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Is Informal Transit Land-Oriented? Investigating the Links Between Informal Transit and Land-Use Planning in Quito, Ecuador

Working Paper WP19JG1

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May 2019

Abstract

Like many Latin American cities, Quito has undergone rapid urban transformation due to transportation interventions aimed at improving equity and environmental outcomes. Yet, informal transport continues to be a viable strategy for low-income residents living in peripheral areas to move around, as cities are still built up through a relationship between informal and formal systems. There is a long and rich tradition of Latin American peripheral urbanization through unregulated or illegal processes tied to auto construction (Caldeira 2017). In this context, this paper seeks to analyze the relationship between informal transit and land use in Quito, Ecuador. It asks if informal transit is land-oriented. It seeks to discover how informal transit route decisions are made, if land use regulations have any influence, what type of spatial patterns arise, and the impacts on individuals. However, it is unclear how and where informal transit operators place routes, which may or may not deviate from standard routes of formal transportation services.

The analysis directly adds to transit-oriented research by uncovering the nature of the relationship between land use regulation and informal transportation. We use a variety of research methods: interviews, participant observation, sample survey, and GPS technology. The initial findings demonstrate the importance of social networks in neighborhoods, and how informal transportation routes provide connections between rural-urban, and urban-peri-urban areas, that might be a continued and necessary option for cities. Informal transportation lines operate in dense urban areas regulated by land use, as well as connecting modes for formal transit that is integrated with the public transportation network. The high incidence of informal transportation lines in the fastest growing areas of Quito seems to indicate where land markets are burgeoning.

Keywords: informal transport, land uses, urban planning, transit planning

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Acknowledgements

We are thankful to Bernhard Snizek and Thomas Sick-Nielsen for the GIS spatial analysis as part of the research team. In Quito, we are grateful for the on-the-ground support from students Daniela Pabon and Maria Emilia Fierro. Our gratitude also goes directly to the companies who participated in the study. We are appreciative of their time, collaboration and openness to share their everyday challenges. Finally, we are incredibly thankful for the opportunity to conduct this research with the generous support from the Lincoln Institute for Land Policy.

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Is Informal Transit Land-Oriented? Investigating the Links Between Informal Transit and Land-Use Planning in Quito, Ecuador

Introduction

Like many Latin American cities, Quito has undergone rapid urban transformation due to transportation interventions pursuing to improve equity and environmental outcomes. To achieve such ends municipalities plan for transit-oriented development, which has been studied under the rubric of housing provision and rail service (Chatman 2013), or bus-rapid transit and land-use decisions (Rodriguez and Vergel 2013). Yet, informal transport continues to be a strategy for low-income residents living in peripheral areas to move around as cities are still built up through a relationship between informal and formal systems. There is a long and rich tradition of Latin American peripheral urbanization through unregulated or illegal processes tied to auto-construction (T. P. Caldeira 2017). Thus, areas outside of regulated and zoned urban land are unregulated. These areas are better understood as "gray spaces" (Yiftachel 2009), where urban informality becomes a mode of planning (Roy 2005). In this study, we do not treat informal transport as a closed category that is opposite to the formal (McFarlane and Waibel 2016). Rather, we analyze the multiple layers and logic of negotiated processes that shape the practices of transit drivers.

In this context, this research seeks to investigate the relationship between informal transit and land-use in Quito, Ecuador. It asks how informal transit is land-oriented. It seeks to discover how decisions on informal transit routes are made, if land-use regulations have any influence, what type of spatial patterns arise, and the impacts on individuals with different income levels. Transit scholars argue how informal transit holds an important place for transportation in cities of developing countries. It operates in the peripheries, which are usually unregulated. Informal transit offers many benefits akin to formal public transportation and provides services at higher frequencies at hours outside of operation of public transit. Informal transit usually covers areas that lack formal bus services, and provides a flexible service adaptable to passenger needs, connecting residents to public transport lines. It also might offer door-to-door attention or can deviate from standard routes. Thus, this paper argues that informal transit operates in regulated and unregulated areas of the city to capture the "holes" in the formal transportation service. However, it is unclear how and where informal transit operators locate routes, which may or may not deviate from standard routes of service provided by formal services.

This paper aims to directly add to transit-oriented research by uncovering the nature of the relationship between land-use regulations and informal transit. It also proposes to examine the qualitative characteristics and motivations of informal transit providers, starting from the social networks in the neighborhoods they serve. These characteristics also demonstrate the importance of social networks and neighborhood collective action. By employing a variety of research methods that comprise qualitative and quantitative techniques, including interviews, participant observation, survey, and GPS technology, this study aims to reveal the possibilities of informal transit as a continued and viable option for cities. In this study, we define land-use regulation through density restrictions, zoning, commercial, industrial and residential use—but, we will also

use other built environment indicators such formal transit infrastructure, and areas designated as risky or unregulated to test other possible explanatory relationships with informal transit corridors. This paper presents initial results that capture a slice of the informal transit network in Quito. We analyze participant observation and semi-structured interviews to delineate the social networks that underpin the organization of informal transit in Quito, showing how trust and security are elements that are attributed to the areas of the city that it serves. Subsequently, we report on the spatial patterns that have surfaced with informal transit operators and depict findings on their relationship to urban land in Quito. The paper concludes by reporting on all findings and offering public policy recommendations.

a) From Latin American Transit Innovation to Land-Oriented Informal Transit

Until recently, the idea of transit innovation in Latin American cities would have left almost any urban resident in Quito speculating. In Latin America, urban planning practices have gone from grandiose modernist experiments (Holston 1989, 41) to diverse-use large urban development projects that emphasize ideas such as sustainability, resilience, and a world-class city (Zeiderman 2016). The attention to land use and transit-oriented development is historically known in Latin America with the example of Curitiba's BRT in the 1970s (Lindau, Hildago, and Facchini 2010). Today, larger normative ideas of planning innovate diverse-use solutions for land, urban policies, and infrastructure. Transit infrastructure innovations are studied, rationalized and analyzed with their relationship to land uses and the greater urban context. However, little attention has been placed on vital services that still move around a large number of urban residents in Latin American cities. Regional superstar cities like Bogotá have focused on civic behavior and sustainable transportation as a root to solving urban problems (Gilbert 2006). In Medellín, known for its success with "social urbanism," public and private institutions concentrated on a combination of spectacular libraries, aerial cars, and museums as a way to regenerate and connect marginalized areas socially and spatially with the rest of the city (Brand and Dávila 2011).

Some Latin American cities, like Medellín, have focused on diverse-use plans that are formed around interventions in urban mobility. For example, a few Colombian cities have become branded or fetishized for transportation successes like the cable car (Álvarez Rivadulla and Bocarejo 2014). Moreover, the profusion of bicycle infrastructure networks has begun to connect cities like Bogotá (R. Cervero, Sarmiento, Jacoby, Gomez, and Neiman 2009). Parallel to these initiatives, in recent years, transit-oriented development has emerged as a key tool and dominant planning idea to promote efficient land-use policy decisions. By coordinating transit and land-use planning, scholars have indicated the positive benefits to the urban environment and the developing world (R. B. Cervero 2013; R. Cervero and Landis 1995). The literature mainly discusses how transportation infrastructure influences urban development patterns (Crane 2000).

Indeed, the links between these two dominant planning ideas, transit and land use, have resulted in improved transit accessibility, and environmental and economic sustainability. However, transit-oriented development has often resulted in dominant ideas like locating new housing developments near rail stations (Chatman 2013), as seen in the case of Mexico City (Guerra 2014). In the Latin American context, the links between bus rapid transit and land use decisions have recently come to the fore , despite its clear integration established in Curitiba (Lindau et al.

2010). BRT systems can stimulate land development (Rodriguez and Vergel 2013, 14) as in Curitiba. Transit-supportive development based on TOD strategies can promote compact and mixed land uses, as well as concentrate demand, "balance passenger flows, and create opportunities for multimodal travel" (Rodriguez and Vergel 2013, 14). Therefore, given the importance of land use planning along transportation corridors, it is necessary to understand how urban development facilitates and enhances public transportation use.

Yet, amongst these innovations in transit across Latin American cities, informal transit services still serve a vital role in moving people around. Informal transit services are questionably a good response for cities, but are also a vital source to move people around in the absence of state services (R. Cervero 2000). As a result, cities have tried to place formal regulations on informal transport through policies that restrict registration and licensing (Golub, Balassiano, Araújo, and Ferreira 2009; Mateo-Babiano 2016). Popularly, informal transit services like rickshaws in India (McConville 2010; Sonuparlak 2012) or Matatu routes in Nairobi (Badger 2014) demonstrate, spatially and culturally, the relevance of informal transport to an urban economy (Mateo-Babiano 2016). Informal transit services take place in the informal economy, as an entrepreneurial response to a lack of state capacity (Soto 2010). Or, as we argue, informal transit is a collective social action of people to provide their services at the neighborhood level (Castells 1984). These kinds of actions highlight how informal transit represents a fundamental right to move around a city (T. P. R. Caldeira 2012).

The field of transit studies has mainly captured the characteristics of the supply and demand of the informal transit market. It is conceptualized as a mobility option for poor households, as a source of employment, and a complementary service between formal transportation routes and efficient low cost systems that can alter and respond to changes in market conditions swiftly (R. Cervero 2000; R. Cervero and Golub 2007). Similarly, informal transit services operating in the peripheries are usually unregulated and pursued by local authorities, but at the same time offer many benefits that formal public transportation does not (R. Cervero and Golub 2007). They usually cover areas lacking regular buses and give a flexible service adaptable to passenger needs, perhaps offering door-to-door attention and can deviate from standard routes (Cervero and Golub 2007, 446–447). In the case of Quito, and compared to other modes of transportation, informal transit offers higher sense of passenger safety, operates in extended schedules, and is a more comfortable riding experience since a seat is guaranteed.

The spontaneity and hybridity of these kind of services, pricing, and routes are still not fully understood but are rather often described as unorganized. For instance, supply-side studies classify the different kinds of informal transit vehicles like passenger vans, microbuses, station-wagons, sedans, pick-up trucks and even 2–3 wheel motorized and non-motorized services (Cervero 2000, 15–25). Further, vehicles are distinguished by the class of vehicle, passenger load, fare, and route. Studies have also been conducted on the kinds of owners and operators of informal transit services, showing that they tend to have lower socioeconomic standing and adapt differently to ideas of climate change (Ames, Mateo-Babiano, and Susilo 2014). Vehicle owners are often found to be operators and this kind of work is fulfilled by rural migrants to cities, unemployed men, or men who work in low-paying formal sector jobs (Cervero 2000, 3). Usually, they are residents of the neighborhoods they serve. Furthermore, passengers that take informal transit services are linked to the informal economic sector or have a lower socio-

economic standing and go shorter distances for purposes such as shopping. Further analyses of these characteristics of the supply and demand sides of informal transit markets are imperative to get a working understanding of the service.

A central aspect to understanding informal transit services is that it operates as self-organized initiatives. Informal transit services offer safety and privatized trips for people who wish to travel inter-regionally or trans-nationally (Valenzuela Jr., Schweitzer, and Robles 2005). They are linked to greater processes of urban informality as a dominant mode of city production (Roy 2005). For example, motorcycles or moto-taxis is one kind of informal transit, such as all other modes, following the logic of informality and defining how the city functions. Studies of moto-taxis elucidate the importance of the motorcycle industry as part of the socio-technical systems of cities in South East Asia. In general, many studies highlight the vital role of the motorcycle, labelling the motorized service as critical to solutions in South Asian and South East Asian cities (Joewono and Kubota 2005), as well as in the Philippines (Guillen, Ishida, and Okamoto 2013).

Informal transit services have also been evaluated from the point of view of the cultural and social specificity (Mateo-Babiano 2016) and efficiency for users (Gupta, Chen, Miller, and Surya 2010, 6–13). Often in Latin America, as seen in Brazil, there is a trend to regulate or eliminate informal transit services due to a host of factors including: rising traffic congestion, chaotic driving practices, increased public safety concerns, competition to formal operators, higher fares, and negative environmental impact, among others. In this sector, the prevalence of older vehicles and a myriad of other factors produce both air and noise pollution (Golub et al. 2009). As such, capturing the basic characteristics of the informal transit market is essential for understanding its operations (Kassa 2014).

Yet, the study of informal transit is still looked at as a way for urban residents to "problem-solve" in the absence of public provision and quality. This sector is labelled as a chaotic, laissez faire system that is unable to be organized (Cervero 2000, 7). While informal transit is viewed in some studies as highly efficient and adaptable due to a lack of hard infrastructure (Cervero and Golub 2007, 449), it is still poorly understood why specific routes go to certain places in the city, and how the urban land context influences informal transit provision. Thus, while most studies seek to characterize or place order on how transit services are provided, this study seeks to understand how informal transit services operate within the logic of urban land regulation. How do informal transit providers choose their routes? How do they produce urban space? How are they sensitive to urban land use? How do they serve "illegal" settlements or "areas in need"?

In Latin America, informal transit is characterized as a symptom of economic crises that influences new forms of employment in the informal sector and liberalizes the transportation sector. Informal transit competes in major cities by offering more flexible services. Informal transit grew quickly as public policies in favor of automobility increased across the region. Transit scholar Oscar Figueroa has written comprehensibly about informal transit in the era of globalization across the region (Figueroa 2005, 46–48). He suggests that informal transit should be labeled neither legal or informal, but rather, as a sector that is based in vehicles that are not designed or adopted for collective use. Smaller passenger vehicles such as vans, jeeps and microbuses in this context can be adapted to special transit needs in cities such as La Paz, Lima, Bogotá, Caracas, Mexico City, and Buenos Aires. In general, the increase in congestion is

correlated with the diminished quality of public transit in Latin American cities. Informal transit and the continued deregulation of transportation in cities contributes to congestion. However, Figueroa notes that while high-income sectors have higher purchasing power to buy and maintain private vehicles, the demand for transportation from lower income groups continues to grow. This disparity draws out socio-spatial segregation due to the splint of transportation services—informal transit is correlated with social differentiation (Figueroa 2005, 46–48).

In this context, the field of transit studies continues to see informal transit as a system that responds to travel-demand and can be sold to governments as a transit solution (Soto 1989). Yet, as transit-oriented development (TOD) is a policy that has updated approaches to the field to deal with contemporary situations and urban realities, transit scholar Peter Calthorpe reminds us that "transit is more than a transportation system; it also comes with an intrinsic land use logic" (2010, 86). Thus, we understand informal transit as a system that is a functional part of transit systems in Latin American cities. In this age of sustainable urbanism, there is a need to test the relationships between alternative modes of public transportation used by urban residents. This is particularly salient, as TODs must expand their reach in a polycentric, networked city. Informal systems have the potentialities to provide on-demand ride services that also feed passengers onto traditional public transit systems (McLeod, Scheurer, and Curtis 2017, 229). Transit scholars have argued that density impacts commuting trips. But this opens up the classical "chicken and egg" relationship, questioning if density needs to precede investment in public transport or vice versa (Falconer and Richardson 2010, 3). We suggest that informal transit systems depend on dense environments. Understanding how informal transit systems are integrated with land use is required to promote better social distribution and capture the potentialities of informal transit. We aim to show that dense areas can be anchored by efficient informal transit services.

Land use regulation in the global south is an understudied field. In general, land use regulation provides motivation to restricting possible externalities like urban informality in the "developing world." In literature, urban informality is treated and understood as people living in squatter settlements that lack basic services due to rapid urbanization (Roy 2005). The pace of urban growth precludes local governments to manage the process, either by limiting urban growth and/or efficiently distributing public goods and services. Municipalities regulate land through zoning, which controls a range of different uses such as commercial, industrial, and residential—assigning specific functions to land. Land use regulates density, which makes it difficult to build (Glaeser, Gyourko, and Saks 2005) or control the possibility for new constructions (Quigley and Raphael 2005). Yet, in the context of the United States, it has also been proven that there is higher concentration of poverty in urban areas due to better access to public transportation (Kahn, Glaeser, and Rappaport 2008).

