: Secretaria Municipal de Habitação, Rio de Janeiro Municipal Housing Secretariat. This Secretariat is the public authority responsible for the favela upgrading programs in the city of Rio.

UPP: Unidades de Polícia Pacificadora, units of the pacifying police, the new model of community policing whereby the police officers occupy and then maintain a physical presence in the favelas. Program was created by the State Governor, Sergio Cabral in 2008, and is run by the State Secretary for Security, José Mariano Beltrame.

UPP Social: These units are the social side of the pacifying police, run through a collaboration of Rio's city government and UN-Habitat. The force of the UPP aims to allow the power of the state, including all social and public services to enter into the favela territories. The UPP Social aims to be a layer of contact between the city government and the favela communities, mediating local requests and articulating local desires. The UPP Social establishes local staff in the favelas and will conduct detailed community mappings and surveys, in collaboration with local residents and youth.

Zona Sul: the southern zone of the city, tourist friendly and including most of the traditional middle and upper classes, stretching from Flamengo/Botafogo to Ipanema/Leblon.

Zona Norte: the northern, largely industrial zone of Rio. Home to many working class neighborhoods as well as low-income neighborhoods and informal settlements and favelas.

Zona Oeste: the western zone of the city, the site of future mega-events and fastest growing part of the city, physically separated from the Zona Sul and Zona Norte by the Tijuca National Forest.

Appendix A—Annotated Previous Slum Transport Studies

Gulyani, S., Talukdar, D., Jack, D. 2010. "Poverty, Living Conditions, and Infrastructure Access: A Comparison of Slums in Dakar, Johannesburg, and Nairobi." Policy Research Working Paper 5388, the World Bank.
World Bank research teams surveyed 1,755 households in Nairobi and 1,960 households in Dakar. Slums were randomly selected, 88 were selected in Nairobi and 99 in Dakar. A separate World Bank team surveyed 5,100 households selected from 253 slums in Johannesburg, but this paper only utilizes 1,618 informal housing residents, for comparisons sake. Found that use of motorized public transport was low across all 3 cities, and walking was the primary transport mode for slum residents in Nairobi and Dakar.

Salon, D. and S. Gulyani. 2010. "Mobility, poverty and gender: Travel 'choices' of slum residents in Nairobi, Kenya," Transport Reviews, A Transnational Transdisciplinary Journal 30(5): 641–657
Comprehensive quality of life survey of 5,000 slums residents in Nairobi, Kenya completed by the World Bank in 2004, with help from the Kenya Central Bureau of Statistics. The paper narrows the sample to the 1596 households and 3292 individuals who travel daily to work or school. Findings show that "both poverty and gender matter in explaining differences in the travel choices of working adults in Nairobi's slums."

Renny, M. 2009. "Access to Transportation for the Urban Poor in Indonesia," background paper by the Institute for Transportation Studies for the workshop "Access to Transport for the Urban Poor in Asia," Yogyakarta, Indonesia, UN-Habitat—Global Energy Network for Urban Settlements (GENUS).
Case studies of 5 informal settlements in Indonesia. 50 interviews conducted in each slum area, randomly selecting participants over the age of 15. Study focused on understanding "mobility needs and access to transportation." It utilized a broad methodology that aimed "to capture the travel system—formal and informal—in the settlements, typical destinations/trip purposes and key challenges."

Zhong-Ren, P., Yi, Z., and Shunfeng, S. 2008. "Mobility of the Chinese Urban Poor: A Case Study of Hefei City." ***Chinese Economy*** **41, no. 1: 36–57.**
Study analyzes the results of a 2003 citywide household survey in Hefei, China of over 100,000 households, collected by the city government and Southeast (China) University. Focus is on the urban poor, rather than slum residents.

Venter, C., Vokolkova, V., and Michalek, J. 2007. "Gender, Residential Location, and Household Travel: Empirical Findings from Low income Urban Settlements in Durban, South Africa," ***Transport Reviews: A Transnational Transdisciplinary Journal*****, 27:6, 653–677**
Survey implemented in 6 communities spread geographically across the Metropolitan Region of Durban, South Africa. Survey sample of 600 households, 2183 individuals. Research found that "residential location significantly affects the access and mobility conditions faced by low-income urban communities."