Still, little is known about the effects of land use regulation on households of different income levels in Latin America (Goytia, de Mendoza, and Pasquini 2010). Land use regulation has mainly been looked at as an explanatory variable for its effects on urban informality. However, in this study, we apply the logic of urban informality as an emerging planning practice (Miraftab 2009; Roy 2005), opening up the possibility to better comprehend the relationship between self-organized initiatives and dominant logics of planning urban land. For instance, in the case of Mexico City, the link and role of land use regularization has been studied drawing attention to how the state mediates land through informal and formal development processes (Connolly and

Wigle 2017). In other words, informality is defined often through the application of land use regulations, determining what is informal and what is formal, reinforcing inequalities associated with informality (Connolly and Wigle 2017). While these debates continue to focus on informality and settlements, the multiple logics and systems of informality have not been considered. Specifically, the inter-linked relationships between informal transit and land has not been studied. We argue the importance of studying both the formal and the informal transit systems in their relations with land-use. Moreover, informal transit needs to be studied to determine whether it is only linked to informal settlements or irregular areas in urban centers. Our research examines how modes of land use regulation (which we define through municipal zoning laws) produce the unplannable, or exceptions to the rule. We do not wish to theorize between terms such as "indigenous," "informal," "paratransit," "third-world transport," "intermediate technologies," or "low cost transport," but to see how transit operates within and transversally vis-à-vis the dominant logic of land use regulation (R. Cervero 2000). We understand informal transit as illegal or illicit services that function outside of transit regulations and have not been object of public concessions. A better understanding of informal transit lines can suggest what future interventions are needed in the areas of public transit, and the proliferation and consolidation of new land markets.

b) **Context of Quito**

Quito is Ecuador's capital and is located at 2,800 meters above sea level. By 2015, the city had an estimated population of 2,456,938 inhabitants and an annual growth rate of 1.7% (DMQ 2012b). The high demand of commuting is motivated by an elongated city form which sprawls to the peripheries of the north and south, and at the east to the valleys (DMQ 2012b). This is further intensified by a decline in population in the center of the city and population growth in the valleys and the northern and southern extremities of the city (INEC 2010). The figure below demonstrates the growth per administrative zone in Quito:

Table 1: Quito's Population in Recent Census Years by Administrative Zones

Administrative zones	2001		2011		Increase / decrease 2001–2011%
	Population	%	Population	%	
CONSOLIDATED CITY	**1,099,482**	**49.1**	**1,040,423**	**56.5**	**-2,5**
Eloy Alfaro	453,092	20.2	412,297	22.4	- 2.2
Eugenio Espejo	421,782	18.9	394,005	21.4	- 2.5
Manuela Sáenz	224,608	10.0	234,121	12.7	- 2.7
URBAN PERIPHERY	**652,624**	**29,2**	**471,702**	**25,6**	**+ 1,8**
La Delicia	364,104	16.3	274,368	14.9	+ 1.4
Quitumbe	288,520	12.9	197,334	10.7	+ 2.2
RURAL AREA	**487,085**	**22**	**330,076**	**18**	**+ 1,3**
Los Chillos	166,812	7.4	116,946	6.3	+ 1.1
Calderón	162,915	7.3	93,989	5.1	+ 2.2
Tumbaco	157,358	7.0	119,141	6.5	+ 0.5

Source: Municipio del Distrito Metropolitano de Quito 2012b.

Table 1 indicates that the largest growth rate occurred in Calderón and La Delicia in the extreme north of the city, Quitumbe in the far south, and the valleys Tumbaco and Los Chillos. The majority of illegal o irregular neighborhoods are in Quitumbe at the southwestern edge of the city, and in Calderon, representing the north-east periphery. Usually, illegal neighborhoods are considered as such when they are located at or close to ecological protection areas or risky zones, which is why we will consider these areas as illegal in our spatial analysis. However, the Municipality of Quito (DMQ) reported that informal neighborhoods only refer to those who have requested legalization. In 2009, there was a total of 170 neighborhoods requesting legalization. Subsequently, in response to this demand, in 2010 DMQ created the program "*Regula tu barrio*" to study and facilitate the legalization process of illegal areas (DMQ 2012a, p. 67). In 2011 a study by "*Regula tu Barrio*" revealed that 439 illegal neighborhoods required and requested legal status. However, based on the interviews' statements, regularization processes do not directly considerate service provision (including transport) as a requirement for regularization. Instead, they deliver property titles. This means residents are responsible for upgrading the neighborhood by requesting what they need to the authority in charge.

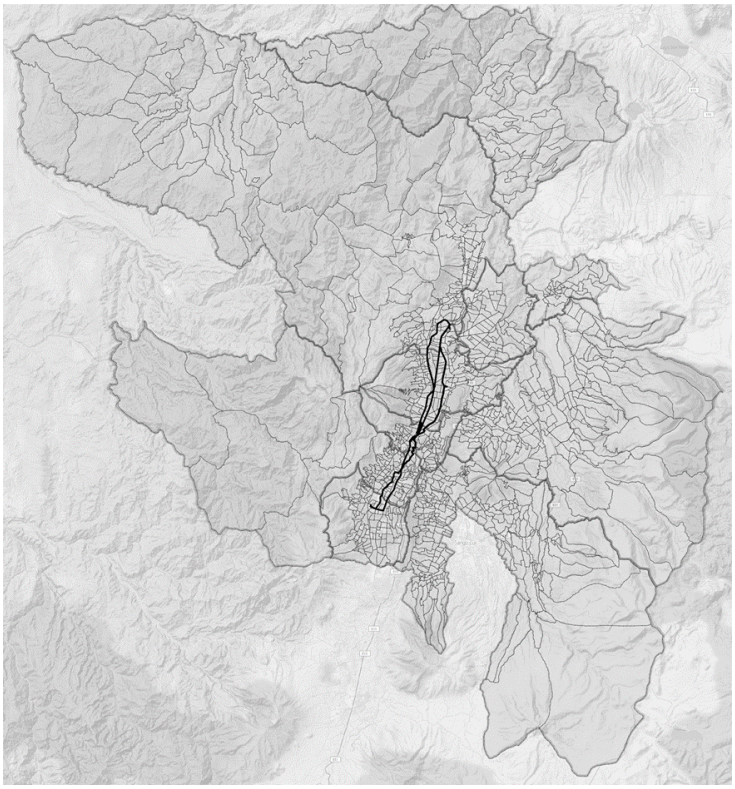
As the city has doubled in population density in the last 30 years, the demand for cheap land and informal occupation has also grown (DMQ 2012a, 57). This has resulted in a lack of control and bureaucratization of procedures for legalization of land with the invention of the *Regula tu Barrio* program. Since the 1970's, Quito has faced informal urban land occupation issues, particularly in the areas of Calderón, Quitumbe, and La Delicia. Consequences of such unprecedented growth include both the lack of basic services and public transit infrastructure. In contrast, amenities including basic services and public transit infrastructure are concentrated in the north and central part of the city, more commonly referred to as *hyper-center* (DMQ 2012a, 32). Social services like education and health are in the central area of the city, far away from

dense residential zones. Although basic public schools are relatively well distributed in the city, high school infrastructure is concentrated in the hyper-center, favoring the north. A similar situation occurs with regard to public health; there are more gaps of health services in the south compared to the north (DMQ 2012a, 23). In this context, the demand for social services also contributes to longer commuting distances to the north. We sustain that this situation has contributed to the growth of the informal transport sector in Quito.

Every day in Quito, 4,565,000 trips are made, of which 3,850,000 are motorized (DMQ 2014). Although 73% of this commuting is carried out by public transportation, this share is decreasing by 1.4% per year (DMQ 2013). Despite this negative growth, the system is saturated, obsolete, and does not satisfy the commuting needs of the people (Vaca 2011). Citizens question the system's coverage, schedule, frequency, quality and safety (El Telegrafo 2016). With a growing rate of vehicle ownership at 9.2% annually, an additional 50,000 vehicles are introduced in the Metropolitan District per year (DMQ 2013). This increase in vehicles surpasses the population growth rate by 4 times, demonstrating a pronounced shift from public to private transport.

Currently, bus rapid transit (mainly publicly operated) and private buses characterize Quito's transit system. The system is both institutionally and physically complex. The *Trolebus* is Quito's first BRT line and is supplemented by two other trunk-feeder systems, *Ecovía* and *MetrobusQ*. The *Trolebus* was one of the first BRTs in Latin America, built in the 1990s to satisfy the transportation needs of the expanding city. The *Ecovía* works with diesel fuel. It was built between 1998 and 2000, and in 2016 was extended to the southern part of the city. The third BRT line, the *MetrobusQ*, is privately operated by a concession agreement between the municipality and a private transit company. Inaugurated in 2005, DMQ financed and installed the physical infrastructure. The three BRT lines are parallel and longitudinally oriented, because of the shape of the city. Now, nearly 20 years later, Quito's BRT system moves 800,000 people a day and has reached its operational capacity. In addition, the city has a system of feeder buses that are supplementary to the BRT lines. Besides the Metropolitan Integrated Transport System and conventional buses, Quito has bicycle infrastructure supported by a public system, the *BiciQuito*, inaugurated in 2012. Finally, there is an underground metro rail that is planned to be built and be integrated into the existing public transit framework. Figure 1 shows a map of existing BRT lanes for reference:

Figure 1: Map of Bus Rapid Transit Lines in Quito



Source: Map, Shape files of formal transit lines, DMQ 2016. Map background, OpenStreet.org

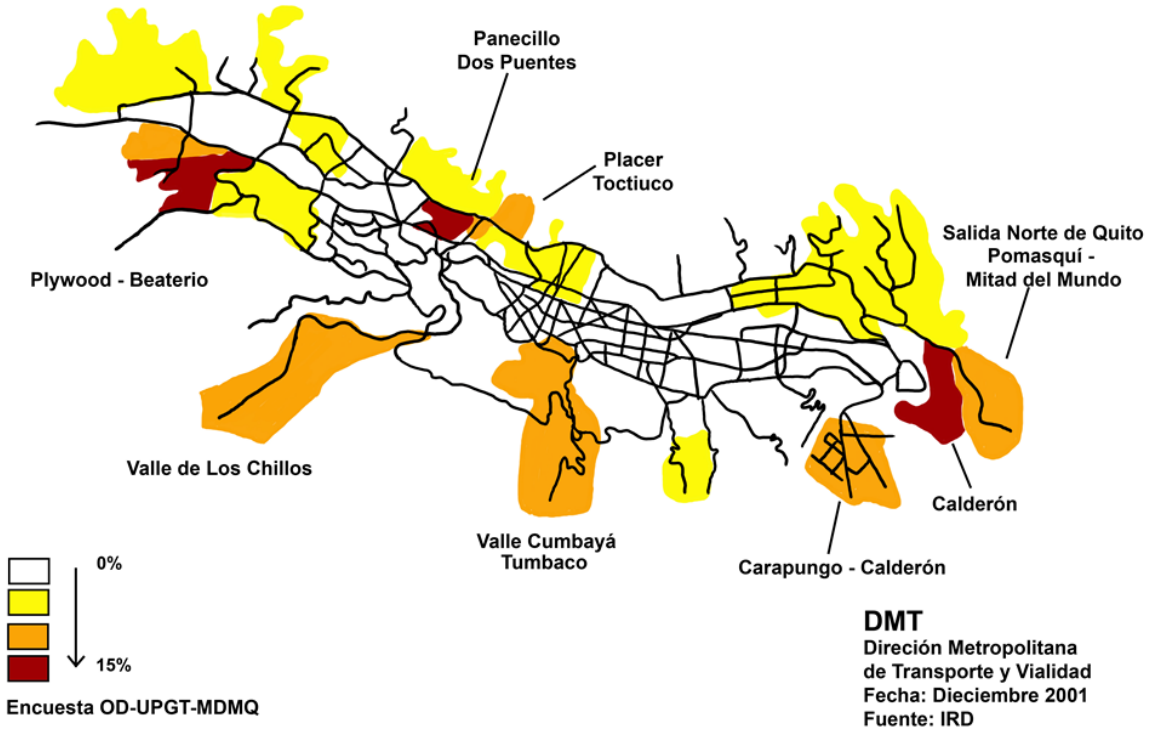
The public transport system in Quito is supported through a complex governance system. But to understand how it functions, it is necessary to consider national regulations. According to article 264 of the Ecuadorian Constitution (República del Ecuador 2008), municipalities have exclusive planning and operating rights regarding transit, transport, and road safety, as part of the current decentralization process. This means that each municipality has the task to plan, regulate, and control transit and public transport within their urban territory, albeit under the oversight of the Minister of Transport and Public Works. The Código Orgánico de Organización Territorial, Autonomía y Descentralización (COOTAD), states that transportation planning must complement development and territorial plans at the local level (Ministerio de Coordinación de la Política y Gobiernos Autónomos Descentralizados 2012). In the case of Quito, the Empresa Pública de Pasajeros de Quito (EMPTQ) operates the *Trolebus* and *Ecovía*, whereas the *MetrobusQ* is currently run by a concessionary agreement between private bus companies. The future *Metrorail* is being planned by the Empresa Pública Metropolitana de Metro de Quito (EPMMDQ). The Empresa Pública Metropolitana de Movilidad y Obras Públicas (EPMMOP) oversees construction of transit infrastructure. Bicycle planning occurs through Agencia Metropolitana de Tránsito de Quito (AMT). AMT also controls traffic, conducts vehicle registration and technical inspections, and manages traffic safety. This all comes together under the Secretariat of Urban Mobility (SUM) at the municipal government level. Furthermore, the Urban Mobility Secretariat is currently studying Quito's taxis market to determine the supply of *taxi-rutas* and shared informal taxis (Secretaría de Movilidad 2017).

Within this context, Quito has faced mobility challenges for many years and has not conducted significant studies on informal transit since the 1980s (Vásconez, Etienne, and Figueroa 1985). In general, informal transit services are provided under different conditions by either competing or complementing conventional bus routes. Their schedules are usually longer and flexible, and the transport units are not as crowded as buses. According to the city's Transport Plan of 2002, informal transport is a response to the deficiencies of the formal system, offering service to popular neighborhoods or *barrios marginales* (DMQ 2002). In 2002, this service helped transfer people from public transport to their peripheral residences at night. Figure 2 illustrates how informal transit served the peripheries.

Since 2002, the informal transit sector has evolved, accounting for 2 percent (60,000) of the 73 percent of trips done by public transport (Empresa Pública Metro de Quito 2011). *Illegal buses and microbuses*, shared *taxis, furgonetas,* or *taxi-rutas* service comprise the informal transit sector in Quito and are not recognized as an option to public transport services according to the national transit laws (República del Ecuador 2015). According to a 2011 mobility survey, of the 2 percent that use informal transit, 54 percent of these users ride informal transit every work day. In the same report 22 percent reported occasionally riding informal transit and 15 percent of users ride these services more than 5 days per week; 4.9 percent reported daily use and finally 3.6 percent of users reported ridership at least once a week (Empresa Pública Metro de Quito 2011).

Meanwhile, Quito's Mobility Master Plan 2009–2025 states that there are fifty percent more illegal taxis than authorized ones (8,766) circulating in the city (DMQ 2009, p. 23). In this study, we look at *illegal buses, taxi-rutas* (private vehicles used for car-sharing) and *furgonetas* or shared passenger vans, but not at all illegal taxis because these operations have a designated and specific route. It is unclear if the municipality differentiates between shared taxis and illegal private taxis that take passengers from door to door. Yet, the municipality plans to eliminate most of illegal taxi services by 2017, guaranteeing that only 10 percent illegal taxis will remain in circulation by then (DMQ 2009, 82). According to the Mobility Diagnosis of Quito (DMQ 2014), the increase in demand for commuting, coupled with deficient territorial coverage of a deteriorating public system, have triggered the use of private vehicles and the growth of informal transport. Commonly, users of informal services are people who live in the peripheries of the city where public transport does not exist or is in limited provision (DMQ 2014, 12). In addition, the growth of informal transport has been further encouraged by a complex regulatory framework that limits the incorporation of new service providers that would complement the public system. Finally, the municipality recognizes that its control over informal transit is unevenly applied and tries not to affect the people who depend on the informal service. It recognizes that large public transport deficiencies in the city peripheries, as to coverage, frequencies and schedules, has led to a parallel informal system (DMQ 2014, 12).

Figure 2: Main Destination Zones that Require Transfer by Means of Informal Transport



Source: Figure redrawn by Julie Gamble from original map (DMQ 2002).

Research Design: Mobility Studies, Informal Transit, and Socio-Technical Experimentation

The central research question of this investigation is: *Is informal transit land-oriented?* The main hypothesis is that informal transit has surfaced in Quito due to peripheral urbanization and currently serves urban areas regulated and unregulated by land use policy. We will draw on multiple research strategies that include an analysis based on semi-structured interviews, photography, documents review, sample survey, and GIS spatial analysis as we seek to understand the multilayered perspective of service providers, users, and local authorities.

The field of informal transit research encompasses the social and economic world of urban residents and their transit market. Academic inquiry has mainly relied on traditional methods of transit planning such as survey data analysis (Bonnel 2009), case studies (Cervero 2000), statistical analysis of policy effects (Golub et al. 2009), and visual methods (Rose 2007) to better understand the context of "indigenous transport" (Mateo-Bibliano 2015). We apply a variety of techniques to capture the world of informal transit. As noted above, the field still employs methods that lead to descriptive analyses of informal transit as a key contributor to urban economies. Indeed, the field of informal transit remains an understudied phenomenon.

Geographers Sengers and Raven (Sengers and Raven 2014) recently experimented with transition studies which draw from a diverse set of disciplines such as science and technology studies (STS), evolutionary economics, innovation systems and the history of technology (Sengers and Raven 2014, 454). Transition studies have looked at how multilevel perspectives encompass a variety of interactions that occur between knowledge, rules, landscape, and alternative spaces or "niche" spaces for the study of socio-technical systems (Rip and Kemp 1998; Geels 2002, cited in Sengers and Raven 2014, 454). These authors experimented with mobility as the object at the center of inquiry to comprehend the importance of informal transit in the future cityscapes of Asian cities. They employed qualitative and explanatory narrative style approaches to engage in a multilevel analysis of motor bikes combining a range of disciplines, including geography, sociology, and transition studies (Sengers and Raven 2014, 457).

While Sengers and Raven modelled their work to grasp the complexities of informal transit, technology use, and the urban context, their work still relies on the mobility object at its center of inquiry. Their work is part of a larger ethnographic project focused on reporting on particular phenomena such as actors (Latour 1987), policies (McCann and Ward 2012), or things (Appadurai 1988). Informal transit studies following migrants in and out of southern California is one example of actor-focused studies (Valenzuela Jr. et al. 2005). Ethnography lends itself useful to study mobile objects due to the very fact that ethnographic methods begin in motion and, thus, inherently questions what a mobile ethnography is (Lugo 2013, 203). This field is known as mobility studies and employs disciplines such as geography, sociology and anthropology to understand objects in motion (Büscher, Urry, and Witchger 2010). Starting from a multi-sited ethnography (Marcus 1995) to study informal transit is important because it involves studying infrastructures defined as socio-technical systems (Star 1999) that are dispersed throughout the city. It is experimental because it aims at producing scientific knowledge through empirical data on urban environment which translates results back into the field (Latour and Woolgar 1979).

Because these illicit, flexible and organized informal transit systems do not have a permanent physical infrastructure, the ways to gather data must necessarily be multi-sited and creative. In our research, we start from an ethnographic perspective, where the researchers are at the center of crafting social relationships in order to study informal transit in Quito (Fortun 2012). We consider the cityscape an urban laboratory full of possibilities to study and distill information of socio-technical phenomena (Coutard and Guy 2007, 3–4). Yet, we must carefully pull together vulnerable subjects and objects as an ensemble (or assemblage) to study outcomes (Gamble 2017; McFarlane 2011).

In this study, we draw from feminist science and technology studies (STS) to understand both the subjects and objects of interest that constitute the ensemble. Subjects and objects of interest draw attention to how and who we do research for (de la Bellacasa 2011). Therefore, we are interested in carefully identifying research relationships to account for neglected subjects and objects of research. The distinction between subjects and objects is necessary to produce the dualities of knowledge that pertain to informal transit. For example, the route or the ways in which informal transit routes are laid out is linked to an organized logic that is predetermined by either a group of individuals or a leader. Yet, these understandings change due to consumer demand and the urban built environment. Therefore, how these socio-technical factors are pulled together for

analysis must be considered carefully. We used "agential cuts" (Barad 2003, 815) to assemble people (subjects such as leaders and associates) and things (objects such as GPS devices, sedans, small passenger vans in motion, or bus stops) to be investigated together. An assemblage pulls together heterogeneous phenomena to ascertain how they interact in order to produce new knowledge (Gamble 2017, 5).

Our research was collaborative from its premise. In contrast to case study approaches to informal transit, we ask what experimental ethnography can look like and what it can accomplish. We view this project as double folded: from its initial stages the work has been horizontal and collective, carefully crafted from the positionality of feminist activist and urbanists, and also having political intent (Collins, Jensen, and Auyero 2017). It began this way because it was necessary to establish careful research relationships between the researchers and the subjects and objects of research. As such, the research team consists of both an American and Ecuadorean participants. The dual nationality of the team was instrumental to develop initial contact and trust with informal transport companies. As these companies recognize their illicit activity, they are weary to trust or work in collaboration with any researcher. Therefore, to gain trust, we had to go in as a team to observe and make initial contact with all the companies we worked with. Riding their buses and sitting in their sedans was a way to build trust.

The legitimacy of the project fell between having local and international contacts and maintaining social relationships with the individuals that work in the informal transit companies. Ethnographic data such as semi-structured interviews, participant observation and photographs were a necessary step to gather geographic data from mobile devices (discussed below). However, this kind of data collection was only possible through the dual nationality team. Trust was at times offered more easily with the presence of an American, and at other times, trust and cooperation relied on having local Ecuadorean support. The field team comprised an American PhD in urban planning and an Ecuadorean urban sociologist trained in the Netherlands. Because we were interviewing and talking to informal transport companies, our commitment had to go beyond collecting data.

We conducted preliminary visits between August 2016 and February 2017 to locate and build relationships with informal transit companies. The first step was to walk the city to identify the location of the informal transport stops. We based this step on previous personal observations, as well as information provided by others. Informal transit services in Quito usually make connections from public transport stops to peripheral areas of the city. Thus, we selected some areas in the north, south, west, east, and the valleys, to walk by. Once the stops were identified, we requested the contact number and name of the leader of the company. We then contacted them to schedule a meeting. It is important to mention that some of the companies did not agree to the interview. We initiated contact by presenting the research team and engaged in informal discussions about how company leaders perceived their work. It was a challenge to gain trust since interviewees believed we were part of the municipality and therefore some kind of negative consequence might result from collaborating with us.

The initial interactions focused on explaining the academic character of the research, and the importance of their work in the context of Quito's mobility challenges. This meant that we had to highlight the way in which our research could be mutually beneficial with their participation. For

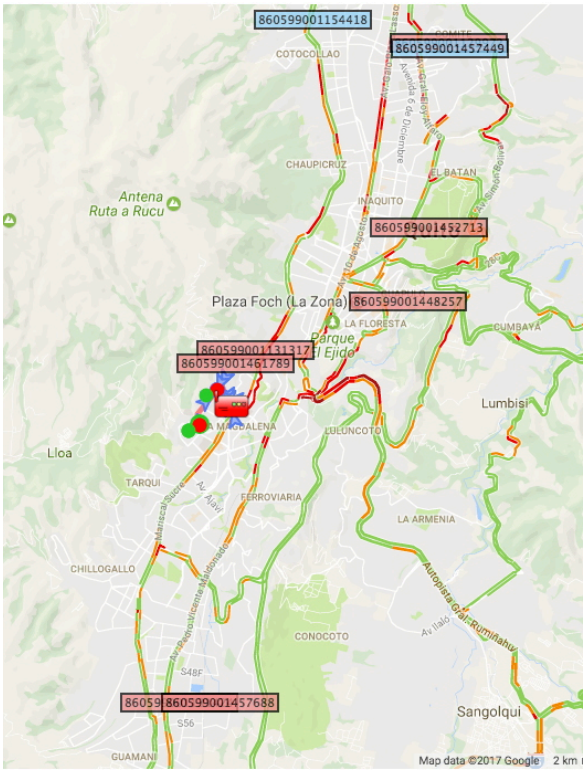
instance, many of these companies work under precarious conditions and do not have the technology to geocode their routes. To gain trust during one interview, a company would only accept GPS devices after we attended a company-wide assembly meeting. In this meeting, they requested human resources and conflict-resolution assistance that we had to provide. That meant us going to their offices outside of the Metropolitan district, bringing an HR expert and subsequently talking to the members of the company. Only after that, they accepted to work with us and use the GPS devices in their vehicles. Establishing trust was hard work. The ethnographic data collection was necessary to build trust and to further activate our political commitment to return this knowledge back to them. We took photos during difficult moments at different sites to visually represent the kinds of working decisions and organization that companies use. Once our research was complete, we would be able to give them back "technical knowledge" that may help their cases of legalization or support political arguments in favor of their work.

The subsequent phase of the research was to test patterns of differences in informal transit. We gave GPS devices to informal transportation drivers and the data generated in this way enabled us to capture, track, and simulate moving systems. Recently, the subject of using mobile methods in transit studies has gained attention (Merriman 2014) because it uncovers geographies and movements that cannot be gathered by large-scale surveys of travel behavior or travel demand usually employed in transit studies. Mobile methods engage with "a range of performative, participative, and ethnographic techniques that enable researchers to more effectively 'move,' 'be' or 'see' with their research subjects and objects" (Merriman 2014, 168). Thus, GPS technology was part of our methodological approach to the study of informal transit (Christensen, Mikkelsen, Nielsen, and Harder 2011; Gamble, Snizek, and Nielsen 2017).

Two GPS devices were distributed to 25 informal transit companies (although we interviewed 30 companies, 5 did not accept the devices) between February and May 2017. We staggered interviews and device dissemination because we worked with 20 GPS units and gave companies the devices over a period of 3 weeks. Participants were given a sheet with specific instructions on how to use the device and at what hours to operate it. Drivers were instructed to turn on devices at the beginning of their work day and turned them off after work hours. During these months, we were able to see where the drivers and their vehicles were going from the website of the company that we use for tracking (Optimus Tracker).[i] The routes and information that we were able to identify during the data collection process were live. Figure 3 shows some of the devices we could see from the website to determine where vehicles were going and where they were at, based on their device number.

Each GPS device tracked several trajectories over the course of three weeks. For each data point, one GPS tract was created. We were able to see what data points agglomerated and if drivers were using the devices correctly, in live time, during the experiment. Therefore, when devices were not working, or individuals were not using them properly, we were able to decipher which information did not pertain to established routes.

Figure 3: Screenshot of GPS Devices Operating Throughout Quito



Source: Image taken by Julie Gamble from Optimus Tracker site under the group's research account.

When we picked up the GPS devices, as we are committed to transparency, we gave the raw data that the devices produced to the companies.

In the GPS analysis phase of the study, we define land use regulation through density restrictions, zoning, commercial, industrial and residential use following the research approach from Goytia and Pasquini in their case study on Buenos Aires (Goytia and Pasquini 2012). For this, we relied specifically on Quito's urban land use ordinance 127, that characterizes all land use categories (DMQ 2016b) in the city. Furthermore, land titles in Quito are the way the municipality has slowly incorporated unregulated land in the peripheries to the official city (Mena Segura 2010). The municipality of Quito currently has areas that are defined as regulated (according to zoning, density rules, etc.), and unregulated, which are associated with greater risks from natural disasters, as well as a lack of land title. Unregulated land generates externalities that are not absorbed or considered in how transportation services are provided at the local level. This will help us reveal if informal transit corridors are sensitive to land use regulation. We are also be open to use other built environment indicators such as road network, transit infrastructure, open spaces and possible urban design features to test other possible explanatory relationships with informal transit corridors. Next, we use data results to discuss how we analyzed interviews and GPS routes to determine their relationship to urban land use, which is situated in a socio-cultural context.

Findings: Land-Oriented Informal Transport

Transit studies have become engaged with ideas such as transit villages or dense neighborhoods and neighborhood-scale improvements that focus on design and urban form. The field has drawn attention to transit-oriented development, arguing for the link between transit and land use planning in order to improve how people move around (R. Cervero and Landis 1995). In this regard, the field of transit studies is concerned with advancing how cities can plan dense neighborhoods around transit to discourage automobile use and ownership (Chatman 2013). Yet, what happens to transit-oriented development in cities that still rely heavily on informal transit? The solution as discussed above has been to turn to "paratransit" or "indigenous transport" but has not considered how these routes are planned and what kinds of organized logics they operate with. In this section we argue that low income areas in cities in the global south, like Quito, have turned to informal transit starting at the neighborhood scale to provide accessibility and more transportation options.

When considering transit-oriented development, precise definitions of the neighborhood unit or the built environment are difficult to determine for cities like Quito, where informal transit services link urban/rural land and regulated/unregulated areas. In this section we will discuss how informal transit companies maneuver and make route decisions based on interactions among the built environment and informal transactions before revealing its relationship to land use regulation. We aim to discuss the concept of the neighborhood as a socially-defined historic unit where collective action takes place to compensate for the lack of collective public services (Castells 1984). We begin from the perspective of the neighborhood not as a spatial unit to conduct travel demand analyses (Ewing and Cervero 2010) but as a sociocultural phenomenon that changes over time with urban form. We then apply GPS trajectories to the urban administrative layout of Quito, demarcating where the informal routes go and comparing them to population densities citywide.

In the field of transit studies, it is well established that the built environment and the socioeconomic status of users are the main influences on travel behavior (R. Cervero 2002; Ewing and Cervero 2010). In general, there is concern for reducing vehicle miles traveled in cities across the world, as cities are expanding, and metropolitan governments are confronting ways to solve more complex mobility patterns. Transit studies address economic and behavioral explanations to understand how the built environment influences travel choices (Ewing and Cervero 2001; 2010). In this literature, some measures of built environment are density, diversity, design, destination, accessibility, and distance to transit (Ewing and Cervero 2010, 267). But, since informal transit is characterized as highly flexible and chaotic, going to city areas located between urban/rural and regulated/un-regulated, it becomes difficult to imagine the usefulness of this conventional research approach.

Instead, we argue that one needs to use a variety of research methods to study informal transit. Ethnographic, qualitative and quantitative methods lend themselves to the study of informal transit. We argue in favor of alternative logics that are transversal or run alongside prediction models. We sustain that such methodology reveals the kinds of behaviors of those who take informal transport and why; as well as how informal transport companies plan services and attract passengers.

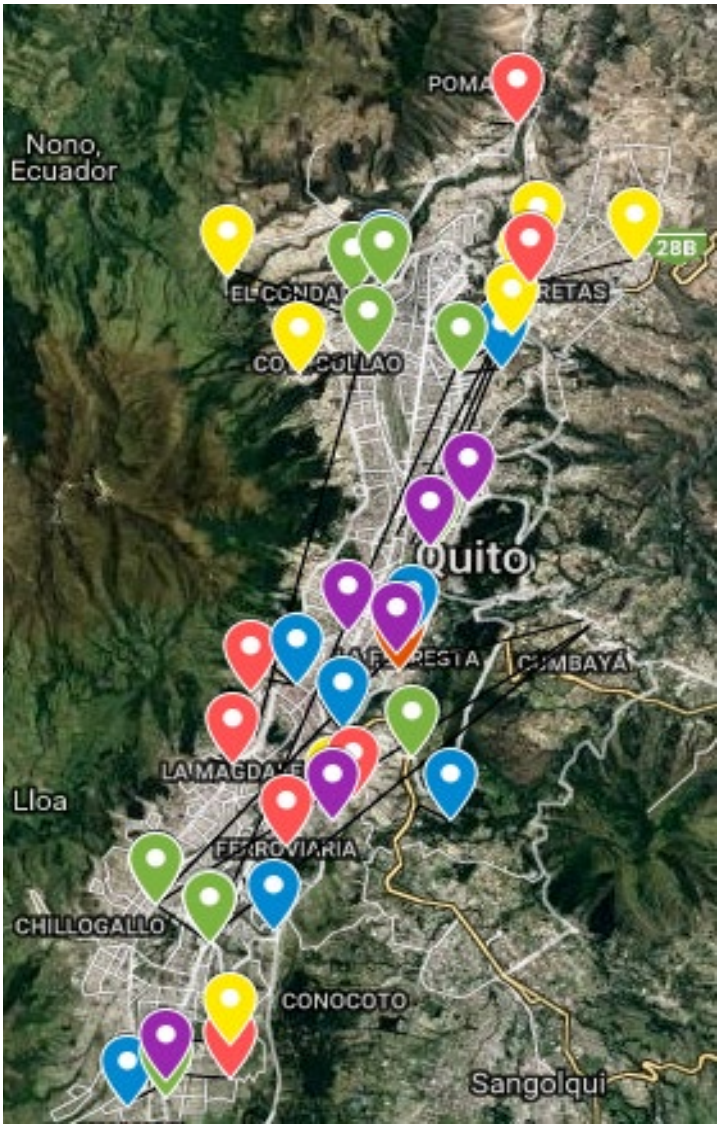
We identified 43 routes (Figure 4) and applied semi-structured interviews to operators of 27 routes. We interviewed mainly male informal transportation company leaders and presidents in January–May 2017 and carried out participant observation since August 2016. In addition, we interviewed 4 representatives of the municipality to explore public policies regarding informal transport and its links to land uses. The interviews were mostly with men because our survey results indicate that the sector mainly employs and is operated by men. Overall, we aim to offer insights into the logic by which informal transit companies choose their routes in Quito.

a) Starting from the Neighborhood

In a city where supposedly only 2% of daily trips are made on informal transit, one would expect that informal transit providers can identify the reasons why they choose their routes and have clear estimates of how many people use their routes. But, many interviewees could not say why they chose their routes without telling historic narratives behind the company and then the route.