Anand, A., and Tiwari G. 2006. "A Gendered Perspective of the Shelter-Transport-Livelihood Link: The Case of Poor Women in Delhi," *Transport Reviews: A Transnational Transdisciplinary Journal*, 26:1, 63–80
Survey of 108 households in a "slum cluster," administered in collaboration with local NGO. Research found that "women lack mobility in the city due to gender-based restrictions, inferior access to transport means, a high dependence on low-quality public transport, and a lack of availability of affordable modes of travel."

Baker, J., Basu, R., Cropper, M., Lall, S., Takeuchi, A., 2005. Urban Poverty and Transport: The Case of Mumbai. World Bank Policy Research Working paper #3693.
Survey of 5,000 randomly samples households in Mumbai, India conducted from August 2003 to February 2004. The project aimed to "study the travel behavior of the poor and the non-poor as a function of residential location, employment location, the time and money costs of travel and the quality of transit service." Study found high reliance on walking for non-work trips, and public transport for work trips.

Srinivasan, S., Rogers, P. 2005. "Travel behavior of low-income residents in two contrasting locations in the city of Chennai, India." *Journal of Transport Geogrpahy* 13, 265–274.
Survey of 70 households in one centrally located and one peripherally located settlement. Research found that residents of the centrally located area make more non-motorized trips and women in the central location make more trips than those in the periphery. Authors conclude, "Location appears to be significant in travel behavior…it appears to affect all aspects of travel behavior: time spent, cost, frequency, and mode choice for the trip."

SITRASS. 2004. "Poverty and Urban Mobility in Douala." SSATP Report No. 09/04/Dla., World Bank Sub-Saharan Policy Transport Program.
Household survey of 1,885 individuals selected from 30 survey areas, as well as 30 in-depth interviews. Findings include that mobility was centered in a small neighborhood radius and most trips were made on foot.

SITRASS. 2004. "Poverty and Urban Mobility in Conakry." SSATP Report No. 09/04/CKR., World Bank Sub-Saharan Policy Transport Program.
Household survey of 2,703 individuals selected from 30 survey areas, as well as 30 in-depth interviews. Research found that mobility is severely constrained by an inadequate road network and an ineffective public transport system. Walking accounts for around three-quarters of trips for both and poor and non-poor residents.

ITRANS—Instituto de Desenvolvimento e Informação em Transporte. 2003. "Mobilidade e Pobreza—Região Metropolitana do Rio de Janeiro." Documento para discussão.
This is the only previous study known to the authors that focuses solely on transport amongst the poor in Rio. Completed 1,600 interviews in low-income households across Rio de Janeiro in addition to focus group interviews. Study found that the poor have generally low mobility indexes (as measured by trips/day). Public transport (bus) and walking were the primary modes of transport, and work and education the primary trip motives.

Shuiying, Z., Han, W., Weili, H., Dening, C. 2003. "A Lifetime of Walking: Poverty and Transportation in Wuhan." Draft Report, Economic Research Institute, Wuhan University.
Analyzes existing data sets as well as using focus groups. Research found that walking is the predominant transport mode for the poor in Wuhan. Public transport is used for trips of greater distance, and bicycles are commonly owned but not that well used.

Urban Resource Center. 2001. Urban Poverty and Transport: A Case Study from Karachi. *Environment and Urbanization* 13:1, 221.
Interviews with 108 transport users in 8 low-income settlements in 5 locations, 4 peripheral and one centrally located area. Study conducted by local NGO in collaboration with international partners. Found lack of mobility options for the poor severely limited opportunities. Also found death and injury from accidents are top concern for users, operators, and regulators.

Howe, J., Bryceson, D., 2000. Poverty and Urban Transport in East Africa: Review of Research and Dutch Donor Experience, Report prepared for the World Bank, IHE, Delft.
Reviewed studies completed in Nairobi and Dar es Salaam (capital cities) and Eldoret and Morogoro (secondary cities). Studies found that in the capital cities walking was the dominant mode choice, sometimes combined with public transport. For the secondary cities walking and bicycling were more used given a comparative lack of public transport options.

Palmer, C.J., Astrop, A.J., Maunder, D.A.C. 1997. "Constraints, attitudes, and travel behavior of low income households in two developing cities." Transport Research Laboratory Report #263.
Found limitations for walking and cycling led to public transport use when available and high use of informal public transport. Limited information describing the sample size and methodology.