Informal transit providers are usually residents of the parish of Calderón. This service opened the doors to many people who were unemployed and has generated a lot of jobs. Due to the increase of people in the parish, which was originally a marginal area sparsely populated, everything began to flourish both with commercial and housing investment. But public urban service did not adequately supply the demand that existed in the area. Then, a group of seven people who were then unemployed got together and started to use their small pickups and old cars as a working tool. Initially the service run from Carapungo to the stop of the trolley down avenue August 10 (at that time Simon Bolivar Avenue didn't exist). The population began to accept the service.

Figure 4: Map of the 43 Routes



Source: Elisa Puga

The male providers discuss their needs to work and their illegal status prior to considering any logic they apply to how they organize their routes. They first identify that their work is illegal, but a fundamental component to the neighborhoods they serve. These characteristics make up a neighborhood unit as theorized by urban sociologist Manuel Castells, who studied the rise of urban social movements from the neighborhood scale (Castells 1984). Castells suggests that the neighborhood unit is fundamentally an independent urban compound comprising processes of production, of consumption, and of exchange, all of which are socio-spatial processes (Arnaud et al.,2012, cited by Castells and Grilló 2006, 57). In our case, the neighborhood is important as producer and consumer of informal transit, enabling the service to exist. The neighborhood unit thus cannot be only understood as a structure that is based on urban facilities or agglomeration as studied under the rubric of transit demand; it is also a socio-spatial unit that allows for multiple processes and practices of informality to coincide.

The links between urban land and informal transport are clearly apparent between areas with a high level of population growth and trip transfers to the consolidated city. The results show that the informal transport routes reach central areas of the city, as well as provide services between urban, rural and semi-peripheral parishes. The informal transport routes serve as intermodal connections for the Integrated Public Transportation System of Quito.

In fact, many companies emerged at the same time or a little after the creation of the neighborhoods to respond to commuting demands. Others have been created in the last years because of the fast population growth in peripheral areas and the concomitant deficiencies of the public transport system. According to the informal transit companies' interviews, 26% of them have emerged in the last five years, and 30% between the last 6 to 10 years. While 22% of the companies operate over more than 20 years, their creation coincides with the formation of some of the neighborhoods. A similar percentage is found for the routes that operate between 11 and 15 years and have become part of the neighborhood life.

The importance of the neighborhood was not just a matter of resolving employment needs, it was about how the self-organizing logic was a component tied to where individuals live. While certain areas of the urban built environment exhibit specific characteristics of land use such as residential, regulated or unregulated, the residents who are also informal transit operators assert their logic of route choice based on their social networks, sense of trust, and cultural identity. In other words, how informal transit companies choose their routes based on neighborhood needs organized around their relationship to urban land precedes their perspective on travel demand. Placing the logic of production and consumption of informal transit necessarily comes from socio-spatial interactions. This is further evident when discussing specific informal transit routes:

> [We started] precisely because of the transportation deficit that existed at that time, and because transport was not as citizens deserve […] and need. And despite there is a company that in quotation marks was legal but right now is illegal, because they do not have the documents updated.

Travel demand forecasting is meant to estimate or guide regional highway and transit investment projects, some of which do not lead to sustainable or smart growth. However, since informal services define route choice by starting from a lack of services in the neighborhood, we argue that it inherently becomes an urban land question (Robinson and Roy 2016) where informal and self-organizing logic for collective action creates the framework for route choice. For example, the first quote above mentions Calderón, which is a rural parish and runs directly to urban parishes. The self-organizing logic of the informal transit providers selects routes and the ways in which the choice is made is determined by the built environment (Crane 2000). The route is a line chosen **in-between** the rural-urban connection or peri-urban connections and could, thus, be considered *informal transit* connection. Therefore, we sustain that land use, or where urban functions are located, is fundamentally a characteristic to how informal transit service provision is decided. Informal transit from here on, we will refer to as informal transport because of its tie to urbanization as a process continually done by citizens (T. P. Caldeira 2017). Next, we consider the concept of how "people's needs" characterize the routes chosen and how this is also ultimately tied to urban land functions.

b) Traveling to and from the Neighborhood: In/visible Logics to Travel Prediction

As many scholars have cited land use patterns affect travel behavior, we argue that this then impacts how informal transit is planned, self-regulated, and something that should be considered when determining the relationship between urban land and informal transport. So, in this section we rely on interviews to understand the areas that informal transit providers serve, how they are organized, and what they do to meet travel demands. We do this to apprehend the in/visible dynamics that individuals consider as reasons to take informal transit. In Section C, we discuss results of the intercept survey we conducted because during interviews it became clear that there were several competing logics that needed to be understood. There is a constellation of determinants that factor into why providers chose specific routes.

The built environment and socio-economic status are two factors that influence travel. Thus, it is important to comprehend the relationship between informal transit services and the clientele targeted by the companies. Typically, interviewees of informal transit companies referred to their clientele as:

> [We work for] all kind of people. They leave their jobs, they come to the bridge of Guajalo and because they know that we provide the service; even the transit agents make use of it. And to earn their will, if they listen to what you are recording: We do not charge them a ticket ... [We serve] children, women, seniors (...) who are from this sector.

To understand the critical way in which these companies view their users, we had to examine the overall perspective of informal transit providers. Listening to the profiles of their users was critical for thinking about how and why their services continue. It was also insightful for understanding how companies predict travel behavior. We knew that the dominant mode of prediction was self-organized logic and had to be further understood, starting from the drivers themselves.

In interviews, the ways in which people became associated, or became drivers, depended on the socio-cultural relationships within the neighborhood served by the company. Interviews illustrated that workers started working with company often by living in the neighborhood it serves. A *morador* (resident) would inherit the rights of the previous driver vis-à-vis family or trusted friends. Companies usually do not charge the driver a fee for being part of the company, as the formal taxi service does. Instead, informal taxi drivers, or associates, usually request help to pay fines the other partners have paid *(ponerse al día en las cuotas*) or commit themselves to pay a monthly fee to cover administration costs.

Through interviews we documented that informal transport does not mean it lacks order or structure. Internally, companies organize themselves and might have hierarchies and democratic elections. Also, they have monthly fees to cover administration costs, accounting procedures, formal and standardized processes for accepting partners, and infrastructure such as offices and parking lots or stops. However, not all the companies have the same degree of organization. That varies according to the number of years they are operating, the size of the fleet, the length of the routes, and the kind of leadership. The routes with higher levels of organization, even have

frequency control tables, penalties in case of absence or when schedules are not respected, and economic support when cars are arrested. These factors contributed to keeping up with customer demands as well as providing a consistent and reliable service.

Companies do not rely on sophisticated predictions but have alternative strategies for deciphering and interpreting the preferences of their users. We overwhelmingly found that informal transit operators care about the opinion of clients as their service is sensitive to users' satisfaction. Users, when having the option (meaning access to public transport), can choose not to use their service. Therefore, operators are attentive to overall service quality including fares, waiting time, conditions of the cars, or safety, among others.

In general, informal transit companies are less interested in the socio-economic profile of the user as they have little information on this. But, interviewees described that their services increased as the neighborhood or people that lived in the area discovered their mode of transport. Two dominant and in/visible logics surfaced from the interviews regarding route choice. On the one hand, (1) companies could determine that they were key interlocutors in the transit landscape of Quito based on a *dignified*, intermodal, comfortable, and frequent service for citizens at market competitive prices to strategic areas of the city. On the other hand, (2) the idea of *confianza*, or trust, was central to why they believed users preferred their informal services:

> (1) ... to give them the service they deserve and to guarantee citizens are well-treated in the 8 northeastern parishes. (…) They have a shared taxi with minimum costs, so they no longer pay much as they used to 8–9 years ago, when going to Cumbayá from La Floresta taxis cost between 12 to 15 dollars, to bring them here to the capital of Quito or vice versa (to go down to Cumbayá.) Then we were born as *taxiruta*, so all the 8 northeastern parishes have a shared taxi service for a minimum fare of one dollar per person, which means the driver would earn for the trip 4 dollars, something that here in Pichincha is the most economic for taxi service, and for citizens and the society.
>
> (2) Three years ago, we implemented [a life insurance service] because, since Simón Bolívar Avenue was created 5 years ago, there were too many traffic accidents due to high speed on the road. Before in the sector there was no such high traffic and high speeds. So, we hired an insurance service company which assured us, the vehicle, and third parties. And then we started to advertise [this benefit] to the whole parish indicating that now they can travel safely, that now in case of accident there is protection for the vehicle, the driver and the passengers.

This shows that networks based on ideas of *confianza* (trust) attract users who desire to arrive at specific areas of the city to use informal transit. Concepts like *confianza* are critical components to sociocultural relationships upon which these services are based, incentivizing users to connect to their neighborhood providers and to prefer their services.

While case studies of informal transit discuss what the characteristics of operation are, they do not discuss the organized self-managed logic that regulates the provision of their collective services. Here, the idea of *confianza* surfaces again because individuals could travel to their destinations in a comfortable way for an equivalent or competitive price. For instance, in many neighborhoods, small 4-cab sedans called taxi-*rutas* ran the same route as buses that serve peripheral neighborhoods. These informal services usually charge 25 cents per seat (depending on the route, the price might vary between 20 cents to 1 dollar) and only travel the same route as the bus that accesses the same neighborhood:

> [This happens] most of all because the transport service provided by the municipality is very inefficient. Why is it inefficient? Because the bus comes every half hour, and people are in a hurry and they stand with the risk of being robbed. We try as they say, we collaborate with them because all the people live in a fast-paced world, and they cannot be there waiting half an hour for the bus. In other words, we provide the service faster, we arrive every 5 minutes.

Passengers opt for this service because it gets them to their destinations more comfortably, safely, and quickly, and can serve to connect people to the public service as a form of inter-modality. The logic of the informal line is to provide a trusted service based on social relationships that at many times runs parallel and uses the same existing public bus stops and route that was determined based on modern prediction models.

Confianza is a dual logic that works to get and obtain clients but is also a way for informal transit to compete with the formal public system. For instance, women in Quito who ride public buses have a heightened level of feeling being stared down and report being touched inappropriately, etc. In a report on violence and insecurity on public transport in Quito, the municipal administration found that within its integrated *Trolebus* system, 38 percent of women felt most insecure while entering the bus (Observatorio Metropolitano de Seguridad 2014). Informal transport vehicles work according to socio-cultural or in/visible logics that quite often influence the way their routes are set and why people take and prefer them. Furthermore, comprehending these logics is important because it can be understood as a motivating factor for travel demand in "indigenous" or "informal" transit services. In Quito, ideas of violence and insecurity influence people's travel behavior. We suggest this is one compelling factor for people who have pre-established networks of trust to prefer or choose informal transport.

Moreover, most informal operators work outside of operating hours of public transit. This is a motivating factor for individuals to use their services. Informal transit operators complement buses during peak hours. For example, peak hours in neighborhoods that provide informal services also take children to areas that are between schools and bus routes. Safety and trust are evident, as parents send their children in *taxi-rutas* in between the public bus stop and the school. Lines run alongside and fill existing holes between the service of public transit lines and are a critical component to collective organization and *confianza* in the neighborhood. Therefore, in Quito it is seen that informal transit companies either earned the route over struggles with other companies over time, continue to compete with other companies, or work parallel to established public transit routes. There is a common understanding or agreement between informal transit companies that can be considered the alliances that hold them together (R. Cervero 2000), but we

suggest that this demonstrates the multiple logics at work that determine their routes. Thus, it is both the idea of the security that the service offers, coupled with traveling the route that fills gaps of service which is predicted by the built environment.

In interviews, it was also difficult for informal transit providers to make distinctions between their users and their socio-economic status. As such, we draw attention to people who are outside of planning processes that depend on social networks of *confianza* and use informal transport:

> We transport all kinds of people who have different activities, most of them to their jobs, offices and/or place of study. But, as you will see, we are near a huge sports park, there are many people who come in the early morning to jog in La Carolina. They come in *pantalonetita* (shorts), before they get to their jobs. We mobilize the entire sector across all areas and activities they do.

Companies see that they transport people, not necessarily socio-economic status categories, when asked specifically about their clientele. They can discuss the neighborhoods they serve, but do not necessarily directly address the influence of socio-economic factors on travel. These kinds of travel behaviors are incompatible to the ways in which modern transport or travel predictions are conceived.

The idea of *confianza* is a mutual logic that works for informal transport routes—trajectories that go in-between different land uses, such as residential/commercial or urban/rural. Logics of trust, dignity, and urban land are interwoven and coexist, and are not easily untangled. Informal transit drivers comprehend these in/visible links and adjust their services to meet the client's preferences. This can be interpreted as the free-market transport choice because providers have the ability to adjust their services according to market competition and self-regulate (R. Cervero 2000).

These in/visible logics are inherently attached and connected to urban land designation. We aim to show this spatially in the next section. We understand that the companies that we interviewed may have not surveyed their users to find out data on socio-economic background or other characteristics (such as residential choice,) but we argue—and are uncovering how—in fact, the informal logic works parallel to efficient and modern ways of understanding travel management. These informal transit companies have a logic centered on the client which we must further decode.

c) Surveying Informal Transit Users

The previous section relied on ethnographic research conducted throughout 2016 and 2017. We analyzed interviews and field notes to ascertain the socio-cultural processes that influence travel from the perspective of the informal transit companies. In this section, we draw on a survey of transit user perceptions. Survey responses complement the ethnographic insights to the logics behind how informalities work within the spaces between land and transit. It is important to understand the rationalities behind why urban dwellers use collective transport services that are not provided by the city. Urban residents recognize the services they use that are unregulated and are influenced by the multiple processes of informality that link land use and transit in Quito.

Understanding informal transport also implies explaining the perspectives of the different actors involved, including authorities and control organisms, service providers and users. While there is an evident and permanent tension between authorities and operators regarding the legality of the service, the users remain in the background and its habits and reasons for using this mode of transport are not fully understood. As part our methodology, a user-oriented survey was implemented at some informal transport stops, with the support of the companies.[ii] In total 403 survey interviews were made, mainly in peak hours using a non-probabilistic sample. The criteria for selecting the informants was to choose people waiting in the line for the cars to leave and their voluntary cooperation. The survey was done in seven informal transport stops (See figure 15, appendix), where 10 companies provided the service. There was one stop located in the valley, where three informal operators work. Most of the companies cover routes which also have public transport, although it is not always direct. Four of the routes offer long-distance trips (more than 10 km). The type of vehicles that provide informal service were buses, mini buses, vans, private cars and some illegal and legal taxis[iii].

The results of the survey reveal the demographic profile of users, their commuting habits, and reasons and opinions of the informal transit service (see figure 16, appendix). Among the survey respondents, 54% were women and 46% men. Most were aged 21–30 (33.4%) and 22.3% were in the age group of 31–40. Next, 18.2% of the users are people from 15 to20 years; 15.7% were 41–50 years, and only 2% of people were older than 61 years.

The results of the survey were also used to understand the main trip destination. Figure 17 (see appendix) indicates that 73% of survey respondents use informal transport to go to or from work, which is coherent with data on the age of the users, since most belong to the economically active population. There was no significant difference between men and women in the responses. Further, 16.4% of users affirmed using informal transit to go to and from school (3% more women than men chose this option). Other reasons for travel were of little significance. However, we suggest that more women reported using informal transit because women take kids to and from school.

As we will show in the next section, the use of informal transport to reach formal bus lines or other modes of formal transportation is common. Survey results reveal how informal transit works as a component of the intermodal system or as a link to the formal system. We wanted to understand their travel chain to test this hypothesis. For example, table 3 (see appendix) indicates that in a one-way route 52% of respondents use informal transport (taxi-*rutas*, vans or illegal or school buses) as their first travel mode usually when leaving the house for work or school to reach the stops of formal buses. This also means that, when returning, informal transport is the last travel mode they use. In the first phase of travel, 43% of the people use formal transport. But in the second phase of the trip, 32% use informal modes (compared to 41% who use public transport, and 23% who walk). In the third phase of their trip, people mainly walk (59% of the respondents), 19% use informal transport, and 17% take regular bus lines.

Living at the margins of the city might be cheaper in terms of land price and rent. However informality is expensive (Smolka 2003). This means that accessing certain services that are not provided in irregular areas might be higher in cost than in the regular ones. Similarly, when commuting, people need to combine informal transport with regular buses because of distance

and availability. As a result, people pay two or more fares to reach their destination, or pay a higher informal transit fare because sometimes it might be faster and more comfortable than regular buses.

Travel time was also a motivating factor that seemed to influence users. For instance, figure 18 (see appendix) draws attention to one-way travel time in a motivation to use an informal vehicle: 25% of users declare travel takes 16 to 30 minutes, while 22% state it lasts 45 to 60 minutes, and 21% state it is more than 60 minutes. Moreover, 14% of respondents declare the journey lasts 5 to 15 minutes and 18% 31 to 45 minutes. These trip times were supplemented with repeated observations and interviews that we witnessed during our fieldwork. Informal transport helps to reduce the duration of the trips, since we found that people usually do not have to wait for long periods for the vehicles to arrive. Also, the frequency of trips is higher since the vehicles get full rapidly due to its lower capacity. However, waiting times might increase in peak hours due to higher demand, as well as in earlier or later hours when there are less informal vehicles circulating. While some informal companies have permanent routes and stops, others might adapt their services to their clients' needs, which is indicative of a more flexible route. But, informal vehicles do not stop as often as public transport, and the routes are shorter, making the trip more efficient.

The survey results also indicate that the speed of the service is the most valued characteristic: 56% of users said it is the most important reason for using informal transport (see figure 19, appendix). As mentioned above, most users combine several modes of transport, and informal service usually is the last or first phase of their travel. People trust that this service will take them to or from home faster. The second most appreciated factor of informal transit is that people can sit; 25% of the respondents use informal transit because it is impossible to get a seat on public transit. If we add this percentage to other options like traveling in less crowded vehicles than public buses or having good customer service, the result is that 36% of the users of informal transit value comfort. On the one hand, this result is relevant because, according to the municipality, 80% of public transport vehicles exceed their occupancy rate in peak hours (MDMQ 2014). On the other hand, 18% of the people use informal transport because they lack public transport options, 15% of respondents suggested it was because of the price, and 11% cited that the frequency and schedule influenced their choice of service. In general, informal transport offers people some benefits they do not find in formal bus services. Safety is also another compelling reason for choosing informal transit service for 16% of the respondents. The data on this indicator seen by gender shows that 62% of the answers were from women and 38% from men. This result is corroborated by interviews with transit providers, who indicated that people chose their services because they perceive it to be safe.

The survey results revealed the perception of security in informal transport units by gender, especially among women (see figure 20, appendix). Results show that 35% of users said they felt safer against a sexual harassment situation; of this percentage, 58% are women. Regarding robberies, 34% said informal transport is safer, and 55% of these respondents were also women. If compared with public transport, 13% of those surveyed said informal transport is equally safe. From this percentage, 53% of respondents were women and 47% were men. Finally, 18% of users responded they felt informal transit is as safe as a private car, of which 56% were women and 44% were men. One of the common complaints of public transport users is sexual

harassment, particularly among women. According to the Survey on Violence in Public Spaces carried out in the Administrations Eloy Alfaro and Quitumbe, 68.4% of the women said they had suffered some form of harassment or sexual abuse (UN Women 2011). As such, a question about this topic was included in the survey, showing that 10% have experienced this kind of situations at informal transport vehicles, evidencing higher security conditions. During the interviews, transit providers mentioned that users can and will complain with the company in the event of sexual harassment, and they would take actions against the perpetrator if is one of the drivers. Also, users mentioned that because there are few people in the vehicle and everyone is seated, harassment or violence are not likely to happen (see section B).

Finally, the survey data enabled us to evaluate the service to understand it in comparison to formal transit. This was complementary to our assessment that informal transport is a service that exists between services and is an intermodal option for urban residents. On a scale of 1 to 10 (with 10 being excellent), 17% of users value the service as a 7/10, 25% ranked it as 8/10, 16% as 9/10, and 21% as 10/10. This means that 79% of the users evaluate the service positively, which is a higher percentage if compared to formal public transport options (as 9 of 10 users believe formal service has continued to decline) (El Telegrafo 2017). According to respondents' comments, informal transit service is good in general because they can travel fast, safely, and comfortably. Plus, they know the company and the drivers, therefore they trust them, since usually they are people from the same neighborhood. These comments, in addition to the observations described on previous sections of this investigation, suggest that there is an element that continues to return to the neighborhood unit.

In this section, we have detailed the results related to the informal transit user. The motivation behind this survey was to apprehend the user's perspective, which often is missing in research conducted on informal transit. Studies in the field of transit often detail the perspective of the companies or their relationship with state institutions. However, our multilayered analysis depends on individuals that consume their neighborhood services. It becomes evident that users are not being represented in the planning process of transit. This is further verified by interviews with city officials that denied the existence of informal transit. Responses from several top officials and politicians claimed informal transit does not exist and that users are committing a legal infraction by using it (Sánchez 2017). In fact, their transit needs are being covered by informal transit which exists in spaces between land and transit or are intermodal points of connection. There are multiple logics that surface in this section that complement the findings presented from the perspective of transit providers, as users' responses show how they adapt to the collective systems that interlink formal and informal services. Next, we discuss the findings of the spatial aspects of informal transit routes to grasp how they are land-oriented.

d) Locating Informal Routes

Thus far we have drawn attention to the complex web of logics that makes the world of informal transit in Quito function and work alongside the formal networks of public transit. As our main intent in this investigation is to expose the relationship between land use regulation and informal transit routes, we now turn to this last aspect of our analysis. In the previous sections, we determined that informal transit provision starts at the neighborhood level, but this cannot only be considered a spatial unit of analysis of the built environment. Instead, we suggested that

informal transport starts from a neighborhood unit and adapts to its in/visible logics to move to and from their neighborhoods. Now, we proceed to discuss initial results from the GPS analysis related to the participation of informal transit providers.

Throughout the data collection process, it became clear that drivers went to areas outside of "the map," or were moving in-between regulated, centric areas of the city. However, other routes function as intermodal transit services between major public transit lines. This was evident from participant observation as well as the tabulated data that the GPS devices provided.

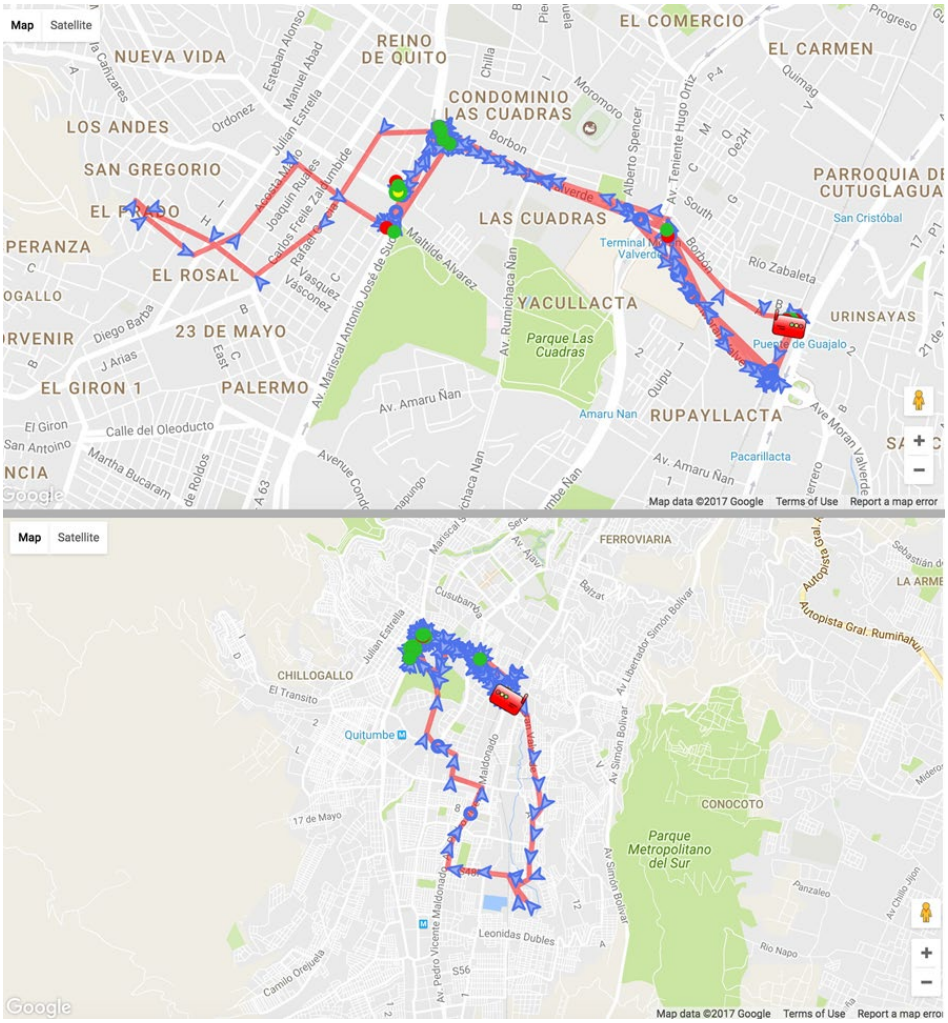
Table 2: Sample Driving Record from GPS Device

Unit: 860599001131317									
Día	**Hora Salida**	**Dirección Salida**	**Tiempo en Mov.**	**Distancia**	**Velocidad Max**	**Velocidad Promedio**	**Hora Llegada**	**Dirección de llegada**	**Estac.**
3/29/2017 12:00:00 AM	9:27:09 AM	Avenue Gualberto Perez. Quito, Pichincha, EC.	00:12:17	0.14	5.47	2.09	9:39:26 AM	Avenida Pedro Vicente Maldonado. Quito, Pichincha, EC.	00:06:10
3/29/2017 12:00:00 AM	9:45:36 AM	Avenida Pedro Vicente Maldonado. Quito, Pichincha, EC.	00:36:11	3.4	16.28	4.9	10:21:47 AM	Hualcopo. Quito, Pichincha, EC.	00:49:02
3/29/2017 12:00:00 AM	11:10:49 AM	Jauja. Quito, Pichincha, EC.	00:05:35	0.23	15.66	4.39	11:16:24 AM	Puruhá. Quito, Pichincha, EC.	00:29:31
3/29/2017 12:00:00 AM	12:04:14 PM	Puruhá. Quito, Pichincha, EC.	00:18:47	1.96	23.36	11.45	12:23:01 PM	Unnamed Road. Quito, Pichincha, EC.	00:11:56
3/29/2017 12:00:00 AM	12:34:57 PM	Unnamed Road. Quito, Pichincha, EC.	01:06:37	6	32.87	7.82	1:41:34 PM	Puruhá. Quito, Pichincha, EC.	00:05:39
3/29/2017 12:00:00 AM	1:47:13 PM	Puruhá. Quito, Pichincha, EC.	00:33:20	4.22	25.79	11.44	2:20:33 PM	General Pintag. Quito, Pichincha, EC.	00:31:08
3/29/2017 12:00:00 AM	2:51:41 PM	General Pintag. Quito, Pichincha, EC.	01:29:18	10.57	29.76	4.77	4:20:59 PM	R. Moran. Quito, Pichincha, EC.	00:10:24

Source: GPS device records (Optimus Tracker 2017)

The different trajectories of informal transit make up a complex picture that shows that informal transit goes between areas that are zoned for specific uses (albeit still off the map). Data from GPS devices show different data points such as tracks, addresses, time in movement, velocity, etc. (see table 2). These indicators enabled us to keep track of the units throughout the data collection process. Furthermore, it allows us to see how routes were formed after agglomerated data was assembled over time. The driving reports also documented how informal transit went in between bus lines, as every data point is accounted for.

Figure 5: Sample Trajectories of GPS Unit



Source: GPS circulations, downloaded from Optimus Tracker (Optimus Tracker 2017)

These two trajectories represent how we have assembled routes to ascertain that it is a valid route that the interview would report on. We verified the pattern of the trajectory repetition using the data on driving records. Based on the dates that companies used the GPS devices, we filtered the data to define the routes based on the repetition of trajectories before loading it into mapping software. Next, we took the data for the companies that we worked with.

We present our findings in the following map (figure 6) developed with the participation of informal transit companies. Trajectories were downloaded in kml files and edited in map matching. Then they were subsequently loaded into mapping software where they were arranged with shape files that we obtained from the municipal government open data project (DMQ 2017).[iv] The source of all map backgrounds comes from OpenStreetMaps (OpenStreetMap 2017).[v] For comparison, figure 7 shows the density of existing formal transit stations. Figure 8 reflects the population densities and growth of the city in 2010 and figure 9 depicts the informal transit lines along the fastest growing edges of Quito.

Figure 6: Informal Transit Line

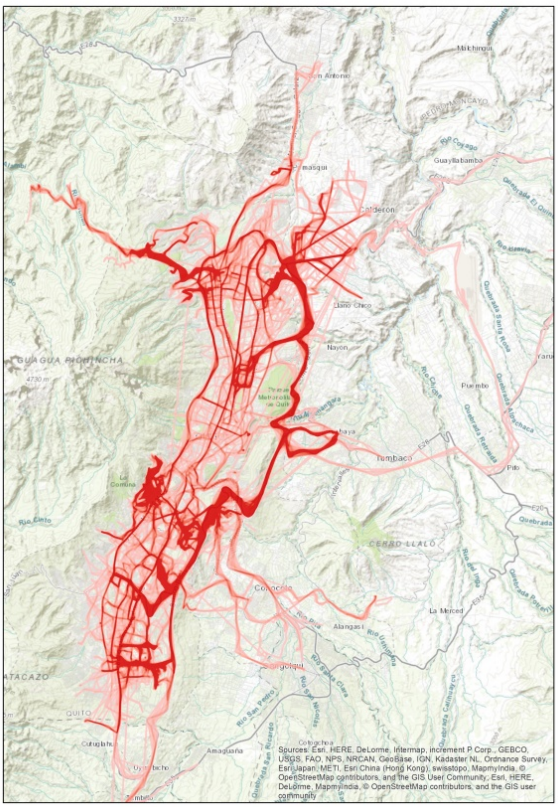
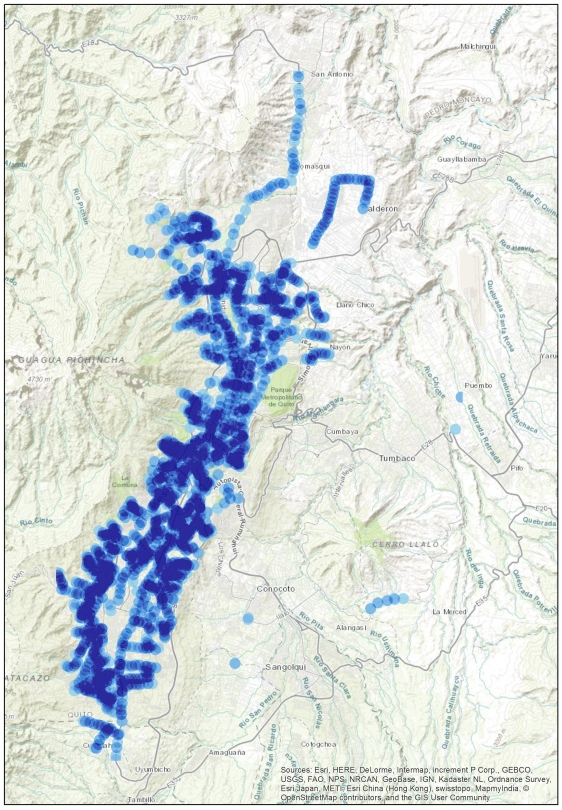