Astrop, A., 1996. "The urban travel behavior and constraints of low- income households and females in Pune, India." In: Women's Travel Issues, Second National Conference, Baltimore, MD.
Household travel survey implemented in 9 neighborhoods, comprising 1005 interviews. Research also targeted specific user groups, including female cyclists, male and female public transportation users, etc. Results found that women are more likely to walk or take public transport, and have less access to private vehicles.

Appendix B—Survey Questionnaire

Bom dia / Boa tarde, meu nome é ... Eu trabalho para o Instituto Informa e, no momento, estamos realizando uma pesquisa sobre transporte urbano, com o objetivo de trazer melhorias futuras para a sua comunidade. Sua participação é muito importante. A entrevista durará, no máximo, 10 minutos e todas as suas informações são de caráter estritamente confidencial, não serão compartilhadas. O(a) Sr.(a) pode colaborar conosco?

FILTROS DE CUMPRIMENTO OBRIGATÓRIO

F1. O(a) Sr.(a) mora nesta comunidade? Sim Não (ENCERRE)

F2. Há quantos anos você vive de forma permanente nesta comunidade? _____ Se menos de 1 ano (ENCERRE)

F3. O(a) Sr.(a) trabalha em:

- Agência de publicidade ou marketing?	Sim (ENCERRE)	Não
- Institutos de pesquisa de mercado?	Sim (ENCERRE)	Não
- Imprensa (rádio, jornal, revista, televisão)?	Sim (ENCERRE)	Não
- Empresas de transporte coletivo?	Sim (ENCERRE)	Não
- Mototáxi	Sim (ENCERRE)	Não

F5. O(a) Sr.(a) poderia me fornecer seu **NOME E TELEFONE (FIXO OU CELULAR)** para que a supervisão do instituto faça a verificação das entrevistas realizadas visando garantir a qualidade do nosso trabalho?

NOME _____

DDD / TELEFONE (FIXO OU CELULAR) |___|___| |___|___|___|___|___|___|___|___|

PERGUNTAS

Você é proprietário de?

1. Bicicleta	**01** |__| Sim	**02** |__| Não
2. Motocicleta	**01** |__| Sim	**02** |__| Não
3. Automóvel	**01** |__| Sim	**02** |__| Não

Agora gostaria que o(a) Sr.(a) me desse algumas informações sobre seus veículos:

4. Qual o ano de fabricação de seus veículos?

5. Pensando de modo geral, o qual o estado/condição de seus veículos?

6. Qual o tipo de combustível utilizado?

7. Seu veículo está registrado no Detran?

	P04 Ano fabricação	P05 Condição Geral			P06 Combustível 1 = gasolina 2 = álcool 3 = diesel 4 = veículo flex	P07 Registro Detran
		Boa	Regular	Ruim		
Motocicletas	|__|	01|__|	02|__|	03|__|	|__|	01 |__| Sim 02 |__| Não
Carros	|__|	01|__|	02|__|	03|__|	|__|	01 |__| Sim 02 |__| Não

ATENÇÃO ENTREVISTADOR: FAÇA AS PERGUNTAS 8 A 9 APENAS PARA OS ENTREVISTADOS QUE POSSUEM CARRO OU MOTO. PARA OS DEMAIS, PULE P/P10.

8. Onde o(a) Sr.(a) costuma guardar seu carro?

01 |__| Na sua casa

02 |__| Na rua

03 |__| Na casa de um amigo/familiar

04 |__| Em estacionamento pago

99 |__| NR

9. Onde o(a) Sr.(a) costuma guardar sua moto?

01 |__| Na sua casa

02 |__| Na rua

03 |__| Na casa de um amigo/familiar

05 |__| Em estacionamento pago

99 |__| NR

As perguntas que seguem dizem respeito a todas as atividades e deslocamentos que você realizou **ONTEM.** Por favor, considere todos os deslocamentos, inclusive aqueles realizados a pé.