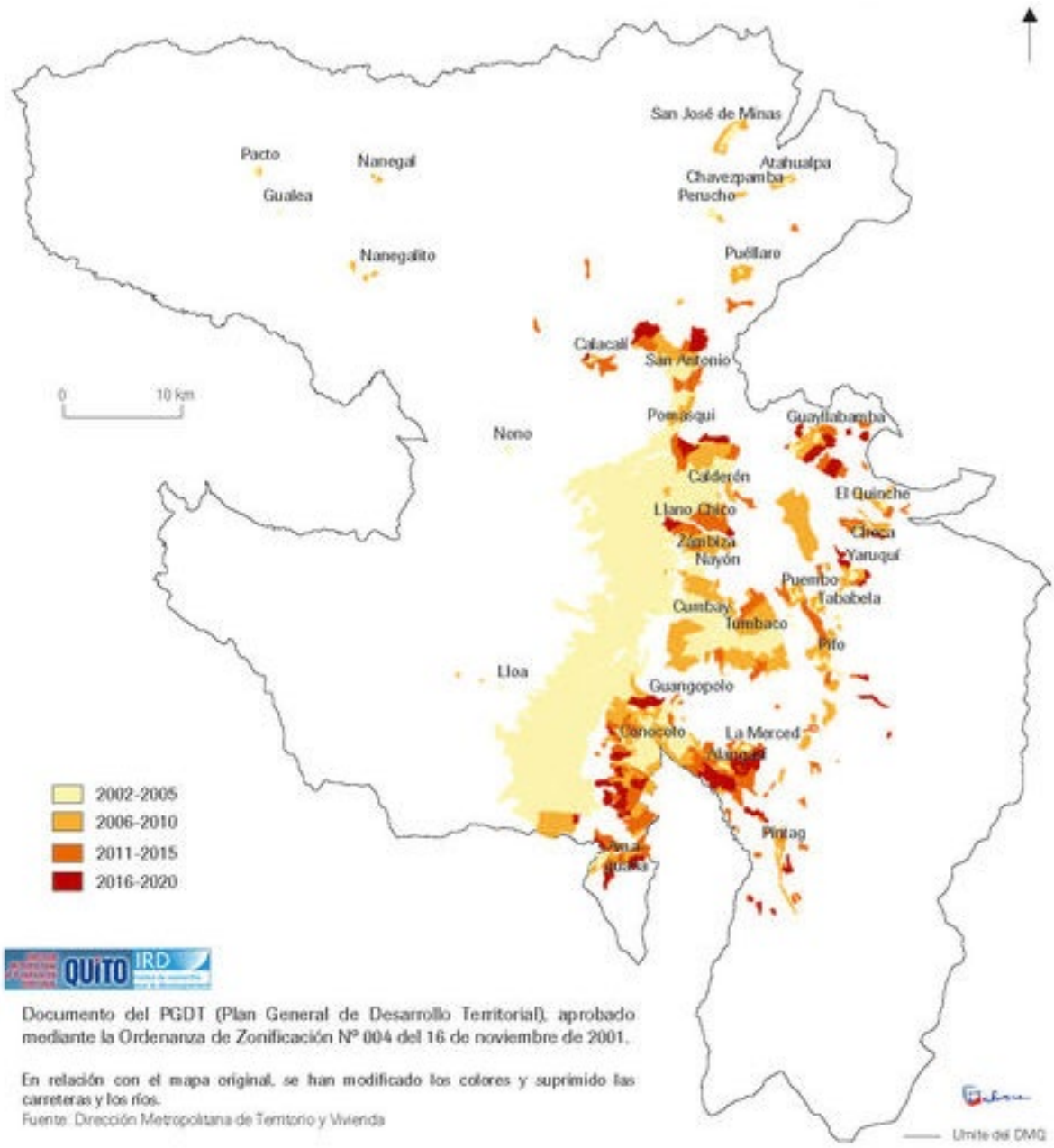
Figure 7: Formal Transit Bus Services (density of bus and metro stops)



Sources for both figures: Authors' GPS devices, DMQ STHV 2016, Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster N, Ordinance SurveyEsri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

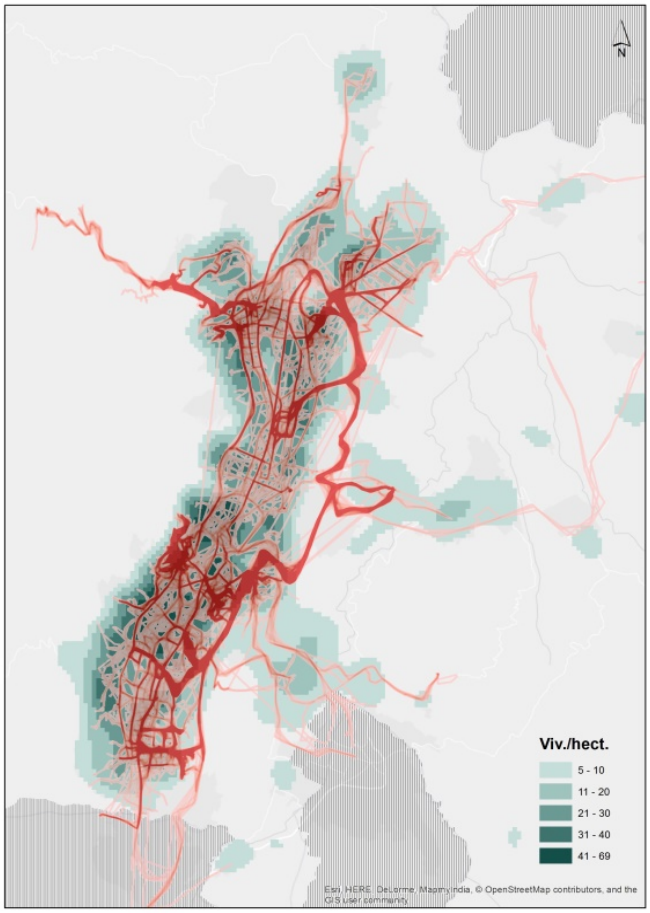
When we compare figure 6 with figure 8, we can see how informal transport routes have darker colors not only in consolidated but also in expansion areas—defined since 2003 as new urban land to be incorporated to the city. Zones like Calderon, Pomasqui, San Antonio, Conocoto (where Loma de Puengasi is located), Cumbaya, and Llano Chico (close to La Bota), are part of the informal routes identified. The maps show that informal transport is oriented toward expansion zones of the city, that might be or not informal, but have recently experienced urbanization processes.

Figure 8: Urban Land Incorporation Stages in Quito



Source: IRD 2003

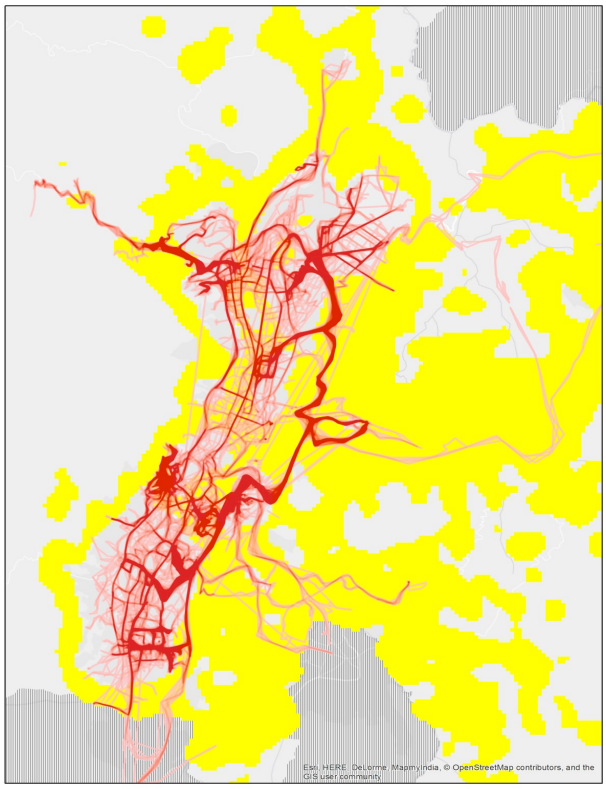
Figure 9: Generalized Population of Quito (Housing Data from 2010) and Informal Transit



Source: Authors' GPS devices, DMQ STHV 2016, INEC 2010, Esri, HERE,MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Figures 9 and 10 delineate the relationship between the informal transit lines and the population density of the city. Figure 9 depicts the links between the routes and the faster growing edges of the urban area. The population density of Quito (based on housing data from 2010) was overlaid with informal lines. The map's darkest shade of turquoise captures how the urban core continues to be the most densely populated area and where informal transit intensively serves. Figure 10 indicates the faster growing areas of the city in yellow. These areas experienced rapid population growth at a rate of more than 50% between 2001 and 2010. This map exposes how Quito is growing and informal transit is keeping up with demand in comparison to formal transit. In that sense, informal transit lines can serve as a proxy to understand where to put public transit lines and where land markets are growing.

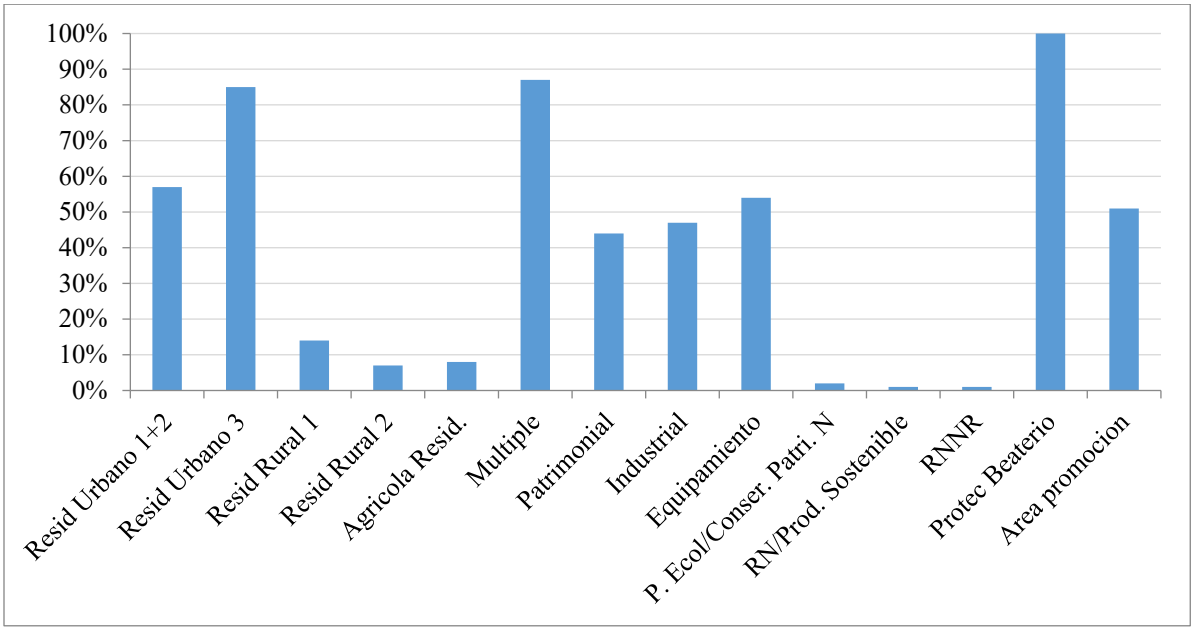
Figure 10: Informal Transit Lines and Areas That Experienced Rapid Growth



Source: Authors' GPS devices, STHV 2016, Esri, HERE,MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Together, these maps allow us to spatially locate the distribution of informal transit lines at the metropolitan scale. They are also important to comprehend the next phase of our analysis. As discussed above, we used the land use regulation categories established in Municipal Ordinance 127 (DMQ 2016a) and classified them into commercial, industrial, and residential zones. Density restrictions were incorporated into residential use. Based on the categories established by the municipality, we then further specified the zones in the following land use regulation categories: residential urban, residential rural, mixed-use, commercial, industrial, protection areas, public institutions, and patrimonial. A description of these categories is given in table 5 in the appendix. The following graph (figure 11) indicates the relationship between informal transit coverage and the land use regulation categories.

Figure 11: Proportion of Land Use Types Within 200 Meters of Informal Transit Line or Service

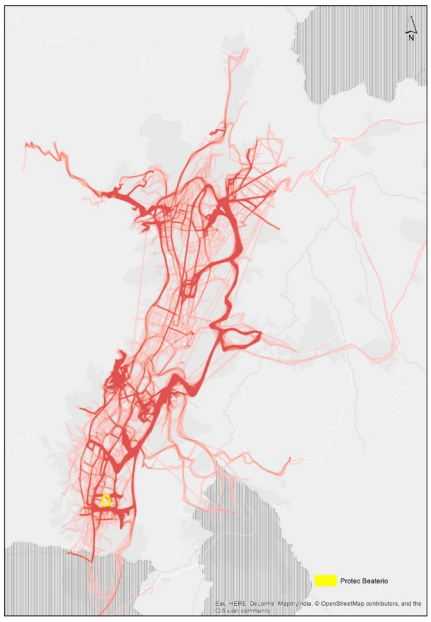


Source: Informal transit routes and STHV 2016

The areas that demonstrate the highest level of service include urban residential areas 1+2 and 3, Multiple, and Protec Beaterio. We combined the analysis of urban residential areas 1+2 because they are areas with the same characteristics (including limited public facilities, neighborhood level services, and commercial activity). We note a direct relationship between dense urban residential areas with neighborhood level services and the use of informal transit. Also, survey respondents reported that informal transit is usually their first or last leg of travel of the day. Similarly, Residencial Urbano 3 is a category that allows for more commercial and economic activity as well as industrial development that has low impact but higher density restrictions. The category Multiple is mixed, including residential, public facilities, commercial activity and services. Combined with Residencial Urbano 3, these areas show a high propensity to use informal transit services.

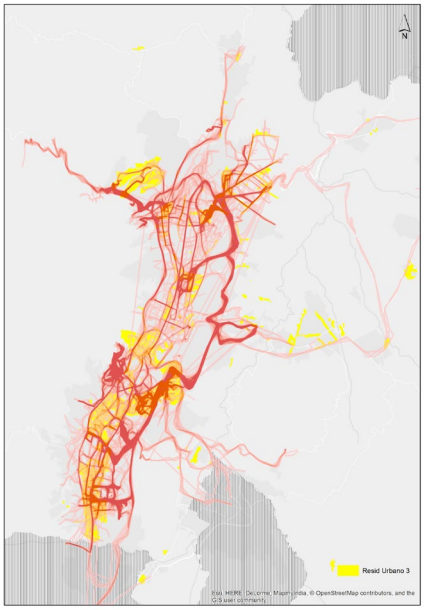
The Protec Beaterio is an area previously protected by the municipality to act as a buffer around installations such as tanks of liquid gas from PetroEcuador. In 2016, the size of buffer was reduced. The high incidence of informal transit in this area is probably an indication of population growth (see appendix, table 6 for the specific share of land served by informal transit).

Figure 12: Map Protec Beaterio



Source: Source: Authors' GPS Devices, STHV 2016 and Esri, HERE,MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Figure 13: Map Resid Urb 3



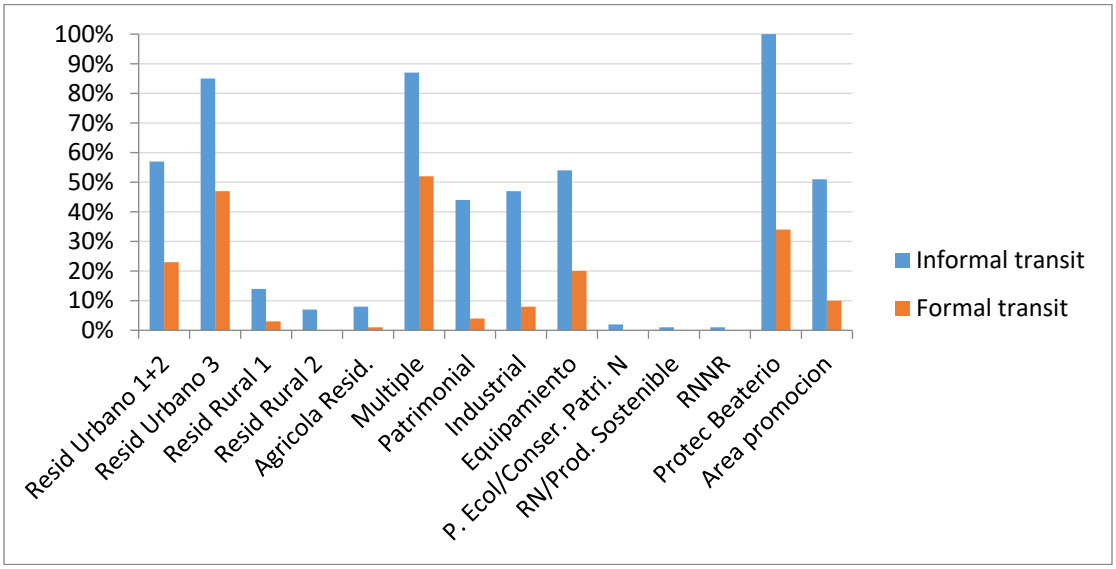
Source: Authors' GPS Devices, STHV 2016 and Esri, HERE,MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Overall, the maps show that informal transit services indeed are oriented toward land use regulation categories. Specifically, we have demonstrated how informal transit lines have built off existing formal transit lines, but also provide services in unexpected areas such as Protec Beaterio. This in turn indicates that informal transit offers an alternative competing service to public transit, as found in studies of informal transit in other countries. Moreover, it highlights the relationship between urban transport and land use. Cervero states the need to link transit with land use in order to develop transit services that are accessible to urban activities that are pro-poor and sustainable (R. B. Cervero 2013). Our results show that informal transit services are indeed linked with dense residential and mixed-use areas that are characteristics of sustainable urbanism and transport (Chatman 2013). The Protec Beaterio area, once a buffer zone, has become highly urbanized and requires attention.