10. Você foi trabalhar	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
11. Você foi estudar	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
12. Foi tratar da saúde	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
13. Foi fazer compras	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
14. Foi se divertir	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
15. Foi levar filhos à escola	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não
Outro (especificar)	**01** |__| Sim, dentro da comunicade	**02** |__| Sim, fora da comunicade	**03** |__| Não

Meio de transporte, duração e custo do deslocamento de ida e volta

IDA

			Transporte dentro da comunidade						Custo		Transporte fora da comunidade						Custo	
Número do deslocamento	Destino final:	Motivo do deslocamento:	Hora de partida:	Tempo da caminhada a pé inicial - ou total se não usar veículo:	Tempo de espera pelo veículo	Veículo utilizado:	Tempo gasto dentro do veículo:	Caminhada a pé final desde onde saiu do veículo até o destino:	Quanto gastou R$	Se utilizou vale transporte:	Hora de partida:	Tempo da caminhada a pé inicial - ou total se não usar veículo:	Tempo de espera pelo veículo	Veículo utilizado:	Tempo gasto dentro do veículo:	Caminhada a pé final desde onde saiu do veículo até o destino:	Quanto gastou R$	Se utilizou vale transporte:
	1= dentro do bairro 2= fora do bairro	1= trabalho 2= estudo 3= saúde 4= compras 5= diversão 6= trabalho+estudo 7= trabalho+compras 8= trabalho+diversão 9= estudo+compras 10= estudo+diversão	(hh:mm)	(minutos)	(minutos)	1= van/kombi 2= ônibus 3= moto-taxi 4= motocicleta 5= automóvel 6= taxi 7= bicicleta 8= não utilizou veículo	(minutos)	(minutos)		1= sim 2= não	(hh:mm)	(minutos)	(minutos)	1= van/kombi 2= ônibus 3= moto-taxi 4= motocicleta 5= automóvel 6= taxi 7= barca 8= trem suburbano 9= metro 10= combinação de meios sobre pneus e trilhos 11= bicicleta 12= não utilizou veículo	(minutos)	(minutos)		1= sim 2= não
1																		
2																		
3																		
4																		
5																		
6																		

Meio de transporte

VOLTA

			Transporte dentro da comunidade						Custo		Transporte fora da comunidade						Custo	
Número do deslocamento	Destino final:	Hora de partida:	Tempo da caminhada a pé inicial - ou total se não usar veículo:	Tempo de espera pelo veículo	Veículo utilizado:	Tempo gasto dentro do veículo:	Caminhada a pé final desde onde saiu do veículo até o destino:	Quanto gastou R$	Se utilizou vale transporte:	Hora de partida:	Tempo da caminhada a pé inicial - ou total se não usar veículo:	Tempo de espera pelo veículo	Veículo utilizado:	Tempo gasto dentro do veículo:	Caminhada a pé final desde onde saiu do veículo até o destino:	Quanto gastou R$	Se utilizou vale transporte:
	1= dentro do bairro 2= fora do bairro	(hh:mm)	(minutos)	(minutos)	1= van/kombi 2= ônibus 3= moto-taxi 4= motocicleta 5= automóvel 6= taxi 7= bicicleta 8= não utilizou veículo	(minutos)	(minutos)		1= sim 2= não	(hh:mm)	(minutos)	(minutos)	1= van/kombi 2= ônibus 3= moto-taxi 4= motocicleta 5= automóvel 6= taxi 7= barca 8= trem suburbano 9= metro 10= combinação de meios sobre pneus e trilhos 11= bicicleta 12= não utilizou veículo	(minutos)	(minutos)		1= sim 2= não
1																		
2																		
3																		
4																		
5																		
6																		

16. Como **pedestre** como você se sente com relação a um possível atropelamento nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

17. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

18. Independente de ser ciclista ou não, como você se sente, como **ciclista,** com relação a um possível atropelamento d **ciclista** nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

19. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

20. Independente de ser condutor de moto ou não, como você se sente, como **condutor de moto** com relação a u possível acidente de trânsito nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

21. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

22. Independente de você andar ou não de moto, como você se sente como **passageiro de moto,** com relaçã a um possível acidente de trânsito nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

23. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

24. Independente de você andar ou não de ônibus, como você se sente como **passageiro de ônibus** com relação a um possível acidente de trânsito nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

25. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

26. Independente de você andar ou não de van/Kombi, como você se sente como **passageiro de van/kombi** com relação a um possível acidente de trânsito nas ruas da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

27. E nas vias (ruas) da cidade do Rio de Janeiro fora da sua comunidade?

01 |__| Muito inseguro **02** |__| Inseguro **03** |__| Nem seguro, nem inseguro
04 |__| Seguro **05** |__| Muito seguro **99** |__| NR **(ESPONTÂNEO)**

PERFIL

28. Faixa etária (anos)

01 |__| 18 a 19 **02** |__| 20 a 29 **03** |__| 30 a 39 **04** |__| 40 a 49 **05** |__| 50 ou mais **99** |__| NR

29. Escolaridade **(espontânea e única)** **(LISTA RENDA)**

01 |__| Sem instrução
02 |__| Ensino Fundamental Incompleto (1º grau)
03 |__| Ensino Fundamental Completo (1º grau)
04 |__| Ensino Médio Incompleto (2º grau)
05 |__| Ensino Médio Completo (2º grau)
06 |__| Ensino Superior Incompleto (3º grau)
07 |__| Ensino Superior Completo (3º grau)

30. Possui carteira de habilitação para?

Carro	Moto	Ambos	Não possui
01 |___|	02 |___|	03 |___|	04 |___|

31. Possui bilhete único (municipal, intermunicipal)?

01 |__| **Sim** **02** |__| **Não**

32. Sabe andar de bicicleta?

01 |__| **Sim** **02** |__| **Não**

33. Renda Chefe Domicílio **(LISTA RENDA)**

01 |__| Até 03 SM (até R$1.866,00)
02 |__| Entre 03 e 05 SM (R$1.866,01 a R$3.110,00)
03 |__| Entre 05 e 10 SM (R$3.110,01 a R$6.220,00)
04 |__| 10 SM ou mais (mais de R$6.220,01)
99 |__| NR

34. Renda Familiar **(LISTA RENDA)**

01 |__| Até 03 SM (até R$1.866,00)
02 |__| Entre 03 e 05 SM (R$1.866,01 a R$3.110,00)
03 |__| Entre 05 e 10 SM (R$3.110,01 a R$6.220,00)
04 |__| 10 SM ou mais (mais de R$6.220,01)
99 |__| NR

35. Ocupação **(espontânea e única) (LISTA OCUPAÇÃO)**
(NÃO ACEITAR COMO RESPOSTA A PROFISSÃO, EX: ENGENHEIRO, MÉDICO E ETC)

01 |__| Aposentado / pensionista
02 |__| Autônomo
03 |__| Empregado com carteira assinada
04 |__| Empregado sem carteira assinada
05 |__| Estudante (sem trabalhar)
06 |__| Funcionário público
07 |__| Profissional liberal
08 |__| Sem ocupação, procurando emprego
09 |__| Sem ocupação, sem procurar emprego
10 |__| Outra, qual? |____||____| _____
99 |__| NR

36. Sexo

01 |__| Masculino
02 |__| Feminino

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37. Região |____||____|

38. Bairro |____||____||____|

39. Nome do bairro _____

40. Data da coleta |____||____| / |____||____|

41. Supervisor Código |____||____||____||____| Nome _____

42. Controlador Código |____||____||____||____| Nome _____

43. Entrevistador Código |____||____||____||____| Nome _____

Appendix C—Community Profiles: Income, Employment, and Education

Here we present findings on socio-demographic indicators for income, employment, and education in our surveyed favelas. It is important to emphasize that we are presenting findings on specific communities in order to provide background on our survey sample. We are not speculating on broader socio-economic trends in the favelas of Rio de Janeiro nor attempting to generalize our findings to other communities.

Income

For family income levels, Complexo da Penha has the highest percentage of low-wage earners (those earning up to 2 minimum salaries). 88.7 percent of families across the 3 favelas earned 5 minimum salaries or less, or less than R$3,110/month[107]. Batam had the highest percentage of families earning over 5 minimum salaries/month, just ahead of Babilônia/Chapéu Mangueira.

Table 55. Family Income[108]

Family Income	1	2	3	Total
Up to 02 Minimum Wage (< R$ 1.244,01)	52,8%	37,7%	35,4%	50,2%
02-05 MW (R$1.244,01 - R$3.110,00)	37,4%	42,5%	46,1%	38,5%
05-10 MW (R$3.110,01-R$6.220,00)	8,1%	16,4%	14,6%	9,3%
More than 10 MW (> R$6.2220,01)	1,4%	2,7%	3,9%	1,7%
Not Informed	0,2%	0,7%	0,0%	0,2%

A previous study in 2010 of the first 9 communities with UPP by the Instituto de Estudos de Trabalho e Sociedade found Batam had the lowest per capita income.[109] The IETS study found a wide range in per capita monthly household income amongst the UPP favelas, ranging from Batam at R$406 to Pavão/Pavãozinho at R$691.[110]