Three areas in Quito metropolitan area that are zoned for agriculture, environmental sustainability, and non-renewable uses show very little informal transit service. This finding indicates that land use regulation for these areas has managed to protect zones from population growth and preserve important environmental resources.

Finally, the results indicate that the relationships between informal transit and land use regulation are founded in multiple layers of informalities connected to formal urban practices (Waibel 2016). As such, these relationships indicate that informal transit providers coordinate their services with land use regulation. To further test these arguments, we analyze land use within 200 meters from an informal transit line, or 200 meters from a formal bus stop or train station in figure 14

Figure 14: Land Use Type Within 200 Meters from an Informal Line or a Formal Transit Stop



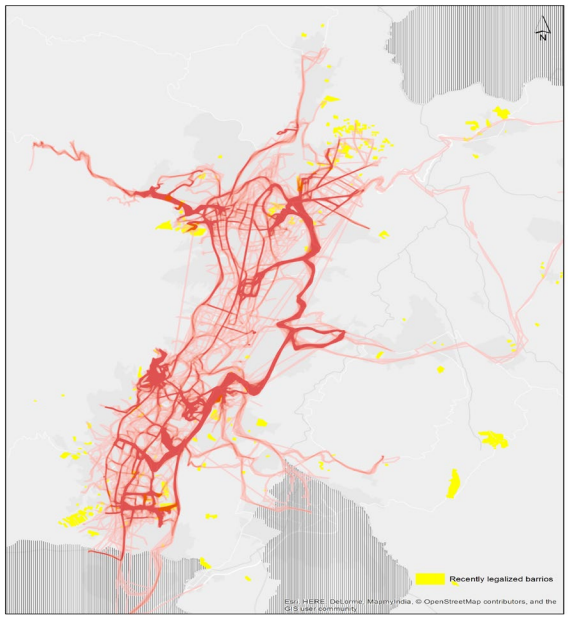
Source: Informal transit routes gathered in 2017 and STHV 2016

This last graph shows that, compared with formal transit, informal transit coverage reaches a higher proportion of the urban areas when classified according to land use. Though the data is

not perfectly comparable, we suggest that informal transit captures a wider diversity of land use categories in comparison to formal transit. There is a propensity to exclude, or not pay attention to, the ways in which informal transit operates sustaining urban practices that are directed to marginal populations. This is verified by the transit user survey.

While the DMQ characterizes and quantifies the number of informal settlements, this does not mean the data available is accurate or completely account for settlement growth. We were able to obtain the shape files for areas that have recently been legalized, which means that they are in the process of gaining land titles, basic services, and access to roads.

Figure 15: Recently Legalized Neighborhoods and Informal Transit Lines



Source: Authors' GPS Devices, STHV 2016 and Esri, HERE,MapmyIndia, © OpenStreetMap contributors, and the GIS user community

As figure 15 shows, there is a clear relationship between areas that have recently been legalized and informal transit lines, especially in the north near the La Bota neighborhood, as well as in Quitumbe in the south. These recently legalized areas are not exhaustive and need to be mapped for future studies. However, one of the characteristics of informal areas is the lack of public services including transportation (Connolly and Wigle 2017), and even some legal areas in process of expansion might lack them. This is primarily because informal and/or peripheral areas lack proper streets conditions, dissuading the provision of transportation services (buses deteriorate faster because of lack pavement, holes, irregularities on the grounds, as well as the small width of the streets.) Also, low passenger demand due to low densities in recent urbanized areas or where mobility needs are high only in peak hours, make public transport provision not a profitable business. Long distances might also be a problem because a higher number of vehicles is required for a lower number of passengers. As a result, where formal transport sees no opportunities for a good business, informal companies expand their services.

Conclusions

In this paper, we have discussed the relationship between informal transport and urban land as well as the multiple logics that influence this service. The principal finding specifies that informal transit routes establish a relationship with land use regulation and that informal routes have clear links with formal transit. This indicates that informal transit can anchor dense urban areas or areas not easily accessed by transit, as well as recently regularized areas. The proliferation of informal transit services is planned by urban residents who take into consideration categories such as neighborhoods and densely populated residential areas. Areas with highest population growth are sustained by informal transit services, not public transit. Results also show that informal services function as ride-sharing services for transfers and can complement multimodal transit services. Our data indicate that informal transit lines have a correlation to the fastest growing areas in Quito. This means that informal transit can serve as a proxy to understand how to integrate these areas with the public transit network. It also suggests that informal transit lines can signal where land markets are burgeoning.

The emergence of informal transport services is generally related to the creation or consolidation of new neighborhoods (often informal) that lack public transport services. However, it also arises due to the deficiencies of regular transportation, both in terms of geographical coverage and schedules, frequency, capacity (overcrowding particularly during peak hours), and security against theft and harassment. The absence or low quality of public transport, which does not respond quickly to the growth of the population and demand, sets the stage for informal transit to establish itself as an alternative. In fact, informal transport comes to structure the neighborhood and affects its consolidation process. Further, because in some areas the demand is not high enough for high-capacity public transport service (buses) to be profitable, informal transport is an intermediate option that guarantees service.

Our findings indicate that there is a direct relationship between the incidence of informal transit and mixed-use zones and residential urban areas that offer multiple neighborhood services. Thus, our study contributes to the literature on transit-oriented development, as it looks specifically at the role of informal transit and its necessary connection to land use. At the same time, this research shows the importance of transport, independently of its legal status, for consolidating/upgrading urban areas guaranteeing people's rights of mobility. From this perspective, our study contributes to the field of urban informality and how unregulated practices such as informal transit can contribute to our understanding of sustainable, bottom-up urbanism. Understanding the relationship between land use and informal transport means focusing on how all practices are a form of planning. Informality, in any of its expressions, from housing to work and transport, is a set of practices that become a form of urbanization, "rather than as the binary 'other' to the formal sector" (Connolly and Wigle 2017, 186). Therefore, one should overcome the antagonism between formal and informal, or legal and illegal, to break the dominant paradigm of understanding only some forms of public transport (buses, BRT, metro). Instead of chasing and delegitimizing informal transport, we argue the importance of how it contributes to meeting peoples' needs, expanding the urban economy, resolving mobility challenges, and integrating citizens to the city. This research indicates that through the lens of informal transit, the results can contribute to a vital discussion on the practices of people outside of formal planning processes for satisfying their commuting needs and what they do to improve transit and simultaneously integrate transportation with land use. We demonstrate how the neighborhood

unit needs to be accounted for as a socio-spatial unit, as an integral component to how, why and where informal transit companies trace their routes.

The research uses multiple methods starting from an ethnographic perspective to engage and understand the social world of informal transport and its connection to urban land. We created a moving assemblage to carefully pull together specific pieces of data which we have begun to interpret in this paper. Starting from an ethnographic perspective is necessary to explore and understand the organized knowledge behind how informal transit works from the perspective of informal transit drivers. Yet, it was necessary to use multiple methods to understand how informal transit is related to urban land. Our approach was created to pull together neglected components of research, starting from considering the moving configuration comprised of informal drivers, their routes, the companies, the cars, urban land, and the social networks required to make the service work. Multiple methods were used and built on one another to be able to carefully craft each layer of analysis, starting from the neighborhood level as a socio-spatial unit. Subsequently, we studied subjects that are providers and users of informal transit outside formal planning processes. For this, we focused on the invisible logics that sustain informal transit decisions on how companies are formed, where the routes go, and rationalities behind. To do this, it was necessary to rely on quantitative methods to engage in an intercept survey. Overall, the results of the survey of users confirmed information obtained during interviews on why and where companies define their routes along with a better understanding of why urban residents use these services. Results showed that people prefer informal transit for more safety, efficiency and as a service connecting formal routes. Finally, we used GPS technology to conduct a spatial analysis to represent these findings. This spatial analysis captures how we fundamentally believe that informal transit is land oriented because it works alongside (and at sometimes contests) formal transit as well as land use regulation.

Understanding informal transport from a public policy perspective is urgent to link land use and transport policies, including policies toward neighborhood legalization which currently do not consider the provision of transport services. We aim to start a debate about what is happening with this citizen-driven solution to mobility demands. This study is a first step to evaluate what the municipality is doing and what it can do going forward. This implies considering informal transit beyond the discussion of their illegality as the number of companies keep growing. It is imperative to have clear public policies that prevent the formation of new transport mafias, but that at the same time, satisfy the needs of the population by encouraging local economies. Companies are gaining power and influence in the neighborhoods and their power can be such as to limit the entry of formal public transport.

The policy implications that we derive from this study are based on empirical data and are inspired by current public transit principles and trends (McLeod et al. 2017, 226–234). First, evidence suggests that informal transit lines can be integrated with other transport services in the urban mobility system. Informal transit offers unique door-to-door services and meet infrequent transit needs that formal systems do not. Second, a new governance scheme is needed to generate collaboration between actors involving state-recognized institutions, informal transit companies, and urban residents. This scheme supports the role of stakeholders or residents that can broaden the scope of transit services in cities. Third, the findings linking informal transit and land use categories in Quito suggest that urban design interventions should be expanded to integrate

informal transit into dense and less-densely populated areas that have topographic challenges. Fourth, urban planning challenges are not always solved by rational planning approaches and, therefore, substantial collaboration with agencies and urban residents are required to better regulate and reform the transit sector. Reform in this sector means coordination with cooperatives and accepting more flexible mobility patterns. Sixth, public transit networks are not currently part of the regularization of informal settlements, although they should be considered a basic infrastructural service. Overall, informal transit is a sustainable transit option to be considered within equity policies and goals for cities.

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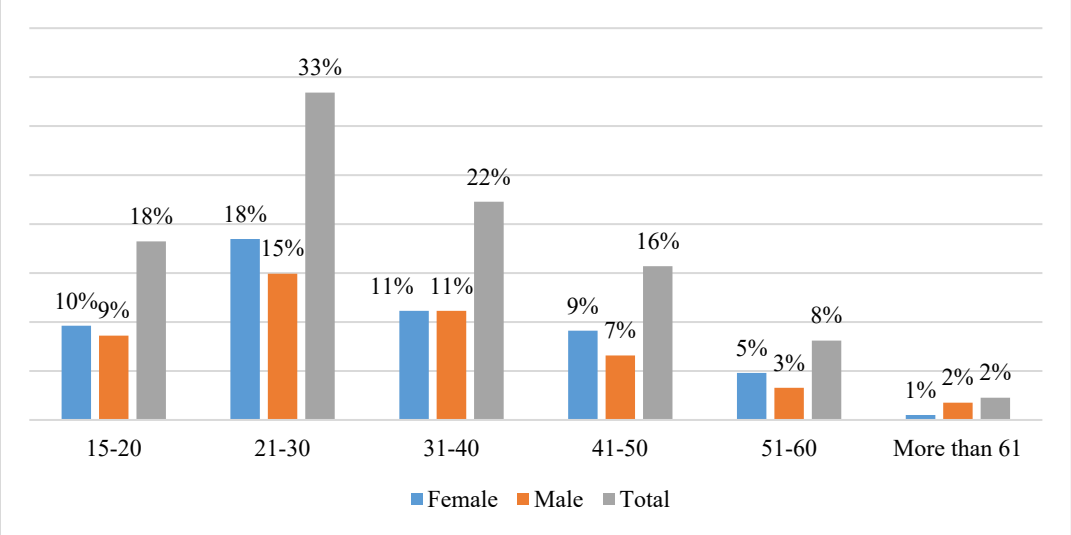
Appendix

a) Survey results

Figure 16: Location of the Surveys Implemented

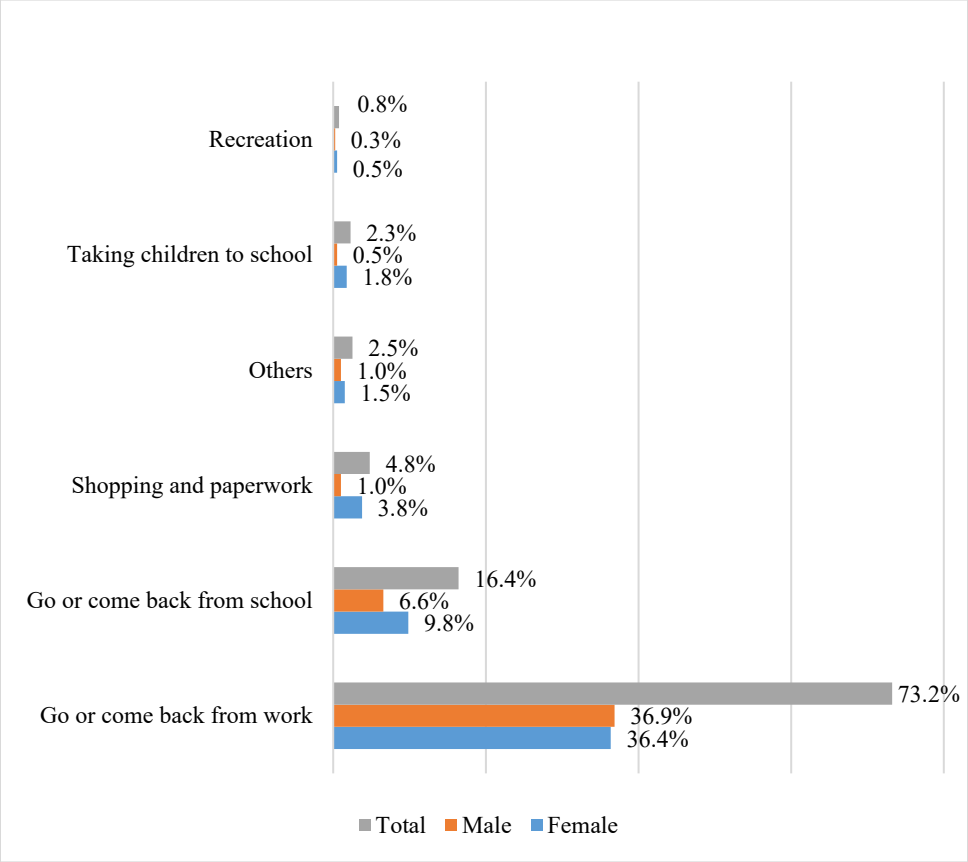
Source: Authors

Figure 17: Gender and Age of the Survey's Respondents



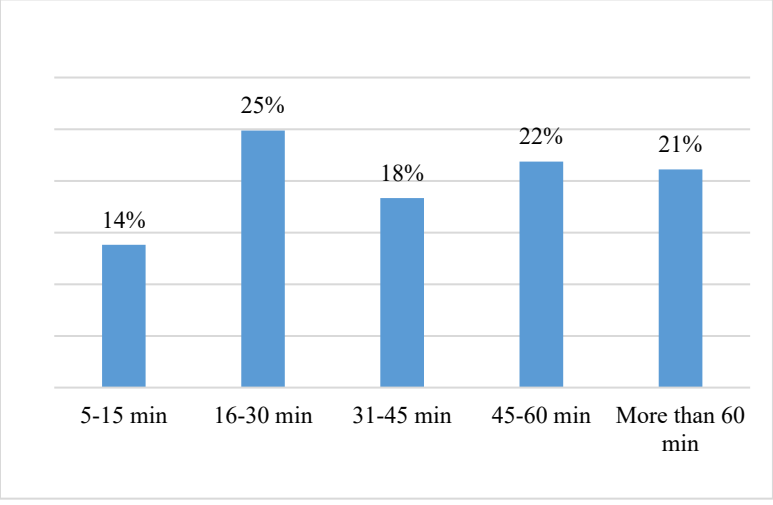
Source: Authors

Figure 18: Main Destination to Travel for the Survey Respondents



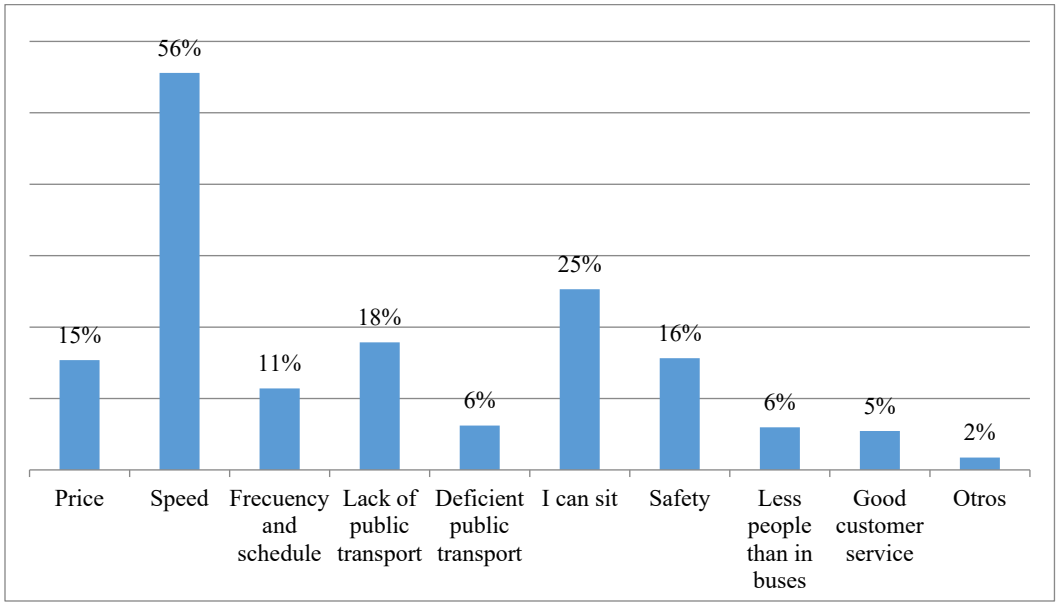
Source: Authors

Figure 19: Travel Time According to the Survey Respondents



Source: Authors

Figure 20: Reasons for Using Informal Transport According to the Survey Respondents



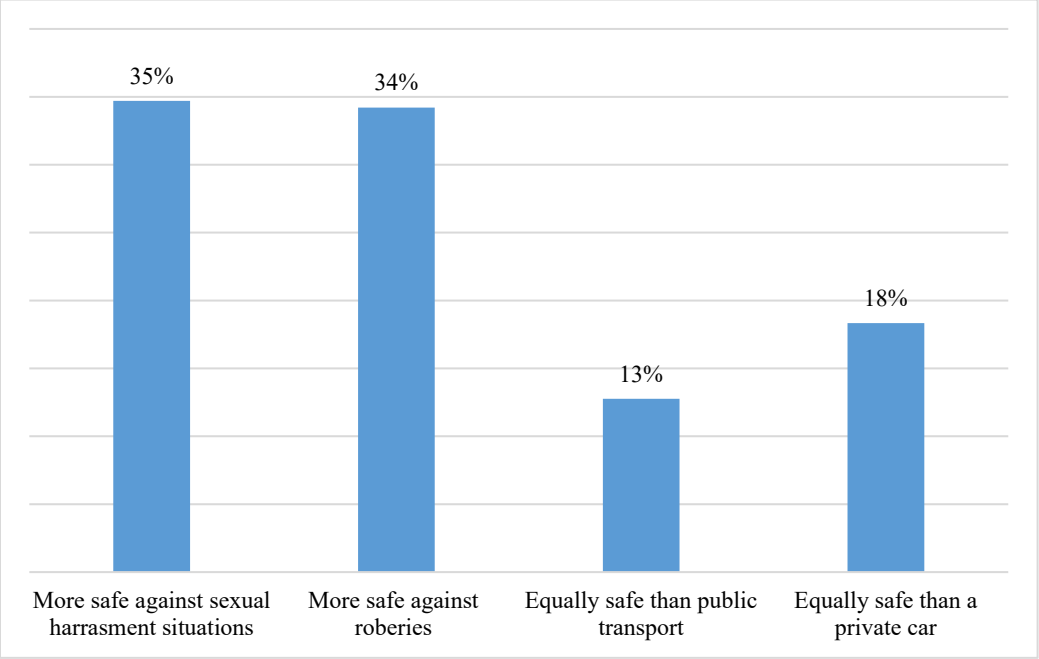
Source: Authors

Table 3: Transport Mode According the Travel Phase

Mode	**Phase 1**	**Phase 2**	**Phase 3**
Informal	52%	32%	19%
Buses	43%	41%	17%
Legal Taxi	2%	2%	3%
Others:	3%	2%	2%
Walking	-	23%	59%
TOTAL	**100%**	**100%**	**100%**

Source: Authors

Figure 21: Safety Perception According to the Survey Respondents



Source: Authors

b) **Survey Instrument**

ENCUESTA TAXIRUTAS EN QUITO: PERSPECTIVA DEL USUARIO

Nombre: _____ **Lugar**: _____
Fecha: _____ **Hora:** _____ **# Encuesta:** _____

Género del encuestado:
☐ Masculino
☐ Femenino

Tipo de transporte:
☐ Taxiruta/taxi compartido
☐ Bus blanco o microbús
☐ Furgoneta/buseta

Presentación*: esta encuesta es parte de un proyecto de investigación de la USFQ, financiado por el Lincoln Institute of Land Policy de EEUU, y tiene como objetivo analizar cómo el transporte informal contribuye a la movilidad de las y los Quiteños. ¿Nos podría ayudar con unos minutos? Esta encuesta es anónima y voluntaria.*

HÁBITOS

1. ¿Cuál es el motivo principal de este viaje?

☐ Ir al trabajo ☐ Ir al lugar de estudio ☐ Dejar a su hijo/a en la escuela/colegio
☐ Diversión/recreación ☐ Compras/trámites ☐ Otro _____

2. **¿Usualmente cómo es su viaje (SOLO IDA) desde que sale de la casa?** *Al movilizarse, los usuarios dependen de una variedad de tipos de transporte para llegar a su destino. Mapear en las 3 columnas, una opción para cada fase del viaje (no se incluye la opción de caminar).*

Ejemplos: Salgo de mi casa y tomo un bus, y luego el taxi ruta para llegar a mi trabajo
Mi papá me lleva en auto hasta la parada de las furgonetas y tomo una para ir a la universidad

Trayecto 1	**Trayecto 2**	**Trayecto 3**
☐ Bus azul	☐ Bus azul	☐ Bus azul
☐ Bus verde	☐ Bus verde	☐ Bus verde
☐ Trole/Ecovía/Metrovía	☐ Trole/Ecovía/Metrovía	☐ Trole/Ecovía/Metrovía
☐ Taxiruta o taxi compartido	☐ Taxiruta o taxi compartido	☐ Taxiruta o taxi compartido
☐ Taxi amarrillo	☐ Taxi amarrillo	☐ Taxi amarrillo
☐ Furgoneta o buseta	☐ Furgoneta o buseta	☐ Furgoneta o buseta
☐ Bus blanco o microbús	☐ Bus blanco o microbús	☐ Bus blanco o microbús
☐ Auto particular	☐ Auto particular	☐ Auto particular
☐ Moto	☐ Moto	☐ Moto
☐ Bicicleta	☐ Bicicleta	☐ Bicicleta

3. ¿Cuántas veces a la semana realiza este viaje? _____

4. **¿Cuánto tiempo dura su viaje (SOLO IDA)?** *No leer opciones, marcar lo que diga la persona*

☐ 5 a 15 min ☐ 16 a 30 min ☐ 31 a 45 ☐ 45 a 60 min ☐ Más de 60 min

OPINIÓN SOBRE LAS TAXIRUTA/BUS BLANCO/FURGONETA

5. **¿Por qué utiliza este tipo de transporte?** *No leer las opciones, marcar lo que diga la persona*
Múltiples respuestas

☐ El precio es bajo
☐ Frecuencia del servicio y horarios
☐ No hay transporte público en mi sector
☐ El transporte público es ineficiente (poca frecuencia, pocos horarios, está saturado)
☐ La atención es buena
☐ Me siento seguro/a
☐ Puedo ir sentada/o
☐ Menor número de personas
☐ Rapidez del viaje

6. **Cree usted que este tipo de transporte es:** *Leer opciones* Múltiples respuestas

☐ Más seguro contra situaciones de acoso
☐ Más seguro contra situaciones de robo o asalto
☐ Igual de seguro que el transporte público (bus, Trole, Ecovía, Metrovía)
☐ Igual de seguro que un auto particular

7. **¿En este tipo de transporte, alguna vez se ha sentido acosada/o?** (roces, miradas incomodas, apegos o toques de un extraño)

☐ Sí ☐ No

8. **En una escala del 1 al 10, califique la calidad del servicio que ofrece el transporte informal (1 mal, 10 excelente)**

1 2 3 4 5 6 7 8 9 10

9. **¿Qué se podría mejorar en este servicio?** *No leer las opciones, marcar lo que diga la persona*
Múltiples respuestas

☐ Atención al usuario
☐ Mantenimiento mecánico el auto
☐ Aseo del auto
☐ Respeto a las leyes de tránsito al conducir
☐ Respecto entre pasajeros
☐ Frecuencia de las unidades
☐ Horario de las unidades
☐ Reducir el precio del pasaje

DATOS SOCIODEMOGRÁFICOS

10. ¿Cuál es su edad?

- ☐ 15-20 años
- ☐ 21-30 años
- ☐ 41-50 años
- ☐ 31-40 años
- ☐ 51-60 años
- ☐ Más de 61 años

11. ¿Cuánto gasta usted en transporte a la semana (promedio)? $_____ dólares

c) **Geoprocessing**

Table 4: Geoprocessing

1) Devices continuously upload to server within the project duration from February 15th to June 30th, 2017.
2) After research period has finished for every of the 18 DEVICES, each devices data-stream was downloaded as a KML file.
3) Each of the files was imported to a geodatabase [P]
4) The GPS streams were segmented into 8674 *SEGMENTS by TrackToTrip (https://pypi.python.org/pypi/tracktotrip).* [N]
5) All 8674 SEGMENTS were buffered by 200 meters. [O]
6) The SEGMENT BUFFERS were cut by the barrio sector [K] and for each, the intersecting polygons from [E] were selected and the fraction of each of the land use classes of [E] within every segment buffer calculated: [S]
7) The SEGMENT BUFFERS were cut by the barrio sector [K] and dissolved into [A].
8) 200m buffers were created from the metro stop theme [] and the bus stop theme [] and dissolved into [D].
9) Population densities were calculated for formal and informal traffic modes for 2001 and 2010: [B1...4].
10) Areas served by informal and formal transport and stratified by land use classes: [F] and [G].

Note: *Numbers in brackets [*] refer to theme IDs in table 5 below.*

Table 5: Quito 2017—Overview—Geodata and Methods

theme ID	table name / shape file name	what	geoprocessing method	Data Source	datatype	# records
A	A_segment_buffer_200_clipped_unioned	Informal segments buffered 200m and then combined to 1 polygon.	Buffer (K, 200m). trimmed by (K)	GEO-PROCESSING	MULTIPOLYGON	1
B1	B1_vivendos_formal_2001	Population densities in 200m catchment areas of formal transport in 2001	Clip(D, L)	GEO-PROCESSING	POLYGON	2751
B2	B2_vivendos_formal_2010	Population densities in 200m catchment areas of formal transport in 2010	Clip(D, M)	GEO-PROCESSING	POLYGON	3631
B3	B3_vivendos_informal_2001	Population densities in 200m catchment areas of informal transport in 2001	Clip(A, L)	GEO-PROCESSING	POLYGON	5012
B4	B4_vivendos_informal_2010	Population densities in 200m catchment areas of informal transport in 2010	Clip(D, L)	GEO-PROCESSING	POLYGON	5012
D	D_formal_transport_dissolved	200 around Bus stops and metro stations.	Buffer (Busstop + metrostation, 200m).dissolved()	GEO-PROCESSING	MULTIPOLYGON	1

E	E_puos_ord_127_2016	Land use classes from 2016	-	PORTAL	POLYGON	6025
F	F_land_use_classes_informal	Land use classes served by informal transport.	Clip(A, E)	GEO-PROCESSING	POLYGON	4005
G	G_land_use_classes_formal	Land use classes served by formal transport.	Clip(D, E)	GEO-PROCESSING	POLYGON	2369
K	K_barrio_sector	sector boundary	Dissolve(E)		POLYGON	1
L	L_den_viv_2001	Population density of 2001	-	PORTAL	POLYGON	4149
M	M_den_viv_2010	Population density of 2010	-	PORTAL	POLYGON	5993
N	N_segment_original	Segments produced by the tracktotrip module. NB: exceeds K (barrio...)	Python	GEO-PROCESSING	POLYLINE	8674
O	O_segments_buffered_200	Buffers		GEO-PROCESSING	POLYGON	8764
P	P_GPS_point	Derived from the KML files		GEO-PROCESSING	POINT	TODO
Q	KML Files	Downloaded from the GPS Service Server		GPS UNITS	FILE	18
S	S_puos_ord_127_2016__uso_actual.xls	Fractions of 19 land use classes (uso_actual) from (E)	O inside K and then INTERSECTION AND INTERSECT by PUOS	GEO-PROCESSING	TABLE	8567

Source: Authors

Table 6: Land Use Regulation Categories

Category	Use Description*
Resid Urbano 1+2	Zones with residential use with limited commercial activity and neighborhood services, public equipment and sectors, some low impact industrial development
Resid Urbano 3	Residential zones that allow for commercial activity, neighborhood sectorial, zonal and metropolitan level of services, and low impact industrial development
Resid Rural 1	Zones with residential use with limited commercial activity and neighborhood services, public equipment and sectors
Resid Rural 2	Zones with residential use with limited commercial activity and neighborhood services, public equipment and sectors, some low impact industrial development
Agricola Resid.	Housing mixed with agricultural use including fishing and hunting, also includes gardening and small-scale agricultural cultivation
Multiple	Diverse uses including diverse residences, facilities, commerce and services, characterized by neighborhood, sectoral city and metropolitan zones, low impact industrial development
Patrimonial	Research, inspection and possible excavations of the various archeological sites and resources in Quito
Industrial	We mixed industry 1–4 as this is not the focus of our study, but industrial development understood as low impact on the environment
Equipamiento	Social services, public services that are categorized differently at scales of neighborhood, sector, zone of the city and metropolitan level
P. Ecol/Conser. Patri. N	Historic Preservation: natural areas including ecosystems, faults and relevant elements and services that are environmentally historic
RN/Prod. Sostenible	Sustainable agro-fishing related activities; sustainable forests
RNNR	Non-renewable resources such as mining
Protec Beaterio	PetroEcuador facilities
Area promocion	Commercial activity
	*For further specification on categories please Ordinance 127: http://www7.quito.gob.ec/mdmq_ordenanzas/Ordenanzas/ORDENANZAS%20MUNICIPALES%202016/ORDM%20-%20127%20%20%20%20%20%20%20%20%20Plan%20Metropolitano%20de%20Desarrollo%20y%20Ordenamiento%20Territorial%20-%20Ref.%20ORDM-041.pdf

Source: DMQ 2012

Table 7: Tabulations of Figures 12 and 13

				Informal transit	Formal transit		
uso_actual	**if_area**	**Area**	**f_are**	**If share**	**F share**	**IF_over rep**	**F_over rep**
Resid Urbano 1+2	0.011034413	0.019238545	0.004440202	57%	23%	49%	20%
Resid Urbano 3	0.003643543	0.004303051	0.002040195	85%	47%	77%	45%
Resid Rural 1	3.91865E-05	0.000274014	7.3363E-06	14%	3%	6%	0%
Resid Rural 2	3.95956E-05	0.000561738	0	7%	0%	-1%	-3%
Agricola Resid.	0.000713778	0.009437533	0.000065172	8%	1%	0%	-2%
Multiple	0.001813655	0.002091818	0.001090401	87%	52%	79%	49%
Patrimonial	2.93347E-05	6.60019E-05	2.4474E-06	44%	4%	36%	1%
Industrial	0.000719454	0.001543671	0.000119652	47%	8%	39%	5%
Equipamiento	0.003069491	0.005678596	0.001113093	54%	20%	46%	17%
P. Ecol/Conser. Patri.	0.004659282	0.186709788	0.000659917	2%	0%	-6%	-2%
RN/Prod. Sostenible	0.001250688	0.10969013	1.61856E-05	1%	0%	-7%	-3%
RNNR	5.14188E-05	0.003724458	0	1%	0%	-7%	-3%
Protec Beaterio	2.09028E-05	2.09028E-05	7.0905E-06	100%	34%	92%	31%
Area promocion	0.000330943	0.00064402	6.29365E-05	51%	10%	43%	7%

Source: Authors

[i] www.optimustracker.com, entering a login active site to view the data as they move.
[ii] See appendix for survey instrument
[iii] For all of section C see appendix for tables and charts on survey results.
[iv] Open data project for the municipality where shape files can be found: http://gobiernoabierto.quito.gob.ec/?page_id=1114
[v] See appendix for table on methods for the geoprocessing of data.