Table 56. Head of Household Income

Household Head Income	1	2	3	Total
Up to 02 Minimum Wage (< R$ 1.244,01)	65,5%	54,1%	55,1%	63,8%
02-05 MW (R$1.244,01 - R$3.110,00)	29,8%	37,7%	36,5%	30,9%
05-10 MW (R$3.110,01-R$6.220,00)	4,0%	8,2%	6,7%	4,5%
More than 10 MW (> R$6.2220,01)	0,6%	0,0%	1,7%	0,6%
Not Informed	0,2%	0,0%	0,0%	0,1%

[107] Equivalent to $1,520 USD at January 2013 exchange rates.

[108] The tables in this section present data collected from the brief demographic section of the Survey Questionnaire. Please see Appendix B for the Survey Questionnaire.

[109] IETS, 2010, p. 5. It is important to clarify that the UPP installation in Batam encompasses 6 distinct favelas, including Batam. Batam is the largest and most formalized of the 6, and most likely the wealthiest. Therefore, the IETS sample for Batam is skewed by the other, poorer favelas within the UPP territory. This would explain the discrepancy between the IETS study findings and our findings for Batam.

[110] IETS, 2010, p. 4.

Complexo da Penha also had the highest percentage of very low head of household earners. Batam had a slightly higher percentage of those making between 2 and 10 minimum salaries than Babilônia/Chapéu Mangueira, but Babilônia/Chapéu Mangueira was the only favela with more than 1 percent making over 10 minimum salaries.

Our results show that favelas are not homogenous low-income communities. There is commonly a wide range of income levels present in these areas. However, Complexo da Penha was clearly the poorest of our three surveyed communities, with less than 10 percent of families making over 5 minimum salaries and fewer than 5 percent of head of households earning more than 5 minimum salaries. Given that it is the largest, this begs the question of whether there is an inverse relationship to size and favela income level. However size is only one component that may help determine the wealth of favela residents, together with other factors such as location, age, level of consolidation and political power, and others. Perhaps demonstrating the importance of location as a primary factor in income level and partially explaining the income disparity between Complexo da Penha and our other locations, the IETS 2012 study found that family income was 53 percent greater in Zona Sul favelas compared to Zona Norte favelas.[111]

Employment

We found generally high levels of employment in the surveyed favelas (see table 57). 66.7 percent of our total surveyed population was economically active. The unemployment rate was under 9.6 percent and unemployed but looking for a job was 9.7 percent. The 32 percent of respondents who are either self-employed or have informal employment mirrors the 32 percent of the local population with formal sector jobs. We found higher informal sector employment than previous studies.[112]

Table 57. Employment

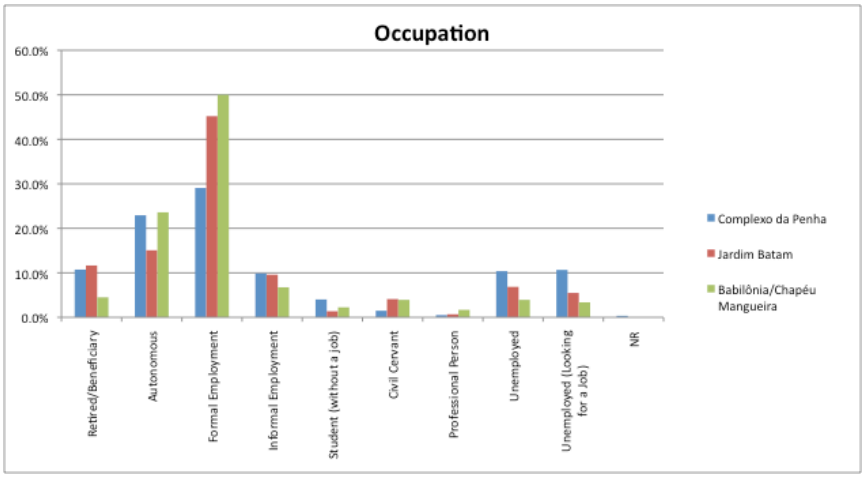
Occupation	1	2	3	Total
Retired/Beneficiary	10.7%	11.6%	4.5%	10.3%
Autonomous	22.9%	15.1%	23.6%	22.4%
Formal Employment	29.1%	45.2%	50.0%	32.0%
Informal Employment	9.9%	9.6%	6.7%	9.6%
Student (without a job)	4.0%	1.4%	2.2%	3.7%
Civil Cervant	1.5%	4.1%	3.9%	1.9%
Professional Person	0.5%	0.7%	1.7%	0.6%
Unemployed	10.4%	6.8%	3.9%	9.6%
Unemployed (Looking for a Job)	10.7%	5.5%	3.4%	9.7%
NR	0.3%	0.0%	0.0%	0.3%

Amongst the three favelas surveyed, Babilônia/Chapéu Mangueira had the highest formal employment, closely followed by Batam. Babilônia/Chapéu Mangueira had the lowest percentage of retirees and the lowest percentage of unemployed. Complexo da Penha had the highest percentage of unemployed and together with Babilônia/Chapéu Mangueira had the highest percentage of self-employed.

[111] IETS, 2012, p. 14.

[112] IETS, 2012, p. 8.

Graph 23. Occupations in the Favelas



There is likely a significant survey bias in the findings for employment due to our methodology of surveying people in the streets rather than knocking on doors and speaking to people in their homes. Due to this, it is probable that we under-represent the portion of the favela population that is economically inactive, or those who do not leave home to work every day. There is more research needed in this area to better understand economic diversity in the favelas and to generate more advanced data collection methodologies.

In the IETS study Batam had by far the largest unemployment rate, 19.7 percent, of any UPP favela.[113] Again it is important to emphasize that the IETS study included other areas adjacent to Batam that we did not include in our survey area, many of which are likely poorer given the IETS findings.

Education

Our surveyed favela population had relatively low educational achievement. Only 35.8 percent of the population graduated from high school. Almost 1/3 did not finish elementary school. Fewer than 4 percent on average reached any college-level education.

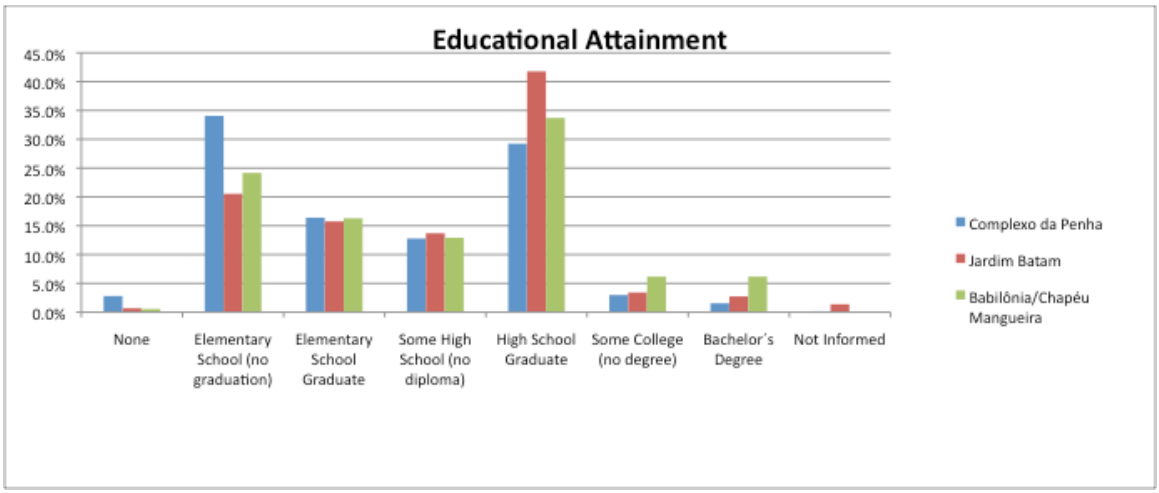
Table 58. Favela Education Levels

Educational Attainment of the Population	1	2	3	Total
None	2,8%	0,0%	0,6%	2,4%
Elementary School (no graduation)	34,1%	20,5%	24,2%	32,3%
Elementary School Graduate	16,4%	15,8%	16,3%	16,3%
Some High School (no diploma)	12,8%	13,7%	12,9%	12,9%
High School Graduate	29,2%	41,8%	33,7%	30,5%
Some College (no degree)	3,0%	3,4%	6,2%	3,3%
Bachelor´s Degree	1,5%	2,7%	6,2%	2,0%
Not Informed	0,2%	2,1%	0,0%	0,3%

[113] IETS, 2012, p. 7.

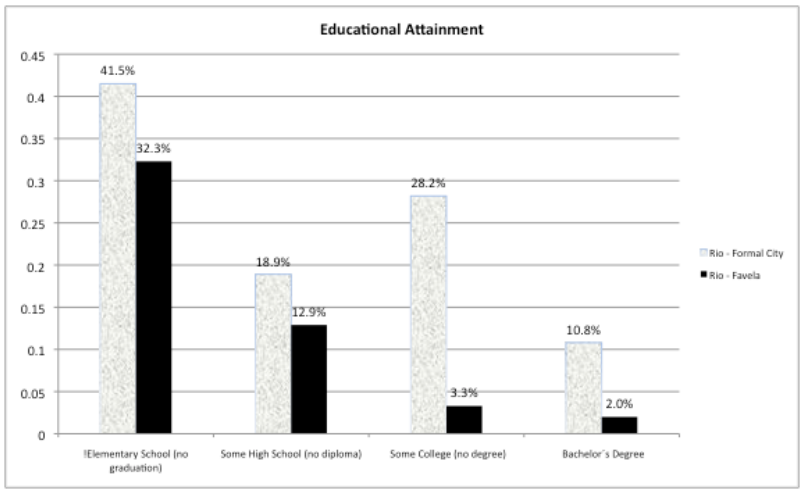
Complexo da Penha shows the highest percentage of residents who have not completed elementary school, at 34.1 percent. The numbers for completion of elementary school and those with some high school fall within a small range. Batam has the highest percentage of those who have completed high school, with 41.8 percent. Babilônia/Chapéu Mangueira has the highest percentage of those with some college and those with a college degree, both at 6.2 percent. Those who responded that they have no education was under 1 percent for Batam and Babilônia/Chapéu Mangueira, but was 2.8 percent for Complexo da Penha.

Graph 24. Favela Education Levels



Graph 25 shows the educational levels for the metropolitan region of Rio de Janeiro as measured by the 2010 census compared with our surveyed favela population. While education levels are generally lower in the favelas than in the general population, the most dramatic difference is seen for those people with some college experience. While 28.19 percent of the general population of Rio has achieved some college, only 3.3 percent of the favela population achieved the same. Resident's of Rio's favelas consistently fall behind the general population in educational achievement, but lag most dramatically in attaining college experience and advanced degrees.

Graph 25. Rio de Janeiro Formal City and Favelas Education Levels[114]



In the 2012 IETS study of UPP-occupied favelas, Babilônia/Chapéu Mangueira was amongst the highest for educational achievement and Batam was firmly in the middle of the pack. Complexo da Penha was not included in the survey sample.

If the UPP favela pacification is successful and the areas become more accessible to researchers, knowledge of the details presented in this Appendix will become more advanced.

[114] Formal city data retrieved from IBGE, 2010, Censo Demográfico – Resultados gerais da amostra.

Appendix D—Photographs of Favela Parking Situations[115]

Batam—Parking of motorcycle and car in alleyway.

[115] All photographs by Jacob Koch.

Batam—Complex scene of cars parked on the street, on the sidewalk, and in “private” driveways. 70 percent of people in Batam said they parked their cars in their homes and 85 percent said they parked their motorcycles in their homes. The definition of private parking space is blurry, and many consider the area directly in front of their home to be their private space, rather than a public sidewalk. Curb cuts, some done officially by the city and many done on the resident’s own initiative, only complicate the matter.

Complexo da Penha—Motorcycles parked on the side of a staircase.

Complexo da Penha—Vehicles parking half on very narrow sidewalk and half on the street.

Complexo da Penha—Vehicles parked on street/sidewalks. One side of the street (on the left in photo) has a very narrow sidewalk, so cars are parked half on the sidewalk and half on the street. On the right side of the photo, there is a wider sidewalk, allowing residents to park their cars predominantly on the sidewalks (though parts of the car are still in the street).

Babilonia—Motorcycles parked on the walkway on the steep hillside.

Babilonia/Chapéu Mangueira—Bicycles parked at the bottom of the hill at the entrance to the access road that leads up from the formal neighborhood to the favela on the hillside.

Babilonia/Chapéu Mangueira—Cars parked on the sidewalk and in the street on the main road of the community.